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Work-related musculoskeletal disorders: prevalence, costs and demographics in the EU

European Risk Observatory

Report

European Agency for Safety and Health at Work

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Introduction

Musculoskeletal disorders (MSDs) remain the most common work-related health problem in the European Union (EU). MSDs concern workers in all sectors and occupations. Besides the effects on workers themselves, they lead to high costs to enterprises and society.

In order to support policy-makers, researchers and the occupational safety and health (OSH) community at EU and national levels, the European Agency for Safety and Health at Work (EU-OSHA) has carried out a study that provides an accurate picture of MSDs across Europe. This study pulls together and analyses existing data relating to MSDs from the main EU surveys and administrative data. These data are completed and enriched with data from national sources. The main outcomes of this study are presented in this executive summary[1].

Musculoskeletal disorders (MSDs) are impairments of bodily structures such as muscles, joints, tendons, ligaments, nerves, cartilage, bones and the localised blood circulation system. If MSDs are caused or aggravated primarily by work and by the effects of the immediate environment in which work is carried out, they are known as **work-related MSDs**.

Policy context

The challenge of work-related MSDs has been recognised and addressed at the European level by the adoption of a number of EU directives, strategies and policies. EU Community strategies since 2002 have called MSD prevention a priority area to improve workers' health and well-being.

The Strategic Framework on Health and Safety at Work 2014-2020[2] defines MSDs as one of the main challenges to address. It recommends that 'specific attention should be given to addressing the impact of changes in work organisation in terms of physical and mental health. In particular, women can face specific risks, such as musculoskeletal disorders (…) as a result of the nature of some jobs where they are over represented.' It also underlines the need to improve 'prevention of work-related diseases by tackling existing, new and emerging risks'.

The Communication from the Commission on Safer and Healthier Work for All — Modernisation of the EU Occupational Safety and Health Legislation and Policy[3] (from 2017) underlines the fact that 'Exposure to ergonomic risks factors represents one of the major occupational safety and health problems in the EU today. Repeated exposure to these risks can result in work-related musculoskeletal disorders — one of the most serious and widespread work-related illnesses, which give rise to major cost burden for individuals, businesses and society in general.'

Preventing workers from suffering MSDs and promoting workers' musculoskeletal health throughout their working life, from their first job onwards, are key to allowing them to work for longer. This therefore contributes to addressing the long-term effects of demographic ageing, in line with the Europe 2020 strategy's objectives for smart, sustainable and inclusive growth. MSDs are therefore not only an occupational health challenge, but also a public health challenge, a demographic challenge and a social

[1] The full report and the national reports, including a synthesis report, are available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

[2] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'An EU Strategic Framework on Health and Safety at Work 2014-2020', COM(2014) 332 final, p.5 and p.6. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2014:332:FIN

[3] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'Safer and Healthier Work for All — Modernisation of the EU Occupational Safety and Health Legislation and Policy', COM(2017) 12 final, p.9. Available at https://ec.europa.eu/social/BlobServlet?docId=16874&langId=en

challenge. They are also a European challenge, and addressing it means developing working conditions that are sustainable over the working lives of European workers.

This summary starts by providing an overview of the main findings of the study, after which several policy pointers and key messages are presented.

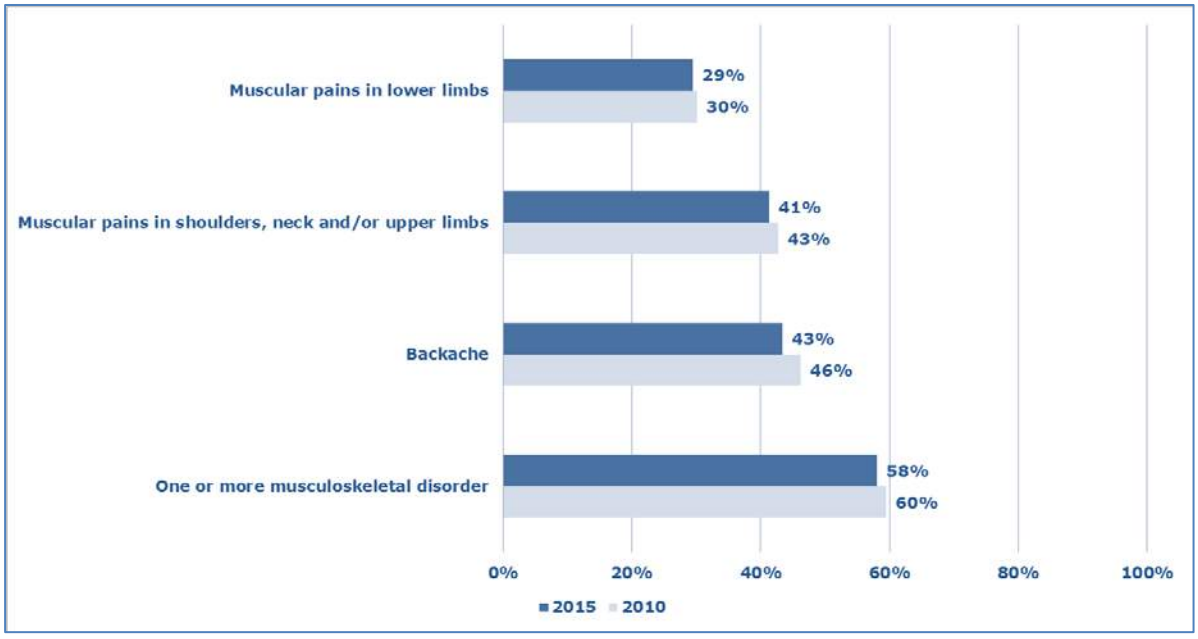
MSDs can be caused by many different (combinations of) factors. These include not only physical factors (whereby mechanical load applied to the musculoskeletal tissues can cause MSDs), but also organisational and psychosocial ones. The extent to which these risk factors occur and affect the musculoskeletal health of workers is related to various contextual dimensions, including the social, political and economic environment, the organisation of the workplace, and also sociodemographic and individual factors.

Main findings

MSDs are the most prevalent work-related health problem

- Roughly three out of every five workers in the EU-28 report MSD complaints. The most common types of MSDs reported by workers are backache and muscular pains in the upper limbs. As can be seen in Figure 1, muscular pains in the lower limbs are reported less often.
- Of all workers in the EU with a work-related health problem, 60 % identify MSDs as their most serious issue, as can be seen in Figure 2.
- One out of five people in the EU-28 suffered from a chronic back or neck disorder in the past year.
- The proportion of workers in the EU-28 reporting MSD complaints decreased slightly between 2010 and 2015.

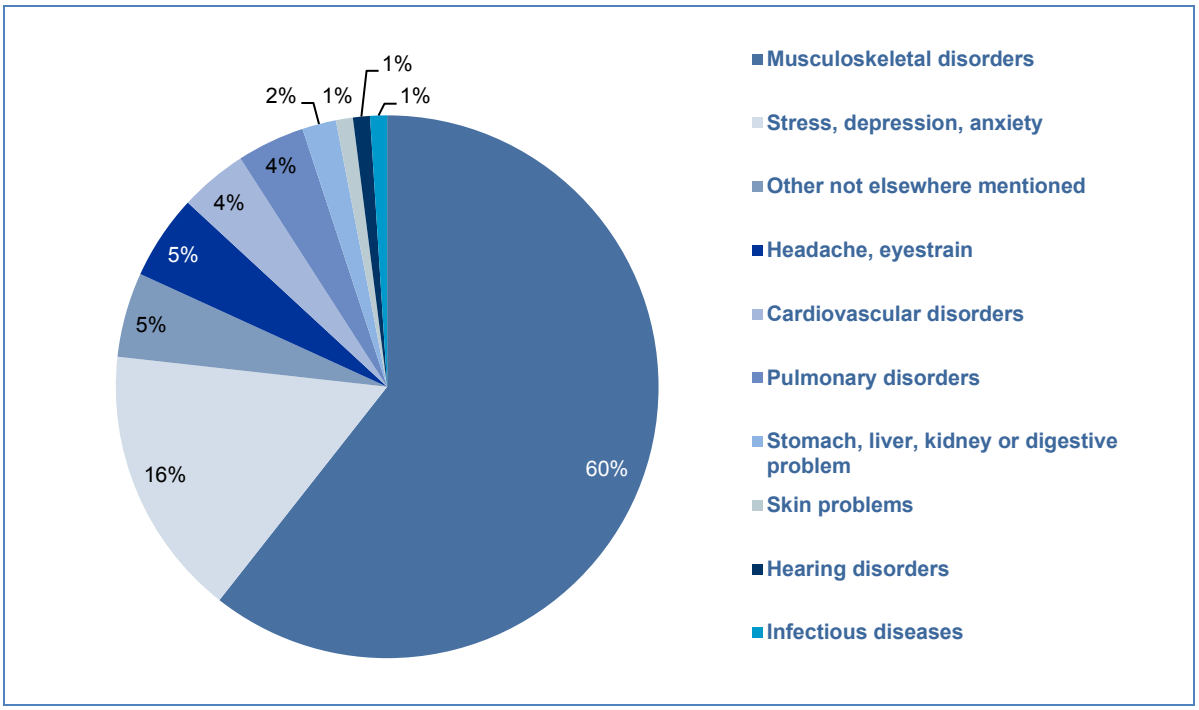
Figure 1: Percentage of workers reporting different musculoskeletal disorders in the past 12 months, EU-28, 2010 and 2015



N = 33,173 (2010); *N* = 31,612 (2015)

Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

Figure 2: Percentage of workers reporting a work-related health problem, by type of problem, EU-27, 2013



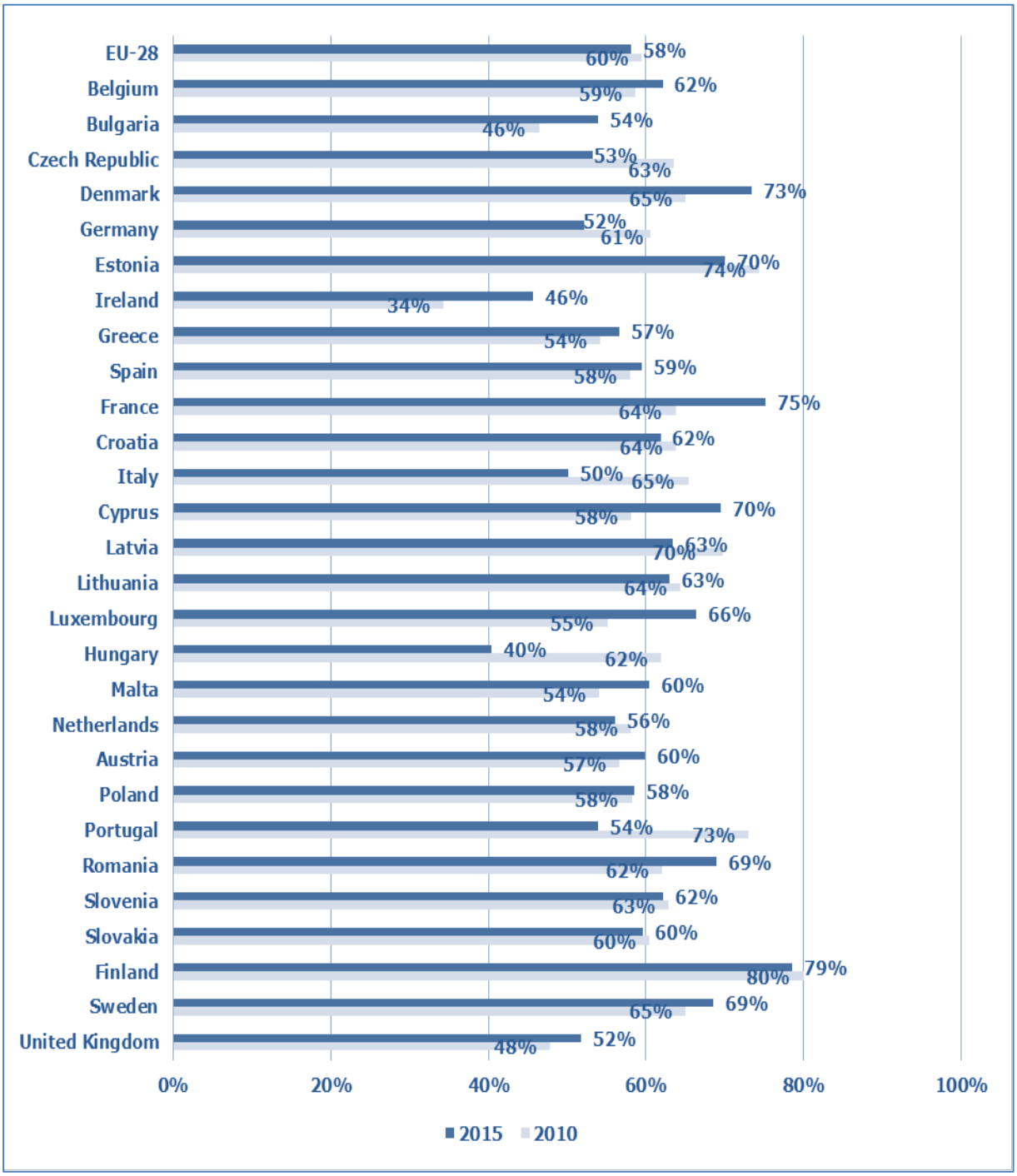
Note: The population of workers includes everybody aged 15 to 64 who was working or had worked during the past 12 months before the survey took place.

Source: Eurostat, Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013). All EU Member States participated in this ad hoc module except for the Netherlands.

Prevalence of MSDs varies between Member States, sectors and occupations

- The proportions of workers reporting MSD complaints vary considerably between Member States (Figure 3).
- The prevalence of self-reported MSDs shows significant differences between sectors. MSDs in the back, upper limbs and lower limbs are most often mentioned by workers employed in the following sectors: construction, water supply, and agriculture, forestry and fishing. MSD prevalence is also above average among workers in human health and social work activities. The sectors where MSDs are reported least often are financial and insurance activities, professional, scientific and technical activities, education, and arts, entertainment and recreation.
- The prevalence of self-reported MSDs shows significant differences between occupations (Figure 4). In 2015, approximately 69 % of skilled agricultural, forestry and fishery workers reported having one or more MSDs, whereas for professionals this was the case for 52 % of workers.

Figure 3: Percentage of workers reporting that they suffered from one or more musculoskeletal disorders in the past 12 months, by Member State, 2010 and 2015

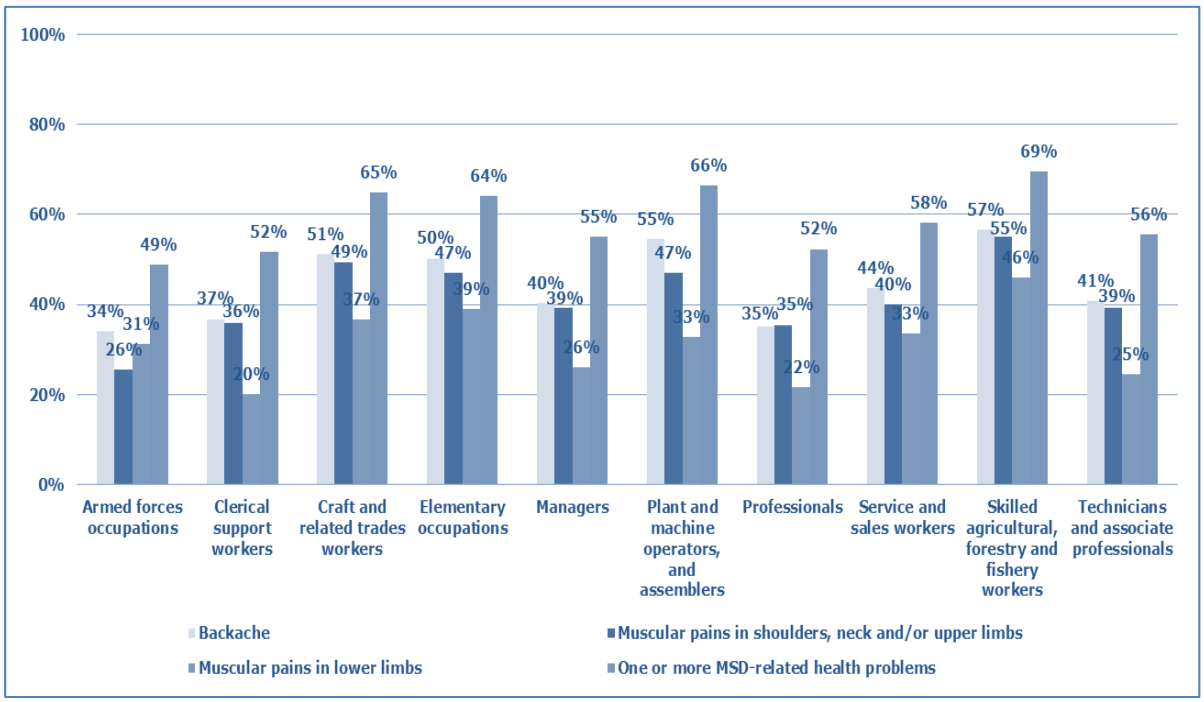


Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

N = 33,173 (2010); *N* = 31,612 (2015)

Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

Figure 4: Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by International Standard Classification of Occupations 2008 (ISCO-08), EU-28, 2015



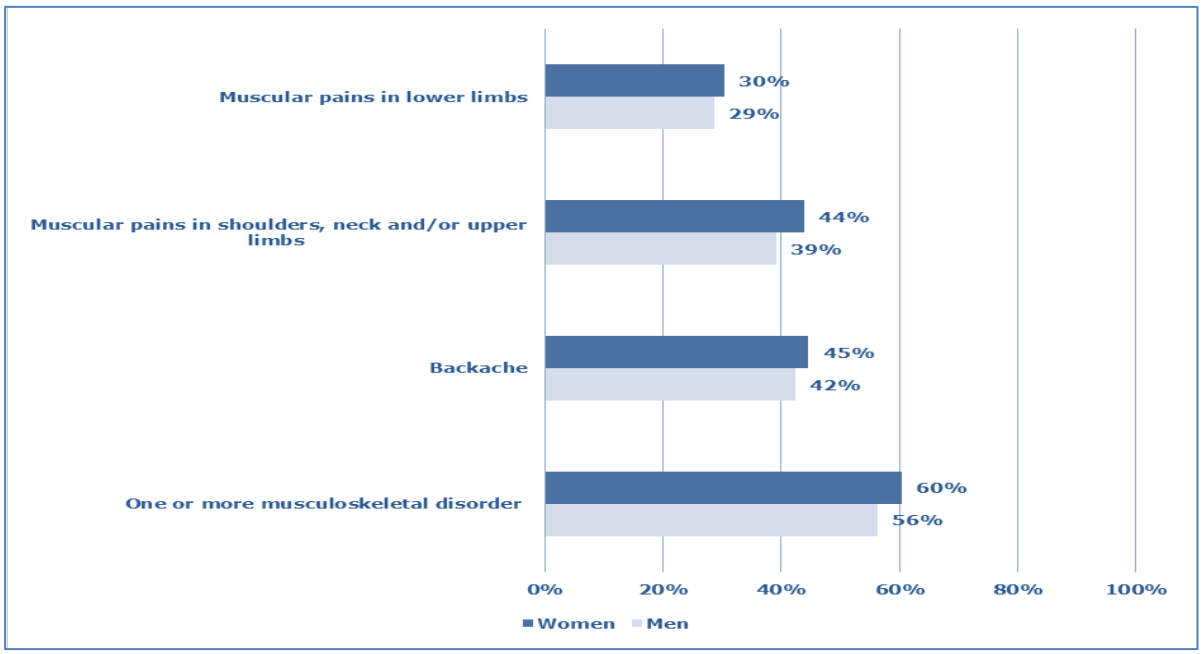
N = 35,536

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Prevalence of MSDs also varies with sociodemographic factors

- The prevalence rates of MSDs are higher for female workers than for male workers. This applies to all types of MSDs, as can be seen in Figure 5.
- The likelihood of reporting MSDs increases significantly with age. The difference between age groups applies to all types of MSDs in Figure 6.
- Workers with only pre-primary or primary education are more likely to report muscular pains in the upper limbs, lower limbs and/or back, and are also more likely to report chronic MSDs.

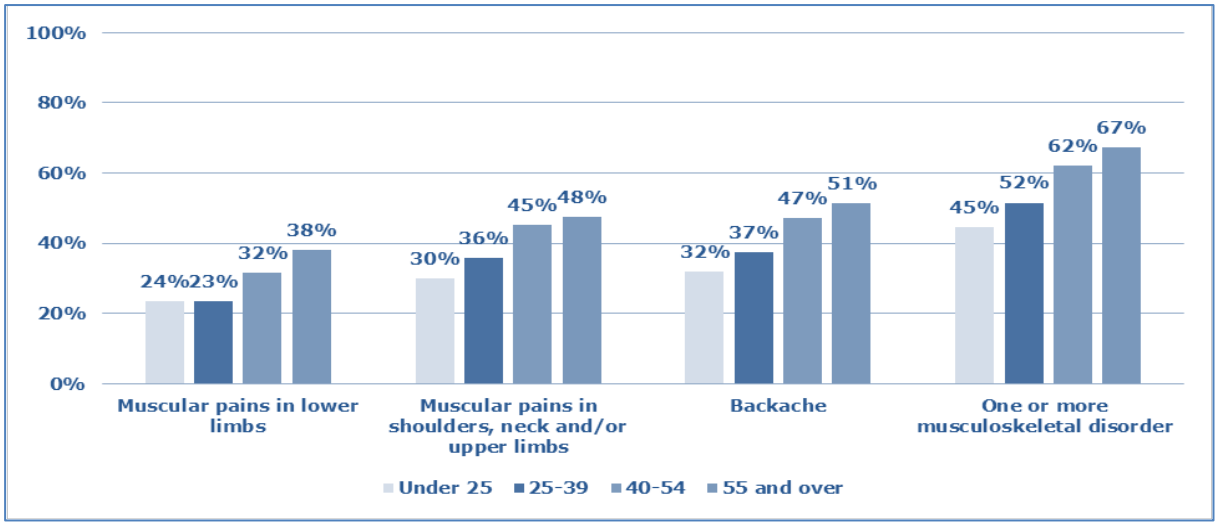
Figure 5: Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by gender, EU-28, 2015



N = 31,612

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 6: Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by age group, EU-28, 2015



N = 31,612

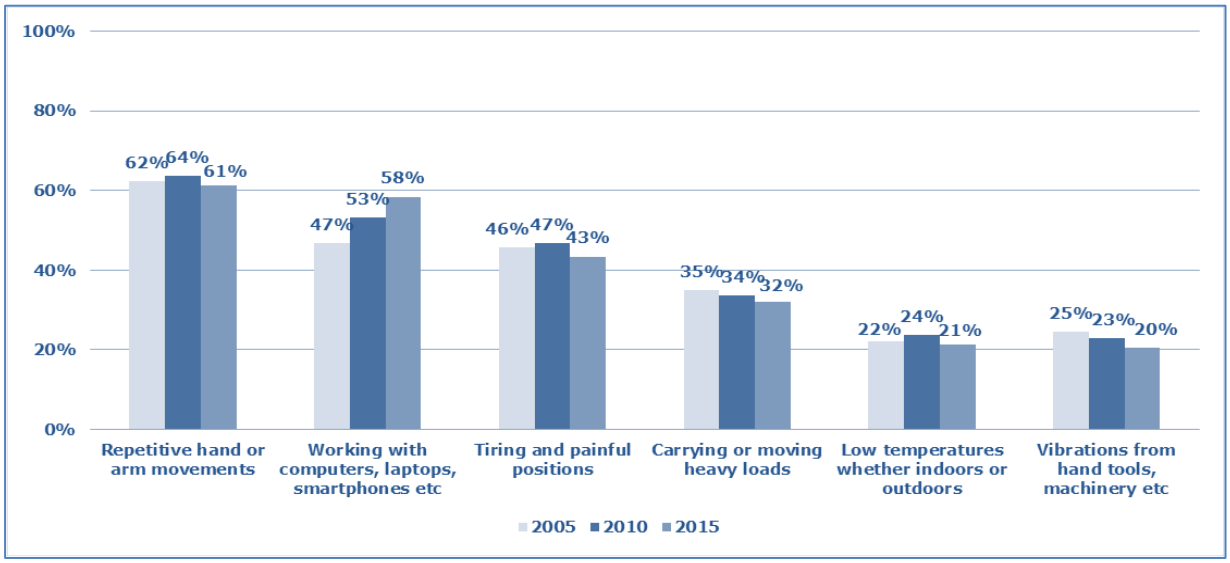
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Exposure to MSD risk factors

For this study, the contribution of physical, organisational, psychosocial and sociodemographic risk factors has been analysed in detail using available EU-wide data sources. The main findings regarding the relationship between different risk factors and MSD complaints are summarised below:

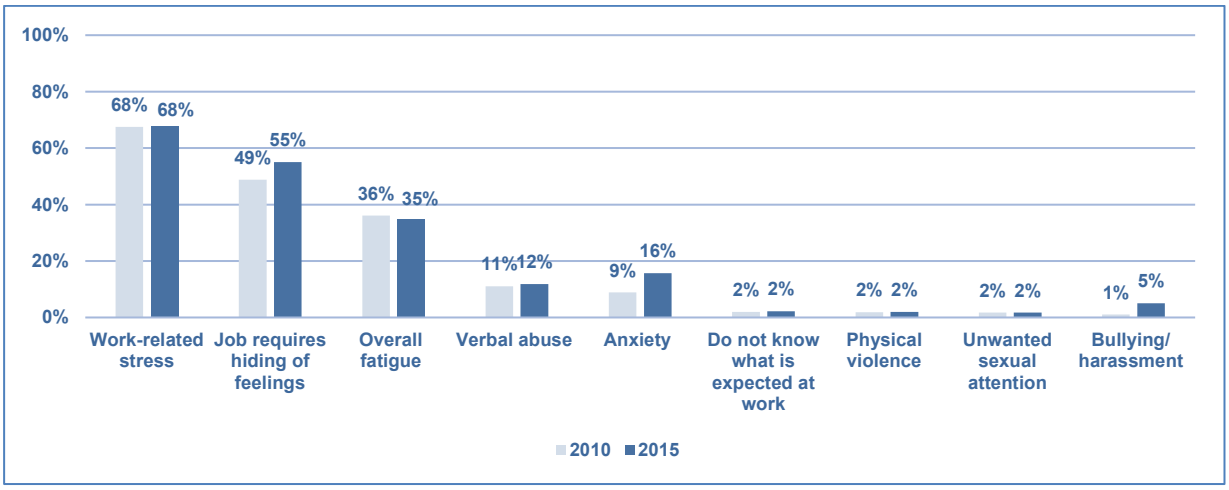
- Various studies find that the following physical risk factors are related to MSDs (in the back, upper limbs and/or lower limbs): posture and working in awkward positions (such as working in tiring and painful positions), heavy physical work, lifting, repetitive work, being exposed to vibrations from hand tools and being exposed to low temperatures. The prevalence of these risk factors among the working population shows considerable variation (Figure 7).
- Previous research indicates that self-reported time spent sitting is positively related to chronic diseases and mortality. Analysis of European Working Conditions Survey (EWCS) data carried out for the current study cannot confirm that sitting increases the risk of different types of MSDs. Further research is needed to determine whether this is due to measurement problems or because prolonged sitting does not in itself increase the risk of developing MSD complaints.
- A total of 21 different organisational and psychosocial risk factors are significantly related to at least one of the three types of MSDs considered (backache, MSDs in upper limbs, MSDs in lower limbs). Many of these risk factors are related to only one of these MSD types. This confirms the idea that each type of MSDs has its own specific risk factors. The exploratory analyses conducted for the current study should be followed by further analyses in order to better explore the nature of the interrelationships between MSDs and these psychosocial and organisational risk factors in statistical terms.
- Nine organisational and psychosocial risk factors were found to be significantly related to at least two of the three MSD types considered: anxiety, overall fatigue, sleeping problems, low level of mental well-being, being subjected to verbal abuse at work (each related to three types of MSDs), being subjected to unwanted sexual attention at work, feeling energised, having enough time to get the job done and knowing what is expected at work. As can be seen in Figure 8., the prevalence of some of these risk factors is high, while other risk factors are not often mentioned.

Figure 7: Percentage of workers reporting that they are exposed to different physical risk factors at their work at least a quarter of the time, EU-28, 2005, 2010 and 2015



Note: Data concern workers who work at least 12 hours per week.
Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

Figure 8: Percentage of workers reporting different organisational and psychosocial risks, EU-28, 2010 and 2015

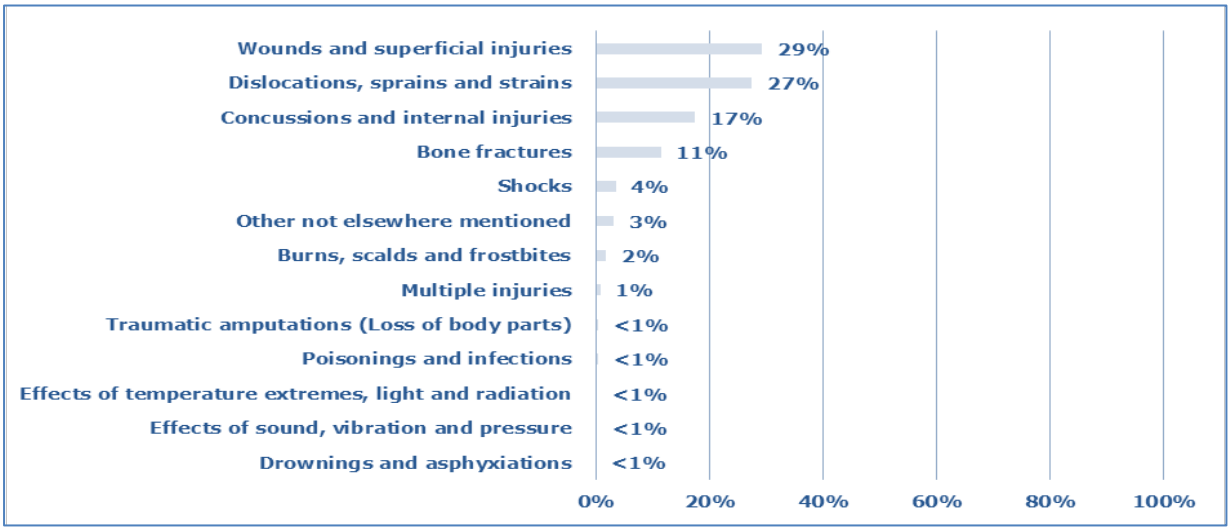


Note: Trend for anxiety is modified (in 2010 the question included the word 'depression'; in 2015 this word was removed).
Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

MSD-related accidents

- Several types of injuries may be interpreted as acute MSDs, for instance dislocations, sprains and strains and bone fractures.
- These types of accidents accounted for 38 % of all reported fatal and non-fatal serious accidents at work. In particular, dislocation, sprains and strains are the second most common group of work-related injuries in the EU-28 (after wounds and superficial injuries), accounting for 27 % of all fatal and non-fatal work-related injuries. Bone fractures are lower, at 11 %, (Figure 9).
- In some countries accident figures address acute episodes of musculoskeletal problems, for instance those occurring after lifting of heavy loads. Where this is the case, the proportion of these accidents are among the most (or the most) common work-related accidents.

Figure 9: Distribution of fatal and non-fatal accidents at work by type of injury, EU-28, 2016



Note: Non-fatal (serious) accidents reported in the framework of European Statistics on Accidents at Work (ESAW) are accidents that imply at least four full calendar days of absence from work. Provisional.

N = 3,288,581

Source: Eurostat, European Statistics on Accidents at Work (ESAW).

MSDs are the most common recognised occupational diseases in some Member States

- National compensation and reporting systems used to register occupational diseases show considerable institutional differences.
- The lists of recognised diseases and recognition practices vary considerably between Member States.
- The pattern and distribution of occupational diseases currently recognised and compensated is far from reflecting the actual health impairment of workers through MSDs caused by their work.
- Data collected at national level show that MSDs are the most common recognised occupational diseases in France, Italy and Spain.
- There is a higher proportion of women than men and a higher proportion of older workers than younger ones among the total cases of recognised MSD-related occupational diseases (based on the data gathered at Member State level and despite differences between countries).

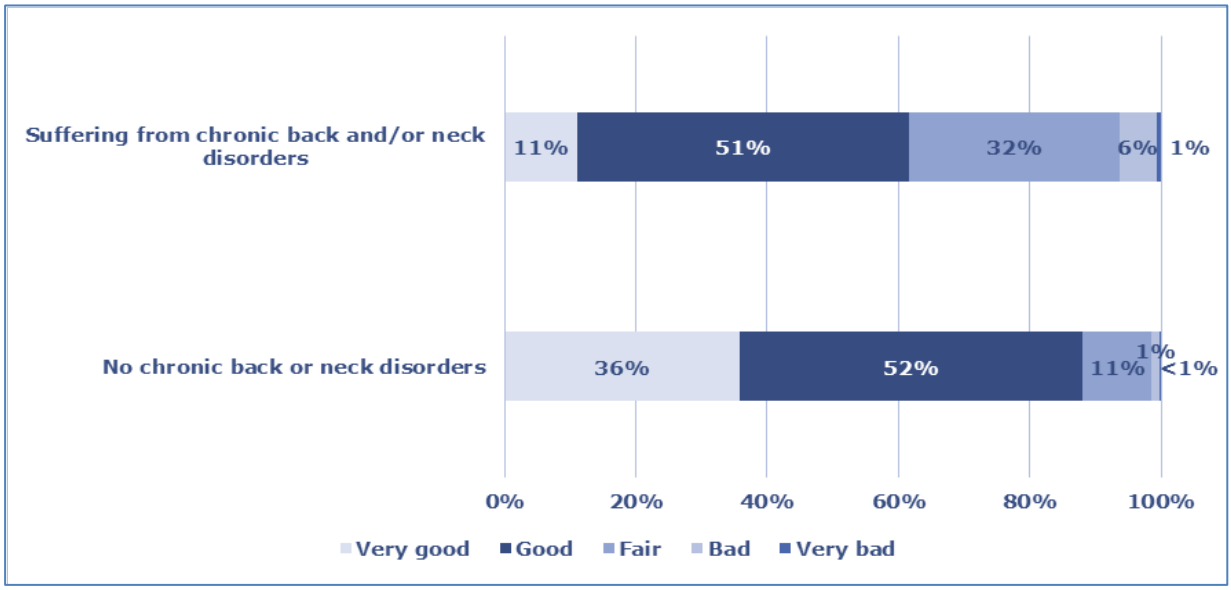
Impact of MSDs

MSDs are a major cause of concern: first of all because they affect the general health situation of so many workers, and secondly because of the economic impacts on enterprises and the financial and social costs to European countries.

The main findings regarding the general health situation of EU workers are:

- The large majority of workers with MSD complaints report a good or very good health condition. This indicates that self-reported MSD complaints include not only severe cases of MSDs but also less severe ones. This also applies to chronic MSDs in the back and/or neck (see Figure 10), although to a lesser extent.
- MSDs, on the one hand, and stress, depression and anxiety (mental health problems), on the other, are the two most common work-related health problems faced by EU workers (see Figure 2).
- The prevalence of MSDs is associated with higher levels of anxiety, sleeping problems and overall fatigue of workers. MSD prevalence is also related to the mental well-being of workers (MSDs are more prevalent among workers with lower levels of mental well-being). These relationships apply to MSDs in the upper limbs, lower limbs and back.
- Workers can suffer from anxiety, overall fatigue, sleeping problems and (lack of) mental well-being alongside MSD problems. In some cases, MSDs may even cause these health problems, or make them worse. The causality could, however, also run the other way: high levels of anxiety, overall fatigue and sleeping problems may cause MSD complaints or worsen already existing MSD complaints.

Figure 10 Percentage of workers reporting that their general health is very good, good, fair, bad or very bad, by presence or absence of chronic back or neck disorders in the past 12 months, EU-28, 2014



Note: The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 127,338

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

The true extent of the costs and burdens associated with MSDs is difficult to assess and compare at EU level. Different indicators that are used to shed some light on the costs and burdens include disability-adjusted life years (DALYs), absenteeism, and production and productivity losses for enterprises.

- DALYs are calculated as the number of years lost as a result of ill-health, disability or early death, and reflect the effect of diseases on the general population in terms of both quality of life and death. MSDs add up to a total of 15 % of the total number of (disability-adjusted) life years lost because of work-related injuries and illness.
- Absence from work due to MSDs accounts for a high proportion of working days lost in EU Member States. In 2015, more than half (53 %) of the workers with MSDs (including those with other health problems) reported being absent from work during the past year, which is considerably higher than the proportion of workers without health problems (32 %). Workers with MSDs are not only more likely to be absent from work, but (given absence) on average are also absent for a longer period of time. For example, 26 % of workers with chronic MSDs and other health problems report being absent for more than eight days during the past year, which is considerably higher than the 7 % for workers with no health problems.
- At the level of individual Member States, some studies have been identified that show the impact of MSDs in economic terms (loss of productivity and higher social expenses). In Germany for example, musculoskeletal and connective tissue disorders accounted for EUR 17.2 billion (EUR 17,200 million) of production loss (production loss costs based on labour costs) in 2016 and EUR 30.4 billion in loss of gross value added (loss of labour productivity). This represents 0.5 % and 1.0 % of Germany's gross domestic product (GDP), respectively.

MSD prevention

The European Survey of Enterprises on New and Emerging Risks[4] (ESENER) provides some insight on the prevention of work-related MSDs currently provided by employers:

- Most employees work in establishments where one or several preventive measures are in place, including provision of ergonomic equipment, encouraging regular breaks for people in uncomfortable working positions, and rotation of tasks to reduce repetitive movements. These measures are provided by establishments in all sectors and of all sizes. The establishment's size class has, however, a clear effect: the availability of preventive measures increases by establishment size.
- There are considerable differences between EU-28 Member States regarding the proportion of establishments that have policies to support employees to return to work after a long-term sickness absence. Large percentages of employees in the United Kingdom (97 %), Sweden (95 %), Finland (93 %) and the Netherlands (92 %) work in enterprises where support is provided to employees to help them to return to work after a long-term sickness. In Lithuania (19 %) and Estonia (27 %), the percentages are significantly lower than the EU-28 average (73 %).
- Investing in preventive measures is especially rewarding, since they prove to be effective. Workers in countries and sectors where more preventive measures are in place are less likely to report MSD complaints. The percentage of workers reporting backaches drops from 51 % (for workers in countries and sectors where on average one to three preventive measures are in place) to 31 % (for workers in countries and sectors where on average five or six preventive measures are in place). The prevalence of MSDs in lower limbs shows a comparable development.

Policy pointers

Based on the findings from this study, this section presents several pointers for policy actions in prevention.

An integrated and combined MSD prevention approach is needed

- Different groups of factors may contribute to MSDs, including physical, organisational, psychosocial, sociodemographic and individual factors. Most of the time, these factors interact with each other. Because of these multiple causes, the best way to tackle MSDs is through a combined approach.
- Research has shown that interventions based on single measures appear to be less effective at preventing MSDs. Actions addressing one risk factor in isolation will probably be less effective than a combination of actions targeting several factors. These types of interventions are often described as 'holistic' or 'integrated'.
- An integrated approach to prevention seems the most promising strategy. This strategy must start by identifying MSD risks. Policy-makers should focus on providing practical risk assessment tools and guides, which can be quite simple, consisting of items that connect the several MSD risk factors mentioned in this report.
- The availability of preventive measures increases with establishment size. This indicates that micro and small enterprises need further policy attention. Practical guides and risk assessment tools should be targeted to meet the specific needs and challenges faced by smaller enterprises and establishments (when it comes to the prevention of MSDs on their premises).

[4] ESENER covers employees in enterprises employing five or more workers.

- A successful and integrated approach can be especially fruitful when set up as a participatory approach including the workers themselves.
- The promotion and dissemination of these more integrated and participatory approaches would require actions in terms of increased awareness and in terms of knowledge transfer regarding MSDs (their causes, their impact and their preventive measures). The Healthy Workplaces Campaign (HWC) 2020-22 on the theme of 'Prevention of work-related musculoskeletal disorders (MSDs)' (and/or equivalent campaigns) should be an opportunity for this.
- Upper limb MSDs, lower limb MSDs and back MSDs are all examples of MSDs. However, the way they arise, the degree of risk, the type of health impact and the type of measures required to prevent them differ. When developing interventions and policies, this should be taken into account. In practice, this means that targeted interventions are needed for each type of MSDs.
- Bearing in mind the multifactorial nature of MSDs, a focus on work-related MSD prevention should be integrated with and complemented by an occupational health promotion approach focusing on the promotion of good musculoskeletal health at the workplace (also from a more public health point of view).

Exposure to MSD risk factors

- Workers are usually exposed to a combination of MSD risk factors. For instance, a cluster analysis performed in this study on physical risk factors shows that certain combinations of risk factors occur more often than others. These kinds of findings could have relevant implications for MSD prevention. Future studies should further examine these specific combinations of risk factors (and also health problems) related to MSDs. For instance, an area of further research could be to what extent these different risk factors (or health problems) reinforce each other, and how this reinforcing effect could be inhibited.
- Regardless of the specific nature of the relationship between sitting, computer work and MSDs, sedentary behaviour at work can be hazardous for health (cardiovascular pathologies, cancer, diabetes, etc.) and this occupational risk needs to be prevented, especially in a context in which sitting at the workplace is increasing.
- Very often, when organisational and psychosocial risks are assessed at the workplace level, this is done in isolation, focusing purely on the mental health consequences of 'stress' without considering their impact on other risks or other health problems, such as musculoskeletal pain. As workers are exposed to several MSD risk factors at the same time, one dimensional risk-outcome approaches (based on the relation between a single risk factor and a single outcome measure), should be avoided as part of the risk assessment process, opting instead for more holistic approaches. The challenge is to transfer the existing knowledge into workplaces in order to bridge the silos of MSD risk assessment and psychosocial risk assessment. Guidance and risk management tools that integrate these dimensions should be put at the disposal of employers and workers at the workplace.
- Psychosocial risk factors such as stress, anxiety, sleeping problems and mental well-being may play a role in the onset of MSDs. However, research suggests that they play an especially important role in the progress of the chronicity of MSDs, from acute (reversible problems) to chronic. This means that psychosocial risk factors have to be taken into account when assessing and preventing MSD risks (primary prevention), but above all when the first symptoms of musculoskeletal pain appear.
- By improving the way work is organised and the social climate, enterprises also contribute to MSD prevention. It is important to increase awareness at the workplace level about this interrelationship and to encourage actors in the field to consider the prevention of MSDs when introducing changes in work organisation or when preventing exposure to psychosocial risks.

Prevalence of MSDs varies between countries, sectors and occupations, and along sociodemographic dimensions

- The prevalence of MSDs shows wide variations, across different levels (national, sectoral, organisational and individual). This calls for additional research to better understand these differences.
- National differences in proportions of workers reporting MSD complaints indicate that policies and strategies to prevent MSDs must be tailored and adapted to the specific national circumstances of a country.
- Given the differences in prevalence, type and severity of MSDs between sectors, it also appears logical to design sector-specific approaches to addressing MSDs. Such approaches would include the introduction of specific sectoral standards, risk assessment tools and sector-specific MSD risks catalogues (including preventive and protective measures adapted to the specific MSD risks of the sector).
- The differentiation of the prevalence of MSDs by gender, age and level of education underlines that there is a need for diversity-sensitive approaches/risk assessments to better prevent and manage MSDs. Prevention of MSDs should ideally follow an inclusive and differentiated approach that adapts to an increasingly diverse working population. Such a comprehensive approach will most likely include actions to increase awareness of the need for these approaches to tackle MSDs, and to develop specific guidance and practical tools that address this issue in order to support and guide employers and workers at the workplace. The development of policies and schemes supporting such initiatives is highly recommended.
- Three age-related developments reinforce each other: increasing MSD risk with age, ageing of the population and higher retirement age. This indicates that specific measures are necessary. Preventing exposure to risk factors that contribute to work-related MSDs is important for the sustainability of work. In the context of the ageing workforce, OSH strategies should therefore pay particular attention to the cumulative exposure of workers to physical and psychological hazards, as this affects the sustainable employability of all workers.

Impact of MSDs

- Absenteeism among workers with MSD complaints is higher than among workers without health problems. This stresses the importance of actions aimed at primary prevention. However, once sickness or absenteeism occurs, measures focusing on rehabilitation and return to work are also important in avoiding or minimising sickness absence leading to disability and/or occupational diseases.
- This also stresses the importance of early interventions. Early intervention to minimise disability and restore health can lead to tangible savings in health, social welfare and reduced absenteeism. A large percentage of MSDs are short-term (or acute), so workers could recover by taking simple measures as soon as the first symptoms appear. The sooner an MSD is managed, the less likely it is to become a chronic condition leading to long-term work absence.
- OSH has an important role to support workers with chronic MSDs to continue in work and ensure that work does not make those painful conditions worse. A driver for developing rehabilitation and return to work systems is the cost of sickness absence and of disability benefit schemes, as these are a major burden on social security systems.

Key messages

- More than half of the EU workforce reports MSD complaints, and the impact of MSDs should not be underestimated.
- The challenge of work-related MSDs has been recognised and addressed at the European level, but extra efforts are needed in terms of prevention.

- New trends and changes (of very different nature) have or may have an impact (positive or negative) on the exposure of EU workers to MSD risk factors: the ageing population and workforce, growing employment in the services sector, the new business models and forms of employment, new forms of organisation of work, digitalisation, sedentary work, etc. MSD prevention will need to adapt to face these new trends and changes.
- Efforts to prevent MSDs at enterprise level must be supported by changes/efforts at political, social and economic levels (regulatory dimensions, health policies, market conditions, organisation of the economic sectors, etc.) to foster the development of more sustainable and healthy workplaces.
- Traditionally, MSD prevention has focused on the prevention of physical/biomechanical risk factors. Research has found that organisational and psychosocial risk factors also need to be considered in MSD prevention. The challenge now is to transfer this knowledge into the workplaces (through campaigns, practical tools, guidance, etc.).
- Prevention of MSDs should ideally follow an inclusive and differentiated approach that adapts to an increasingly diverse working population.
- Bearing in mind the multifactorial nature of MSDs, work-related MSD prevention should be integrated with and complemented by an occupational health promotion approach focusing on the promotion of good musculoskeletal health at work.
- Statistics show that MSDs and mental health problems (stress, depression and anxiety) are among the most important OSH health problems in Europe. This report (confirming other studies/research findings) shows that the two types of health problems can be or are often connected or associated (even if the nature of these interrelationships cannot be explained, at least in statistical terms). This has important implications in terms of prevention. More combined approaches to deal with these two types of health problems need to be promoted.

1 Introduction

1.1 Background

Musculoskeletal disorders (MSDs) remain the most common work-related health problem in the EU, and workers in all sectors and occupations are concerned. Besides the effects on workers themselves, MSDs lead to high costs to enterprises and society as a whole.

It is in this context that EU-OSHA started in 2017 a 4-year research activity on work-related MSDs. The specific objectives of this activity are the following:

- Encourage more and better-targeted policy instruments at EU and national levels by providing a better picture of the prevalence and costs of MSDs in Europe.
- Contribute to improving the prevention of MSDs, as well as the management of chronic MSDs, in European workplaces by raising awareness and by identifying and disseminating good practice among national authorities, employers and sector-level organisations in particular.
- Stimulate and support measures at national level among policy-makers and OSH intermediaries designed to improve preventive action at the workplace through the identification and sharing of successful initiatives.
- Promote greater success in the sustainable reintegration of workers with MSDs by identifying successful schemes and workplace measures.
- Identify research priorities and improve understanding of underlying causes of MSDs through a targeted analysis of research and data.

In the context of this research activity, several studies are being carried out:

- review of research, policy and practice on prevention of work-related MSDs;
- working with chronic MSDs;
- diversity in the workforce and MSDs;
- MSDs associated with prolonged static postures (sitting/standing) and lower limb disorders;
- participatory ergonomics to prevent MSDs;
- psychosocial risk factors and MSDs.

The research tasks include literature reviews, collecting and analysing data, case studies, and identifying best practices, practical tools and training and awareness-raising materials[5].

This project is also being carried out within the context of the forthcoming Healthy Workplaces Campaign (HWC) 2020-22 on the theme of 'Prevention of work-related musculoskeletal disorders (MSDs)'.

1.2 Objectives of the project

In order to support policy-makers at EU and national levels, it is necessary to provide an accurate picture of MSDs across Europe, pulling together existing data from a number of relevant and reliable official statistical sources.

The aims of this project are:

- to provide quantitative information on the prevalence and costs of MSDs;
- to improve understanding of underlying causes of MSDs through targeted analysis of data;
- to contribute to the earlier identification of emerging trends and risks at work with the aim of enabling more timely and effective interventions.

The data presented in this report are based on descriptive and advanced statistical analysis of various surveys carried out at the European level, and administrative data relating to MSDs collected at EU

[5]Available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

level. Where relevant these results are complemented and enriched with data from national sources in Austria, Denmark, Finland, France, Germany, Hungary, Italy, the Netherlands, Spain and Sweden.

A methodological report[6] (published separately) including an analysis of the quality, comparability, coverage and reliability of the existing data on MSDs, identifying shortcomings or gaps in terms of knowledge and information to be addressed and providing recommendations for policy-makers has also been produced as part of this project.

1.3 Methodology applied

In order to carry out this task, several European data sources have been collected and analysed to assess whether or not data related to MSDs are included. These analyses include descriptive analyses as well as multivariate analyses. The annexes to this report provide a detailed description of the process of identifying relevant data sources, the descriptive and exploratory multivariate analyses (logistic regressions and cluster analysis) applied and the relevant data sources that are used in this study.

The data sources that are used are presented in Table 1.

Table 1 Overview of the data sources that are used.

Data source	Nature of data	Supplier
Labour Force Survey (LFS) ad hoc modules 2007 and 2013	Survey	Eurostat
European Health Interview Survey (EHIS)	Survey	Eurostat
European Survey of Enterprises on New and Emerging Risks (ESENER)	Survey	EU-OSHA
European Working Conditions Survey (EWCS)	Survey	Eurofound
European Statistics on Accidents at Work (ESAW)	Administrative data	Eurostat
European Health for All database	Administrative data	World Health Organisation (WHO)
WHO European Mortality Database	Administrative data	WHO

1.4 Structure of the report

Based on literature research and expert advice, a theoretical framework is developed illustrating the causes and consequences of MSDs. This framework is presented in Chapter 2. Chapter 3 presents data on the prevalence of MSDs in the 28 Member States of the EU. Chapter 4 provides an analysis of the impact of MSDs on the health of workers and on public health, and on employment and work outcomes. Chapter 5 presents a detailed analysis of the data regarding the risk factors that are associated with MSDs. A distinction is made between sociodemographic and individual factors, physical factors and organisational and psychosocial risk factors at work. Chapter 6 focuses on the activities of

[6]The national reports, including a synthesis report, and the methodological report are available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

establishments to prevent MSD complaints. Chapter 7 draws a summary of the main results and Chapter 8 presents the overall conclusions and recommendations.

Annex 1 provides a detailed description of the process of identifying relevant data sources and of the descriptive analyses applied to these data sources. Annexes 2 and 3 describe the exploratory multivariate analyses applied to the data obtained. A brief description of the data sources that are used can be found in Annex 4.

2 Causes and consequences of MSDs: a framework

Musculoskeletal disorders are impairments of bodily structures such as muscles, joints, tendons, ligaments, nerves, cartilage, bones and the localised blood circulation system (EU-OSHA, 2007a)[7]. If MSDs are caused or aggravated primarily by work and by the effects of the immediate environment in which work is carried out, they are known as work-related MSDs.

At present, work-related MSDs are the most common work-related health problem in Europe. These health problems entail consequences for workers but also for businesses that experience higher levels of sickness absenteeism and drops in productivity, and for society at large. The framework presented in this chapter illustrates the main determinants and consequences of MSDs in more detail (see Figure 11). The chapter starts with a more detailed description of the term 'MSDs' and how the exposure to MSDs can be identified and measured.

2.1 Defining MSDs and assessing their prevalence

2.1.1 Defining MSDs

The term 'MSD' is used as an umbrella heading for medically established periarticular diseases of the limbs and spine, and for multiple or localised pain syndromes (Roquelaure, 2018)[8].

- **Medically established periarticular diseases of the limbs and spine**

It is not always clear which specific periarticular diseases should be counted as MSDs. In the past, many different classification systems have been developed. For example, Van Eerd *et al.* (2003)[9] found 27 different classification systems for the working population. Since then several experts have been working to reach multidisciplinary consensus on terminology and classification (see for example Huisstede *et al.*, 2007)[10]. In 2018, a review of definitions and clinical characteristics of MSDs identified a list containing 26 different periarticular diseases that are considered to be MSDs (Roquelaure, 2018, table 1[11]):

- 7 types of tendinopathies;
- 8 types of tunnel (or outlet) syndromes and nerve compressions;
- 3 types of hygromas;
- 4 types of bone syndromes;
- 3 types of vascular syndromes;
- 1 type of meniscus lesions.

- **Multiple or localised pain syndromes**

The term 'MSD' refers not only to medically established periarticular diseases of the limbs and spine (specific MSDs), but also to multiple or localised pain syndromes (non-specific MSDs). This refers to

[7] EU-OSHA — European Agency for Safety and Health at Work, 'Introduction to work-related musculoskeletal disorders', factsheet 71, 2007. Available at: https://osha.europa.eu/sites/default/files/publications/documents/en/publications/factsheets/71/Factsheet_71_-_Introduction_to_work-related_musculoskeletal_disorders.pdf

[8] Roquelaure, Y., 'Musculoskeletal disorders and psychosocial factors at work', European Trade Union Institute, report 142, 2018.

[9] Van Eerd, D., Beaton, D., Cole, D., Lucas, J., Hogg-Johnson, S. & Bombardier, C., 'Classification systems for upper-limb musculoskeletal disorders in workers: a review of the literature', *Journal of Clinical Epidemiology*, Vol. 56, No 10, 2003, pp. 925-936.

[10] Huisstede, B. M., Miedema, H. S., Verhagen, A. P., Koes, B. W. & Verhaar, J. A., 'Multidisciplinary consensus on the terminology and classification of complaints of the arm, neck and/or shoulder', *Occupational and Environmental Medicine*, Vol. 64, No 5, 2007, pp. 313-319.

[11] Each of the diseases in this table is identified by a specific ICD-10 (International Classification of Diseases, 10th Revision) code.

MSDs that are less well characterised in clinical terms and involve pain localised in specific anatomical areas. The following non-specific disorders have been identified as the main non-specific MSDs in the limbs and spine[12]:

- non-specific pain in the upper limbs;
- muscular tension in the neck;
- cervical pain (pain in the upper part of the spine);
- dorsal pain (pain in the middle part of the spine);
- non-specific lower back pain and lumbago.

This list does not include non-specific pains in the lower limbs, which may reflect the fact that these complaints occur less often[13].

It would be preferable to label as MSDs only those complaints that at least relate to impairments of any kind of bodily structures that — following a broad definition — can be considered part of the musculoskeletal system. This implies that different types of syndromes, mainly connected to non-specific pain, referred pain and/or fatigue syndromes, should not be labelled as MSDs. First of all, there is no direct relationship to the musculoskeletal system. Second, for these types of complaints the cause and effect pathway is not clear and it is not clear which preventive measures are helpful. Third, these types of pain and fatigue complaints can be and probably are part of the pathway leading to MSDs.
For some types of physical complaints considered systemic, there is no universally accepted way of labelling or defining them. An example is repetitive strain injury (RSI). On one hand this is considered an upper-extremity musculoskeletal disorder, but on the other hand there is a broad variety of locations and backgrounds of this type of complaints. They can include static workloads but also — sometimes within the same person — repetitive/dynamic workloads, tendon problems (such as epicondylitis lateralis or carpal tunnel syndrome) and cold environments. In addition, RSI could also include inflammatory types of symptoms in forearm muscles or local blood flow problems, especially in the neck and shoulder area. Concerning RSI there is a consensus that, if several of these symptoms occur at the same time in combination with working activities that are known to cause this kind of complaints, then these are called RSI. Because of the multiple cause/effect combinations, a variety of names are used and many different classification systems have been introduced. A well-known type of classification is called CANS: musculoskeletal complaints of arm, neck and/or shoulder not caused by acute trauma or by any systemic disease[14].

The point that is made here is that sometimes collective terms are used to classify MSDs but the causes connected to the complaints can be multiple. Another example of this is vibration-induced white finger syndrome: working with machines that vibrate can damage muscles, tendons, blood vessels, nerves and joints in the hand/wrist region of the body[15]. Syndromes (such as RSI/CANS, vibration-induced white finger syndrome, Sudeck´s atrophy, de Quervain's disease and carpal tunnel syndrome) are usually used to describe complaints in the upper part of the body. In the lower limb body segments, the same type of problems can occur, for instance when working with foot pedals in an awkward position (static workload combined with dynamic workload, poor blood flow and pressure on tendons and ligaments).

[12] See Roquelaure (2018), table 1.
[13] The overview presented by Roquelaure (2018) presents the *main* disorders rather than *all* disorders.
[14] Huisstede *et al*. (2007).
[15] Gemne, G., Pyykko, I., Taylor, W. & Pelmear, P. L., 'The Stockholm Workshop scale for the classification of cold-induced Raynaud's phenomenon in the hand-arm vibration syndrome (revision of the Taylor-Pelmear scale)', *Scandinavian Journal of Work, Environment and Health*, Vol. 13, No 4, 1987, pp. 275-278.

- **Acute and chronic MSDs**

Most work-related MSDs are cumulative disorders, resulting from repeated exposure to high- or low-intensity loads over a long period of time. These are known as chronic MSDs. However, MSDs can also be acute traumas, such as fractures, that occur during an accident (either at work or elsewhere).

2.1.2 Main sources of information on MSDs

The two main sources of information and data regarding MSDs are self-reporting through surveys and administrative data.

- **Self-reporting through surveys**

In the case of self-reporting, people are asked whether or not they suffer from an MSD (either in general or a specific type of MSD). When measuring MSDs through surveys, it is customary to ask about the location of health complaints and not about the clinical nature of the complaint. This makes it difficult to separate health complaints caused by musculoskeletal overstrain and health complaints caused by other factors. It is likely that statistics based on self-reported MSDs overestimate the prevalence of MSDs, to the extent that they include health problems that are clinically speaking not recognised as MSDs.

Questions regarding the prevalence of MSDs are included in different surveys. The formulation of the questions used varies between surveys, and also between different waves of these surveys. These differences are likely to result in different outcomes. To illustrate this, the questions used in three main EU-wide surveys are compared: the European Working Conditions Survey (EWCS), the European Health Interview Survey (EHIS) and the Labour Force Survey (LFS).

European Working Conditions Survey

The sixth wave of the EWCS (2015) contains the following questions:

- Over the last 12 months, did you have any of the following health problems?
  - Backache;
  - Muscular pains in shoulders, neck and/or upper limbs;
  - Muscular pains in lower limbs (hips, legs, knees, feet, etc.).

These are generic questions that include all kinds of health problems, both severe and less severe, and are not restricted to health problems caused by musculoskeletal overstrain.

During the first four waves of the EWCS the questions were formulated differently: rather than asking about MSD problems in general, they asked specifically (and only) about work-related MSD problems. Starting with the fifth wave, the questions have been changed to measure the presence of MSDs in general.

European Health Interview Survey

The second EHIS includes the following questions, which can be used to determine if a respondent has chronic MSDs:

- Here is a list of chronic diseases or conditions. During the past 12 months, have you had any of the following diseases or conditions?
  - Low back disorder or other chronic back defect;
  - Neck disorder or other chronic neck defect.

These questions differ from the EWCS questions in several respects:

- The wording of the EHIS questions (using terms such as ‘diseases’, ‘conditions’ and ‘chronic defects’) refers to more severe health problems than the wording of the EWCS questions (which uses terms such as ‘health problems’ and ‘muscular pains’).

- The EHIS questions ask about only chronic diseases, which is not the case for the EWCS.
- The MSD types covered by the EHIS questionnaire are more narrowly defined: whereas the EWCS asks about the presence of muscular pains in a large part of the body (upper limbs, lower limbs and back), EHIS asks about disorders in a smaller part of the body (neck and low back).

This suggests that the questions used by EHIS will lead to a lower prevalence rate of MSD complaints than the questions used by the EWCS.

The first EHIS also includes questions about osteoarthritis and rheumatoid arthritis. These conditions are not included in the second survey.

Labour Force Survey ad hoc module

The LFS ad hoc module (accidents at work and work-related health problems) from 2013 includes the following set of nested questions that can be used to determine if a respondent suffers from MSDs:

- Within the past 12 months, have you suffered from any physical or mental health problems?
    - If yes: were any of these health problems caused or made worse by your job or by work you have done in the past?
        - If yes: how would you describe this health problem (consider most serious health problem):
            - Bone, joint or muscle problem (the only possible answer category related to MSDs).
                - If bone, joint or muscle problem: is this bone, joint or muscle problem mainly affecting your:
                    - Neck, shoulders, arms or hands;
                    - Hips, knees, legs or feet;
                    - Back.

The LFS questions differ from the EWCS and EHIS questions in two respects:

- The occurrence of MSD-related health problems (compared with other health problems) can be determined only for workers reporting work-related health problems.
- The LFS identifies the most serious work-related health problem. In cases where MSD complaints coincide with other, more serious, health problems, the LFS survey will not classify a respondent as having self-reported MSD complaints.

This suggests that the questions used by the LFS survey will lead to a lower prevalence rate of MSD complaints than the questions used by the EWCS.

Administrative data

Another important source of information is administrative data. Three examples of available administrative data are:

- the number (and proportion) of recognised occupational diseases (ODs) due to diseases of the musculoskeletal system and connective tissue diseases;
- declared work-related accidents;
- the number (and proportion) of discharges after hospitalisation due to diseases of the musculoskeletal system and connective tissue diseases.

Estimates of MSD prevalence based on self-reporting may include people with relatively mild health complaints as well as people with severe health complaints. Statistics based on administrative data are likely to include only people with more severe health complaints (severe enough to result in hospitalisation or the recognition of an occupational disease).

Indicators on MSD-related occupational diseases cannot be used for cross-country comparisons. Because of institutional differences between the national systems used to register (the cause of) occupational diseases, these data are not comparable across countries.

Currently, existing EU-wide surveys do not include questions that ask people with MSD complaints if their MSD complaints are caused by accidents at work. This makes it very difficult to examine the relationship between accidents and MSDs. Nevertheless, it may be relevant to know what proportion of work accidents may be expected to result in MSD complaints. One should notice that the influence of work-related accidents on MSDs works both ways. They may cause MSDs, for instance by stumbling, falling or bumping into obstacles. On the other hand, already existing MSDs may cause work-related accidents, for instance when not walking properly caused by a lower limb MSD and stumbling because of this or through loss of coordination caused by muscle fatigue or pain in the upper limbs.

▪ Measuring work-related MSDs

When MSDs are caused or made worse by work, these can be defined as work-related MSDs. Work-related MSDs arise from regular exposure to a certain (work)load. It is a problem that affects all forms of working environments, from physically arduous work to low-intensity static work (da Costa and Viera, 2010[16]; Bernard, 1997[17]).

Each of the three surveys discussed earlier has its own approach regarding work-related MSDs.

EWCS:

- First four waves: these waves include questions that are concerned only with work-related MSDs. Therefore, these waves cannot be used to determine the prevalence of MSDs in general.
- Fifth and sixth waves: these waves can be used to determine the prevalence of MSDs in general. In addition, it is possible to obtain an estimate for an upper boundary of the prevalence of work-related MSDs. This can be done by using a separate question indicating whether or not a person believes that the person's work affects the person's health. A person with self-reported MSDs can then be said to have work-related MSDs if that person believes that his or her health is affected by his or her work. This results in an overestimation of work-related MSDs (or a lower boundary of the proportion of self-reported MSDs that are not work-related).

EHIS:

- First wave: like the fifth and sixth waves of the EWCS, this wave can be used to obtain an upper boundary of the prevalence of chronic work-related MSDs (in the neck or back).
- Second wave: this wave can be used to determine the prevalence of chronic MSDs only in general. This wave does not include questions that can be used to determine which (or what proportion) of these chronic MSDs are work-related.

LFS:

- The 2013 ad hoc module of the LFS can be used to determine the prevalence of only work-related MSDs (as most serious health problem). It does not include questions that can be used to determine the prevalence of MSDs in general.

[16] da Costa, B. R. & Vieira, E. R., 'Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies', *American Journal of Industrial Medicine*, Vol. 53, No 3, 2010, pp. 285-323.

[17] Bernard, B. P., editor, *Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*, DHHS (NIOSH) Publication No 97B141, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Cincinnati (OH), 1997. Available at: https://certisafety.com/pdf/mdwf97-141.pdf

The 2010 report by EU-OSHA on MSDs[18] contains various indicators showing the prevalence of work-related MSDs, based on the third and fourth waves of the EWCS. More recent data on the prevalence of work-related MSDs does not appear to be available, at least not based on the identified available EU-wide surveys containing MSD-related questions.

2.2 A multidimensional model of MSDs

MSDs can be caused by many different (combinations of) factors and may have many different consequences. Various frameworks have been developed in the past to model the interrelationships between MSDs and possible causes and consequences. These models can be classified into three main groups: biomedical models, biopsychosocial models and ergonomic or organisational models (Roquelaure, 2018, p. 25).

- Biomedical models have their roots in research on soft tissue biomechanics and neurobiology. These models consider, among other things, how MSDs can be caused by mechanical load applied to the musculoskeletal tissues.
- Biopsychosocial models go one step further. They consider not only physical (biological) factors that may result in MSDs but also social and psychological factors.
- Ergonomic or organisational models build on biopsychosocial models of MSDs and also take organisational factors into consideration.

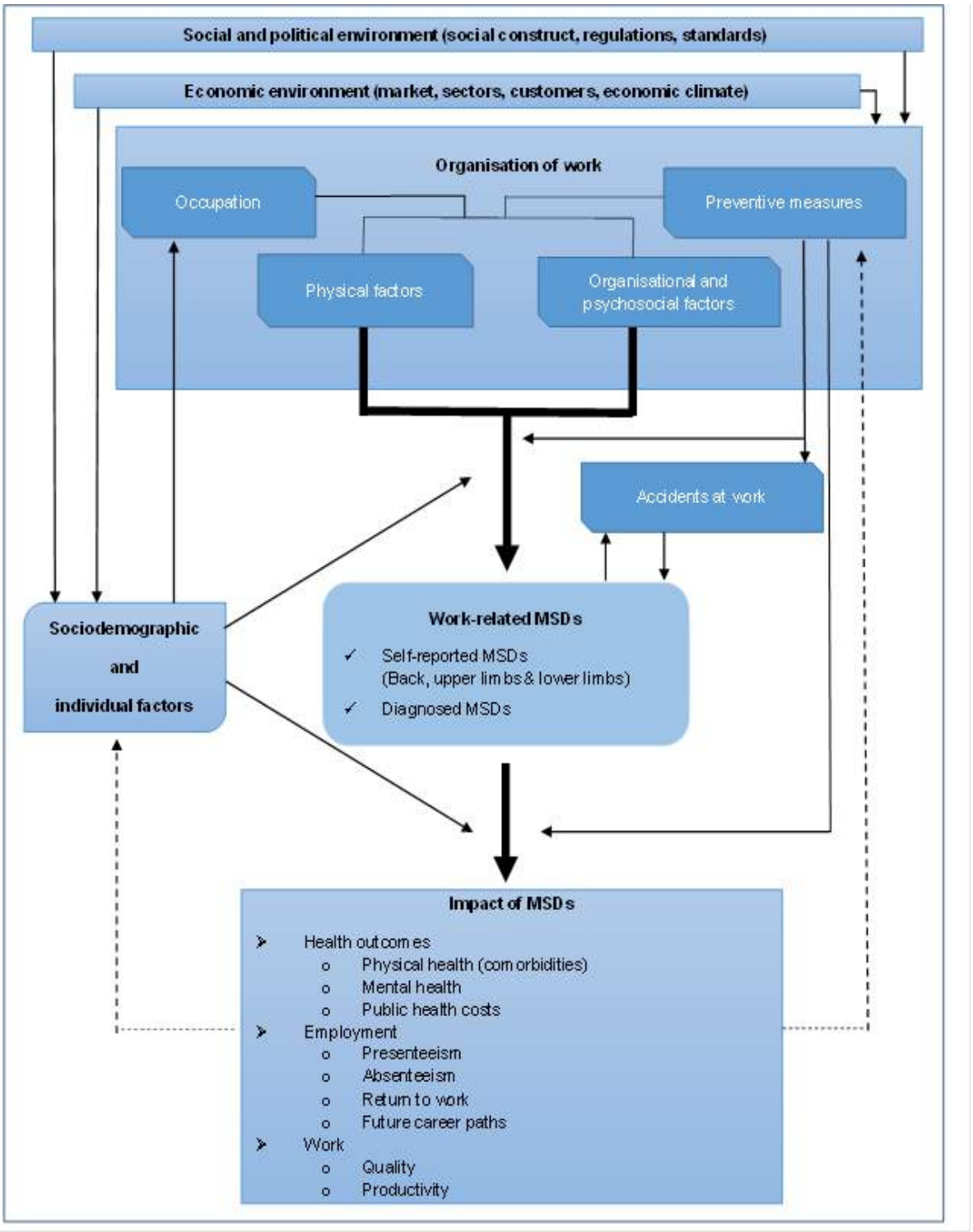
For this study an organisational model is used. The multidimensional model of occupational health as suggested by Roquelaure (Roquelaure, 2018, figure 13, p. 41) is adapted. According to this model (Roquelaure 2018, p. 41):

> *"the organisation of work and management practices determine the conditions under which work is carried out, and therefore also determine the biomechanical and psychosocial exposures to which workers must adapt. Individual resources are not only influenced by these exposures, but also exercise a codetermining influence on their impacts in terms of health, the quantity and quality of work and job security. Stress (i) promotes the onset of MSDs by interfering with muscle activation, the mechanisms of inflammation and pain and tissue repair and (ii) promotes the chronicity of pain and disability".*

The framework for this study is presented in Figure 11. The different parts of the model and how they are related to prevalence of MSDs are discussed in the remainder of this chapter.

[18] EU-OSHA — European Agency for Safety and Health at Work, *OSH in figures: work-related musculoskeletal disorders in the EU — facts and figures,* 2010. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/TERO09009ENC

Figure 11 Theoretical framework of work-related MSDs



Note: theoretical framework developed by Panteia, vhp human performance and IKEI

2.2.1 Sociodemographic factors and individual factors

- **Sociodemographic factors**

In this study, the focus is on four sociodemographic factors that numerous studies have shown are related to the prevalence of MSDs: gender, age, education level and country of birth.

Gender

Women are underrepresented in the European labour market and their employment rate is much lower than men's (66.5 % versus 78 % in 2017). In addition to that, women are also more frequently discriminated against when accessing employment and — when employed — in the workplace, as broad range of evidence shows. Such discrimination results in higher psychosocial risk, having therefore an impact on mental and physical health (including MSDs) (Pavalko *et al*., 2003)[19].

Focusing on MSDs, previous studies have shown that women are more at risk of certain MSDs (such as carpal tunnel syndrome) and less at risk of other MSDs (such as lower back pain). For example, Andorsen *et al*. (2014)[20] conducted a cohort study to examine the prevalence of MSDs in the general population in Norway. Their findings show that women report more musculoskeletal issues (both mild and severe) than men (63.4 % versus 52.9 % for men). Likewise, Eltayeb *et al*. (2007)[21] examined the occurrence of MSDs in Dutch office workers and found that musculoskeletal complaints and specifically shoulder and neck complaints are more frequent among women than men.

How can these gender differences be explained? An EU-OSHA (2013)[22] review on emerging risks and trends in the safety and health of women at work shows that women are affected by MSDs as well as stress due to several psychosocial demands but also risks that exist in their work. More specifically, women are segregated into jobs or occupations with higher MSD risks: informal work and hence 'unstable, unprotected and precarious' jobs appear to be more common for women (EU-OSHA, 2013, p. 16). Moreover, the limited prospects for career development of women together with the repetitive and monotonous characteristics of many female-dominated jobs increase the risk of developing stress and MSDs. It is also more likely for women to face discrimination and harassment at the workplace than men. Finally, the review provides evidence to show that women are more exposed to slips, falls and accidents related to violence, which can significantly increase the prevalence of MSDs.

According to Roquelaure (2018, p. 13), it is, however, not possible to determine to what extent gender differences in the prevalence of specific types of MSDs are a consequence of potential 'physiological predispositions' (anthropometric, hormonal, etc.) or of the gender differences in the division of labour, which result in a higher exposure to occupational risk factors for women (Roquelaure, 2018; Hooftman *et al*., 2009[23]; Messing *et al*., 2009[24]; Heilskov-Hansen *et al*., 2016[25]).

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[19] Pavalko, E. K., Mossakowski, K. N. & Hamilton, V. J., 'Does perceived discrimination affect health? Longitudinal relationships between work discrimination and women's physical and emotional health', *Journal of Health and Social Behavior,* Vol. 44, No 1, 2003, pp. 18-33.

[20] Andorsen, O. F., Ahmed, L. A., Emaus, N. & Klouman, E., 'High prevalence of chronic musculoskeletal complaints among women in a Norwegian general population: the Tromsø study', *BMC Research Notes*, Vol. 7, No 1, 2014, 506.

[21] Eltayeb, S., Staal, J. B., Kennes, J., Lamberts, P. H. & De Bie, R. A., 'Prevalence of complaints of arm, neck and shoulder among computer office workers and psychometric evaluation of a risk factor questionnaire', *BMC Musculoskeletal Disorders*, Vol. 8, No 1, 2007, 68.

[22] EU-OSHA — European Agency for Safety and Health at Work, *New risks and trends in the safety and health of women at work*, 2013. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/new-risks-and-trends-in-the-safety-and-health-of-women-at-work

[23] Hooftman, W. E., Van der Beek, A. J., Bongers, P. M. & Van Mechelen, W., 'Is there a gender difference in the effect of work-related physical and psychosocial risk factors on musculoskeletal symptoms and related sickness absence?', *Scandinavian Journal of Work, Environment and Health*, Vol. 35, No 2, 2009, pp. 85-95.

[24] Messing, K., Stock, S. R. & Tissot, F., 'Should studies of risk factors for musculoskeletal disorders be stratified by gender? Lessons from the 1998 Québec Health and Social Survey', *Scandinavian Journal of Work, Environment and Health*, Vol. 35, No 2, 2009, pp. 96-112.

[25] Heilskov-Hansen, T., Mikkelsen, S., Svendsen, S. W., Thygesen, L. C., Hansson, G. Å. & Thomsen, J. F., 'Exposure-response relationships between movements and postures of the wrist and carpal tunnel syndrome among male and female house painters: a retrospective cohort study', *Occupational and Environmental Medicine*, Vol. 73, No 6, 2016, pp. 401-408.

Age

Another important sociodemographic factor is the age of the worker. Age is clearly related to MSD prevalence: older workers are more likely to suffer from a musculoskeletal symptom than younger workers (Okunribido and Wynn, 2010[26]; Yeomans, 2011[27]). Here too, the question is how this age effect can be explained. Based on a review of the literature on ageing and work-related MSDs, Okunribido and Wynn (2010) conclude that older workers tend to suffer more from diminished functional capacity, which in turn increases the likelihood of suffering from work-related MSDs. Hence, age is not a stand-alone risk factor for work-related MSDs. Furthermore, they mention that the tendency towards injury is associated more with the difference between work demands and the employee's physical work capacity and/or ability than with age.

There are, however, also indications that younger workers are more exposed to certain MSD risk factors than older workers. An EU-OSHA report on young workers (EU-OSHA, 2007b, pp. 11-12)[28] shows that young workers are exposed to a greater extent to noise, vibrations, heat or cold and the handling of dangerous materials, and also to physically demanding work factors such as working in awkward positions, handling heavy loads and repetitive work. Furthermore, the report shows that young workers tend to work under pressure, with tight deadlines and at very high speed. All these physical and psychosocial factors can increase the risk of developing MSDs for these young workers.

Still, younger workers are on average less likely than older workers to report MSDs. In the case of chronic MSDs, this is related to the duration of exposure to risk factors (at work and elsewhere): chronic MSDs are often the result of prolonged periods of strain, and will therefore occur more among elder workers. This also suggest that the relationship between age and MSD prevalence is (at least partially) mediated by other variables, in this case the number of years that a worker has been exposed to certain risks. Besides these indirect effects, age may also have a direct effect on MSD prevalence (Palmer and Goodson, 2016[29]).

Country of origin

A third demographic factor that may matter is country of origin, which can be used to distinguish between native workers and migrant workers (workers born in another country). Migrant workers also tend to be segregated into jobs with higher MSD risks: they tend to work on the so-called 3-D jobs (dirty, dangerous and demanding) (Moyce and Schenker, 2018, p. 352)[30], which are found particularly in the agriculture and horticulture, construction, health care, household, transport and food sectors. The working conditions of migrant workers are usually unfavourable compared with those of non-migrants, characterised by low wages, long working hours, physically demanding and monotonous tasks and temporary contracts (Moyce and Schenker, 2018, p. 352; EU-OSHA, 2007c, pp. 21-22[31]). In addition to that, health discrepancies appear between migrant workers often as a consequence of culture and language barriers, limited access to health care, their documentation status and also the political environment of the host state (Moyce and Schenker, 2018, pp. 356-358). All these factors (physical and psychosocial) increase the vulnerability of migrant workers compared with non-migrants and in particular can increase the risk of developing musculoskeletal symptoms.

Indeed, as it is stated in an EU-OSHA report on migrant workers (EU-OSHA, 2007c, pp. 33-34), there is evidence indicating higher levels of MSDs among immigrant workers. In the same line, Mladovsky

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[26] Okunribido, O., & Wynn, T., *Ageing and work-related musculoskeletal disorders: a review of the recent literature*, Health and Safety Laboratory, RR*799,* Buxton, United Kingdom, 2010. Available at: http://www.hse.gov.uk/research/rrpdf/rr799.pdf

[27] Yeomans, L., *An update of the literature on age and employment*, Health and Safety Laboratory*,* Buxton, United Kingdom, 2011.

[28] EU-OSHA — European Agency for Safety and Health at Work, *OSH in figures: young workers — facts and figures*, European Risk Observatory Report 4, 2007. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/7606507

[29] Palmer, K. & N. Goodson, 'Ageing, musculoskeletal health and work', *Best Practice & Research: Clinical Rheumatology*, Vol. 29, No 3, 2016, pp. 391-404. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4762198/

[30] Moyce, S. C. & Schenker, M., 'Migrant workers and their occupational health and safety', *Annual Review of Public Health*, Vol. 39, 2018, pp. 351-365. Available at: https://www.annualreviews.org/doi/pdf/10.1146/annurev-publhealth-040617-013714

[31] EU-OSHA — European Agency for Safety and Health at Work, *Literature study on migrant workers*, 2007. Available at: https://osha.europa.eu/en/publications/literature_reviews/migrant_workers.

(2007, p. 9)[32] underlines that 'infectious diseases, accidents, injuries, musculoskeletal disorders and violence disproportionately affect certain migrant groups compared to long settled populations in the European Union'. It is also the case that newly arrived migrants may suffer from (among other health issues) musculoskeletal issues as a consequence of their long and demanding journey (Scholz, 2016, p. 2)[33], another fact that highlights the high vulnerability of migrant workers.

Education level

Education level is another factor that can influence the prevalence of MSDs. Dalstra *et al*. (2005)[34] examine the prevalence of common chronic diseases in eight EU Member States by using health survey data. They conclude that the prevalence of MSDs is higher among people with low levels of education than those with high education level. Andorsen *et al*. (2014) in their cohort study on the general Norwegian population also find a negative relationship between education level and musculoskeletal complaints, suggesting that paying attention to those with a low level of education might have positive outcomes in preventing musculoskeletal complaints. Similar findings are provided by an eumusc.net[35] study on musculoskeletal health in Europe. In particular, according to this study (eumusc.net, n.d., p. 48), workers with a low education level often tend to report more work-related issues and they are more likely to report MSDs as the most serious work-related issue. Moreover, the eumusc.net study (n.d., p. 72) underlines the importance of patients' education as a factor that can enable them to understand and manage musculoskeletal conditions.

- **Individual factors**

Individual factors may refer to a person's leisure physical activity, smoking and alcohol habits, and body mass index (BMI). The evidence linking these factors to the prevalence of MSDs is, however, not always very strong (see Table 2). These individual factors will be briefly discussed here, but will not be included in the remainder of this study.

Nilsen *et al*. (2011)[36] examine the associations between physical activity, BMI and musculoskeletal symptoms in the Norwegian general population. Their findings indicate that increased levels of leisure time physical activity are related to fewer musculoskeletal symptoms. Individuals who are obese have a 20 % higher risk of back, neck and shoulder pain. Nevertheless, physical activity could counterbalance the adverse effect of obesity on risk of chronic pain in the low back, neck and shoulders (Nilsen *et al*., 2011, p. 270). A similar study in Norway by Andorsen *et al*. (2014) shows that, besides high BMI and low levels of physical activity, smoking is also associated with a significantly higher risk of reporting MSDs.

In the same line, Viester *et al*. (2013)[37] examine the relationship between BMI and musculoskeletal disorders in the working population in the Netherlands. For a high BMI a higher 12 month prevalence of MSDs was found, this association is stronger for workers with low physical workload. Furthermore, obese workers have greater risk for developing MSDs and less recovery from musculoskeletal symptoms compared to workers with normal weight. A study by eumusc.net on musculoskeletal health in Europe (n.d., p. 75) states that a healthy lifestyle can be a significant preventative factor for MSDs. In

[32] Mladovsky, P., 'Migrant health in the EU', *Eurohealth*, Vol., 13, No 1, 2007, pp. 9-11. Available at: http://www.lse.ac.uk/LSEHealthAndSocialCare/pdf/eurohealth/VOL13No1/Mladovsky.pdf

[33] Scholz, N., 'The public health dimension of the European migrant crisis', European Parliamentary Research Service, 2016. Available at: http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573908/EPRS_BRI(2016)573908_EN.pdf

[34] Dalstra, J. A., Kunst, A. E., Borrell, C., Breeze, E., Cambois, E., Costa, G., Geurts, J. J., Lahelma, E., Van Oyen, H., Rasmussen, N. K. and Regidor, E., 'Socioeconomic differences in the prevalence of common chronic diseases: an overview of eight European countries', *International Journal of Epidemiology*, Vol. 34, No 2, 2005, pp. 316-326. Available at: https://academic.oup.com/ije/article/34/2/316/747011

[35] eumusc.net, *Musculoskeletal health in Europe: Report v5.0*, n.d. Retrieved 14 January 2019, from: http://www.eumusc.net/myUploadData/files/Musculoskeletal%20Health%20in%20Europe%20Report%20v5.pdf

[36] Nilsen, T. I. L., Holtermann, A. & Mork, P. J., 'Physical exercise, body mass index, and risk of chronic pain in the low back and neck/shoulders: longitudinal data from the Nord-Trøndelag Health Study', *American Journal of Epidemiology*, Vol. 174, No 3, 2011, pp. 267-273.

[37] Viester, L., Verhagen, E. A., Hengel, K. M. O., Koppes, L. L., Van der Beek, A. J. & Bongers, P. M., 'The relation between body mass index and musculoskeletal symptoms in the working population', *BMC Musculoskeletal Disorders*, Vol. 14, 2013, 238. Available at: https://bmcmusculoskeletdisord.biomedcentral.com/track/pdf/10.1186/1471-2474-14-238

particular, the report mentions that physical activity, balanced weight and diet, avoiding smoking and the balanced use of alcohol and avoidance of alcohol abuse are habits that significantly reduce the risk of MSDs. Finally, an EU-OSHA report (2005, p. 8)[38] underlines that occupations that lack physical activity (due to the increasing use of visual display units and of automated systems) lead to higher risk of MSDs and mainly to upper limb and back disorders.

Table 2 Strength of evidence found for relationship to MSDs, by body area, for different risk factors

Body area	Strong evidence	Reasonable evidence	Insufficient evidence
Back and neck	None	• Psychosocial factors • Smoking • Gender • Posture • Comorbidity	• Heavy physical work • Lifting • Sedentarism • Older age • High BMI
Lower back	None	• Awkward postures • Heavy physical work • Lifting • Psychosocial factors • Younger age • High BMI	• Gender • Smoking • Comorbidity
Upper limbs: shoulder	None	• Heavy physical work • Psychosocial factors	• Repetitive work • Older age • High BMI • Sedentarism
Upper limbs: elbow/forearm	None	• Awkward postures • Comorbidity • Repetitive work • Older age	• Repetitive work • High BMI • Sedentarism
Upper limbs: wrist/hand	None	• Prolonged computer work • Heavy physical work • High BMI • Older age • Female gender • Awkward posture • Repetitive work	• Smoking • Comorbidity • Psychosocial factors
Lower limbs: non-specific lower limb MSDs	None	• None	• Comorbidity • Psychosocial factors • Smoking • High BMI
Lower limbs: hip	None	• Lifting • Heavy physical work	• Repetitive work
Lower limbs: knee	None	• Awkward postures • Lifting • Repetition • Comorbidity	• Psychological distress • Smoking • Heavy physical work • High BMI
Non-specific MSDs	None	• Comorbidity	• Psychosocial factors (fear avoidance) • Older age • Smoking

Sources: da Costa and Viera, 2010; Coggon *et al*., 2013[39]

[38] EU-OSHA — European Agency for Safety and Health at Work, *Expert forecast on emerging physical risks related to occupational safety and health*, Risk Observatory 1, 2005. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/6805478

[39] Coggon, *et al*., 'Disabling musculoskeletal pain in working populations: is it the job, the person, or the culture?'. *Pain,* Vol. 154, No 6, 2013, pp. 856-863. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3675684/

In sum, there is ample evidence that sociodemographic factors and personal habits that may affect a person's general health situation are related to the prevalence of MSDs. It is, however, not always clear how this relationship should be understood. One possibility is that individual factors act as moderators: the extent to which physical, organisational and psychosocial risk factors increase the risk of MSDs may differ between individuals with different demographics or different personal habits. For example, the likelihood that repeated lifting of heavy loads results in an MSD may be higher for older workers than for younger workers (because older workers have been exposed to repeat lifting of heavy loads for a longer time). This is reflected in the theoretical framework by including individual factors as moderating variables: individual factors not only have a direct effect themselves on the occurrence of MSDs, but they also affect how the various physical and psychosocial risk factors at the workplace affect MSDs.

2.2.2 Organisation of work

The organisation of work includes numerous conditions that may increase the risk of workers suffering from MSDs. These conditions include physical factors, organisational factors and psychosocial factors. Table 2 presents an overview of physical, organisational and psychosocial factors (besides individual factors) for which reasonable evidence has been found that they have an impact on MSDs. This overview is based on the outcomes of two overview studies (see sources of Table 2).

For all of these factors, the long-term effect on the prevalence of MSDs may be different from the short-term effect. Furthermore, different risk factors may reinforce each other. In 2005, EU-OSHA conducted an expert survey on new and emerging physical risks related to occupational safety and health[40] (EU-OSHA, 2005). There was a high degree of consensus among the experts that the combined exposure to physical and psychosocial risk factors was identified as a serious emerging risk. Multifactorial MSDs were perceived as important issues to be tackled in the future, especially those that include human, social and organisational factors.

2.2.3 Physical factors at work

Previous research has identified several physical working conditions that may increase the risk of developing MSD complaints. These physical risk factors (also known as biomechanical risk factors) include job hazards and posture-related risks.

Job hazards are hazards such as:

- vibrations from hand tools (resulting in vibrations of the upper limbs);
- vibrations from machinery (resulting in vibrations of the whole body);
- working in low temperatures;
- machine-paced work;
- poor workstation design;
- poor tool design.

Because of data restrictions, only the first four of these job hazards are considered in this study.

Posture-related risks are risks such as:

- working in tiring or painful positions;
- lifting people;
- moving people;
- lifting heavy loads (over 11 kg);
- carrying heavy loads;
- moving (pushing/pulling/hoisting) heavy loads;

[40] Twenty-three experts responded to this survey, all with more than 5 years of experience in the field of 'working with risks related to MSDs'.

- standing;
- kneeling, squatting, climbing stairs;
- repetitive hand or arm movements;
- working with visual display units (VDUs).

These findings are supported by extensive literature reviews carried out on behalf of the Health Council of the Netherlands (2012[41], 2011[42]).

A differentiation is made between lifting and moving (of heavy loads and of people), because lifting and moving involve different types of muscle activity and may result in different strains and, hence, have different effects on the development of MSD complaints. In most questionnaires, however, lifting and moving are combined into a single category. Another important remark is that lifting, pushing, pulling and hoisting are especially harmful when these type of actions are performed very quickly. For example, if a worker pushes a wheeled cage up and runs quickly, for example in 2 seconds, the load on the musculoskeletal system is twice as high as taking 4 seconds to carry out this task. It should be realised that taking a few minutes more to perform these types of tasks could halve the musculoskeletal load.

2.2.4 Organisational and psychosocial factors

In comparison with the comprehensive research available regarding physical risk factors, research on psychosocial and organisational risks is still limited. In fact, for psychosocial factors at work there are no globally accepted definitions. These factors mostly relate to individual subjective opinions of the organisation of work, such as work-rest cycles, culture and management type. They usually bear emotional value and potentially cause physical or psychological health issues (van den Heuvel, 2017[43]). According to EU-OSHA (2007d, p. 6)[44], psychosocial risks "are related to the way the work is designed, organised and managed, as well as to the economic and social context of work".

This description is in line with the findings of Hauke *et al*. (2011)[45], who indicate that several psychosocial factors at work such as low social support, high job demands and low job control cause psychosocial stress. This stress can lead to several physiological and biochemical reactions that can potentially increase muscle tension and consequently result in MSDs. In addition, specific psychosocial factors (for instance lack of decision-making autonomy or excessive workload) can also increase musculoskeletal load and tissue strain, hence raising the risk of developing MSDs.

Psychosocial factors includes:

- anxiety, overall fatigue, sleeping problems;
- job-related stress;
- heavy mental load;
- lack of (decision-making) autonomy;
- lack of support from line managers;
- lack of support from colleagues;

[41] Health Council of the Netherlands, *Tillen tijdens werk* (Manual lifting at work), Health Council of the Netherlands, The Hague, 2012. Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2012/12/20/tillen-tijdens-werk/dossier-tillen-tijdens-werk.pdf..

[42] Health Council of the Netherlands, *Staand, geknield en gehurkt werken* (Standing, kneeling and squatting work), Health Council of the Netherlands, The Hague, 2012. Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2011/12/23/staand-geknield-en-gehurkt-werken/dossier-staand-geknield-en-gehurkt-werken.pdf

[43] van den Heuvel, S., 'Psychosocial risk factors for musculoskeletal disorders (MSDs)', OSHWiki. Retrieved from: https://oshwiki.eu/index.php?title=Psychosocial_risk_factors_for_musculoskeletal_disorders_(MSDs)&oldid=246772

[44] EU-OSHA — European Agency for Safety and Health at Work, *Expert forecast on emerging psychosocial risks related to occupational safety and health*, Risk Observatory 5, 2007. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/7807118

[45] Hauke, A., Flintrop, J., Brun, E. & Rugulies, R., 'The impact of work-related psychosocial stressors on the onset of musculoskeletal disorders in specific body regions: a review and meta-analysis of 54 longitudinal studies', *Work Stress*, Vol. 25, No 3, 2011, pp. 243-256.

- lack of recognition for work done;
- lack of knowledge of results;
- sexual or verbal harassment;
- discrimination.

In the case of the first type of psychosocial factors mentioned (health problems), the relationship to MSDs may run both ways. On the one hand, having health problems such as high anxiety levels, overall fatigue or sleeping problems may increase the risk of developing MSDs. For this reason, they are included here as examples of psychosocial factors, and section 5.2 (on organisational and psychosocial factors at work) will include data on the prevalence of these health problems. On the other hand, having MSDs may cause or worsen these health problems. For this reason, their relationship to MSD complaints is also discussed in section 4.1 (on health outcomes).

Alongside psychosocial factors, several studies (for instance Stock *et al*., 2018[46]; Roquelaure, 2016[47]) also address organisational factors that may lead to stress and several other reactions, which in turn raise the risk of MSDs. Organisational factors include factors such as:

- working under time pressure;
- short cycle times (for more than 50 % of the working time);
- lack of time to recover;
- inflexibility of procedures and checks;
- lack of individual/collective leeway;
- lack of resources to carry out high-quality work;
- gender-based division of work;
- lack of control options;
- monotonous tasks/lack of variety.

Several French studies examine the relationship between psychosocial and organisational risk factors and MSDs. Petit *et al*. (2015)[48] show that carpal tunnel syndrome is associated with some factors related to work organisation, such as payment on a piecework basis and work pace dependent on automatic rate. In a similar study, Rigouin *et al*. (2014)[49] find that, among the factors related to work organisation, working with temporary workers is associated with carpal tunnel syndrome for women, but not for men. Task rotation during the job and work pace dependent on quantified targets are associated with carpal tunnel syndrome only for men. The work-related psychosocial factors highlighted by the logistic modelling are high psychological demand for women and low skill discretion for men. Bodin *et al*. (2012a)[50] show that, for men, automatic work pace and low supervisor support are associated with shoulder pain. For women, shoulder pain and rotator cuff syndrome are associated with age, repetitiveness of tasks and low supervisor support. High perceived physical exertion and exposure to

[46] Stock, S. R., Nicolakakis, N., Vezina, M., Vezina, N., Gilbert, L., Turcot, A., Sultan-Taieb, H., Sinden, K., Denis, M. A., Delga, C. & Beaucage, C., 'Are work organization interventions effective in preventing or reducing work-related musculoskeletal disorders? A systematic review of the literature', *Scandinavian Journal of Work, Environment and Health,* Vol. 44, No 2, 2018, pp. 113-133. Available at: http://www.sjweh.fi/show_abstract.php?abstract_id=3696&fullText=1#box-fullText

[47] Roquelaure, Y., 'Promoting a shared representation of workers' activities to improve integrated prevention of work-related musculoskeletal disorders', *Safety and Health at Work*, Vol. 7, No 2, 2016, pp. 171-174. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4909852/pdf/main.pdf

[48] Petit, A., Ha, C., Bodin, J., Rigouin, P., Descatha, A., Brunet, R., Goldberg, M. & Roquelaure, Y., 'Risk factors for carpal tunnel syndrome related to the work organization: a prospective surveillance study in a large working population', *Applied Ergonomics*, Vol. 47, No 1, 2015, pp. 1-10.

[49] Rigouin, P., Ha, C., Bodin, J., Le Manac'h, A. P., Descatha, A., Goldberg, M. & Roquelaure, Y., 'Organizational and psychosocial risk factors for carpal tunnel syndrome: a cross-sectional study of French workers', *International Archives of Occupational and Environmental Health*, Vol. 87, No 2, 2014, pp. 147-154.

[50] Bodin, J., Ha, C., Chastang, J. F., Descatha, A., Leclerc, A., Goldberg, M., Imbernon, E. & Roquelaure, Y., 'Comparison of risk factors for shoulder pain and rotator cuff syndrome in the working population', *American Journal of Industrial Medicine*, Vol. 55, No 7, 2012, pp. 605-615.

cold temperatures are associated with 'shoulder pain'. Finally, Bodin *et al*. (2012b)[51] find that lack of social support is a predictor of rotator cuff syndrome among men.

2.2.5 Employment status

The employment status of individuals, for instance whether they are self-employed or employed on a temporary contract, can play a significant role in the kind and amount of risks that they are exposed to. This reflects the fact that a different employment status implies a different organisation of work, and hence different safety and health standards, which in turn influence the risk of MSDs.

For example, evidence shows that irregular hours (part-time and casual hours), as well as job insecurity, are associated with stress symptoms and MSDs (Zeytinoglu *et al*., 2015)[52]. Other findings indicate that work-related injuries occur more among non-standard workers, such as temporary agency workers, than standard workers (Howard, 2017)[53]. Finally, a recent report from EU-OSHA (2017)[54] underlines the above arguments by exploring the role of online platforms and their OSH implications in the economy (where workers are usually considered self-employed). The report indicates that different working environments linked to digitalisation, such as home-based work or lone working, may increase the risk of exposure to hazards including MSDs, isolation or burnout.

2.2.6 Preventive measures

A part of the organisation of work is what kind of measures companies implement to avoid or to limit their workers' exposure to physical risk factors (i.e. repetitive movements, awkward postures, manual handling of heavy loads, etc.) as well as to organisational and psychological risk factors, and thus prevent them from developing MSDs. These preventive measures are mostly related to workplace risk assessments and interventions and they usually arise from regulatory requirements or from international standards regarding ergonomic design rules for the use of machines, the way to handle heavy loads, etc. (Roquelaure, 2018, p. 59). Such measures can either lower the presence of certain risk factors (for example by reducing the levels of stress at work) or lower the impact of certain risk factors on the health of workers (for example by providing training courses on how to deal with stress at work). This is reflected by two arrows in the theoretical framework.

The implementation of preventive measures that target biomechanical load has proven effective as far as the reduction of workers' exposure to excessive and repetitive workload is concerned. There is, however, limited evidence regarding the effectiveness of these measures in lowering the risks of developing MSDs (Roquelaure, 2018, p. 59; Van Eerd *et al*., 2016[55]).

2.2.7 Occupation

In the previous report on work-related MSDs, EU-OSHA (2010) indicated that the prevalence of MSDs varies among different occupations and that workers from specific occupations are at greater risk. In

[51] Bodin, J., Ha, C., Petit Le Manac'h, A., Sérazin, C., Descatha, A., Leclerc, A., Goldberg, M. & Roquelaure, Y., 'Risk factors for incidence of rotator cuff syndrome in a large working population', *Scandinavian Journal of Work, Environment & Health*, Vol. 38, No 5, 2012, pp. 436-446.

[52] Zeytinoglu, I., Denton, M., Plenderleith, J. & Chowhan, J., 'Associations between workers' health, and non-standard hours and insecurity: the case of home care workers in Ontario, Canada', *International Journal of Human Resource Management*, Vol. 26, No 19, 2015, pp. 2503-2522.

[53] Howard, J. 'Nonstandard work arrangements and worker health and safety', *American Journal of Industrial Medicine*, Vol. 60, No 1, 2017, pp. 1-10.

[54] EU-OSHA — European Agency for Safety and Health at Work, *Protecting workers in the online platform economy: an overview of regulatory and policy developments in the EU*, 2017. Available at: https://osha.europa.eu/en/tools-and-publications/publications/regulating-occupational-safety-and-health-impact-online-platform/view

[55] Van Eerd, D., Munhall, C., Irvin, E., Rempel, D., Brewer, S., van der Beek, A. J., Dennerlein, J. T., Tullar, J., kivington, K., Pinion, C. & Amick, B., 'Effectiveness of workplace interventions in the prevention of upper extremity musculoskeletal disorders and symptoms: an update of the evidence', *Occupational & Environmental Medicine*, Vol. 73, No 1, 2016, pp. 62-70.

particular, this report showed that service workers, manual workers (both skilled and unskilled) and craft-related trade employees were most at risk of developing MSDs.

Nevertheless, because of changes in working conditions and the introduction of new technologies in work, exposure to hazards such as static and awkward positions or repetition of movements may have been introduced to occupations where there was only moderate prevalence of MSDs before. Consequently, it remains important to monitor the prevalence of MSDs by occupation.

As is known from previous studies, sociodemographic variables such as gender and country of origin are related to the occupation of workers: female workers and migrant workers may be segregated into specific occupations. The extent to which women and migrants may be segregated into jobs with higher MSD risks will be the topic of a specific EU-OSHA study (EU-OSHA, forthcoming, a)[56]. In the current study this issue will be discussed only briefly.

2.2.8 Impact of MSDs

MSD complaints have consequences for workers, for enterprises, for society at large and for personal lives (irrespective of whether MSDs are work-related or not). According to the eumusc.net report, musculoskeletal disorders can significantly influence an individual's life, including physical mental and economic well-being, but also the individual's career, family and friends (n.d., p. 114).

For individual workers, the main impact of MSDs concerns their health situation, their sustainable employability in their current job and their labour market situation. MSD complaints may have serious effects on a person's general health situation and in the worst case may force him or her to leave the labour market (because he or she is no longer able to work).

The causality between MSD complaints and other health problems may run both ways: in some cases MSDs may result in other health problems (in which case these other health problems constitute an impact of MSDs), while in other cases other health problems may increase the risk of MSDs (in which case these other health problems are part of the individual factors from the theoretical framework). In Chapter 4, the relationship between MSD complaints and other health problems is examined without differentiating between these opposite causal effects.

The relationship between accidents and MSDs can be examined using administrative data. The European Commission has used the European Statistics on Accidents at Work (ESAW) database to examine the relationship between accidents at work and MSDs. Analysis of ESAW shows that, 'among all accidents registered in the ESAW database, no less than 18 % were directly related to physical stress on the musculoskeletal system, of which 7 % directly involved the use of hand tools' (European Commission, 2009, p. 213[57]). It is, however, not straightforward how these findings can be related to the theoretical framework, since causality may run both ways: work-related accidents can result in (acute) MSDs, but already existing MSDs may also cause work-related accidents.

2.2.9 Social, regulatory and economic environment

The last elements of the model are the social, political and economic environment of a country. These elements may affect the organisation of work but also individual factors.

The social and political environment refers to, among other things, regulations regarding working conditions and health and safety at work. This includes not only existing norms and regulations, but also

[56] EU-OSHA — European Agency for Safety and Health at Work, *Workforce diversity and MSDs: review of facts, figures and case examples* (working title), forthcoming. To be available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

[57] European Commission, Directorate-General for Employment, Social Affairs and Equal Opportunities, Unit F4, *Causes and circumstances of accidents at work in the EU*, Office for Official Publications of the European Communities, Luxembourg, 2009.

the extent to which organisations are monitored and the penalties they receive for not adhering to the relevant rules. These factors mainly influence the organisation of work in a country.

The social, political and economic environment may also affect individual factors such as the average education level in a country or region, the level of access to the labour market and also the inflow of immigrants. In this respect, regulations that are related to discrimination or initiatives for equal opportunities can play a significant role on the determination of the labour market and its working conditions of a country.

Furthermore, the social environment may influence general public awareness about health in general and MSDs in particular. For example, measures to stimulate healthy food habits and exercising may affect the average individual's general health (for example by forbidding smoking in many places or making alcohol less accessible to young people).

Variation in these environments across countries may lead to variation in the prevalence of MSDs as well. Farioli *et al*. (2014)[58] show this by analysing data across EU countries based on the fifth wave of the EWCS. In particular, they find that there is significant variation between EU countries in the prevalence of two types of MSDs (back and upper limbs) that cannot be explained by individual-level risk factors. They have examined if these country differences can be explained by various country-level variables. Although most of these variables are not related to MSD prevalence, they find that the prevalence of both types of MSDs is higher in countries where the risk of poverty or social exclusion for people is lower.

Several studies suggest that awareness regarding MSDs, which is related to the social and political environment, may result in an increase in the level of self-reported MSDs. For instance, Coggon *et al*. (2013), by conducting a cross-sectional survey in 18 countries, find that there is significant variation in the prevalence of disabling back and forearm pain among workers performing similar tasks. They argue that this finding can be partly explained from individual and socioeconomic factors, such as being aware of repetitive strain injury (RSI), or having negative beliefs regarding musculoskeletal pain.

[58] Farioli, A., Mattioli, S., Quaglieri, A., Curti, S., Violante, F. S. and Coggon, D., 'Musculoskeletal pain in Europe: role of personal, occupational and social risk factors.' *Scandinavian Journal of Work, Environment & Health*, Vol. 40, No 1, 2014, 36.

3 Prevalence of MSDs

In the previous report on work-related MSDs, EU-OSHA concluded that MSDs are the most prevalent occupational disease at European level and that millions of European workers are affected by MSDs through their work (EU-OSHA, 2010). This is confirmed by the 2013 ad hoc module from the LFS, which shows that MSDs account for more than half of all reported work-related health problems (see section 3.1.2).

The first two sections of this chapter present statistics on the prevalence of self-reported MSDs and the extent to which the prevalence is related to different dimensions of the theoretical framework presented in the previous chapter:

- social and political environment: country;
- economic environment: sector;
- organisation of work: occupation and employment status;
- sociodemographic factors: gender, age, education and country of birth.

The third section focuses on administrative data on MSDs.

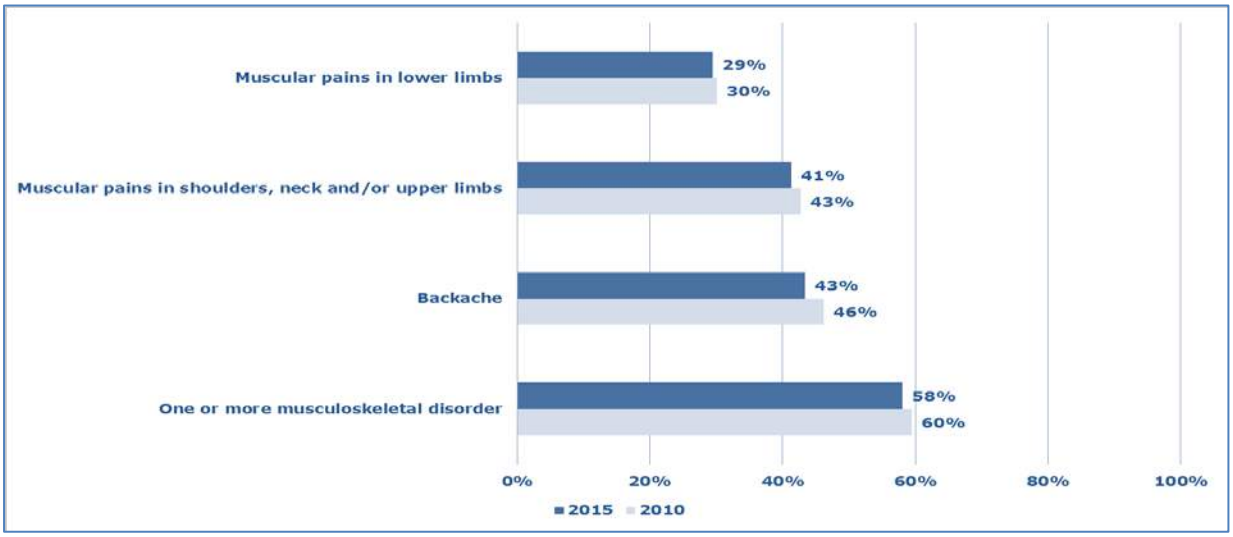
3.1 Self-reported MSDs

3.1.1 MSDs in general

- **Three out of every five workers in the EU-28 report MSD complaints**

In 2015, approximately three out of every five workers in the EU-28 reported MSD complaints in the back, upper limbs and/or lower limbs. This can be concluded from the sixth wave of the EWCS. The most common MSD types among workers in the EU-28 are backache and muscular pains in the upper limbs (43 % and 41 %, respectively, in 2015). Muscular pains in lower limbs are reported less often (29 % in 2015) (Figure 12).

Figure 12 Percentage of workers reporting different musculoskeletal disorders in the past 12 months, EU-28, 2010 and 2015



N = 33,173 (2010); *N* = 31,612 (2015)

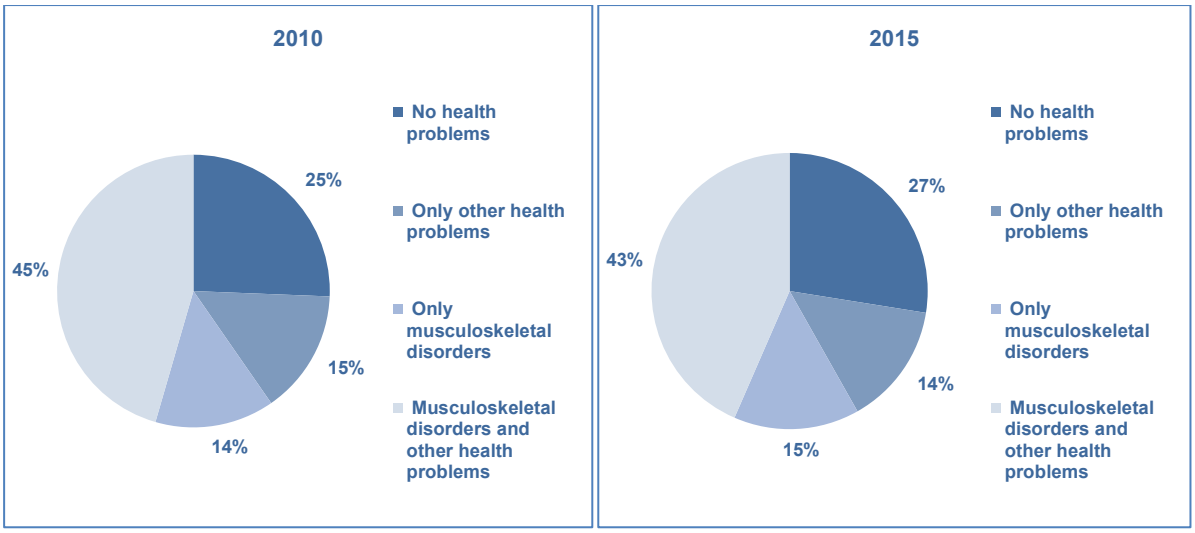
Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

Workers often report more than one type of MSD, which was also found in the previous report on work-related MSDs (EU-OSHA, 2010). Another finding from this previous report was that work-related muscular pains in the lower limbs might be just as prevalent as work-related muscular pains in the upper limbs. This does not seem to be the case any more, although firm conclusions should not be drawn; whereas the results presented in the previous report concern work-related MSDs, the results presented in this section concern MSDs in general.

▪ More often than not, MSDs are accompanied by other health problems

MSDs often occur in combination with other health problems. In 2010 and 2015, roughly three-quarters of all workers in the European Union reported having health problems of some kind during the past year (Figure 13). In four out of five cases, these health problems included MSDs[59], and, more often than not, health problems related to MSDs occurred in combination with other health problems[60]. The relationship between MSDs and other health problems is examined further in the next chapter. This chapter focuses on the prevalence of MSDs.

Figure 13 Percentage of workers with and without different types of health problems during the past 12 months, EU-28, 2010 and 2015



Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

N = 33,173 (2010); *N* = 31,612 (2015)

Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

▪ Different MSD indicators result in different prevalence rates

Different MSD indicators are available, which use different surveys to measure different types and different aspects of MSDs. This leads to different prevalence rates of self-reported MSDs (see also section 2.1).

The indicator based on the EWCS shows that more than half of all workers have MSD-related health problems. This is a high proportion, but this includes all kinds of MSD health problems: severe as well as less severe, chronic as well as acute, and work-related as well as not work-related. The EWCS asks

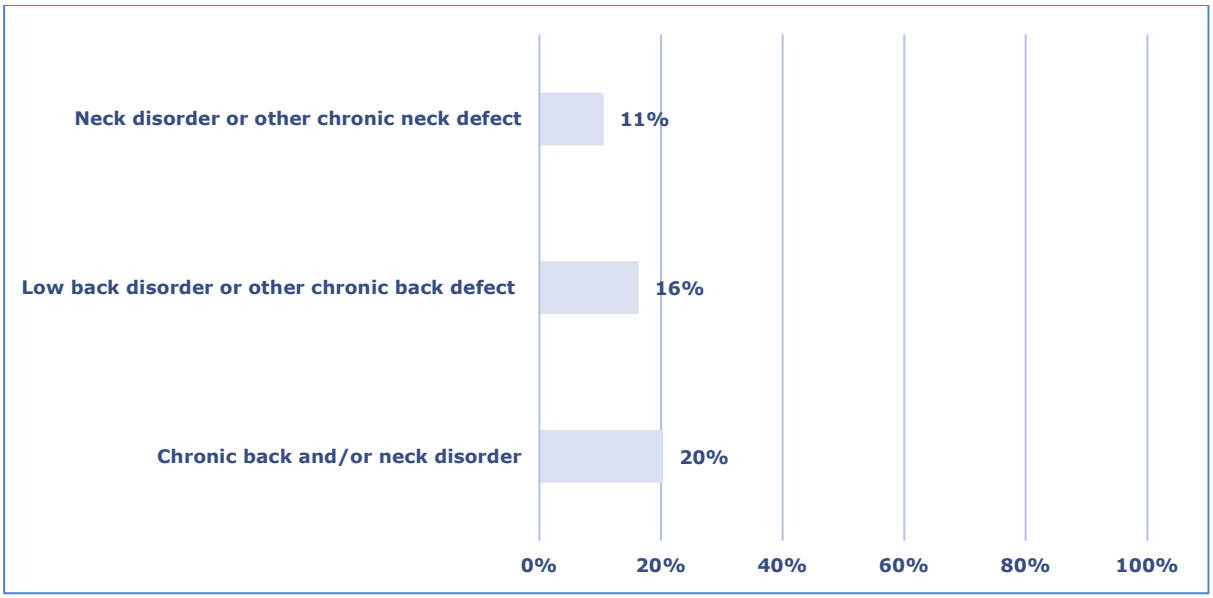
[59] In 2015, 73 % reported having a health problem, 80 % of whom (58 out of 73) reported having MSDs.

[60] In 2015, 58 % reported having MSDs, 75 % of whom (43 out of 58) reported having MSDs in combination with other health problems.

if people suffered from various pains during the past 12 months (in upper limbs, in lower limbs and in the back), and this may range from infrequently occurring mild pains to chronic and severe pains. A large majority of workers (62 %) with self-reported MSDs mention that their general health condition is good or very good (see section 4.1). This suggests that for a large proportion of these workers their health complaints are less severe. The proportion of workers with MSD-related health problems (in the back, upper limbs and/or lower limbs) and a general health condition that is less well[61] is approximately 22 %.

When people are asked about chronic MSD complaints, the percentages are much lower[62]. According to EHIS, which investigates two MSD types (chronic back defects and chronic neck defects), 20 % of the workers in 2014 suffered from a chronic back and/or neck disorder in the past year (Figure 14). This suggests that most MSDs are not considered to be chronic. This is confirmed by additional analysis of EWCS data: of all workers with only MSD complaints, 18 % report having a chronic health issue.

Figure 14 Percentage of workers reporting different chronic musculoskeletal disorders in the past 12 months, EU-28 (excluding Germany), 2014



Note: The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding an apprenticeship or paid traineeship, etc.

N = 122,005

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

▪ Lack of trends

In the previous EU-OSHA publication on work-related MSDs in the EU, data on prevalence of self-reported MSDS could be provided for only 1 or 2 years (EU-OSHA, 2010): for longer trends, data were not available. This is still the case. EU-wide data on self-reported MSDs are obtained through surveys, and either the available surveys include only one or two waves with questions on MSDs (as is the case of EHIS and ESENER) or the data are not comparable between waves because of changes in the underlying questionnaire (as is the case of EWCS, and to a lesser extent also EHIS).

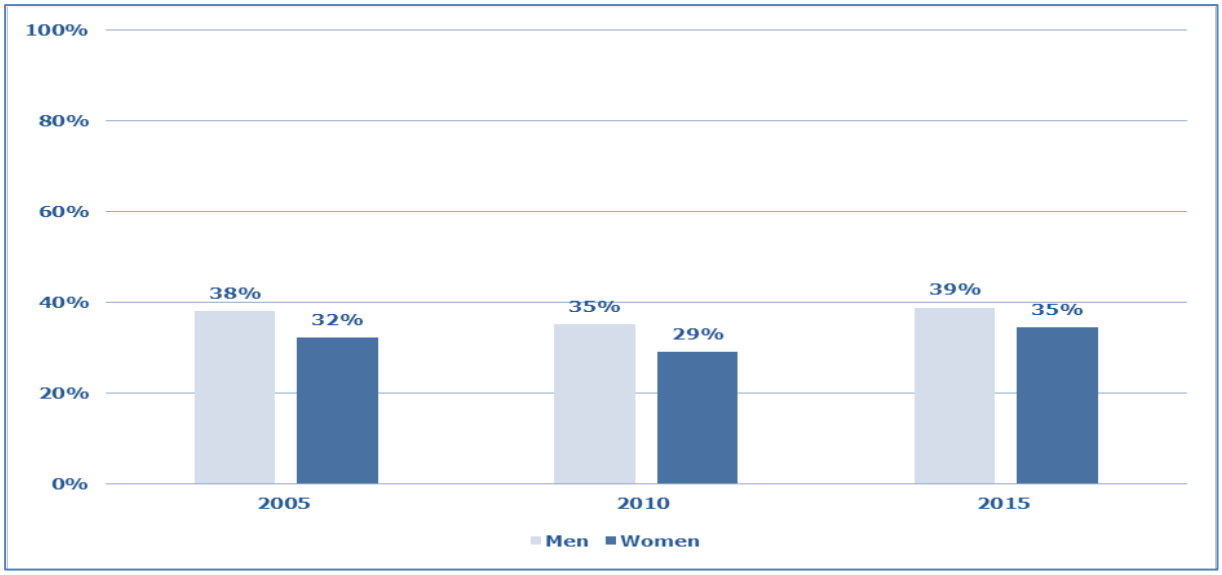
[61] This includes the answer categories 'fair', 'bad' and 'very bad'.
[62] For acute MSD complaints, no indicators are available.

3.1.2 Work-related MSDs

- **More than a third of workers report that their work affects their health negatively**

Somewhat more than one in three workers report that their work affects their health negatively. This proportion is relatively stable over time (see Figure 15). Men are slightly more likely than women to report this — a gender difference that is also relatively stable over time.

Figure 15 Percentages of workers reporting that their work affects their health negatively, by gender, EU-28, 2005, 2010 and 2015



N = 23,984 (2005); *N* = 32,087 (2010); *N* = 30,716 (2015)

Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

- **Data on work-related MSDs available only from ad hoc LFS module**

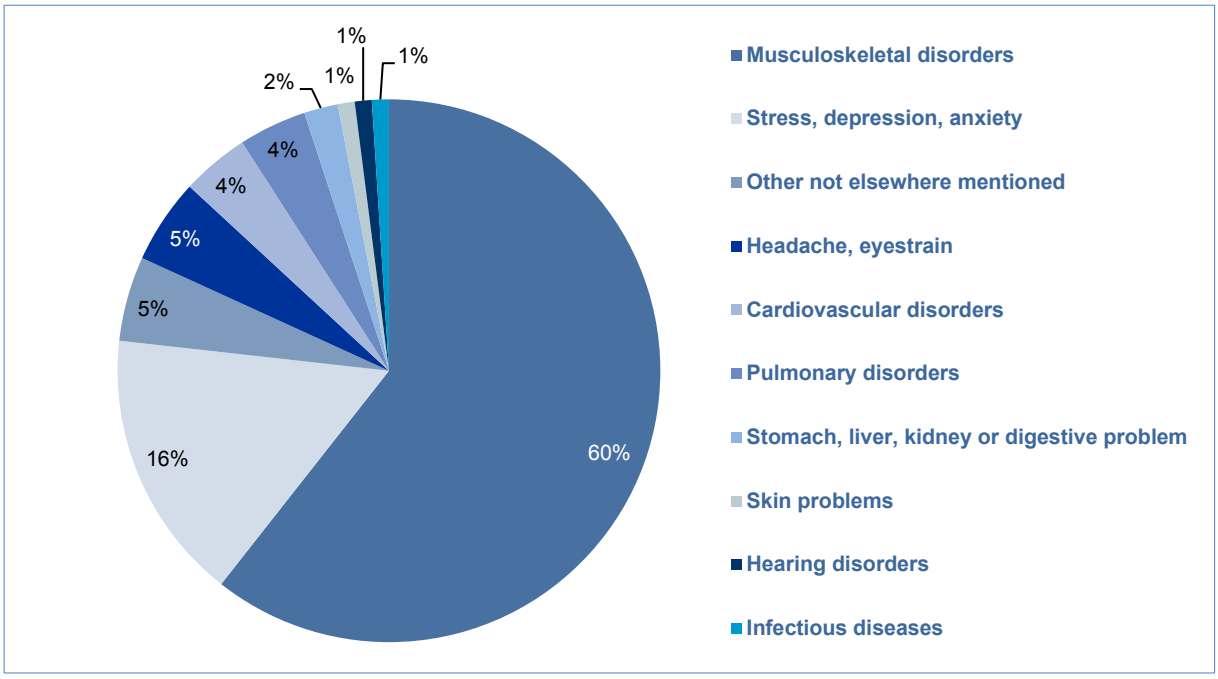
More than 60 % of workers report that their health is not negatively affected by their work. This suggests that a considerable proportion of the self-reported MSDs may also not be work-related. Unfortunately, recent statistics on (self-reported) work-related MSDs are not available.

In the previous EU-OSHA publication on work-related MSDs in the EU, statistics could be provided on the self-reported prevalence of work-related MSDs (EU-OSHA, 2010). These statistics were based on the fourth EWCS, which specifically (and only) asked about work-related MSD problems. Starting with the fifth EWCS wave, the questions have been changed to measure the presence of MSDs in general. The most recent EU-wide data on the prevalence of *work-related* MSDs are based on the 2013 ad hoc LFS module. This module provides information about the proportion of workers who report MSDs as their most serious work-related health problem. This can be interpreted as a lower boundary of the prevalence of work-related MSDs.

- **Of workers with work-related health problems, 60 % mention MSD complaints as their most serious health problem**

The results confirm just how prevalent work-related MSDs were in 2013: of all workers who mentioned that they suffered from any (physical or mental) work-related health problem during the past 12 months, 60 % mentioned MSD-related complaints as their most serious health problem. The second most mentioned health problem (mentioned by 16 %) is stress, depression and anxiety (Figure 16).

Figure 16 Percentage of workers reporting a work-related health problem, by type of problem, EU-27, 2013



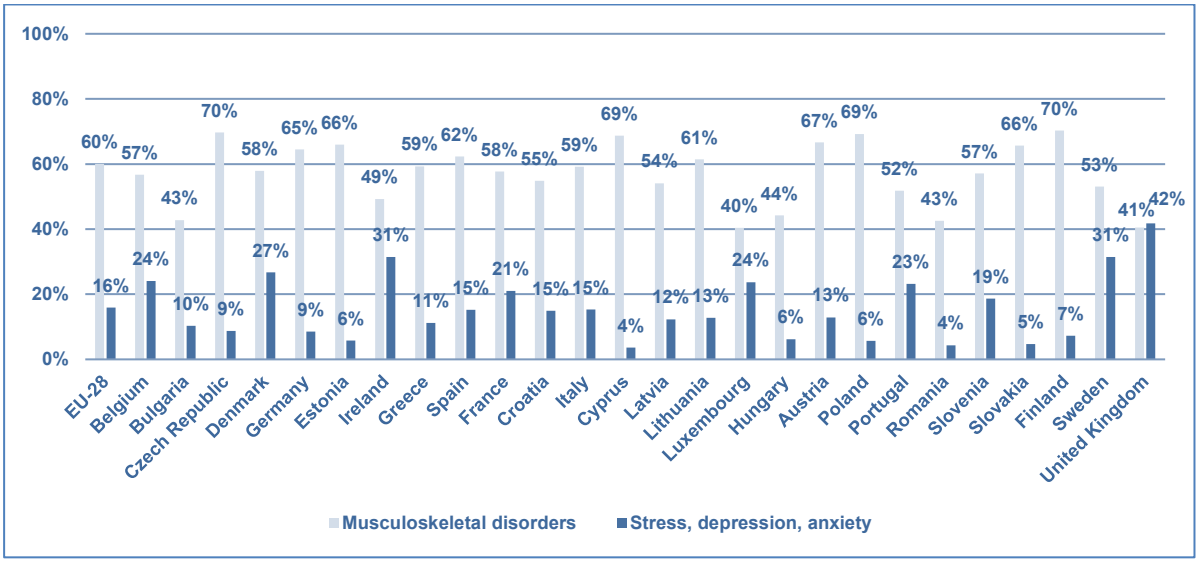
Note: The population of workers includes everybody aged 15 to 64 who was working or had worked during the past 12 months before the survey took place.

Source: Eurostat, Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013). All EU Member States participated in this ad hoc module except for the Netherlands.

In all EU Member States for which data are available, a large majority of all workers report MSD-related complaints and stress, depression and anxiety as their most serious health problems. This ranges from 46 % in Romania to 80 % or more in Denmark, Ireland, Austria, Sweden and the UK. The percentage of workers reporting MSD-related complaints as their most serious health problem ranges from 40 % in Luxembourg to 70 % in Czech Republic and Finland. The percentage of workers reporting stress, depression and anxiety as their most serious health problem shows even more variation and ranges from less than 5 % in Cyprus and Romania to 42 % in the UK (the only Member State where stress, depression and anxiety are most often mentioned as the most serious health problem) (Figure 17).

MSD-related complaints may potentially be related to mental health problems such as stress, depression and anxiety (as discussed in the theoretical framework). This relationship will be explored further in Chapter 4 (MSDs and comorbidities) and Chapter 5 (organisational and psychosocial risk factors).

Figure 17 Workers reporting MSDs or stress, depression and anxiety as their most serious work-related health problem, as a percentage of all workers reporting work-related health problems, by country, 2013



Notes: 'Musculoskeletal disorders' refers to bone, joint or muscle problems. The population of workers includes everybody aged 15 to 64 who was working or had worked during the past 12 months before the survey took place. For Malta and the Netherlands no data were available.

Source: Eurostat, Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013). All EU-28 Member States participated in this ad hoc module except for the Netherlands.

3.2 Variation in self-reported MSD prevalence

3.2.1 Social and political environment: country

The social and political environment in which people are working may affect the prevalence of self-reported MSDs. This study considers differences between countries as indicators of the relevance of the social and political environment (although countries differ in many more respects than just social and political).

- **Prevalence of self-reported MSDs varies considerably, both between and within countries**

At EU level, the prevalence of MSDs hardly changed between 2010 and 2015. Based on the EWCS, which investigates three MSD types, in 2015 58 % of workers in the EU-28 reported that they had suffered from one or more of these MSDs during the past 12 months. Five years earlier, the percentage was almost the same (60 %).

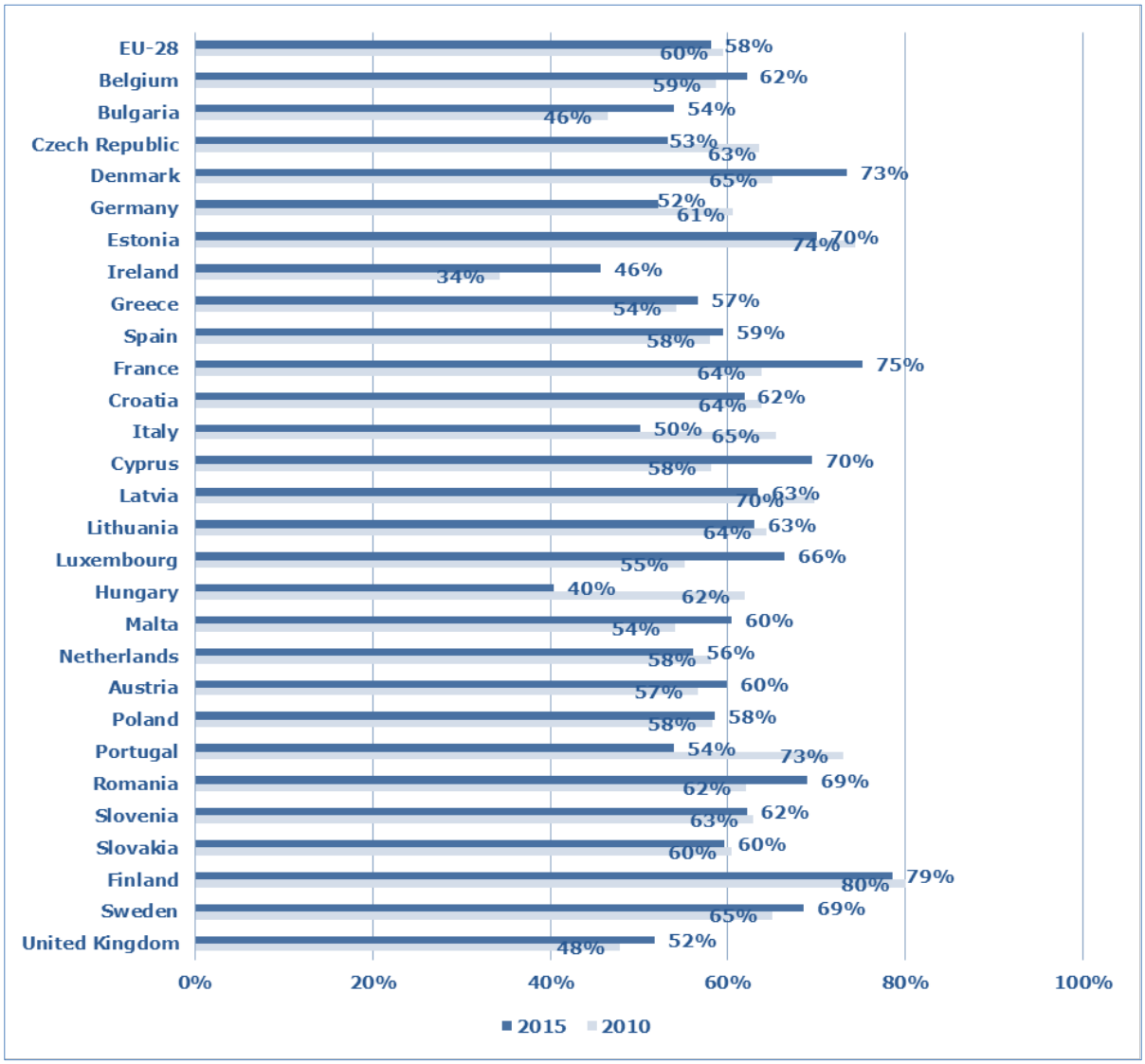
At the level of individual countries, there is, however, a lot of variation. Variation exists both between countries and within countries across time. Regarding the differences within countries across time, for 15 countries the difference between the two years is no more than 5 percentage points, but there are also eight countries where the MSD prevalence rate increased by 6 or more percentage points[63] and six countries where the MSD prevalence rate decreased by 6 or more percentage points[64] (Figure 18).

[63] These are France, Cyprus, Ireland, Luxembourg (+11 percentage points each), Denmark, Bulgaria (+8 percentage points each), Romania (+7 percentage points) and Malta (+6 percentage points).

[64] These are Hungary (-22 percentage points), Portugal (-19 percentage points), Italy (-15 percentage points), Czech Republic (-10 %points), Germany (- 8 %points) and Latvia (- 6 %points).

Additional analyses for 2015[65] have not been able to find an explanation for these country differences: they are hardly (or not at all) related to differences in the sectoral or occupational distribution of the workforce or to differences in terms of age, gender, education level and country of birth of the workforce.

Figure 18 Percentage of workers reporting that they suffer from one or more musculoskeletal disorders in the past 12 months, by country, 2010 and 2015



Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

N = 33,173 (2010); *N* = 31,612 (2015)

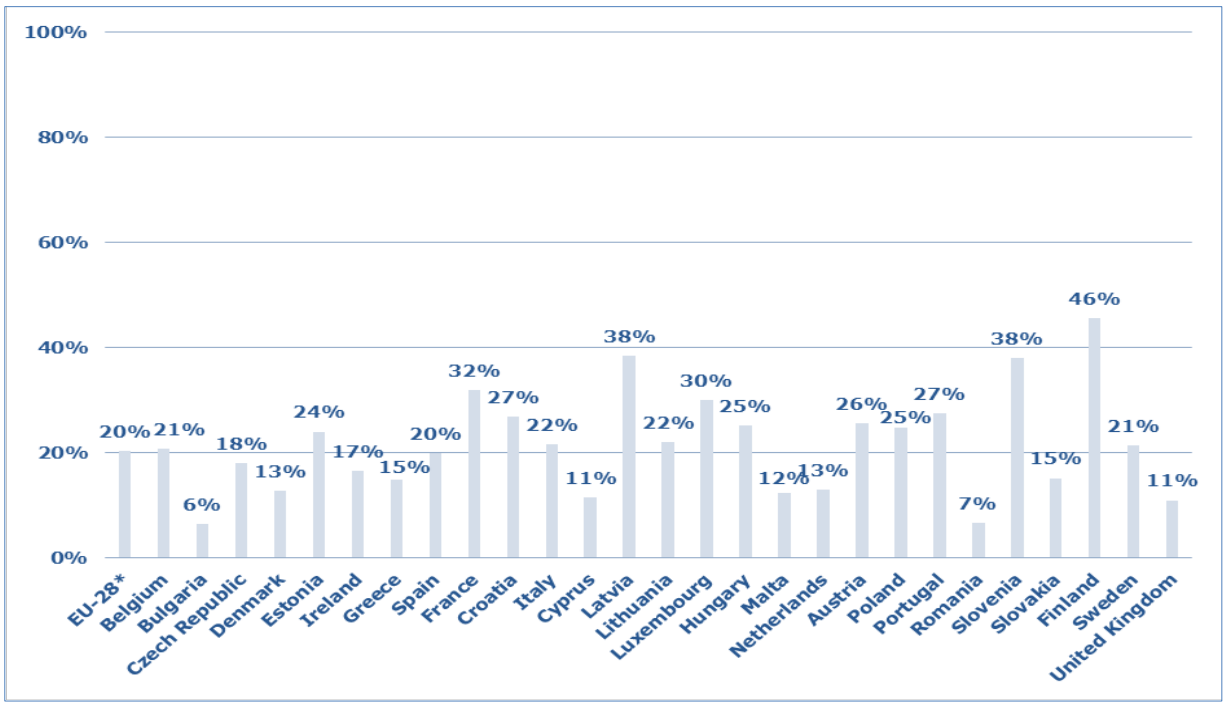
Source: Panteia based on the fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

[65] These concern logistic regressions with self-reported MSD complaints as the dependent variable, and country, sector, occupation, gender, age and various physical, organisational and psychosocial risk factors among the independent variables. These regressions have been applied separately for MSDs in upper limbs, lower limbs and back. More information about these analyses can be found in Annex 2.

- **Prevalence of chronic MSDs also varies considerably between countries**

Similarly to the general MSD prevalence rate, the prevalence of chronic MSDs also varies considerably between countries. According to EHIS, which investigates two MSD types (chronic back defects and chronic neck defects), the self-reported prevalence rate in 2014 ranges from 6 % (Bulgaria) and 7 % (Romania) to 38 % (in Latvia and Slovenia) and even 46 % (in Finland) (Figure 19). Thus, the prevalence of self-reported chronic MSDs in Finland (46 % in 2014) is higher than the prevalence of MSDs in general in Hungary (40 % in 2015)[66].

Figure 19 Percentage of workers reporting that they suffer from chronic back and/or neck disorders, by country, 2014



Note: The figure includes all EU-28 Member States except for Germany**.** The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 122,005

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

- **Data from Member States**

Available national data confirm that MSD complaints or pains in the (low) back and upper limbs are very frequent.

Germany

Information elaborated by the German Federal Institute for Occupational Safety and Health (BAuA) shows that in the previous 12 months MSDs affected a very large percentage of workers during work. Around 48.5 % of workers reported neck and shoulder complaints and 46 % lower back complaints.

[66] The correlation between the prevalence of MSDs in general and the prevalence of chronic MSDs at country level is rather low (0.29). This could indicate that the proportion of workers with MSD complaints who suffer from chronic MSDs varies considerably between countries, but it may also be due to methodological differences between the two data sources (the EWCS and EHIS are organised in different ways, and EHIS measures fewer MSD types than the EWCS).

Moreover, 21 % suffered from pains in the knees or arms, 20 % from pains in the legs or feet, 16 % from pains in the hands and 11.5 % from pain in the hips. The German evidence also suggests that a significant percentage of those who reported MSDs required medical treatment. Around 54 % of those who reported lower back pains were in medical treatment, while for those who reported neck and shoulder pains this percentage was 51 %[67].

Italy

Data from Italy, elaborated by the National Institute for Insurance against Accidents at Work (INAIL), show that back pain is the most commonly identified health problem (51.6 % of all workers), followed by muscular pain in the upper limbs (46.7 % of all workers) (INAIL, 2014)[68].

Netherlands

In the Netherlands, back problems are particularly identified as the main source of discomfort among workers, followed by shoulders and neck (NEA, 2017)[69].

Spain

In Spain, data from the seventh National Survey on Working Conditions (2011)[70] show that a very large percentage of workers (77.6 %) report feeling some type of frequent discomfort associated with postures or efforts made at work. The most common body locations where workers report frequent discomfort associated with postures/efforts made at work are the low back (45.0 % of respondents), the neck (34.4 %) and the high back (27.1 %).

3.2.2 Economic environment: sector

Besides the social and political environment, the economic environment is also related to the prevalence of self-reported MSDs. The economic environment relates to the sectors where workers are employed, the products and services markets they are working for, the customers they deliver to and the economic climate in which the production takes place.

These elements are closely related, and economic sectors can be described by the products that are produced, the services that are delivered and the customers who are served. These, in turn, determine the production processes that are used and the risk factors that individual workers are faced with at work. It is therefore not surprising that the prevalence of self-reported MSDs shows significant differences between sectors (see Figure 20 for backache, Figure 21 for MSDs in the upper limbs and Figure 22 for MSDs in the lower limbs).

MSDs are most prevalent in construction, water supply (sewerage and waste supply) and agriculture, forestry and fishing[71]. MSD prevalence is also above average in human health and social work activities. This applies to all three types of MSDs considered. In the previous report on work-related MSDs (EU-OSHA, 2010) these sectors were also identified as the sectors with the highest levels of MSD prevalence[72]. EU-OSHA (2010) also found MSD prevalence to be high in transport, storage and

[67] Wittig, P., Nöllenheidt, C. & Brenscheidt, S., *Grundauswertung der BIBB/BAuA-Erwerbstätigenbefragung 2012 (*Basic evaluation of the BIBB/BAuA Employment Survey 2012*)*, Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Dortmund, 2012. Available at: https://www.baua.de/DE/Angebote/Publikationen/Berichte/Gd73.pdf?__blob=publicationFile

[68] INAIL, *Indagine sulla Sicurezza sul Lavoro (INSULA) (*Survey on Work-related Security*)*, 2014. Available at: https://www.inail.it/cs/internet/comunicazione/sala-stampa/conferenze-stampa/ucm_140537_indagine-nazionale-sulla-salute-e-sicurezza-sul.html

[69] TNO, *Nationale Enquête Arbeidsomstandigheden 2017* (Netherlands working conditions survey). Available at: https://www.cbs.nl/nl-nl/publicatie/2018/16/nationale-enquete-arbeidsomstandigheden-2017.

[70] Instituto Nacional de Seguridad e Higiene en el Trabajo (INSHT), *Séptima Encuesta Nacional de Condiciones de Trabajo 2011*, (Seventh National Survey on Working Conditions. 2011), Madrid. Available at: http://www.oect.es/InshtWeb/Contenidos/Documentacion/FICHAS%20DE%20PUBLICACIONES/EN%20CATALOGO/OBSERVATORIO/Informe%20(VII%20ENCT).pdf. .

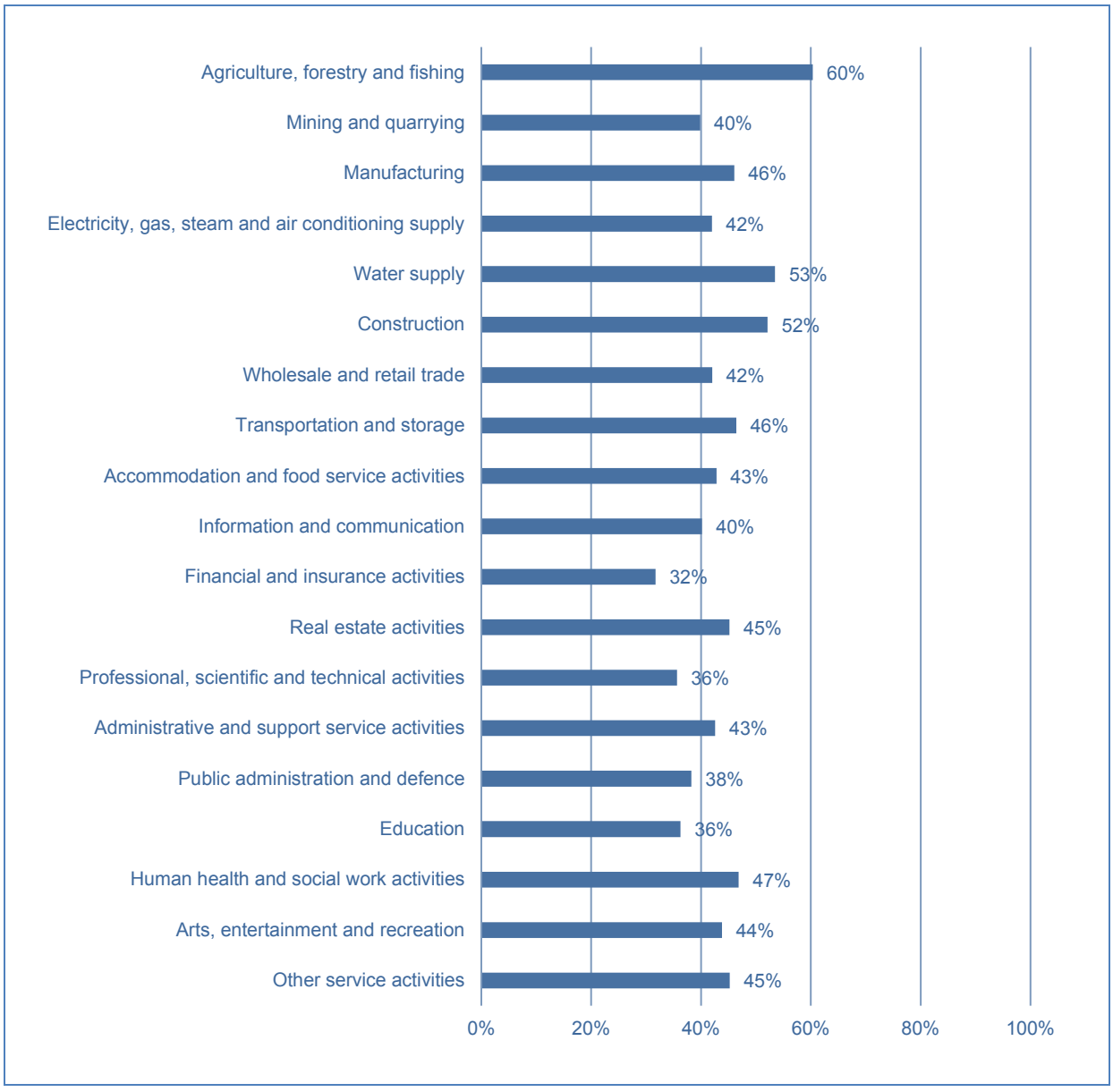
[71] MSDs in upper limbs are also mentioned relatively often by workers from the mining and quarrying sector. The number of observations from this sector is, however, limited (85), which makes it difficult to draw firm conclusions.

[72] This does not apply to the water supply sector, which was not distinguished as a separate sector.

communication, but according to the recent EWCS data these sectors are no longer associated with an above-average MSD prevalence (except for backache in transport and storage).

MSDs are least likely to occur in financial and insurance activities, professional, scientific and technical activities, education, and arts, entertainment and recreation[73].

Figure 20 Percentage of workers reporting backache in the past 12 months, by sector (Statistical Classification of Economic Activities in the European Community, NACE, rev. 2), EU-28, 2015

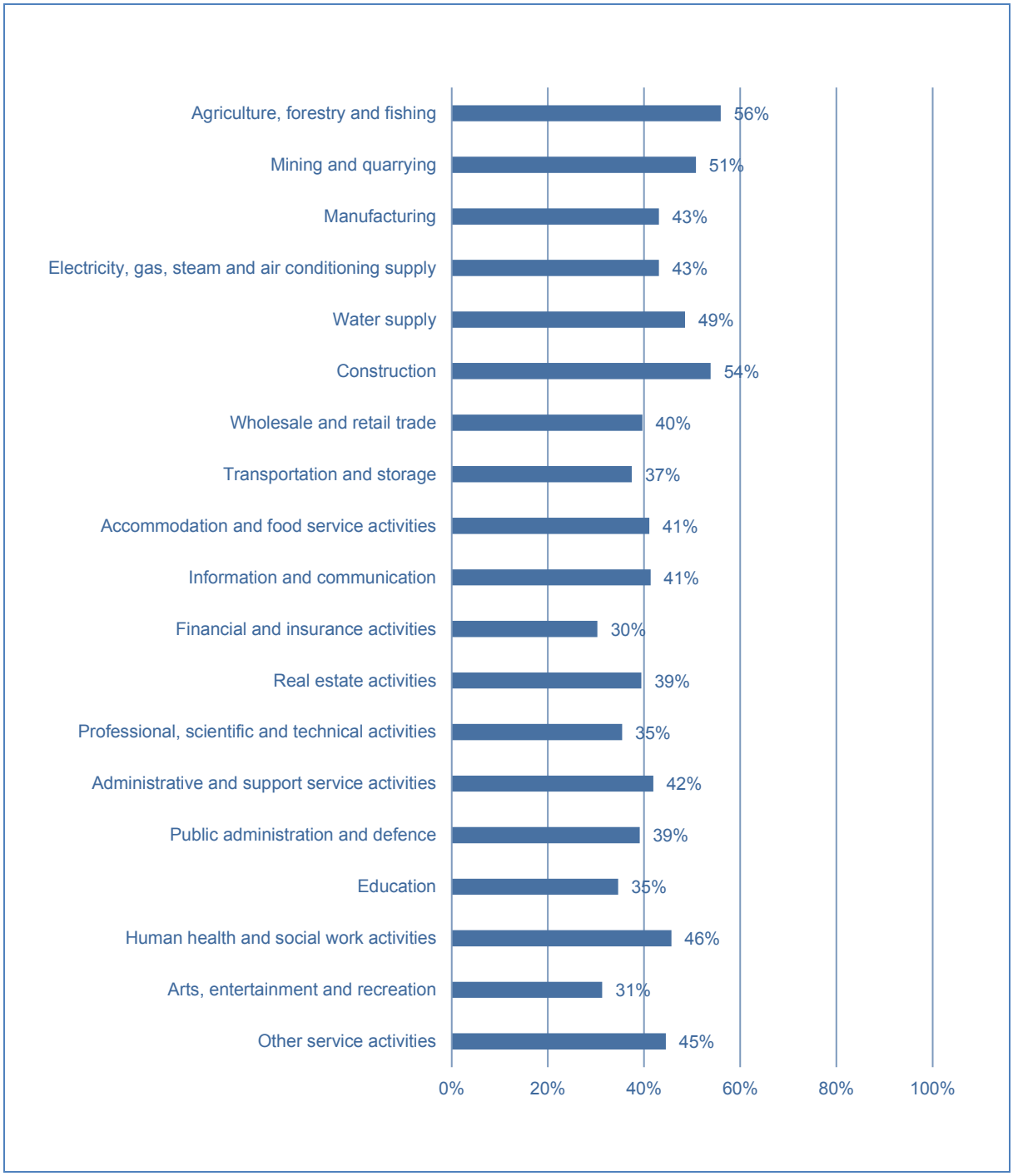


N = 35,536

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

[73] Owing to changes in the Statistical Classification of Economic Activities in the European Community (NACE) sector classifications, the sectors distinguished in this study do not always overlap with the sectors distinguished in EU-OSHA (2010). This is, for instance, the case with water supply, professional, scientific and technical activities, and with arts, entertainment and recreation. This makes a direct comparison of the results difficult.

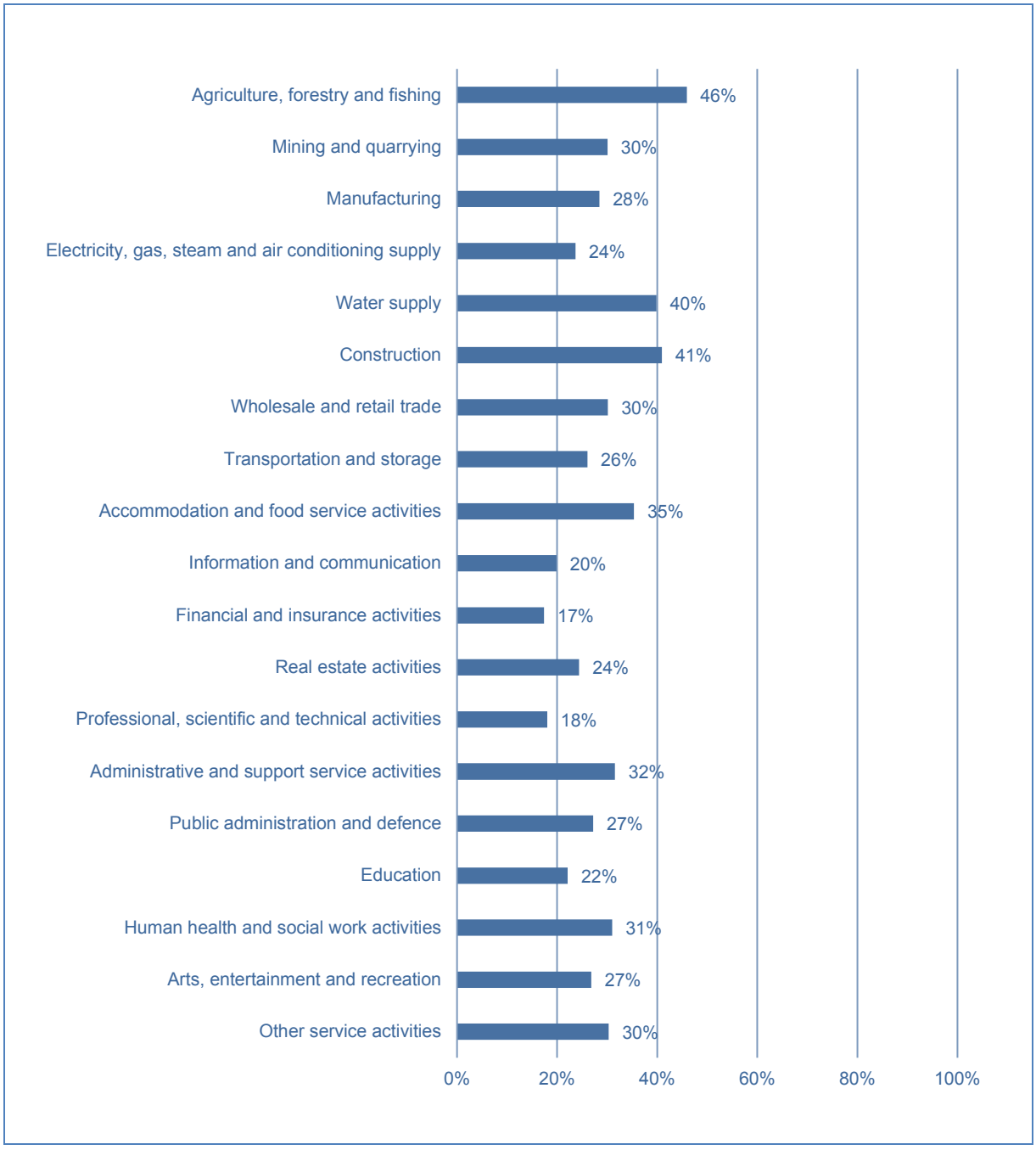
Figure 21 Percentage of workers reporting MSDs in the upper limbs in the past 12 months, by sector (NACE rev. 2), EU-28, 2015



N = 35,536

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 22 Percentage of workers reporting MSDs in the lower limbs in the past 12 months, by sector (NACE rev. 2), EU-28, 2015



N = 35,536

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Data from Member States**

The above argument can be complemented with information from the national reports. The available information indicates that the MSD prevalence by sector varies considerably between countries: not only the level of MSD prevalence by sector, but also the ranking of sectors by MSD prevalence. Although MSD prevalence in education, for example, is relatively low across the EU-28, it is relatively high in Spain and in the Netherlands. Furthermore, there is evidence indicating that specific body parts of workers are affected differently in different sectors.

Netherlands

In the Netherlands, neck and shoulder complaints are mostly reported in the education and healthcare sectors. Arm and elbow complaints are more common in construction and manufacturing, whereas wrist and hand complaints occur more frequently in manufacturing and health care. Finally, back complaints are more prevalent in trade and health care, while lower limb complaints are more common in health care and manufacturing[74].

Spain

In Spain, low back complaints are more prominent in sectors related to transport, construction and health activities. Neck complaints are reported more in sectors related to financial and insurance activities, information and communications, professional activities, real estate activities, public administration and education. Finally, upper limb complaints are mostly reported in sectors related to construction and water supply[75].

3.2.3 Organisation of work: occupation and employment status

- **MSD prevalence highest among blue-collar workers**

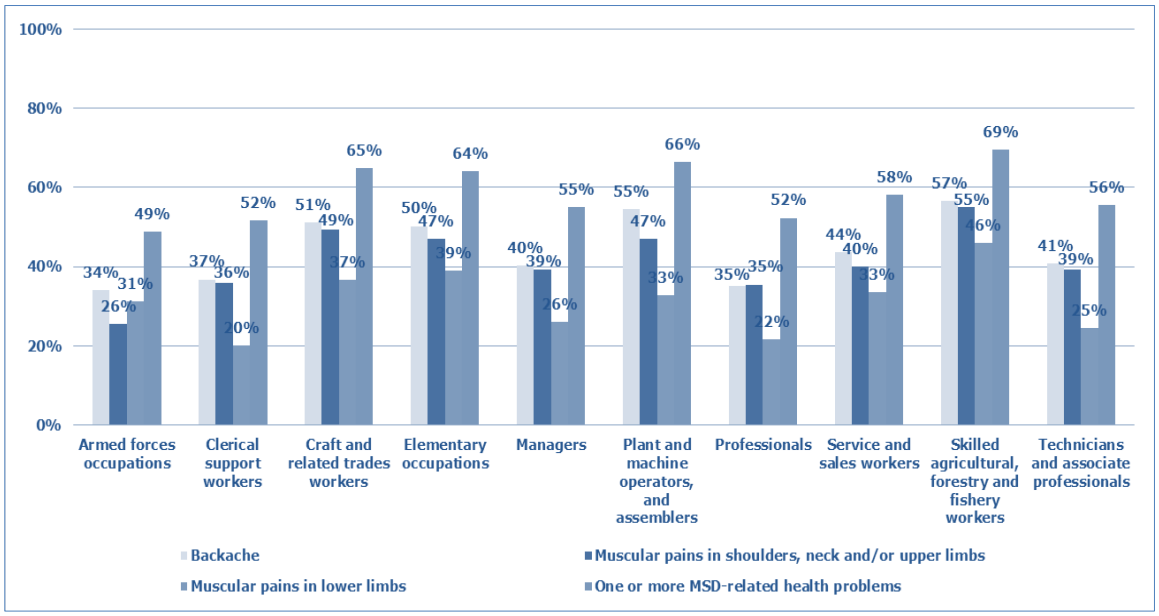
In 2015, around 69 % of skilled agricultural, forestry and fishery workers reported having one or several MSDs (Figure 23). MSD prevalence is also high among other occupations that may be seen as typical examples of blue-collar occupations, such as plant and machine operators and assemblers (66 %), craft and related trades workers (65 %) and workers in elementary occupations (64 %)[76].

These findings are similar to the findings in the previous EU-OSHA study on MSDs (EU-OSHA, 2010) based on EWCS data from 2005. Although the percentages cannot be compared directly (because of changes in the formulation of the MSD-related questions in the EWCS, as discussed in section 2.1), the ranking of the different occupations is very similar (with the highest prevalence of MSDs found among skilled agricultural, forestry and fishery workers, followed by machine operators and assemblers, craft and related trades workers and elementary occupations).

Within each of the occupational groups included in Figure 23, backaches are the most commonly mentioned, followed by MSD in upper limbs and MSDs in lower limbs in third place. For almost all occupations, the difference between backache and MSDs in upper limbs is small (not more than 3 percentage points).

[74] NEA (2017).
[75] Seventh Spanish Survey on Working Conditions (2011).
[76] Data on armed forces occupations are included in the graph but not discussed in the main text (given the low number of observations and the specific characteristics of this occupation).

Figure 23 Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by occupation (ISCO-08), EU-28, 2015



N = 35,536

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Prevalence of MSDs not related to employment status

One of the findings of the previous EU-OSHA study on MSDs (EU-OSHA, 2010) was that self-employed workers are more likely to report work-related MSDs than employees. This applied to backache as well as muscular pains.

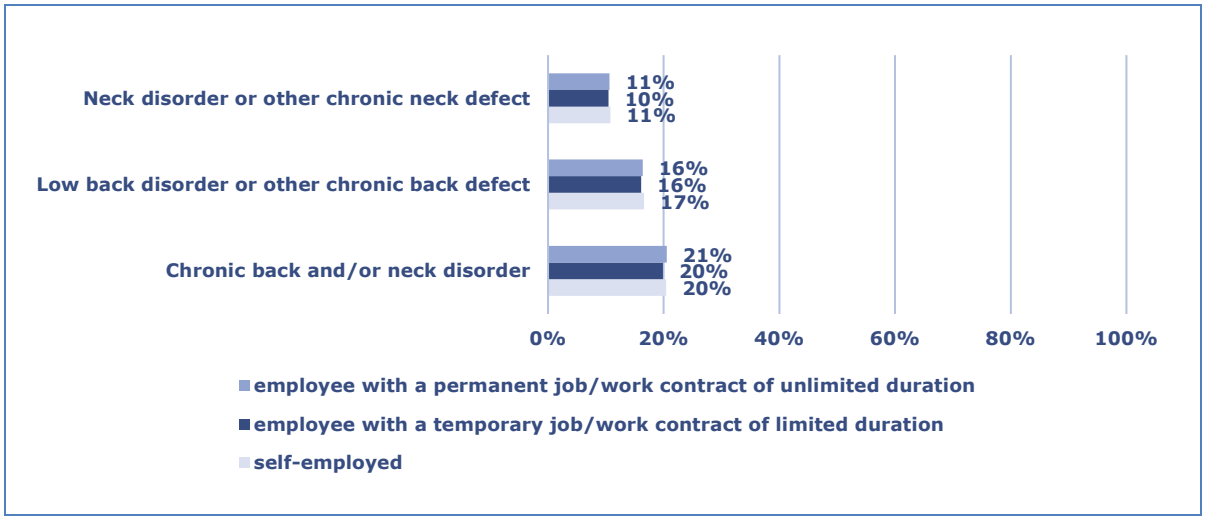
These findings refer to 2005. For 2015, however, data from the EWCS do not support the presence of a relationship between prevalence of MSDs and a worker's employment status (self-employed or employee), at least not for MSDs in general[77]. In 2015, the proportion of self-employed workers reporting MSD complaints in lower limbs was 2 percentage points higher than that of employees. For backache and MSD complaints in upper limbs, the difference between self-employed workers and employees is even smaller. Once gender, age, country, occupation and sector of the respondents are included in the analyses, the differences found are insignificant for all three types of MSDs[78].

The same picture arises if chronic MSDs are considered: the differences in chronic MSD rates (regarding neck and back) between self-employed workers and employees are negligible (Figure 24).

[77] As mentioned earlier, recent data on work-related MSDs are not available.

[78] This is based on a logistic regression with self-reported MSD complaints in upper limbs as the dependent variable, and gender, age, country, occupation, sector and employment status among the independent variables. More information on logistic regressions is included in Annex 2. The estimation results can be found in Annex 2.

Figure 24 Percentage of workers reporting different chronic musculoskeletal disorders in the past 12 months, by employment status, EU-28 (excluding Germany), 2014



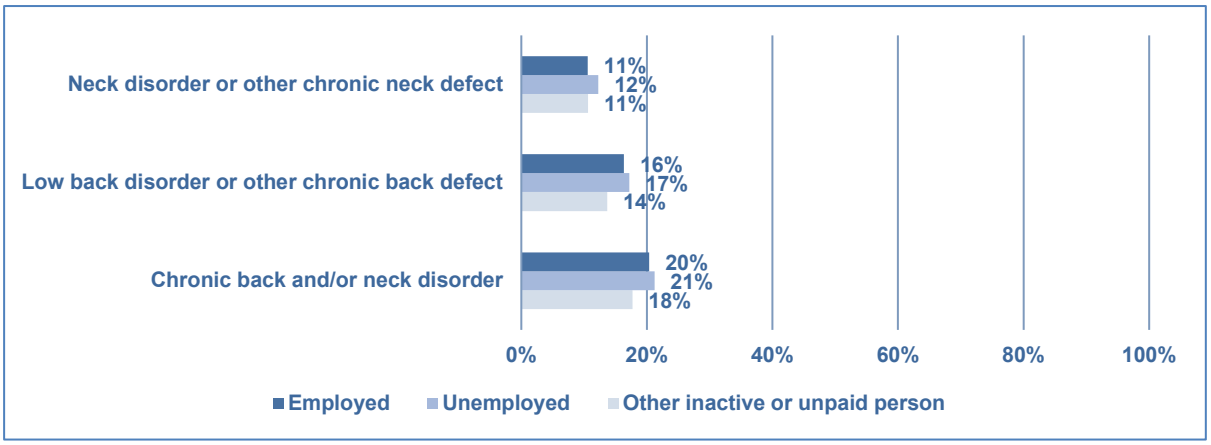
N = 122,005.

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

- **Prevalence of chronic MSDs varies only slightly between employed, unemployed and inactive people**

If the negative health effects of chronic MSDs become too severe, they may cause workers to leave the labour force. This could explain why the prevalence rate of chronic MSDs is slightly higher among unemployed people than employed workers (Figure 25). The difference between employed and unemployed people, however, is not large. One should also keep in mind that the reported chronic MSDs in neck and back are not restricted to work-related MSDs but are MSDs in general. It is therefore also possible that (at least for some unemployed people) the direction of the relationship is opposite: if the negative health effects of chronic (not work-related) MSDs become too severe, they may prevent people from finding a job. This is also consistent with a higher prevalence rate of chronic MSDs among unemployed people.

Figure 25 Percentage of persons reporting different chronic musculoskeletal disorders in the past 12 months, by labour status, EU-28 (excluding Germany), 2014



N = 176,613.

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

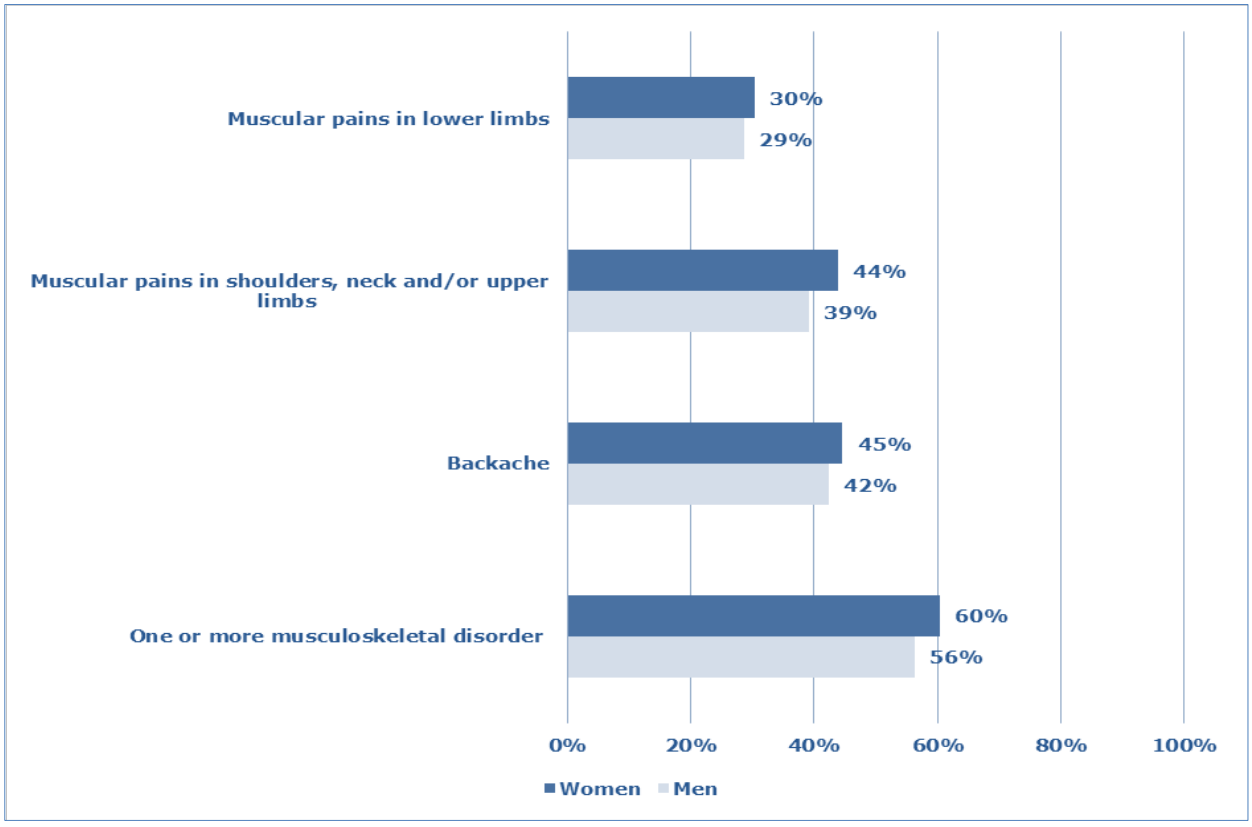
3.2.4 Sociodemographic factors: gender, age, education level and country of birth

- **Women report slightly more MSDs than men**

Previous studies have shown that women are more at risk of certain MSDs (such as carpal tunnel syndrome) and less at risk of other MSDs (such as lower back pain). This implies that, when studies examine the prevalence of MSDs among workers, the specific way in which MSDs are measured will affect the outcomes by gender. This could explain why some studies have found that women are more likely to report MSDs, while other studies have found the opposite. A higher prevalence rate among women has been reported by, among others, Andorsen *et al*. (2014), based on a Norwegian cohort study regarding chronic MSDs in upper limbs, lower limbs and back, and Eltayeb *et al*. (2007), based on a survey among Dutch office workers regarding MSDs in neck and upper limbs. A lower prevalence rate among women has been reported by EU-OSHA, based on the fourth EWCS wave, which covers work-related backaches as well as muscular pains (EU-OSHA, 2010).

Recent data from EWCS indicates that women are more likely than men to report MSD disorders in upper limbs, lower limbs or the back (Figure 26). This gender difference is also present within sectors and within occupations: additional analyses show that the likelihood of women reporting MSDs remains significantly higher than that of men, even when the analysis includes the worker's country, sector and occupation and the extent to which workers are faced with physical, organisational and psychosocial risk factors (this applies to upper limbs, lower limbs and back problems).

Figure 26 Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by gender, EU-28, 2015



N = 31,612

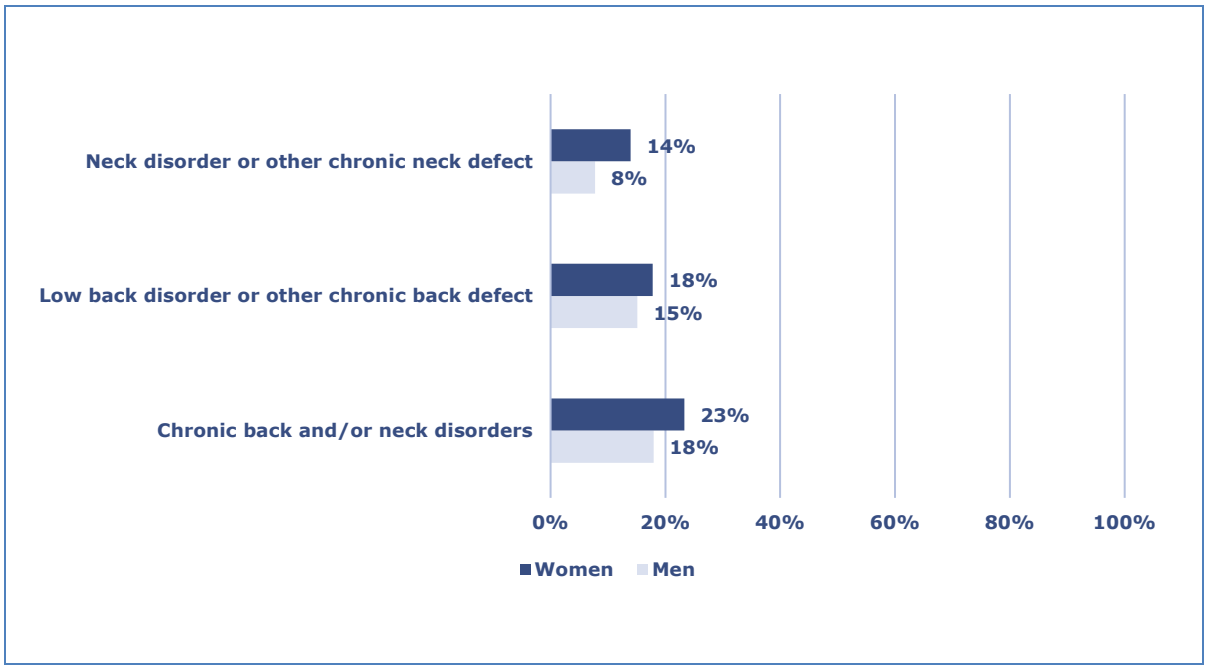
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Women are also more likely than men to report chronic MSD disorders in the neck and in the back, at least according to the most recent EHIS (Figure 27). These findings refer to MSDs in general (rather than work-related MSDs).

Taking into consideration data from the last LFS ad hoc module 'Accidents at work and other work-related health problems', the percentage of workers reporting MSDs as their most serious work-related health problem is almost the same for men and women (Figure 28).

Given these results, the overall picture suggests that, for MSDs in general, prevalence rates are higher for female workers than for male workers. It cannot be ruled out, however, that for more specific types of MSDs or for work-related MSDs an opposite gender gap (or no gender gap) exists. This will be further analysed in a forthcoming report (EU-OSHA, forthcoming, a).

Figure 27 Percentage of workers reporting different chronic musculoskeletal disorders in the past 12 months, EU-28 (excluding Germany), 2014

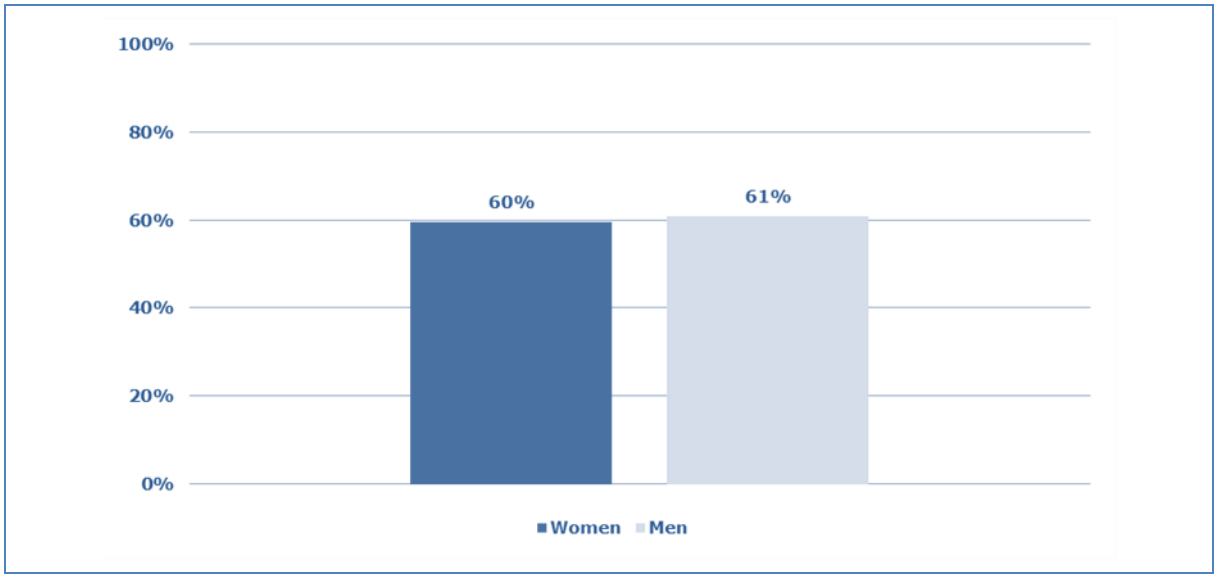


Note: The figure includes all EU-28 Member States except for Germany**.** The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 122,005

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

Figure 28 Percentage of workers reporting MSDs as most serious work-related health problem, by gender, EU-28, 2013 (% of workers with work-related health problem)



Note: 'Musculoskeletal disorders' refers to bone, joint or muscle problems. The population of workers includes everybody aged 15 to 64 who was working or had worked during the past 12 months before the survey took place.

Source: Eurostat, Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013)

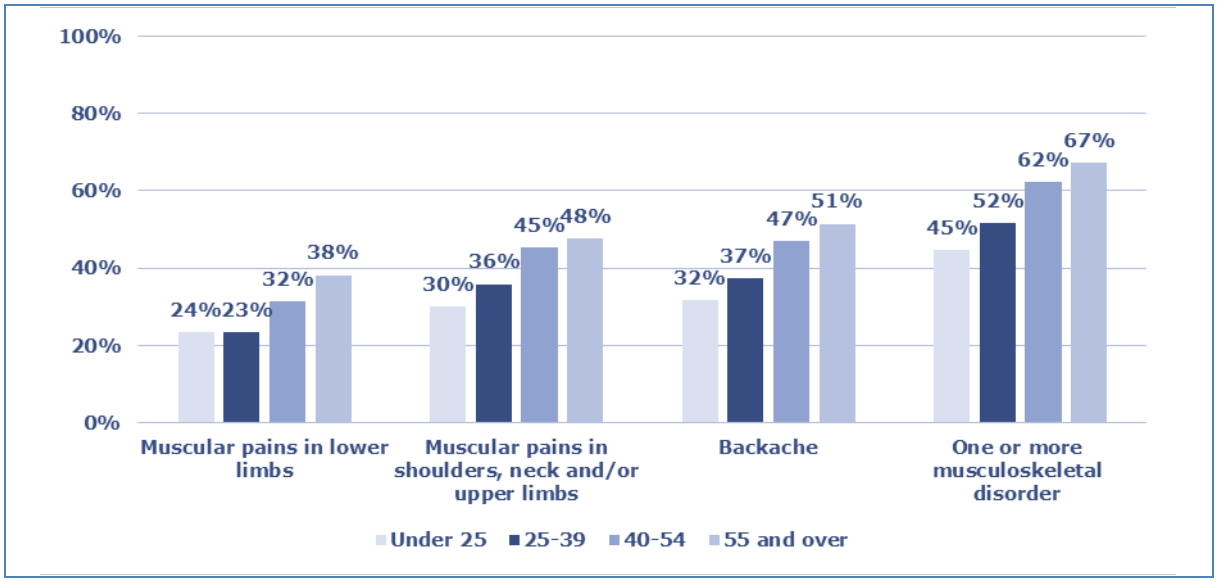
- **MSD prevalence is higher among older workers**

Higher age is associated with a significantly higher probability of reporting MSDs. This relationship between MSDs and age has been found before (as discussed in Chapter 2) and is confirmed by recent data on five different general MSD indicators. The relationship between age and MSD prevalence is confirmed for chronic MSDs as well as for all MSDs, and for MSDs in upper limbs, lower limbs and the back (Figure 29, Figure 30 and Figure 31).

These age differences are also present within sectors and within occupations: additional analyses show that the likelihood of reporting MSDs increases significantly with age, even when the analyses include the worker's country, sector and occupation and the extent to which workers are faced with physical, organisational and psychosocial risk factors (this applies to upper limbs, lower limbs and back problems)[79].

[79] This is based on logistic regressions with self-reported MSD complaints as the dependent variable, and gender, age, country, occupation and sector among the independent variables. These regressions have been run separately for MSDs in upper limbs, lower limbs and back. See Annex 2 for an elaborate discussion of these regressions. Tables with the main regression results can be found in Annex 2.

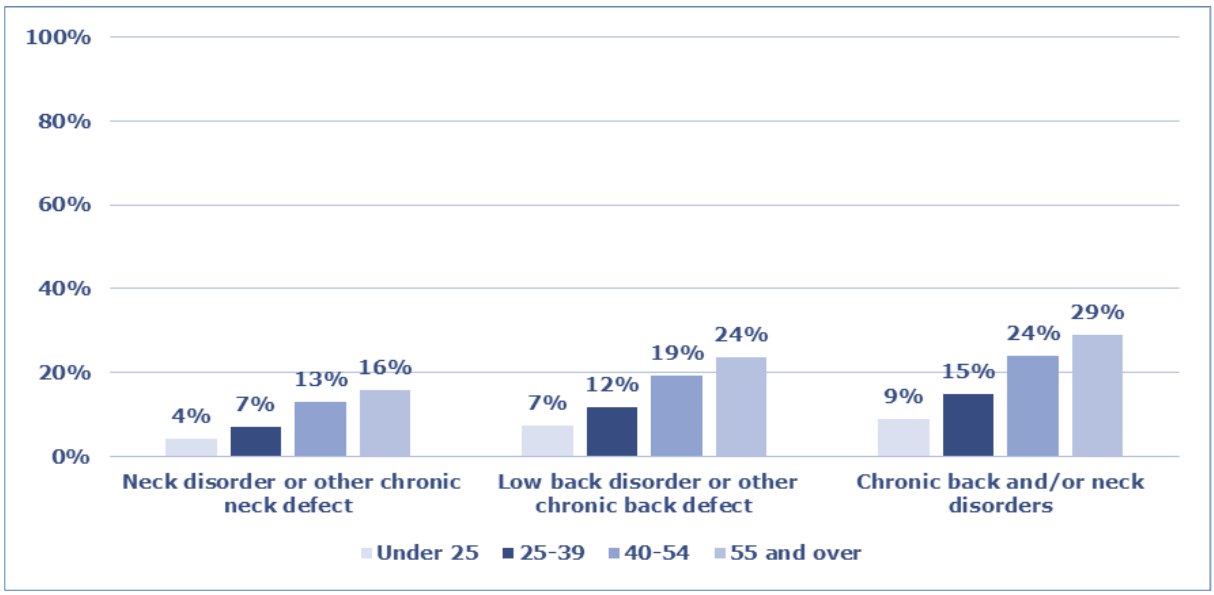
Figure 29 Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by age group, EU-28, 2015



N = 31,612 (2015)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 30 Percentage of workers reporting different chronic musculoskeletal disorders in the past 12 months, by age group, EU-28 (excluding Germany), 2014

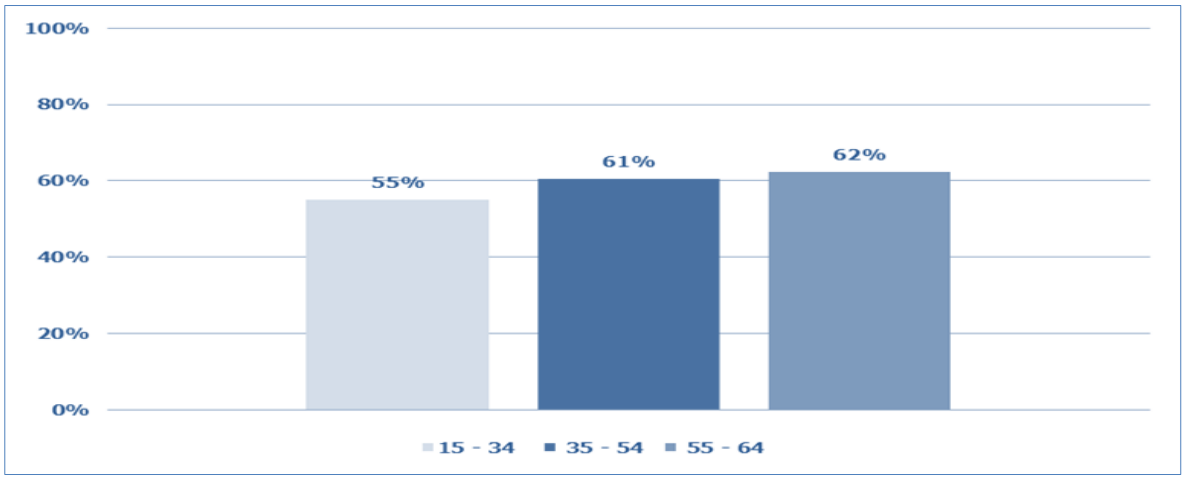


Note: The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 125,205.

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

Figure 31 Percentage of workers reporting MSDs as most serious work-related health problem, by age group, EU-28, 2013 (% of workers with work-related health problem)

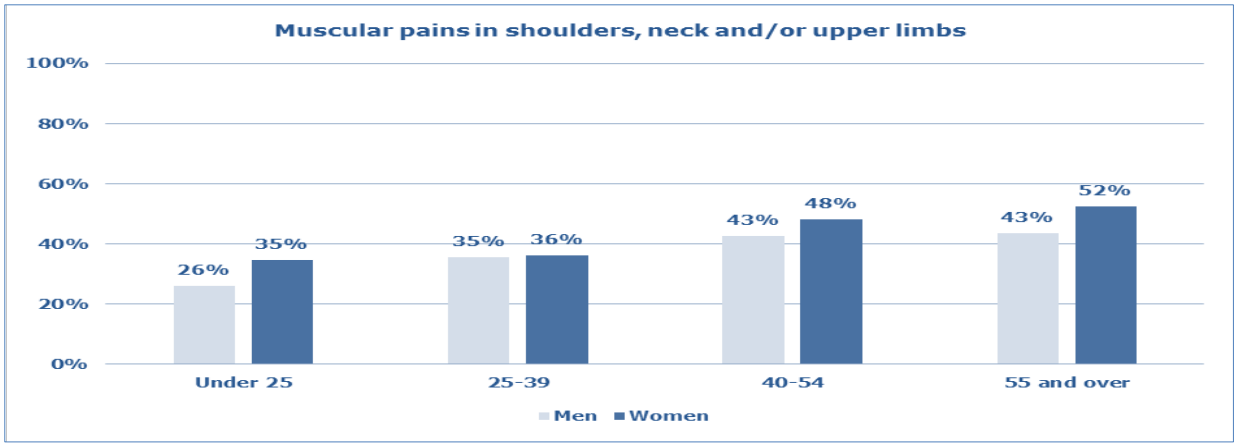


Note: 'Musculoskeletal disorders' refers to bone, joint or muscle problems.

Source: Eurostat, Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013)

For MSDs in upper and lower limbs, the extent to which MSD prevalence increases with age differs between male and female workers[80]. Already at a young age (less than 25 years of age) the MSD prevalence rate is higher for women than for men. This difference decreases at first (for the age group 25-39 the prevalence rates for male and female workers are very similar), but from that age category on the prevalence rate of MSDs in upper and lower limbs increases faster for female workers than for male workers (Figure 32 and Figure 33).

Figure 32 Percentage of workers reporting muscular pains in shoulders, neck and/or upper limbs in the past 12 months, by age group and gender, EU-28, 2015

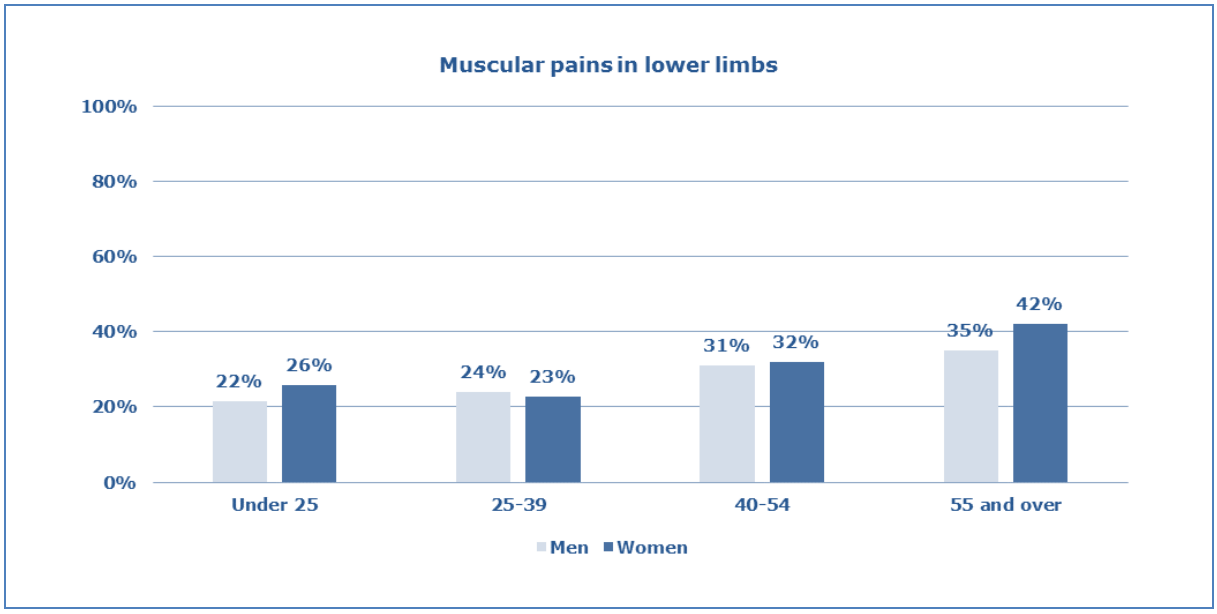


N = 35,677 (2015).

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

[80] Logistic regressions confirm that the relationship between age and MSD prevalence is significantly different for men and women. See Annex 2 for an elaborate discussion of these regressions (the estimation results for MSDs in upper limbs (Table 11) and lower limbs (Table 12)).

Figure 33 Percentage of workers reporting muscular pains in lower limbs in the past 12 months, by age group and gender, EU-28, 2015



N = 35,662 (2015)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Data from Member States

The above findings can be complemented with data from national-level sources, which confirm that prevalence differs by gender and age group. For two countries (Austria and France), national studies confirm that whether MSD prevalence is higher among men or women depends on the specific type of MSD.

Austria

Austrian data show that men complain more frequently than women about back pains (33.7 % versus 30.6 %, respectively) or about lower limb issues such as pains in hips, legs or feet (18.1 % versus 14.3 %, respectively). Women complain more than men about upper limb pains (23.4 % versus 14.9 %, respectively) and particularly in the neck, shoulders, arms or hands[81].

France

A more refined analysis for France shows that the prevalence of upper limb disorders during the preceding 12 months was higher for women than for men (67 % and 54 %, respectively), and the percentage of women who had symptoms for more than 30 days was also higher than the percentage of men (34 % and 20 %, respectively). The highest prevalence during the preceding 12 months was observed for the shoulder for men (37 %) and the hand/wrist for women (49 %). In general, women have significantly higher prevalence rates than men, except for the elbow/forearm. Similarly, another French study (Carton *et al*., 2019)[82] suggests that the prevalence of persistent pain varied between 14 % (in

[81] Statistik Austria, *Arbeitsunfälle und arbeitsbezogene Gesundheitsprobleme 2013* (Work accidents and work-related health problems), module of the Labour Force Survey 2013. (see http://www.statistik.at/web_de/services/publikationen/4/index.html?includePage=detailedView&sectionName=Gesundheit&pubId=694).

[82] Carton, M., Santin, G., Leclerc, A., Gueguen, A., Goldberg, M., Roquelaure, Y., Zins, M. & Descatha, A., 'Prévalence des troubles musculo-squelettiques et des facteurs biomécaniques d'origine professionnelle: premières estimations à partir de Constances' (Prevalence of musculoskeletal disorders and occupational biomechanical factors: preliminary estimates from the French CONSTANCES cohort), *Bulletin Epidémiologique Hebdomadaire*, No 35-36, 2016, pp. 630-639.

the elbow) and 35 % (in the back) in women and between 9 % and 24 % for men (respectively for the same locations)[83].

Netherlands

Data from the Netherlands[84] indicate that complaints in several specific body locations are reported more by female workers but also by those workers in the age group from 55 to 64 years old, particularly in comparison with the youngest groups.

Spain

In Spain, national data show that female workers are more likely to suffer from MSD-related health problems than male workers. As far as the age of workers is concerned, the evidence shows that, the older the employed person is, the more likely he or she is to suffer from work-related MSD health issues[85].

Sweden

National data from the Swedish Work Environment Authority (Arbetsmiljöverket, 2017a) show that a third of the entire working population reported that they suffered at least once per week from pain in the back or neck after working, and this percentage was higher among women than men (45 % versus 28 %, respectively)[86].

United Kingdom

According to the UK Health and Safety Executive (2018)[87], older female workers had significantly higher rates of self-reported work-related MSDs than younger female workers. In particular, women in the age groups of 45-54 and over 55 had prevalence rates of 1,960 and 2,200 cases per 100,000 workers, respectively (average data for years 2015-2018). Female workers aged 16-34 years had a rate of 740 cases per 100,000 workers and those aged 35-44 years had a rate of 1,440 cases per 100,000 workers. According to this, the overall rates for male and female workers did not show significant differences.

▪ MSD prevalence decreases with education level

There is also a clear relationship between the probability of reporting MSDs and education level: workers with only pre-primary or primary education are more likely to report muscular pains in the upper limbs, lower limbs and/or back, and are also more likely to report chronic MSDs. A possible explanation is that less educated people are segregated into jobs with higher MSD risks. Another possibility is that more educated workers have more opportunities to prevent or be protected from MSDs (for example by adopting good working postures, or because of more autonomy at work, better health in general and better access to the health system). With each higher education level the MSD prevalence rates tend to reduce (Figure 34 and Figure 35).

[83] Coset-MSA: Cercier, E., Fouquet, N., Bodin, J., Chazelle, E., Geoffroy-Perez, B., Brunet, R. & Roquelaure, Y., 'Prévalence des symptômes musculo-squelettiques du membre supérieur chez les travailleurs de l'agriculture en France en 2010: résultats de la phase pilote de Coset-MSA' (Prevalence of upper-limb musculoskeletal symptoms in French agricultural workers in 2010: results of the pilot phase of COSET-MSA study), *Bulletin Epidémiolique Hebdomadaire*, No 8, 2015, pp. 134-141.

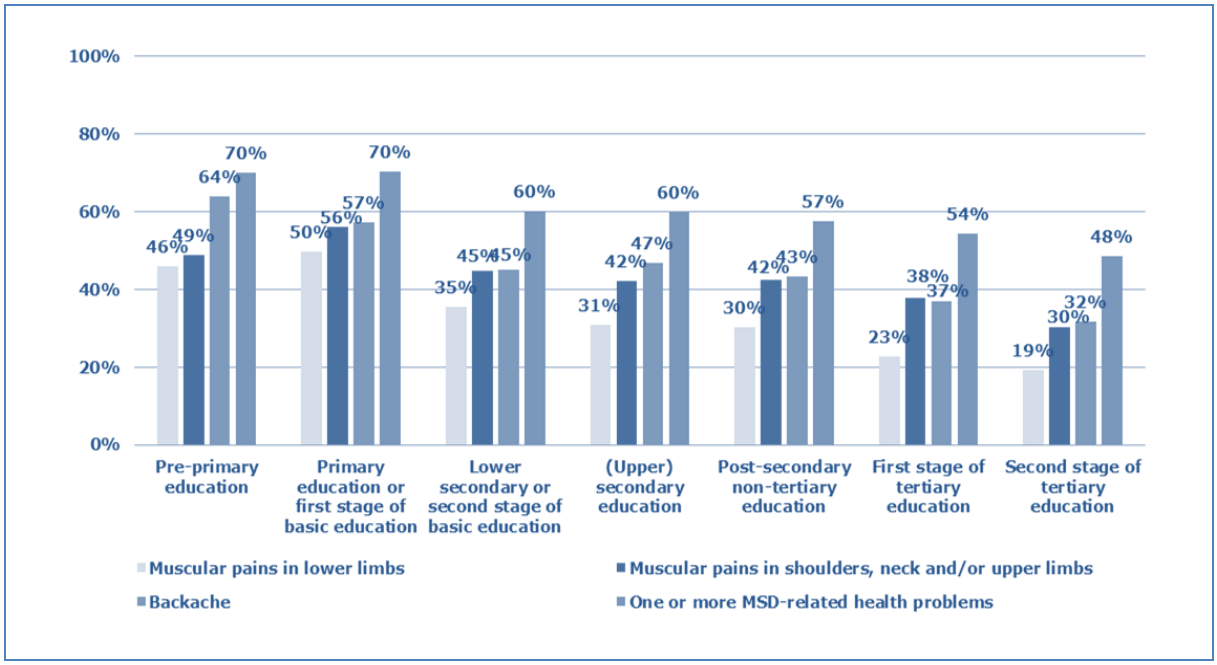
[84] NEA (2017). For more information see national report of the Netherlands.

[85] Instituto Nacional de Seguridad e Higiene en el Trabajo (INSHT), *Encuesta Nacional de Condiciones de Trabajo 2015 6ª EWCS* (Spanish National Survey on Working Conditions based on the sixth wave of the EWCS, 2015), Madrid, (see http://www.oect.es/InshtWeb/Contenidos/Documentacion/FICHAS%20DE%20PUBLICACIONES/EN%20CATALOGO/GENERALIDAD/ENCT%202015.pdf) .

[86] Arbetsmiljöverket, *Arbetsmiljön 2017: the work environment 2017*, October 2018. Available at: https://www.av.se/globalassets/filer/statistik/arbetsmiljon-2017/arbetsmiljostatistik-arbetsmiljon-2017-rapport-2018-2.pdf

[87] Health and Safety Executive, *Work related musculoskeletal disorders in Great Britain (WRMSDs), 2018*, 2018, p. 6. Available at: http://www.hse.gov.uk/statistics/causdis/msd.pdf

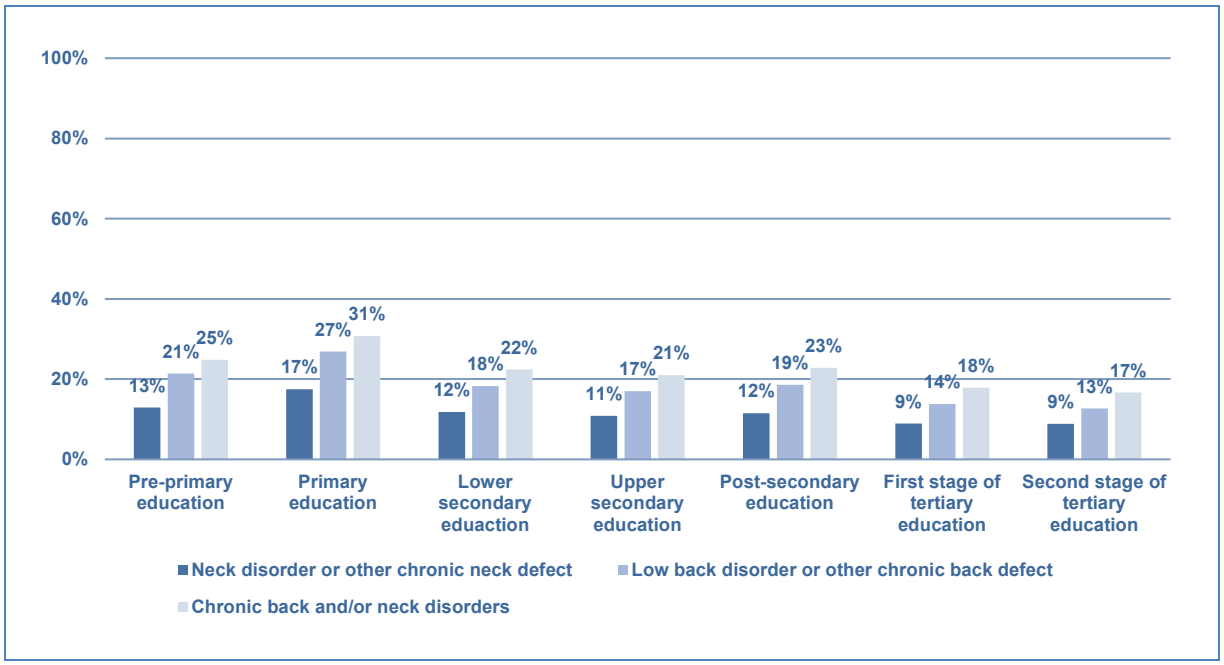
Figure 34 Percentage of workers reporting different musculoskeletal disorders in the past 12 months, by education level, EU-28, 2015



N = 35,538 (2015)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 35 Percentage of workers reporting different chronic musculoskeletal disorders in the past 12 months, by education level, EU-28 (excluding Germany), 2014



Note: The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 124,669.

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

Interesting findings emerge from German sources regarding education level, MSDs and days of sick leave. According to the BKK Health Report 2017[88], the higher the education or occupational level of a worker, the less sick leave. The days of absence due to MSDs among workers with low levels of education or vocational qualifications are significantly higher than among those with higher levels. Sick leave due to musculoskeletal disorders is more prevalent in occupational groups exposed to high physical demands (e.g. manufacturing occupations and construction professions). Workers in physically demanding jobs also have particularly high absenteeism rates due to musculoskeletal disorders (e.g. manufacturing professions).

- **MSD prevalence hardly affected by country of birth**

Previous studies have shown that migrant workers tend to be segregated into jobs with higher MSD risks, and that the working conditions of migrant workers are usually unfavourable compared with those of non-migrants (see Chapter 2). Migrants are usually defined by their nationality (EU-OSHA, 2007c[89]), but information on nationality is not always available in surveys. For example, neither EHIS nor the EWCS includes information on nationality. Instead, information on country of birth is available. This is a good indicator of a person's nationality, but it is not perfect. It does have a specific advantage over nationality: whereas people can have more than one nationality (in which case the definition of migrants may be difficult to apply), by definition they have only one country of birth.

The segregation of workers into jobs with higher MSD risks may pass on the next generation: children of migrants may also be segregated into such jobs. To examine to what extent this is the case, information on country of birth is used to distinguish three groups rather than two:

- native workers — workers who were born in the country they are currently working in, and whose parents were also born in the country the workers are currently working in;
- first-generation immigrants — workers born in another country;
- second-generation immigrants — workers who were born in the country they are currently working in, with at least one parent born in another country.

The extent to which (first- and second-generation) immigrants may be segregated into jobs with higher MSD risks will be the topic of a specific EU-OSHA study (EU-OSHA, forthcoming, a). Here, it is examined whether or not (first- and second-generation) immigrants are more likely to report having MSDs than native workers, after controlling for this kind of segregation. Analysis of the EWCS database finds no support for a difference between first-generation immigrant workers and native workers, but second-generation immigrants are more likely to report MSDs than native workers. The differences from native workers are, however, not very significant. The increased risk for second-generation immigrants is because they have to deal with worse working conditions: once physical, organisational and psychosocial risk factors are controlled for, a workers' country of birth is no longer related to the prevalence of MSDs[90]. This applies to MSDs in the upper limbs, lower limbs and back.

Information on chronic MSDs is based on the EHIS database. This database does not include information regarding country of birth of respondent's parents (so differentiation between first-generation and second-generation immigrants is not possible), but instead allows us to distinguish between first-generation immigrants from EU Member States and first-generation immigrants from outside the EU.

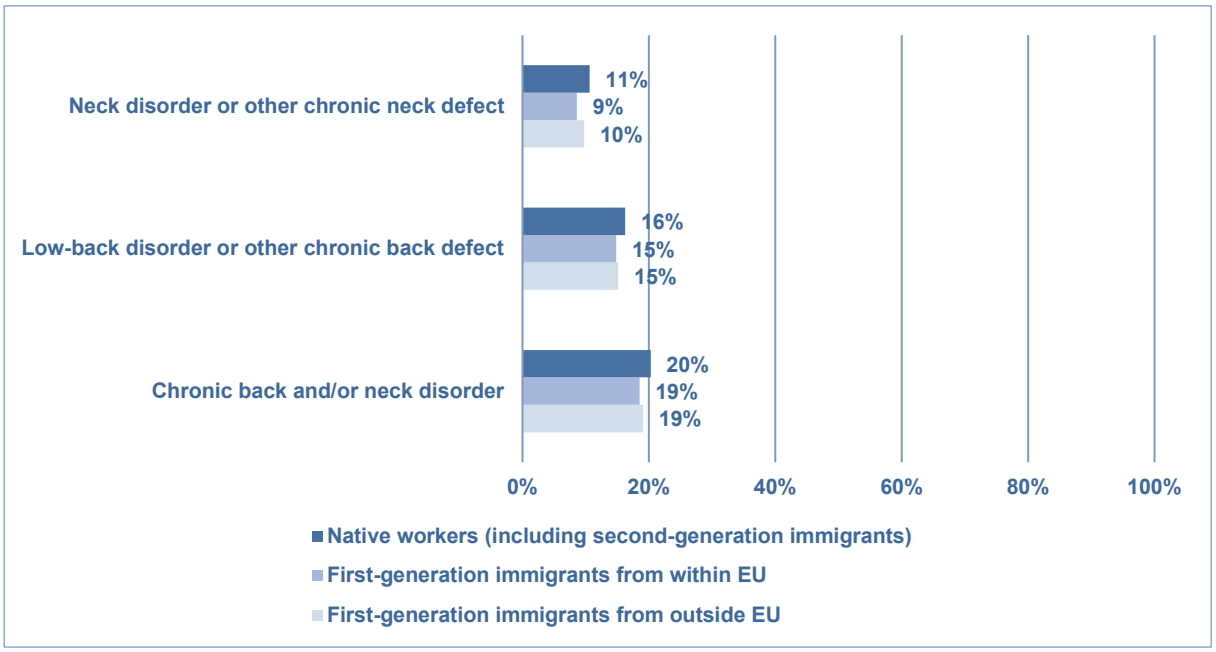
[88] Knieps, F. & Pfaff, H., editors, *Digitale Arbeit — Digitale Gesundheit: Zahlen, Daten, Fakten mit Gastbeiträgen aus Wissenschaft, Politik und Praxis*, Medizinisch Wissenschaftliche Verlagsgesellschaft (Digital Work -Digital Health: Figures and Facts with Contributions from Science, Politics and Praxis), 2017. Available at: https://www.bkk-dachverband.de/fileadmin/publikationen/gesundheitsreport_2017/BKK_Report_2017_gesamt_final.pdf

[89] EU-OSHA — European Agency for Safety and Health at Work, *Literature study on migrant workers*, Office for Official Publications of the European Communities, Luxembourg, 2007. Available at: https://osha.europa.eu/en/tools-and-publications/publications/literature_reviews/migrant_workers

[90] This is based on logistic regressions with self-reported MSD complaints as the dependent variable, and gender, age, country, occupation, sector and risk factors among the independent variables. These regressions have been run separately for MSDs in upper limbs, lower limbs and back. See Annex 2 for an elaborate discussion of these regressions, and specifically Annex 2.3 for the estimation results.

The results indicate that prevalence of chronic MSDs varies only slightly between native workers and first-generation immigrants from either within or outside the EU (Figure 36).

Figure 36 Percentage of workers reporting different chronic musculoskeletal disorders in the past 12 months, by country of birth, EU-28 (excluding Germany), 2014



Note: The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 122,944 (neck disorder or other chronic neck defect); *N* = 122,972 (low back disorder or other chronic back defect); *N* = 123,983 (chronic back or neck disorder)

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

3.3 Administrative data on MSDs

In the previous section, data related to the prevalence of MSD based on self-reporting through surveys have been presented. In this section, administrative data on MSDs are presented.

Based on available data from ESAW, insight is given into the types of accidents that are most likely to lead to MSD complaints. Further insight is provided on the basis of the national data collected in the context of this study.

Next, data are presented on the extent to which MSDs are recognised as Occupational Diseases (ODs). In the past, the European Statistics on Occupational Diseases (EODS) collected comparative administrative data for EU countries. Currently, no update is available for the EODS data, so this data source has not been used in the framework of this report.

Finally, data from the World Health Organisation (WHO) are presented, on the percentages of people who have been hospitalised due to MSDs and connective tissue diseases.

3.3.1 Declared work accidents

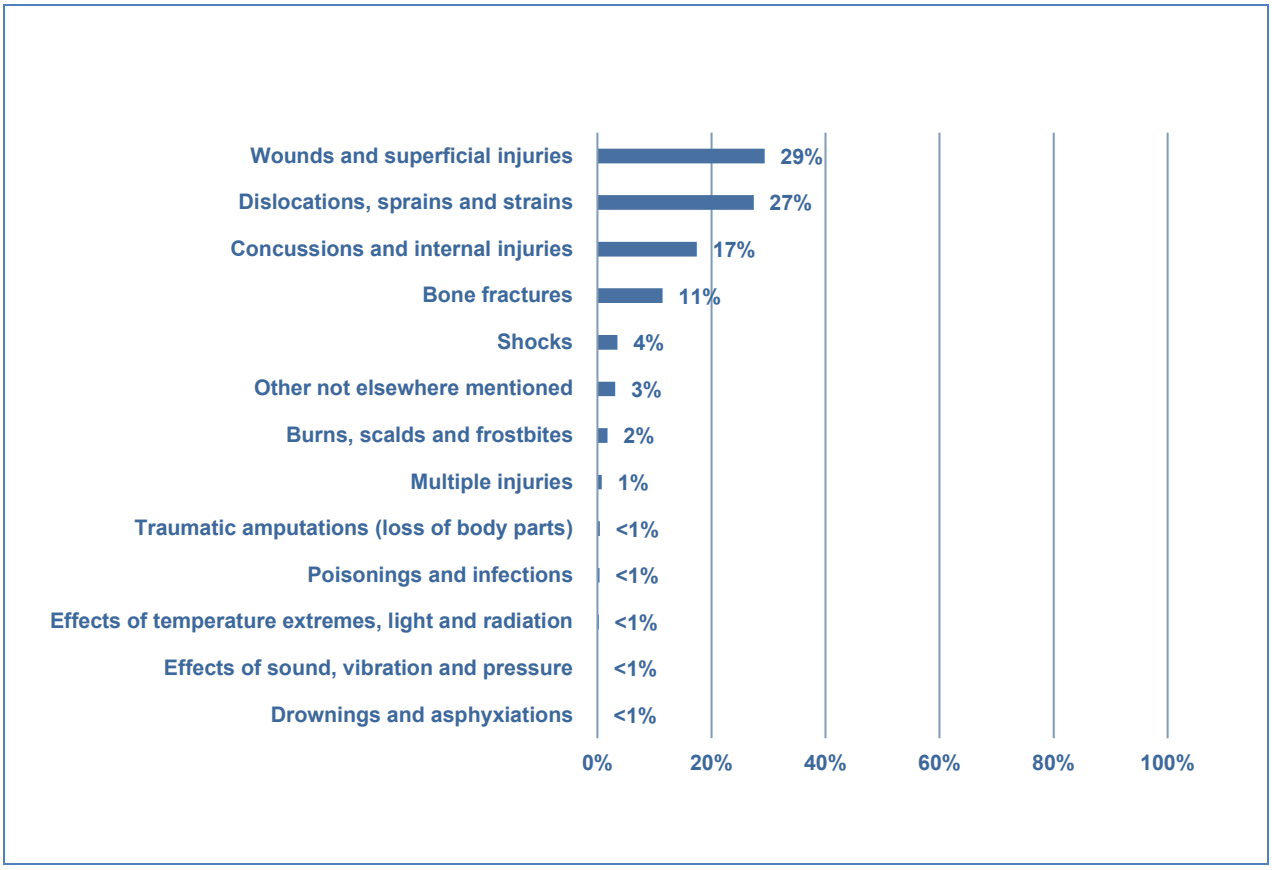
Among the different types of accidents that are distinguished in ESAW, the following types may be considered most likely to lead to MSD complaints:

- dislocations, sprains and strains;
- bone fractures;

In 2016, these types of accidents accounted for 38 % of all reported fatal and non-fatal serious accidents at work (Figure 37). In particular, dislocation, sprains and strains are the second most common group of work-related injuries in the EU-28, after wounds and superficial injuries, accounting for 27 % of all fatal and non-fatal work-related injuries. Bone fractures are lower, at 11 %.

By focusing on the trends in these types of injuries (Figure 38), it can be noted that the percentage of accidents at work due to bone fractures and traumatic amputations hardly shows any variation during the period 2010-2016. Work-related dislocation, sprains and strains show a downward trend in the period until 2013, with a small increase in later years, without, however, reaching the percentage in 2010.

Figure 37 Distribution of fatal and non-fatal accidents at work by type of injury, EU-28, 2016

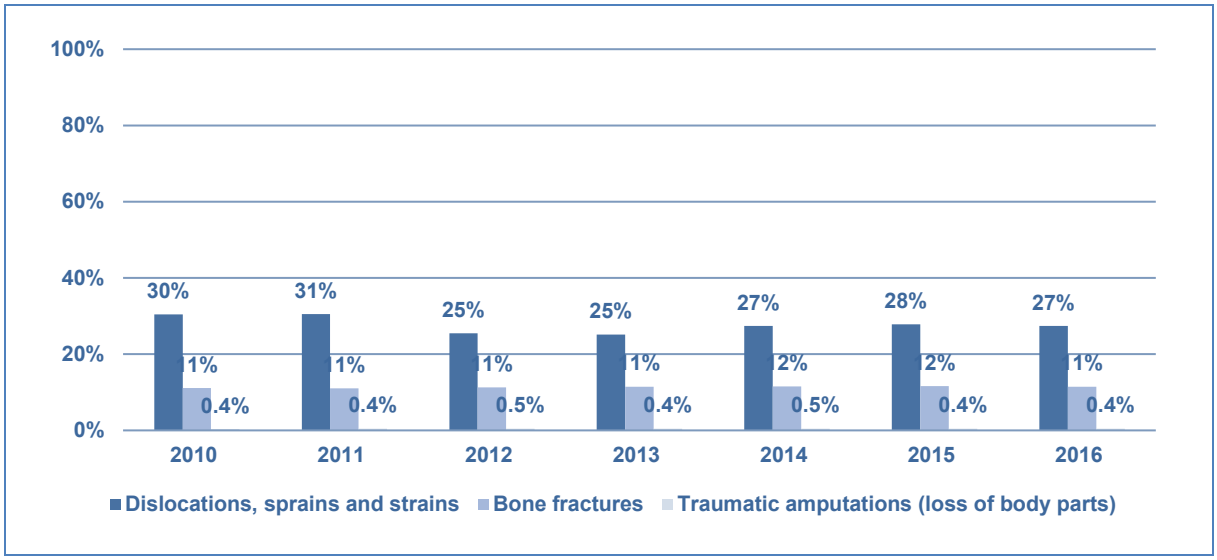


Note: Non-fatal (serious) accidents reported in the framework of ESAW are accidents that imply at least 4 full calendar days of absence from work. Provisional.

N = 3,288,581

Source: Eurostat, ESAW

Figure 38 Trend in percentages of fatal and non-fatal accidents at work due to dislocations, sprains and strains, bone fractures and traumatic amputations, EU-28, 2010-2016



Note: Non-fatal (serious) accidents reported in the framework of ESAW are accidents that imply at least 4 full calendar days of absence from work. Provisional.

N = 3,586,077 (2010); *N* = 3,418,876 (2011); *N* = 3,169,332 (2012); *N* = 3,131,220 (2013); *N* = 3,224,848 (2014); *N* = 3,215,588 (2015); *N* = 3,288,581 (2016)

Source: Eurostat, ESAW

- **Data from Member States**

Data from national sources provide more detailed information on work-related accidents and MSDs. The examples below show information regarding the proportions of MSD-related work accidents among total work accidents for Spain, Sweden and the UK. In several cases, gender differences and differences between workers of different age groups are also mentioned.

Spain

In 2017 in Spain there were a total of 515,082 work accidents resulting in sick leave, of which around 38 % (or 192,029 in absolute terms) were caused by musculoskeletal overload, well above other reasons such as a blow against a stationary object/worker in motion or a shock or hit against an object in motion (25 % and 14 % of total work accidents, respectively). Musculoskeletal overload was consistently the main cause of work accidents during the period 2014-2017.

These MSD-related work accidents particularly affect workers aged 40-49 years old and 30-39 years old (32 % and 28 % of the total number of work accidents or 61,284 and 54,432 in absolute numbers). Men had 68 % of the total number of MSD-related accidents, in comparison with 32 % for women (130,478 and 61,551 work accidents, respectively).

In terms of the main causes (deviation) underpinning these MSD-related work accidents, two main deviations explain nearly 9 out of 10 of the existing MSD-related work accidents. These are body movement under/with physical stress, and body movement without any physical stress, representing 65 % and 24 % of the total MSD-related work accidents, respectively.

Finally, in terms of the body parts affected, the available information for 2017 shows that these MSD-related work accidents particularly affect three main areas, the back (including spine and thoracolumbar

vertebrae) followed by upper limbs and lower limbs (37 %, 27 % and 25 % of the total cases, respectively)[91].

Sweden

The Swedish Work Environment Authority publishes statistics on the distribution of work accidents by type of disease. MSDs are the most common work-related source of work accidents for men in Sweden (40 % of their reported work accidents correspond to MSDs). Meanwhile, for women, psychosocial diseases are the most important source of work accidents (42 % of accidents), followed by work-related MSDs (28 %)[92].

United Kingdom

Data from the Labour Force Survey (3-year average of the period 2009-2012) provide information on the prevalence rate of work-related MSDs that are caused or made worse by workplace accidents. Around 140 cases per 100,000 workers were related to workplace accidents. This rate was lower than for manual handling, tiring/awkward positions and keyboard or repetitive actions (740, 370 and 230 cases per 100,000, respectively) but higher than for stress-related actions (40 cases per 100,000)[93].

3.3.2 Occupational diseases

In 2016, a study was carried out by Eurogip[94] focusing on the recognition of MSDs as ODs in 10 European countries (Austria, Belgium, Denmark, Germany, Finland, France, Italy, Spain, Sweden and Switzerland).

The report presents an overview of:

- MSDs liable to be recognised as ODs;
- national insurance regulations and practices regarding recognition and compensation;
- the number of MSDs in terms of claims for recognition and recognised cases in 2014 and the development over the period 2007-2014.

Based on the list of recognised ODs, three types of MSDs are distinguished: osteoarticular disorders (tendinopathy, meniscopathy, bursitis and hygroma), neurological disorders of the limbs and the spinal column, and vascular disorders and angioneurotic disorders (hand-arm system). Notice that these MSD types are based on the clinical nature of the complaint, rather than the location of health complaints (as in the case of self-reported MSDs).

The statistical data presented are provided by the Ministry of Labour (Spain), the Finnish Institute of Occupational Health (Finland) and national occupational risk insurance organisations (the other countries included in the study). Given the differences in insurance regimes, this means that the data do not cover the same population in each country. In addition, the structure of the working population (gender, age, sector structure, full-time/part-time contracts, etc.) varies by country.

[91] Spanish Ministry of Labour, Migrations and Social Security, *Estadísticas sobre Accidentes de Trabajo* (Statistics on Work Accidents, several years). Available at: http://www.mitramiss.gob.es/estadisticas/eat/welcome.htm.

[92] Swedish Work Environment Authority, Work accidents and Occupational diseases, several years. Access to database available at: http://webbstat.av.se/QvAJAXZfc/opendoc.htm?document=accesspoint%5Carbetsskadestatistik.qvw&host=QVS%40vmextapp02-hk&anonymous=true&sheet=SH_Avancerad.

[93] Information obtained from Health and Safety Executive (2018).

[94] Eurogip, *Musculoskeletal disorders: what recognition as occupational diseases? A study on 10 European countries*, 2016. Available at: https://www.eurogip.fr/en/projects/publications-d-eurogip/4428-msds-what-recognition-as-occupational-diseases-in-europe

Table 3 MSDs in ratios (relative to the insured population) and percentages, 10 countries, 2014

Country	Per 100,000 insured persons		Proportion of MSDs in the total of recognised ODs (%)	Recognition rate of MSDs (%)
	Reported	Recognised		
Austria	Not available	1	3	Not available
Belgium	263	82	69	31
Denmark	257	22	16	8
Germany	23	3	3	12
Finland (2013)	21	10	12	46
France (2013)	463	322	88	69
Italy (2012)	150	64	69	43
Spain	Not available	94	75	Not available
Sweden	15	7	32	48
Switzerland	13	6	10	44

Note: The ratios per 100,000 insured persons compare the number of new cases of MSDs in 2014 with the insured population in that year.

Source: Eurogip (2016)

These ratios are not incidence rates in the epidemiological sense of the term, but compare the number of new cases of MSDs in 2014 with the insured population in the same year.

As Table 3 shows, France, Belgium and Denmark have the highest proportions of MSDs reported as ODs per 100,000 insured persons (463, 263 and 257, respectively) and Germany, Finland, Sweden and Switzerland have the lowest proportions (between 23 and 13). The differences between countries are even larger when the MSDs that are recognised as ODs are compared. The proportion ranges from 322 in France to 1 in Austria.

Different possible explanations for these country differences have been examined, including:

- The specific MSDs that are included in recognition lists. These vary considerably between countries, in terms of both how they are organised (e.g. by location in the body, by type of disease or by cause) and how detailed they are. Nevertheless, the study concludes that 'most MSDs are covered by all the list systems, and there are no major differences between countries regarding the exposure criteria when they are set out formally' (Eurogip, 2016, p. 6).
- Whether or not recognition is based on assessing a causal link between occupational exposure and the disease. If this is the case, the list of recognised MSDs has only an indicative role. Recognition depends on the experience and scientific expertise of the manager in charge of the case. This is even more so if each claim has to be examined on a case-by-case basis.
- The performance of the national reporting systems (in particular, the extent to which the reporting procedures are open to workers reporting MSDs and/or to their doctors, since these parties may be expected to encourage the procedure).
- The levels of awareness of MSD issues among the general public and workers.

According to the Eurogip study, none of these explanations can explain the country differences in the proportions of reported MSDs. The country differences are probably related to the consequences of reporting (claimants' knowledge of the chances of the disease being recognised as work-related, the benefits and compensation of recognition, etc.). These (perceived) consequences do not seem to be related to the prevalence of MSDs, given that the ranking of the countries by ODs reported per 100,000 insured persons (Table 3) is very different from the ranking by self-reported MSDs (Figure 18).

Next to data for 2014, the report also presents the trends between 2007 and 2014. In most cases the trends can be explained by changes in the regulations.

- Switzerland, Sweden (stabilising from 2012 on) and Finland (stabilising in 2013) show a continuous and regular decline in the number of MSDs reported and recognised.
- Denmark and Spain show relatively stable curves since 2007, with a slight downward trend (since 2013 in Denmark).
- In Italy, MSDs have apparently stabilised since 2012, after growing continuously.
- Belgium has experienced a continuous increase in MSDs since 2011.
- In France, following a continuous increase, there has been a reversal of the trend since 2012.

Data from Member States

More detailed data on the recognition of MSDs as ODs at Member State level are presented here. Further information is provided in the national reports.

Denmark

According to the Danish Working Environment Authority[95], MSDs are the main cause of reported work-related diseases in Denmark, representing 34 % of the total (6,850 cases out of 19,940 in 2016). This is well above other groups of diseases such as psychological-related diseases (4,396 cases), ear diseases (2,700 cases) or skin-related diseases (2,493 cases). The two body parts that are most frequently registered in terms of work-related MSDs are the shoulders and the back (1,736 and 1,372 workers affected in 2016). The elbow joint (732 workers) and the knee or knee cap (535 workers) are also recurrently affected body parts among Danish workers.

Finland

Data in Finland[96] show that 'back illness' is one of the main health issues treated/detected by national doctors (around 12 % of the adult population), surpassed only by hay/allergic rhinitis, high blood pressure/hypertension and elevated blood cholesterol (16 %, 15 % and 12.5 %, respectively). According to the data provided by the Finnish social security system (KELA)[97], diseases of the musculoskeletal system and connective tissue are the fourth main reason, in terms of number of recipients, for both the 'disability allowance for persons aged 16 years or over'[98] and the 'care allowance for pensioners'[99], with 1,068 and 22,889 recipients in 2017 (or 8 % and 10 % of the totals). Furthermore, 17,605 individuals received rehabilitation services arranged by KELA because of MSDs in 2017 (around 16 % of the total number of recipients), a number surpassed only by people affected by mental/behavioural disorders (65,413 individuals or 60 % of the total).

[95] Danish Working Environment Authority (WEA), 'Arbejdsulykker i tal' ('Work accidents in numbers'). Retrieved from: https://amid.dk/da/arbejdsmiljoe-i-tal/analyser-og-publikationer/arbejdsulykker-i-tal/ (data retrieved in February 2019). For more information see the national report of Denmark.

[96] National Institute for Health and Welfare, *Suomalaisen aikuisväestön terveyskäyttäytyminen ja terveys* (Health behaviour and Health among the Finnish adult population), 2014 (see https://thl.fi/fi/tutkimus-ja-kehittaminen/tutkimukset-ja-hankkeet/aikuisten-terveys-hyvinvointi-ja-palvelututkimus-ath/aiemmat-tutkimukset/suomalaisen-aikuisvaeston-terveyskayttaytyminen-ja-terveys-avtk). ..

[97] Kansaneläkelaitos (KELA). Kela has some open databases on their webpage (www.kela.fi). Access to data is also possible from Sotkanet (*Tilastotietoja suomalaisten terveydestä ja hyvinvoinnista*, Statistical information on welfare and health in Finland. Available at: www.sotkanet.fi)

[98] This allowance is intended to provide support in everyday life, work and studies for persons aged 16 years or over who have a disability or chronic illness. A person may be entitled to disability allowance if his or her functional ability is impaired for at least a year by disability or illness. Impaired functional ability means that the person has difficulties in taking care of him- or herself and coping with activities of daily living, such as household chores and work or studies.

[99] The care allowance for pensioners is intended to provide support for pensioners with a disability or chronic illness as regards their daily life, functional ability, rehabilitation and care. The allowance can be granted to persons with a disability or chronic illness who are retired full-time.

France

According to the annual report of Sickness insurance on occupational risks in 2016[100], MSDs are the most important cause behind recognised ODs in France. Of the 48,762 recognised cases in total in 2016, 42,535 corresponded to MSD cases, with an incidence of 229.5 cases per 100,000 insured persons, well above other ODs such as cancer (1,775 cases) or pleural plaques (1,693 cases). Among recognised cases of MSDs, the most common corresponded to periarticular disorders caused by certain gestures and postures (38,740 cases).

Italy

National data from Italy show that MSDs are the main type of recognised ODs. More specifically, MSDs account for 12,683 cases out of the 19,291 total recognised ODs in 2017 (66 % of the total). This proportion has increased over recent years. Other types of important ODs such as diseases of the nervous system or diseases of the ear/mastoid process are less relevant (14.4 % and 8.6 % of the total number of recognised ODs in 2017).

The information related to the main and specific types of MSDs resulting in recognised ODs shows that soft tissue diseases and dorsopathies are the two most prevalent types of MSDs in Italy, followed at a considerable distance by arthropathies (51.0 %, 43.6 % and 5.4 %, respectively, in 2017). Furthermore, four specific types of MSDs (hernia of other specified intervertebral disc, rotator cuff syndrome, lumbar and other intervertebral disc disorders associated with radiculopathy, and, finally, shoulder derangement) account for up to two-thirds of the existing cases (21 %, 20 %, 13 % and 10.5 % of total cases in 2017, respectively). The Italian data also show that the largest proportion of recognised ODs related to the musculoskeletal system correspond to cases with a relatively low degree of incapacity, in the sense that up to 96.4 % of cases in 2017 had a degree of incapacity below 15 %[101].

Netherlands

In 2016, the Register of occupational health diseases (*NCvB statistiek register*) included a total of 1,791 MSD-related occupational health diseases. The most common disease was repetitive strain injury of the shoulder/upper arm (around 20 % of workers in 2016), followed by elbow inflammation (12 % in 2016)[102].

Spain

In Spain, the information related to ODs resulting in sick leave shows that by far the highest number of recognised ODs corresponds to ODs caused by physical agents (predominantly those related to MSDs): 7,404 files in total or 81 % of the total in 2017. The sick leave associated with ODs caused by physical agents has an average duration of 84.12 days (data for 2017), lower than ODs caused by carcinogens (231.44 days) or by inhalation of substances and agents not included in other sections (114.40 days)[103].

[100] *Rapport annuel 2016: l'Assurance Maladie — risques professionnels.* Available at: http://www.risquesprofessionnels.ameli.fr/fileadmin/user_upload/document_PDF_a_telecharger/brochures/2017344_DRP_rapportDeGestion_interactif.pdf

[101] INAIL Banca dati (INAIL database). Retrieved from: https://www.inail.it/cs/internet/attivita/dati-e-statistiche.html (retrieved in May 2019).

[102] NCvB statistiek — Nationale Registratie Beroepsziekten — Statistics of the National Office for the registration of occupational health disease. Retrieved from: https://www.beroepsziekten.nl/statistiek-introductie/ncvb-statistiek-nationale-registratie-beroepsziekten (retrieved in February 2019).

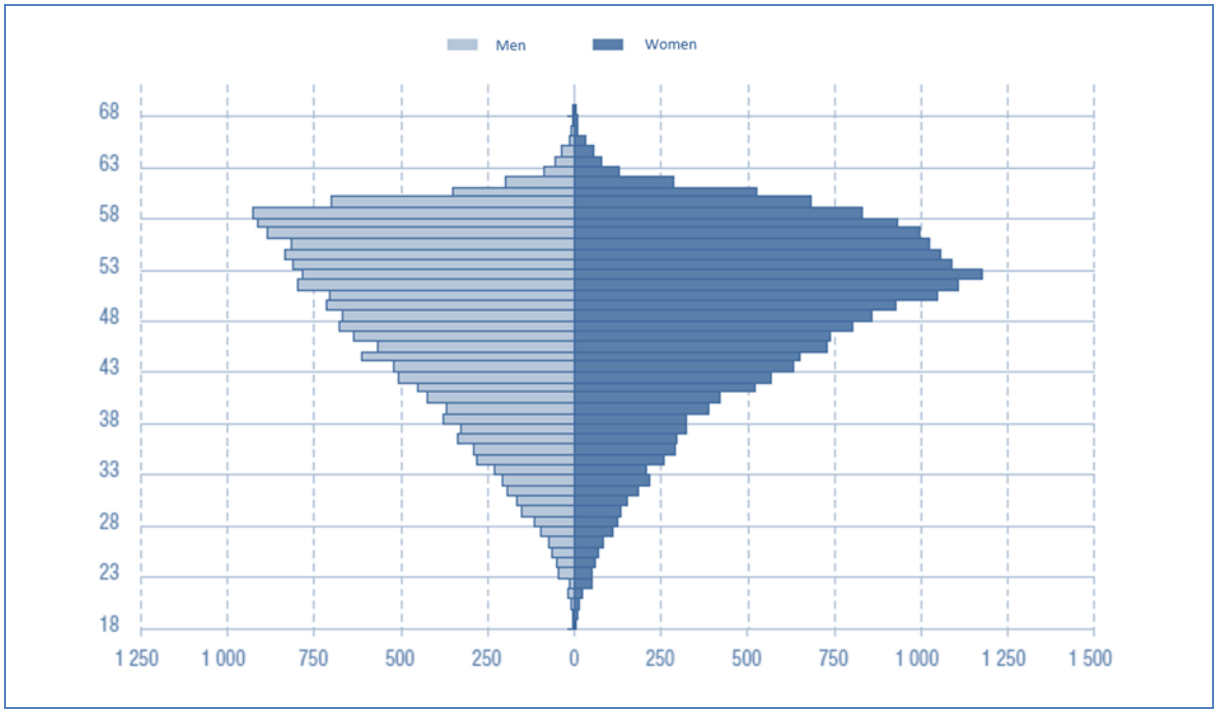
[103] Information obtained from Sistema CEPROSS de Notificación Electronica (CEPROSS electronic notification system), dependant on the Spanish Social Security System. CEPROSS stands for *Comunicación de Enfermedades Profesionales, Seguridad Socia*l (Communication of Professional Diseases, Social Security). Retrieved from: http://www.seg-social.es/wps/portal/wss/internet/EstadisticasPresupuestosEstudios/Estadisticas/EST231/2082?changeLanguage=es (retrieved in June 2019).

- **Variation of recognised MSD-related ODs by gender and age group**

France

The 2016 annual report of French Sickness Health Insurance on occupational risks provides information by gender and age group. Figure 39 shows the number of new recognised cases of MSD-related occupational diseases in 2016. Among them we can see more women than men and more older workers than younger workers. Among women, new recognised MSD cases are particularly concentrated in the age range 48-58 years (women of around 53 years of age have more recognised MSD cases than men). Among men, the number of cases increases more progressively with age, and the largest numbers of cases are in the age range 56-58 years[104].

Figure 39 Distribution of new recognised MSD-related occupational diseases, by gender and age, France, 2016



Source: *Caisse nationale de l'Assurance Maladie des travailleurs salariés, Rapport annuel 2016: l'Assurance Maladie — risques professionnels* (p. 120) (2016 Annual Report: Health Insurance - Occupational Risks). Available at: https://www.ameli.fr/sites/default/files/ra-risques-professionnels-2016_assurance-maladie.pdf

Germany

In Germany, the number of cases of inability to work due to MSDs increases with age, peaking at the group of 55- to 59-year-olds (34.7 cases per 100 members). Similarly, access to new pensions due to MSD-related reduced working capacity is higher among women than men (10,938 new pensions among men and 11,878 among women; data for 2016)[105].

[104] *Rapport annuel 2016: l'Assurance Maladie — risques professionnels*. Available at: https://www.ameli.fr/sites/default/files/ra-risques-professionnels-2016_assurance-maladie.pdf

[105] Knieps and Pfaff (2017).

Italy

In Italy, 70 % of the total recognised ODs among women were related to MSDs, in comparison with 64.5 % among men (data for 2017). This higher proportion among women holds during the whole time period 2014-2017[106].

Netherlands

In contrast to other Member States, national data for 2016 show that, in the Netherlands, MSD-related ODs are more common among male workers (66 %) than among female workers (34 %). As far as age differences are concerned, the most affected age groups are 51-60 years old (36.5 %) and 41-50 years old (30 %)[107].

Spain

Information from Spain related to the number of ODs resulting in sick leave and caused by physical agents[108] broken down by gender and age shows that (since 2013) the number of ODs in women has been higher than the number corresponding to men. Thus, in 2017 there were 3,783 recognised cases in women and 3,621 in men, and in 2011 there were 3,003 recognised cases in women and 3,606 in men. From an age perspective, most of the recognised cases were in workers aged between 35 and 54 years old, particularly in people aged 40-44 years old (1,451 recognised cases) and in people aged 45-49 years old (1,449 recognised cases).

Sweden

According to the Swedish Work Environment Authority (2017b), the ratio of reported ODs connected to MSDs per 1,000 employed persons seems to be higher among women than among men. Moreover, the ratio of reported cases increases with age. The ratio of reported MSD-related ODs per 1,000 employed persons for the age range 16-24 is 0.6 for women and 0.4 for men, whereas for the age range 55-59 the number of ODs connected to MSDs per 1,000 employed persons is 1.2 for women and 0.9 for men[109].

3.3.3 MSDs leading to hospitalisation

In 2015, 58 % of workers in the EU-28 reported having MSDs in the back, upper limbs and/or lower limbs. The percentage of people with chronic MSDs is lower: in 2014, around 20 % of workers reported having chronic back defects and/or chronic neck defects. The percentage of people who have to be hospitalised because of their MSD complaints is of a different order of magnitude: 1.3 % for the EU-28 in 2007, according to WHO statistics on hospital discharges (Figure 40). This is consistent with our finding that a large proportion of workers with MSD complaints have less severe health complaints (see section 3.1.1).

WHO statistics on European hospital discharges are part of the European Health for All (HFA) family of databases. HFA data are collected from several sources including WHO and Europe's technical programmes, partner organisations (for instance Eurostat), UN agencies, the Organisation for Economic Co-operation and Development and a network of country experts[110]. Among other information, WHO

[106] Data retrieved from INAIL database. Retrieved from: https://www.inail.it/cs/internet/attivita/dati-e-statistiche.html (retrieved in June 2019).

[107] NCvB statistiek, *Nationale Registratie Beroepsziekten* (Statistics of the National Office for the registration of occupational health disease). Available at: https://www.beroepsziekten.nl/statistiek-introductie/ncvb-statistiek-nationale-registratie-beroepsziekten (retrieved in February 2019).

[108] Information obtained from Sistema CEPROSS de Notificación Electronica (CEPROSS electronic notification system), dependant on the Spanish Social Security System. CEPROSS stands for *Comunicación de Enfermedades Profesionales, Seguridad Social* (Communication of Professional Diseases, Social Security). Retrieved from: http://www.seg-social.es/wps/portal/wss/internet/EstadisticasPresupuestosEstudios/Estadisticas/EST231/2082?changeLanguage=es (retrieved in June 2019).

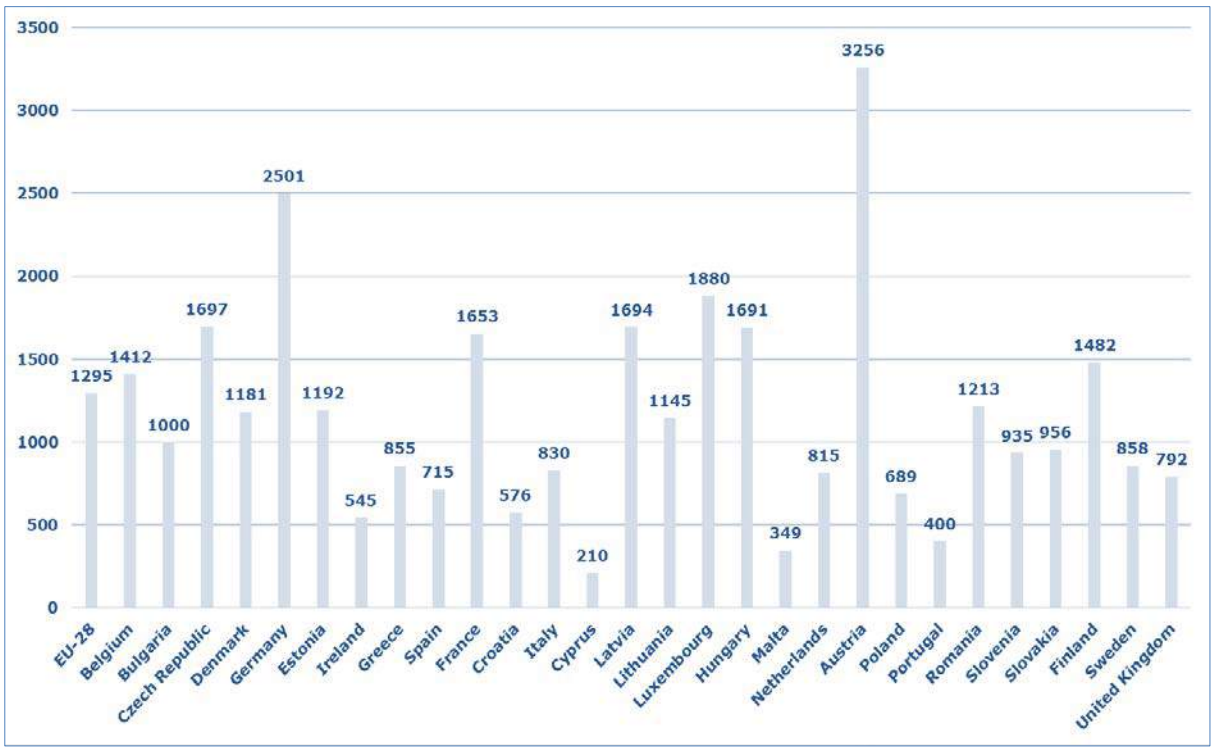
[109] Swedish Work Environment Authority, Arbetsskador 2017 (Occupational accidents and work-related diseases, 2017). Available at: https://www.av.se/globalassets/filer/statistik/arbetsmiljostatistik-arbetsskador-2017-rapport-2018-1.pdf.

[110] For more information: http://www.euro.who.int/en/data-and-evidence/databases/european-health-for-all-family-of-databases-hfa-db

collects data on the number of discharges per 100,000 after hospitalisation due to different types of accidents or diseases. Diseases of the musculoskeletal system and connective tissue diseases are one of these types, which is presented in Figure 40.

Just like the MSD prevalence rates, discharges after hospitalisation due to MSDs and connective tissue diseases show considerable differences between countries. The MSD hospitalisation rate[111] is highest in Austria and Germany, and lowest in Cyprus and Malta. For all countries, however, the MSD hospitalisation rate is only a small fraction of the MSD prevalence rate.

Figure 40 Discharges per 100,000 persons after hospitalisation due to diseases of the musculoskeletal system and connective tissue diseases, by country, 2007



Source: Panteia based on the World Health Organisation (WHO) European Health for All database

[111] The number of discharges per 100,000 after hospitalisation due to diseases of the musculoskeletal system and connective tissue diseases.

4 Impact of MSDs

Approximately three out of every five workers in the EU-28 report MSD back, upper limb and/or lower limb complaints. Given the large proportion of workers reporting MSD complaints, it is highly important to know the impact of MSDs.

MSDs have an impact on the general health of workers. Section 4.1 presents data on the health outcomes for workers, including the general health of workers with and without MSD complaints and the extent to which MSD complaints coexist with other health problems (comorbidities).

If MSDs affect the general health of workers, it stands to reason that they also affect their performance at work. The productive capacity of workers can be affected in two ways: MSDs may reduce the production that workers can realise in an hour (their productivity), and MSDs may reduce the number of hours they can work (e.g. absenteeism). In the case of prolonged absenteeism, it is relevant to know to what extent enterprises have policies in place to support employees to return to work after a long-term sickness absence. These topics are labelled 'employment and work outcomes' and are discussed in section 4.2.

4.1 Health outcomes

4.1.1 MSDs and general health condition

More often than not, health problems related to MSDs occur in combination with other health problems (see section 3.1). This section takes a closer look at the relationship between MSDs and other health problems.

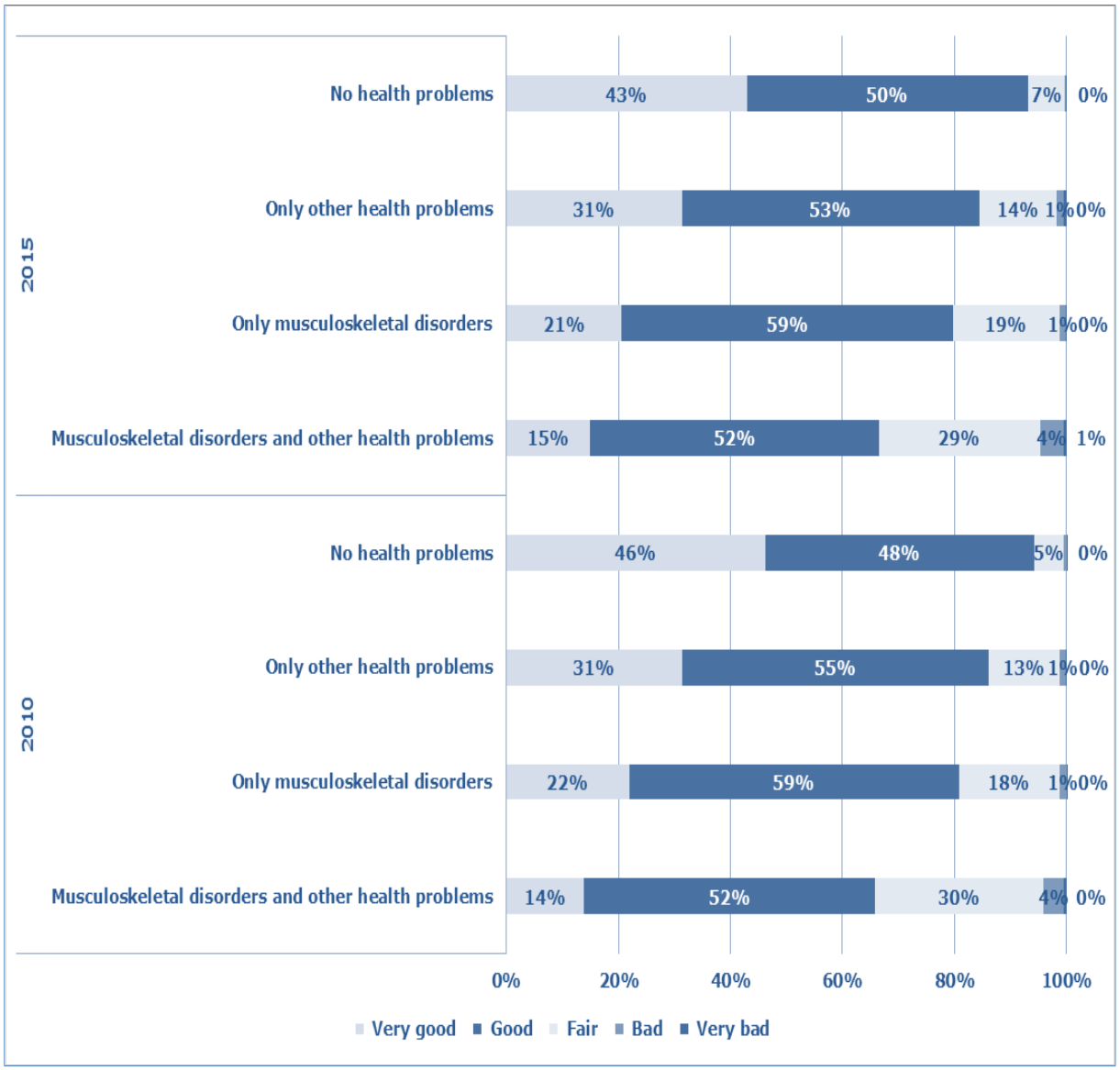
- **Most people with self-reported MSDs report (very) good health, but in cases of chronic MSDs the percentages with very bad general health are higher**

The majority of workers report that their general health is good or very good. This is apparent from data from EHIS and the EWCS. These surveys also show that the proportion of workers with (very) good health is smaller for workers who suffer from MSDs (in the upper limbs, lower limbs and/or back) (Figure 41) and even smaller for workers suffering from chronic MSDs (in the back and/or neck).

As may be expected, workers with health complaints are less positive about their general health than workers without health complaints. In the case of MSDs, having such complaints may have a negative impact on a person's (perception of his or her) own health.

At the same time, including workers with self-reported MSDs, the large majority report good or very good health. This indicates that self-reported MSD complaints include not only severe cases of MSDs but also less severe ones (in the sense that the general health is still considered to be (very) good). This also applies to chronic MSDs in the back and/or neck, although to a lesser extent (Figure 42).

Figure 41 Percentage of workers reporting that their general health is very good, good, fair, bad or very bad, by different health problems in the past 12 months, EU-28, 2010 and 2015

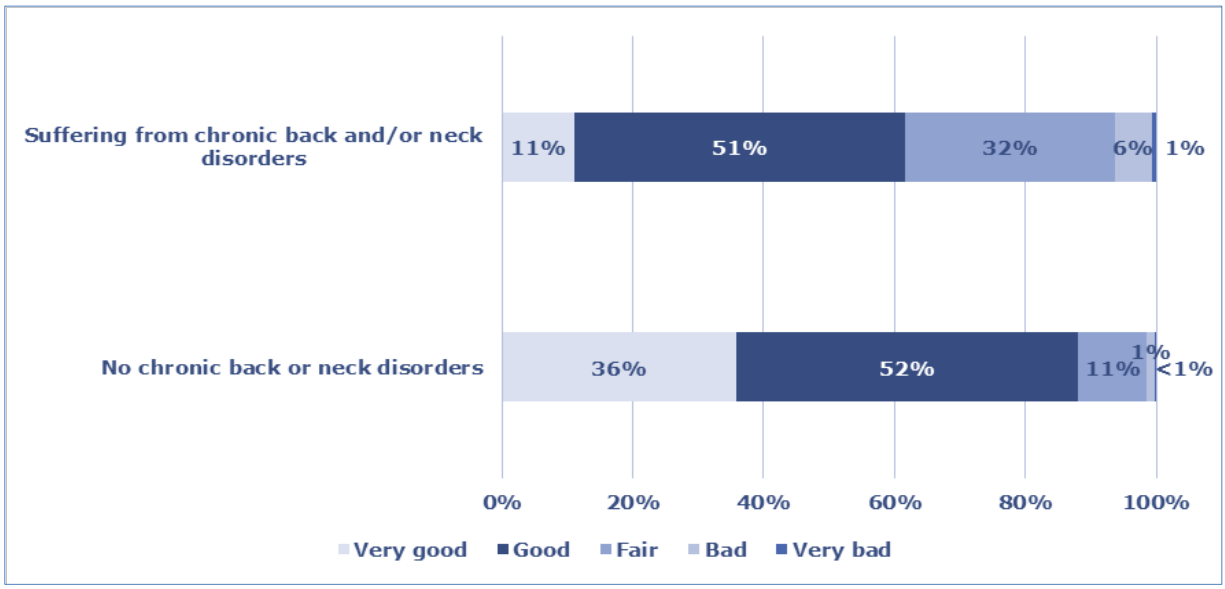


Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

N = 36,132 (2010); *N* = 35,591 (2015)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 42 Percentage of workers reporting that their general health is very good, good, fair, bad or very bad, by presence or absence of chronic back or neck disorders in the past 12 months, EU-28, 2014



Note: The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 127,338

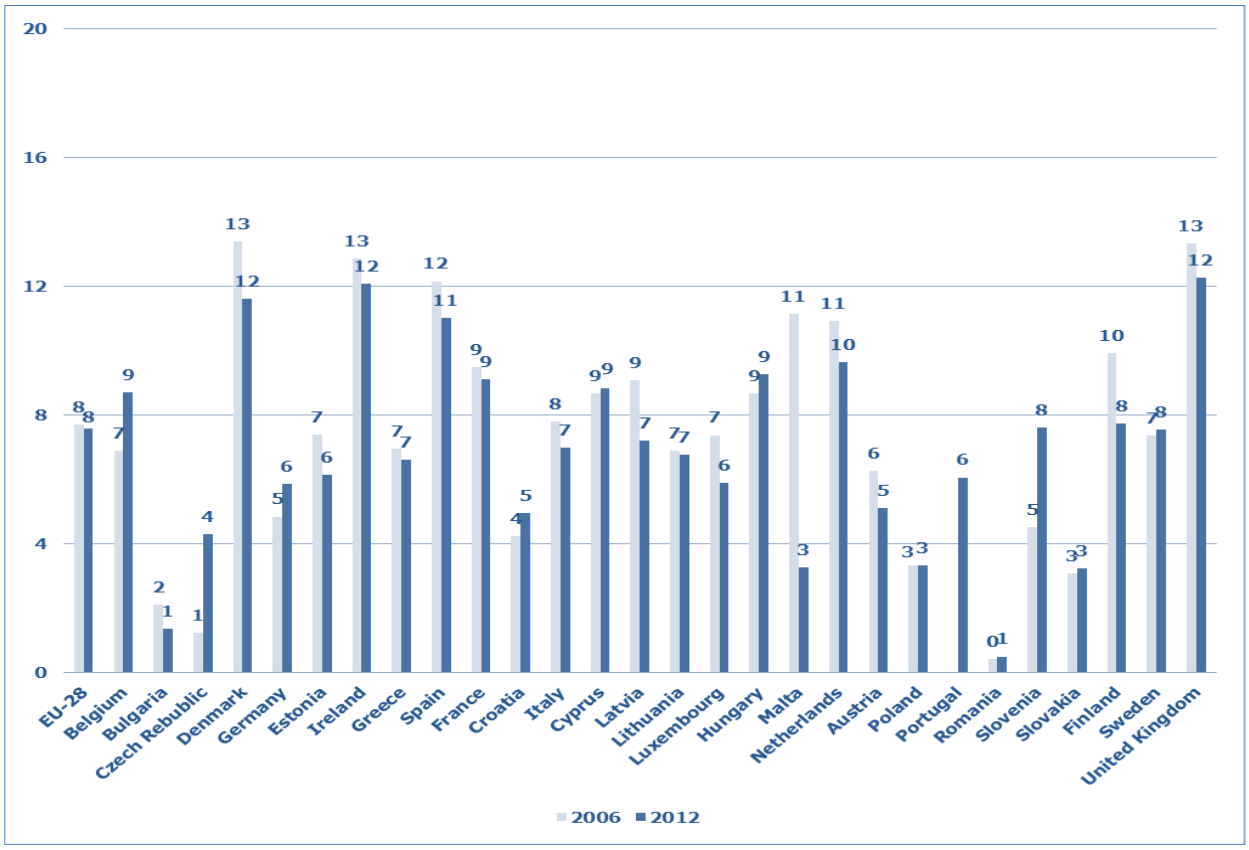
Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

- **Number of deaths due to diseases of musculoskeletal system and connective tissue remained stable in the period 2006-2012**

In the previous chapter, data on hospital discharges have been presented. In some cases, people will not survive hospitalisation. This section therefore considers data on the number of deaths due to MSDs.

Only a very small fraction of people are hospitalised because of their MSD complaints (1.3 % for the EU-28 in 2007, or 1,295 per 100,000 people). The fraction of people who die each year from diseases of the musculoskeletal system and connective tissues is much smaller still, at 8 per 100,000 people for the years 2006 and 2012 (Figure 43).

Figure 43 Deaths per 100,000 persons due to diseases of musculoskeletal system and connective tissue (age-standardised death rate), by country, 2006 and 2012



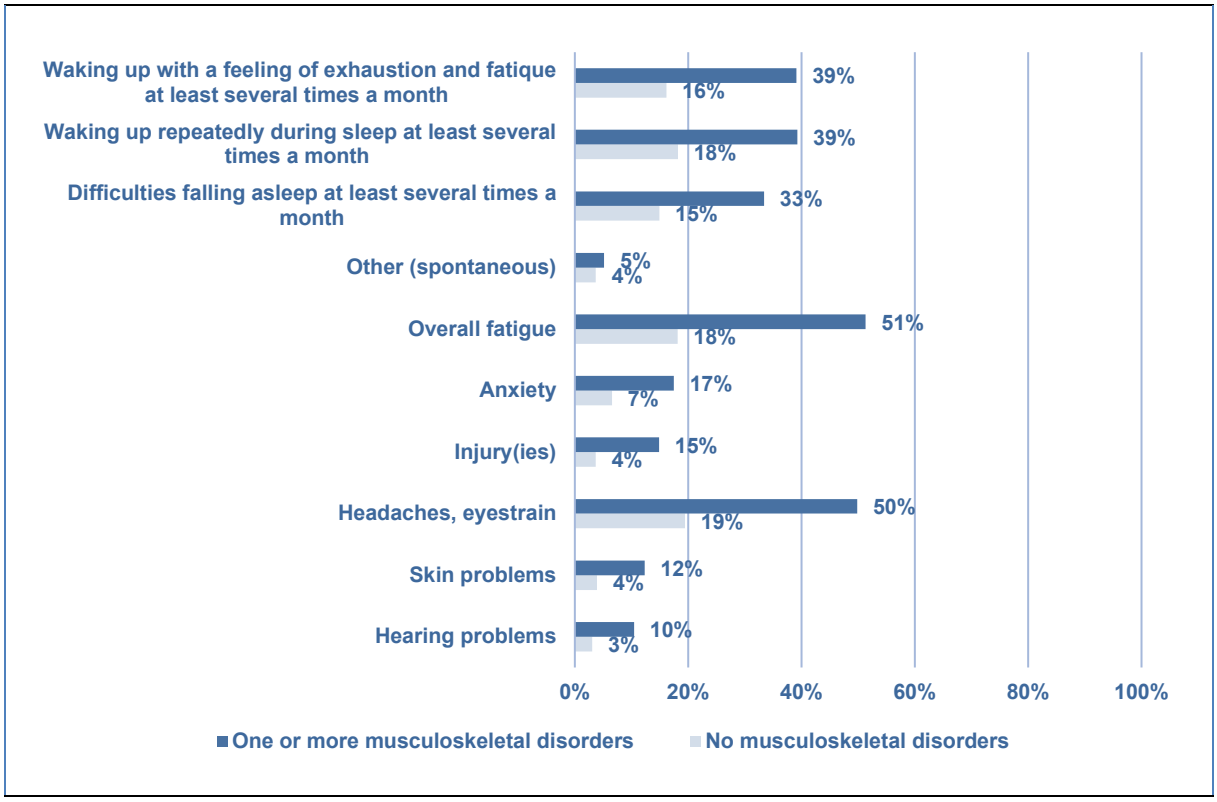
Source: Panteia based on the World Health Organisation (WHO) European Mortality Database

4.1.2 MSDs and comorbidities

- **Headaches, eyestrain, overall fatigue and sleeping problems affect the lives of workers who suffer from MSDs**

Figure 44 indicates the proportions of several health issues that affect the lives of workers with and without MSDs. Headaches, eyestrain and overall fatigue affect the lives of most workers who suffer from one or more musculoskeletal disorders, while sleeping problems appear to have a significant impact as well.

Figure 44 Percentage of workers reporting that different health problems affect their lives, by presence or absence of musculoskeletal disorders, EU-28, 2015



Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Higher levels of anxiety and overall fatigue of workers are associated with a higher likelihood of reporting MSDs, but mental well-being with a lower likelihood**

According to quantitative analyses based on the sixth wave of the EWCS[112], prevalence of MSDs is associated with higher levels of anxiety, sleeping problems and overall fatigue of workers. MSD prevalence is also related to the mental well-being of workers[113]: MSDs are more prevalent among workers with lower levels of mental well-being. These relationships apply to MSDs in upper limbs, lower limbs and the back.

These analyses do not indicate the causality of these relationships. On the one hand, anxiety, overall fatigue and sleeping problems can be considered health problems, and workers can suffer from these health problems alongside MSD problems. For this reason, they are discussed in this section. In some cases, MSDs may even cause these health problems or make them worse. The causality may, however, also run the other way: high levels of anxiety, overall fatigue and sleeping problems may cause MSD complaints or worsen already existing MSD complaints. In this respect, they are considered potential

[112] These concern logistic regressions with self-reported MSD complaints as the dependent variable, and gender, age, country, occupation, sector and reported levels of anxiety, overall fatigue and sleeping problems among the independent variables. These regressions have been applied separately for MSDs in upper limbs, lower limbs and back. More information about these analyses is available. See Annex 2 for an elaborate discussion of these regressions, and specifically Annex 2.3 for the estimation results.

[113] The sixth wave of the EWCS contains five questions about the mental well-being of workers ('How have you been feeling over the past 2 weeks: cheerful and in good spirits; calm and relaxed; active and vigorous; waking up fresh and rested; daily life has been filled with things that interest me?'). The answers to these five questions have been combined into a single scale. Cronbach's alpha for these five questions is 0.88, which indicates that this is a valid option.

risk factors and will be discussed as such in section 5.2. The results presented in section 5.2 and in this section merely reflect associations or relationships without making any claims about the causality of these relationships.

- **MSDs and comorbidities: four groups of workers**

For some workers, MSDs may be their only (work-related) health problem, while other workers may be susceptible to several health problems. This raises the question of how often MSD health problems coincide with other health problems, and if specific combinations of health problems can be identified that occur relatively often. If that were the case, future studies might further examine these specific combinations of health problems (for example to what extent these different health problems reinforce each other, and how this reinforcing effect could be broken).

One of the ways to identify such combinations is to apply a cluster analysis. Based on the sixth wave of the EWCS, a cluster analysis has been performed[114] on 11 different health problems. The outcomes suggest that workers can be grouped into four different clusters:

- cluster 1: no health problems;
- cluster 2: few health problems;
- cluster 3: MSDs and/or other physical health problems;
- cluster 4: MSDs and fatigue.

Figure 45 presents an overview of the reported health problems for each of the four clusters.

Cluster 1: no health problems

This cluster includes about 23 % of all workers. It combines all workers without any reported health problems. The large majority of these workers believe that their health or safety is not at risk because of their work (92 %).

Cluster 2: few health problems

Workers with only a few reported health problems are combined into the second cluster, which includes about 33 % of all workers. Workers in this group report on average 2.0 different health problems (ranging from one to five). Most of these health problems are related to MSDs (45 % report back problems, 42 % report MSD problems in the upper limbs, 24 % report MSDs in the lower limbs); other health complaints that are often mentioned include headaches (36 %), sleeping problems (39 %) and overall fatigue (13 %).

Most of the workers with several health problems are distributed between the remaining two clusters.

Cluster 3: MSDs and/or other physical health problems

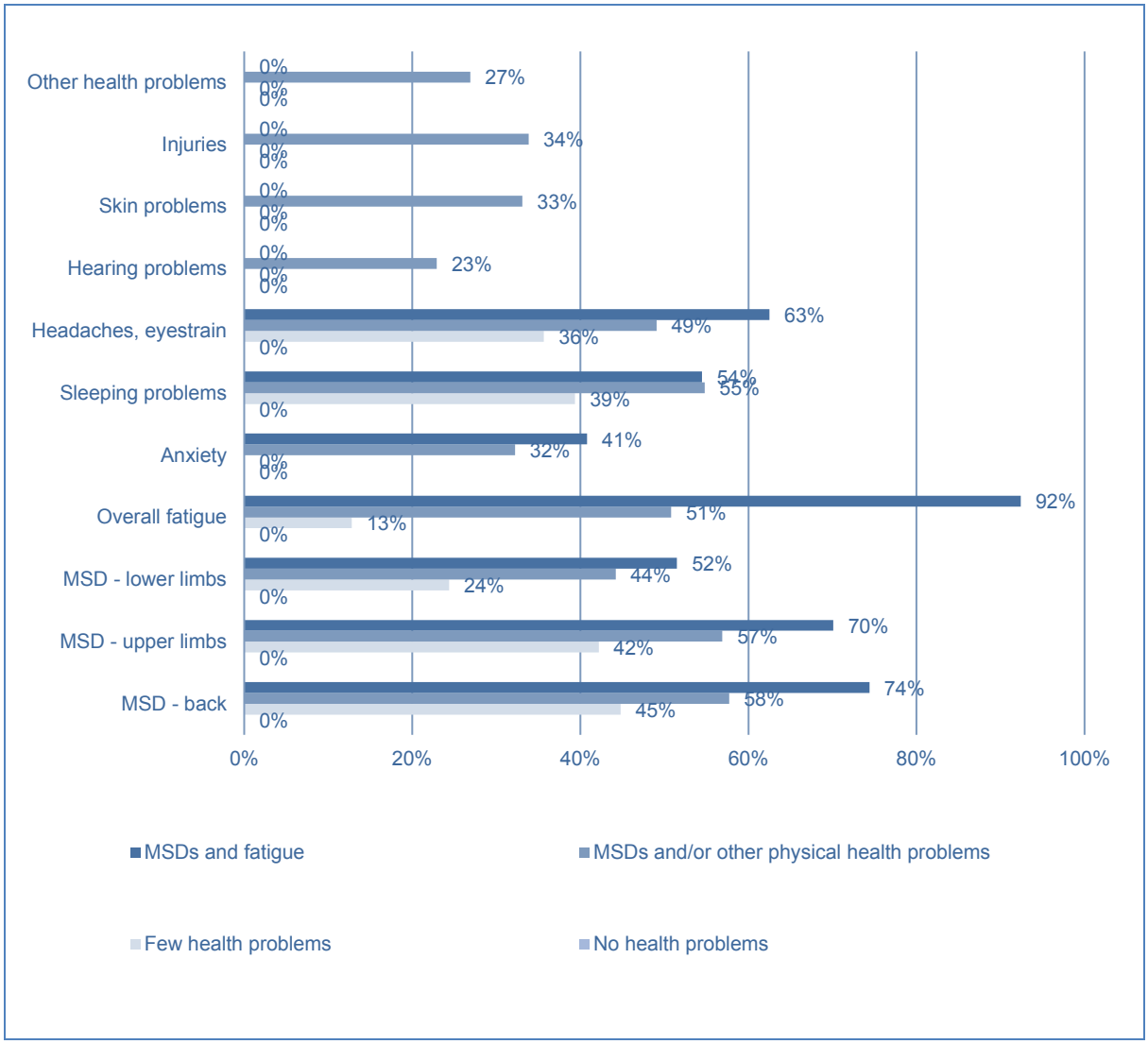
This cluster includes about 23 % of all workers, who on average report 4.6 different health problems (ranging from 1 to 11). All workers with hearing problems, skin problems and injuries are included in this cluster. In addition, 51 % report overall fatigue, 49 % report headaches, 55 % report sleeping problems and 32 % report anxiety. MSDs are also often mentioned: 58 % report back problems, 57 % report MSD problems in the upper limbs and 44 % report MSDs in the lower limbs.

Cluster 4: MSDs and fatigue

The fourth cluster includes about 21 % of all workers, who on average report 4.5 different health problems (ranging from 2 to 7). The main characteristic of this cluster is that it combines MSD complaints with fatigue: almost all workers in this cluster (92 %) report overall fatigue, and it also has the highest proportion of MSD complaints (74 % report back problems, 70 % report MSD problems in the upper limbs, 52 % report MSDs in the lower limbs). In addition, 63 % report headaches, 55 % report sleeping problems and 41 % report anxiety.

[114] See Annex 3.2 for more details on the methodological aspects of this cluster analysis.

Figure 45 Percentage of workers reporting different health problems during the past 12 months, by four clusters of workers, EU-28, 2015



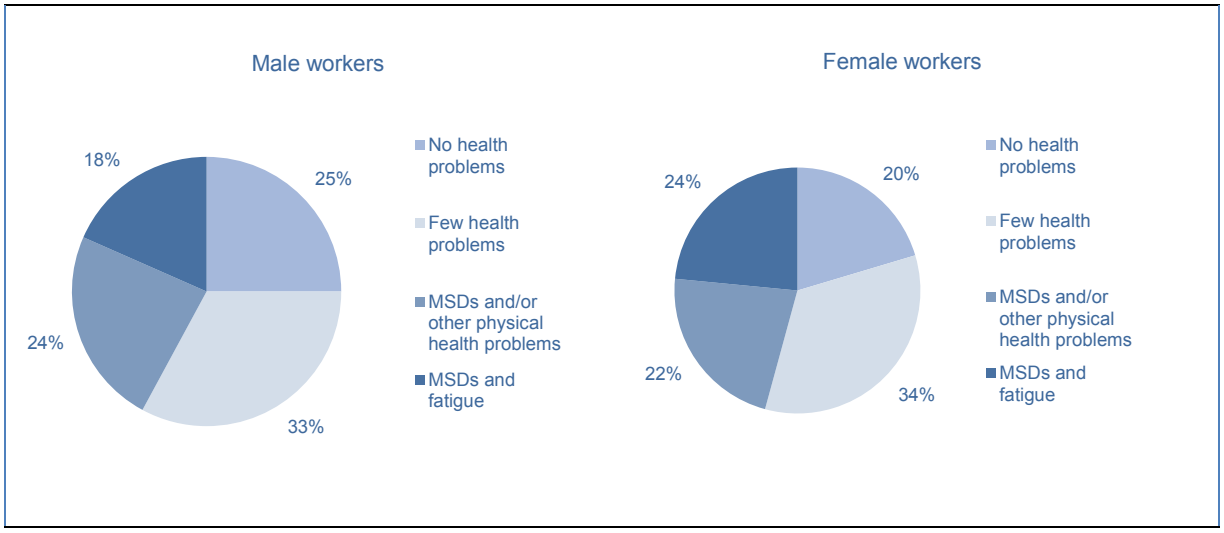
Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

N = 31,409

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

The distribution of workers across these four clusters does not show large gender differences, although male workers are somewhat more likely to report no health problems, whereas female workers are more likely to report MSDs in combination with fatigue (see Figure 46). The distribution is also similar across sectors and occupations (at one-digit level), with the proportion of workers reporting no health problems during the past 12 months ranging from 20 % to 25 %.

Figure 46 Percentage of workers reporting different health problems during the past 12 months, by four clusters of workers, by gender, EU-28, 2015



Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

N = 31,409

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

4.1.3 Cost and burden of MSDs

- **MSDs are the second-ranked work-related illnesses in DALYs**

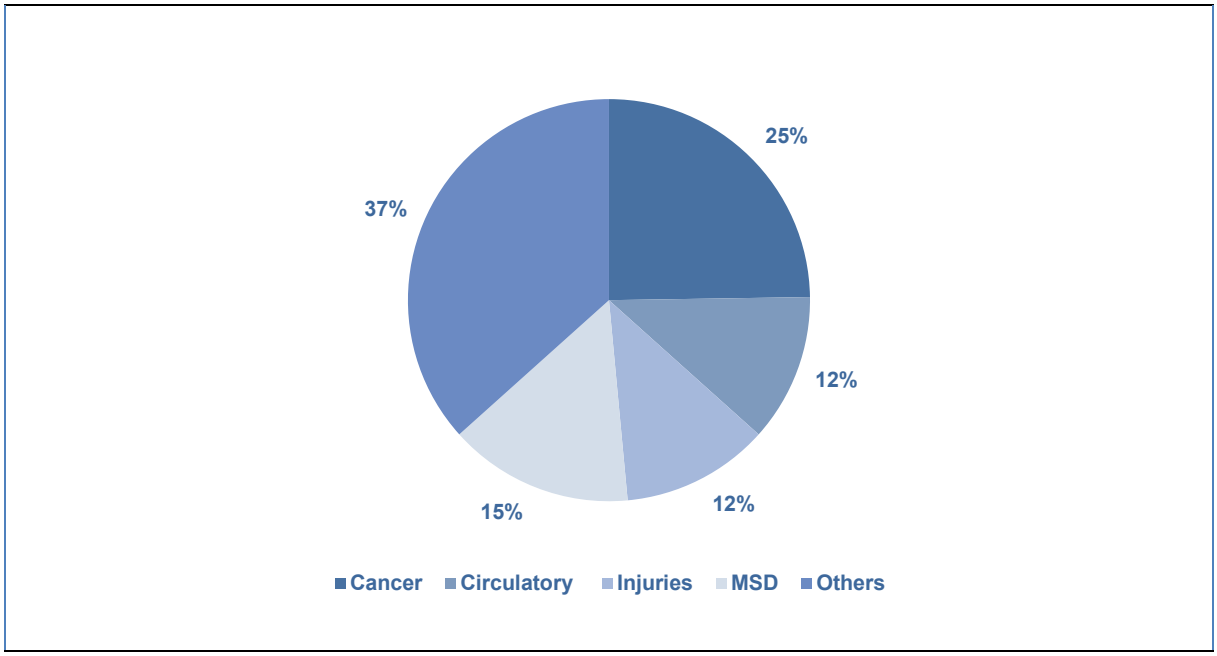
The figure below is based on the findings of a project carried out by the International Labour Organisation (ILO), the Finnish Ministry of Social Affairs and Health (MSAH), the Finnish Institute of Occupational Health (FIOH), the WSH Institute in Singapore, the International Commission on Occupational Health (ICOH) and EU-OSHA to develop updated worldwide estimates of work-related injuries and illnesses. The statistics are based on available data at international level, mainly relying on the World Health Organisation (WHO) and ILO data sources. The figure contains information regarding DALYs due to musculoskeletal disorders. DALYs for an illness or health condition are calculated as the sum of the years of life lost due to premature mortality in the population and the years lived with disability (YLD) for people living with the health condition or its consequences.

In other words, DALYs indicate the gap between current health status and an ideal situation in which individuals live into old age without disease and disability. The measure merges the years lived with disability and the years lost due to premature mortality by using a set value for life expectancy in order to estimate the years of life lost as a consequence of premature death or disability. DALYs reflect the effect of diseases on general population in terms of quality of life and death; however, they have a greater weight on the young adult population and newborns. Even though DALYs do not indicate economic values directly, the impact on productivity could be linked to economic loss (Blyth *et al*., 2019, p. 36)[115].

Figure 47 depicts the proportion of the main work-related illnesses and DALYs per 100,000 workers in the EU-28. Cancer, reaching 25 %, accounts for the main part of the cost, and musculoskeletal disorders follow at approximately 15 %.

[115] Blyth, F. M., Briggs, A. M., Schneider, C. H., Hoy, D. G. & March, L. M., 'The global burden of musculoskeletal pain: where to from here?', *American Journal of Public Health*, Vol. 109, No 1, 2019, pp. 35-40. Available at: https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2018.304747

Figure 47 Distribution of years of life lost and lived with disability (DALYs) per 100,000 workers, by main work-related illnesses, EU-28, 2017



Source: Panteia based on EU-OSHA, data visualisation, 'The economics of occupational safety and health, 2017. Available at: https://visualisation.osha.europa.eu/osh-costs#!/eu-analysis-illness

▪ Data from Member States

The above findings on costs and burden of MSDs can be complemented with more detailed quantitative information regarding the costs, derived from national data. Further information is provided in the national reports.

Austria

National data from Austria suggest that MSDs represent the third most common cause of sick leave (13 % of all cases), after cases generated by diseases of the respiratory system and certain infectious and parasitic diseases (37 % and 16 % of all cases, respectively). MSDs account for 21 % of total work days lost in 2016. The average duration of sick leave caused by MSDs was 15.8 days, well above the general sick-leave period in Austria (around 10 days) but below the average duration caused by other diseases such as neoplasms, mental/behavioural disorders or diseases of the circulatory system (38.5, 37 and 19.5 days, respectively).

From a gender perspective, women remain on sick leave due to MSDs about 2 days longer on average than men. MSD-related sick-leave days also increase with age. The number of MSD-related days of absence from work is higher among workers who are 45 years and older (8 days) than among workers under 45 years of age (3 days)[116].

According to Biffl *et al*. (2009)[117], MSDs were the main cause of new health-related retirement pensions in the years 2001 and 2006. In particular, MSDs were responsible for 32.5 % of these new pensions in

[116] Leoni, T. and Schwinger, J., *Fehlzeitenreport 2017* (Report on workers' absence 2017), Austrian Institute of Economic Research (WIFO), 2017. Available at: https://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=60730&mime_type=application/pdf

[117] Biffl, G., Leoni, T. and Mayrhuber, C., *Arbeitsplatzbelastungen, arbeitsbedingte Krankheiten und Invalidität*, Austrian Institute of Economic Research (WIFO), 2009. Available at: https://www.wifo.ac.at/jart/prj3/wifo/resources/person_dokument/person_dokument.jart?publikationsid=35901&mime_type=application/pdf

2006, and the second and third most common causes were mental/behavioural disorders and diseases of the circulatory system (27 % and 13 % of the total new pensions, respectively). The same year, MSDs were the most common cause of health-related retirement pensions among men (34 % of all cases), while among women it was the second most common cause (29.5 % of cases), after mental/behavioural disorders (345 % of all cases).

Finland

According to the Finnish social security system (KELA) data for 2017, Finland incurred EUR 63.8 million in medical expenses related to MSDs, of which EUR 28.6 million was reimbursed by KELA. In total, more than 1.4 million recipients benefited from 3.1 million MSD-related prescriptions; the cost per each MSD-related prescription was EUR 20.90 and the average reimbursement per prescription was EUR 9.40.

In terms of rehabilitation expenditures, data from KELA show that the total MSD-related expenditure was EUR 41.5 million or 10.9 % of the total, the third largest amount, after the rehabilitation expenditures incurred for mental/behavioural disorders and diseases of the nervous system (data for 2017)[118].

France

In France, work-related lower back pain resulted in 12.2 million lost work days, or 57,000 full-time equivalents. Estimates of the direct annual costs borne by companies exceed EUR 1 billion per year through their contributions to occupational accidents and diseases, while more than half (EUR 580 million) is related to sick day compensation (data for 2017) [119]. Available national information[120] shows that low back pain leads to sick leave for one in five workers affected. In 50 % of the cases, the duration of the sick leave is less than 2 weeks.

Caisse primaire d'assurance maladie (CPAM) of the Loire Region provides information regarding the costs of different types of MSDs for French companies. In particular, it is estimated that the average cost to companies is EUR 17,000 for a back-related MSD, EUR 12,780 for a carpal tunnel-related MSD, EUR 52,759 for a rotator cuff tendinitis-related MSD and EUR 18,220 for an epicondylitis-related MSD. These estimations do not include the days of sick leave for the affected worker, which for back disorders are approximately 220 days, for carpal tunnel 151 days, for rotator cuff tendinitis 298 days and for epicondylitis 195 days.

Indirect costs of MSD-related problems include costs due to disruptions in working teams, decreases in productivity, production delays, etc. According to the French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases (INRS), these indirect costs could be up to 10 times higher than the direct costs for businesses[121].

Germany

According to BAuA (2018)[122], MSDs produce the highest costs compared with all other disease diagnosis groups. It is estimated that EUR 17.2 billion production loss (production loss costs based on labour costs) and EUR 30.4 billion loss of gross value added (loss of labour productivity) arise from

[118] Kansaneläkelaitos (KELA) or Social Insurance Institute pays reimbursement for medicines, clinical nutrients and emollient creams prescribed for the treatment of someone's illness. Access to data is also possible from Sotkanet (Tilastotietoja suomalaisten terveydestä ja hyvinvoinnista, 'Statistical information on welfare and health in Finland'. Available at: www.sotkanet.fi).

[119] Information obtained from the French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases (INRS). Available at: http://www.inrs.fr/risques/lombalgies/statistique.html (retrieved in May 2019).

[120] Assurance Maladie (AMELI), *Campagne de Prévention du Mal de Dos au Travail, Dossier de Presse Novembre 2019* (Campaign to Prevent Back Ache at Work, Press release November 2019). Available at: https://www.ameli.fr/fileadmin/user_upload/documents/DP_Lombalgie-06112018.pdf).

[121] Information obtained from the INRS, *Dossier Lombalgie* (Dossier Low Back Pain), Paris, 2018. Available at: http://www.inrs.fr/dms/inrs/GenerationPDF/accueil/risques/lombalgies/Lombalgie.pdf.

[122] Federal Institute for Occupational Safety and Health (BAuA), *Arbeitswelt im Wandel: Zahlen — Daten — Fakten* (Changing working world: facts and figures), 2018. Available at: https://www.baua.de/DE/Angebote/Publikationen/Praxis/A99.pdf?__blob=publicationFile&v=11

diseases of the musculoskeletal system. This represents 0.5 % and 1.0 % of Germany's gross domestic product (GDP), respectively (data for 2016).

Data by economic sectors show that the manufacturing sector suffers the highest economic losses due to MSDs, with EUR 6.45 million loss of production and EUR 10.63 million loss of gross value added. The public sector, including education and health sector as other service providers follows, in which the loss of production equates to EUR 5.43 million, and the loss of gross value added equates to EUR 6.69 million[123].

BAuA also provides information on the number of days of incapacity to work, comparing the causes of incapacity for work between men and women. Musculoskeletal and connective tissue disorders are the main reason behind the number of days of incapacity to work among men (26 % of the total) and the second most common cause among women (22.5 % of the total) (data for 2016). Moreover, the average number of MSD-related absence days from work (per full-time equivalent membership year in the statutory health insurance) is 5.5 days[124]. According to the BKK Health Report 2017[125], back pain is at the top of the causes among MSDs, accounting for 1,242 days of incapacity to work per 1,000 members.

As far as gender and age are concerned, the BKK Health Report 2017 shows that days of inability to work due to MSDs increase with age, peaking among 60- to 64-year-olds (32.11 days per case). In addition, the numbers of days per 1,000 members and per case vary significantly depending on the specific type of MSD, with some specific types lasting longer than others. In all cases the number of days per case is higher among women.

Furthermore, musculoskeletal and connective tissue disorders are the second most common disease behind access to new pensions due to reduced working capacity in Germany, after psychological/behavioural disorders (10,938 new pensions among men and 11,878 among women). Access to new pensions due to MSDs and connective tissue disorders increased between 2014 and 2016.

Netherlands

In the Netherlands, information from the National Working Conditions Survey in 2017[126] shows that the main reason for Dutch workers (excluding the self-employed) to take sick leave was influenza or common cold (35 % of cases), followed by complaints of the digestive system (6 %) and back complaints (5 %). For self-employed workers, the main reason for taking sick leave was again influenza/common cold (31 %), followed by back complaints (8 %) and complaints of the neck, shoulders, arms, etc. (5.5 %) (data retrieved from Netherlands Survey of the Self-Employed, 2017)[127].

Regarding sociodemographic differences, information indicates that the presence of back and lower limb complaints, as a reason for taking sick leave, is positively related to age, and more frequent among men than women. This result can be extended to both employed and self-employed workers in the Netherlands.

Spain

Lázaro *et al*. (2014)[128] estimated the annual cost of temporary work disability caused by MSDs in Spain. According to this study, MSDs were the leading cause of temporary work disability in Spain in 2007, representing 18 % of the total (908,781 cases), 23 % of all lost working days (39,342,857 in total) and

[123] BAuA, *Sicherheit und Gesundheit bei der Arbeit — Berichtsjahr 2016: Unfallverhütungsbericht Arbeit* (Safety and health at work report, 2016), 2016. Available at: https://www.baua.de/DE/Angebote/Publikationen/Berichte/pdf/Suga-2016-barrierefrei.pdf?__blob=publicationFile&v=2

[124] BAuA (2018).

[125] Knieps and Pfaff (2017).

[126] NEA (2017).

[127] Lautenbach, H., van der Torre, W., de Vroome, E. M. M., Janssen, B. J. M., Wouters, B. & van den Bossche, S. N. J., *Zelfstandigen Enquête Arbeid 2017*, Centraal Bureau voor de Statistiek, The Hague, 2017. Available at: https://www.monitorarbeid.tno.nl/dynamics/modules/SFIL0100/view.php?fil_Id=199

[128] Lázaro, P., Parody, E., García-Vicuña, R., Gabriele, G., Jover, J. Á. & Sevilla, J., 'Coste de la incapacidad temporal debida a enfermedades musculoesqueléticas en España' ('Cost of temporary work disability due to musculoskeletal diseases in Spain'), *Reumatología Clínica*, Vol. 10, No 2, 2014, pp. 65-138.

23 % of the total costs related to temporary work disability (EUR 1.702 billion in total), which is estimated at EUR 1.62 per EUR 1,000 of national GDP. Furthermore, the annual incidence of temporary work disability cases per 1,000 employed persons was 45, and the average cost per temporary work disability process due to MSDs in Spain was EUR 1,873.

Sweden

In Sweden, MSDs are the most common reason for illness and absence from work (Ahlberg, 2014)[129]. According to Ahlberg (2014), around 957,000 Swedes over 16 years old suffered from some form of MSD-related complaint in 2012, and such diseases are more prevalent among people over 45 years old. The study shows that approximately 20-30 % of all visits to Swedish public health care were caused by MSDs and that MSDs accounted for 11 % of total healthcare costs in Sweden (data for 2012).

Regarding direct and indirect costs of MSDs[130], Ahlberg (2014) finds that the total costs for society connected to MSDs were approximately SEK 102.3 billion (around EUR 9.9 billion), which can be translated into SEK 11,000 (approximately EUR 1,065) per inhabitant) or 2.8 % of the national GDP for 2012[131]. In the meantime, direct costs were estimated to be SEK 36.9 billion (36 %), whereas indirect costs amounted to up to SEK 65.4 billion (64 %). Among the direct costs of resource use in health care, outpatient treatment accounted for 62 % of costs, inpatient treatment for 26 % and pharmaceuticals for 12 %. Nevertheless, Ahlberg (2014) underlines that the numbers presented above are most likely an underestimation of the total costs for society, since there are elements regarding MSDs that are very difficult to estimate in monetary terms.

Persistently reduced working capacity due to MSDs that generated sickness and activity compensation accounted for just over 60 % of the indirect costs of loss of production, while morbidity-generated sickness benefit accounted for just over 40 %. Osteoarthritis and back diseases together accounted for 60 % of the sick leave and 64 % of the costs of MSDs. In total, MSDs caused 450,000 days of absence from work distributed among 78,500 people (Ahlberg, 2014).

4.2 Employment and work outcomes

Some people with MSD complaints may find that these complaints restrict them in their daily activities. To the extent that this also applies to daily activities at work, this indicates that workers may become less productive because of their MSD complaints. Another indicator of the effect of MSD complaints on the productivity of workers is the level of presenteeism. Besides affecting workers' hourly productivity, MSD-related health problems may also result in absenteeism and even early retirement. This section presents available information on these topics.

4.2.1 Restrictions in daily activities

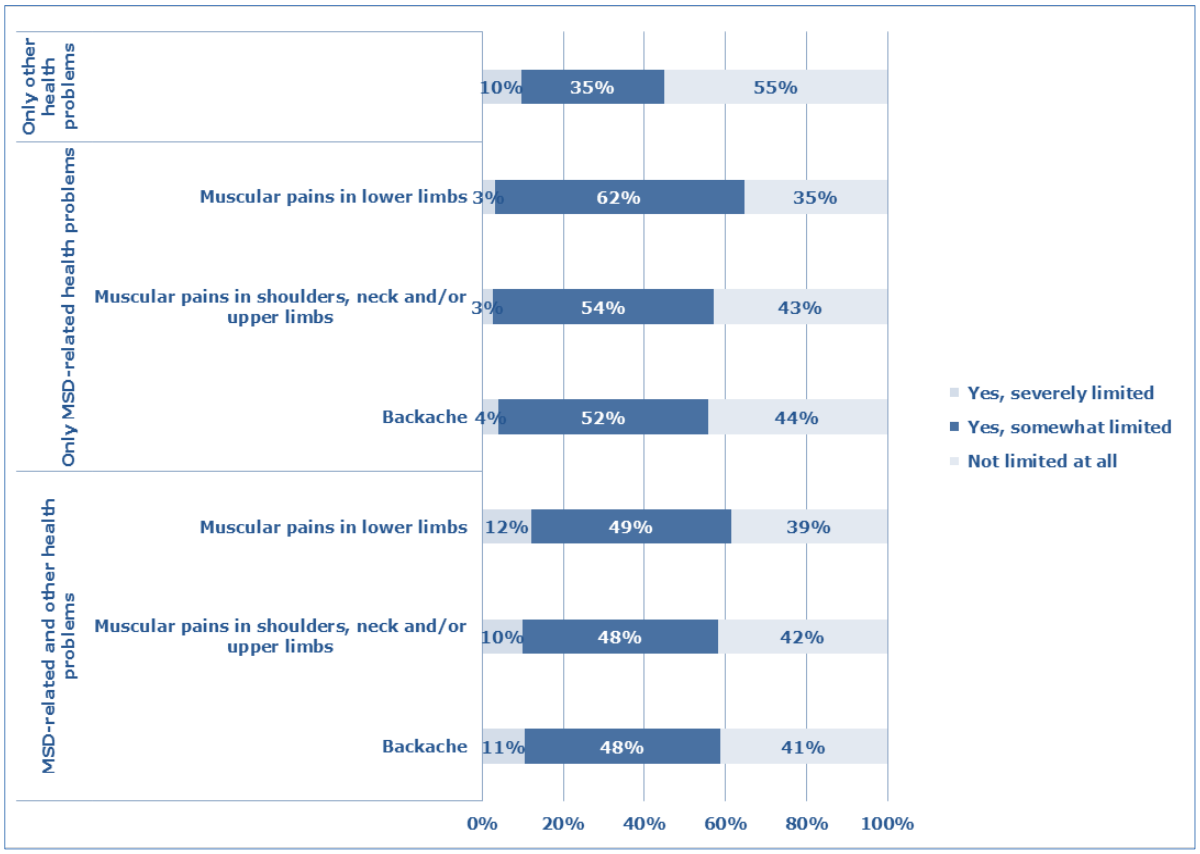
Workers with MSD-related problems in combination with other health problems are most likely to report that their daily activities are restricted by their health problems (Figure 48).

[129] Ahlberg, I., 'The economic costs of musculoskeletal disorders: a cost-of-illness study in Sweden for 2012', MSc dissertation, Lund University, 2014. Available at: http://lup.lub.lu.se/luur/download?func=downloaFile&recordOId=4698739&fileOId=4698740. A version in Swedish can be found at: https://ihe.se/wp-content/uploads/2017/06/IHE_Rapport-2014_4.pdf

[130] Direct costs are incurred when resources are used to diagnose and treat the diseases (costs of health care and medicines). Indirect costs are estimated with regard to a loss of production caused by early deaths, reduced ability to work and sick leave. The loss of production was calculated based on the average salary.

[131] The present authors' own estimation.

Figure 48 Percentage of workers reporting limitations in their daily activities due to health problems, by type of health problems, EU-28, 2015



Only other health problems, *n* = 801; only MSDs, *n* = 592 (backache), *n* = 512 (upper limbs), *n* = 428 (lower limbs); MSDs and other health problems, *n* = 3,797 (backache), *n* = 3,835 (upper limbs), *n* = 3,185 (lower limbs)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

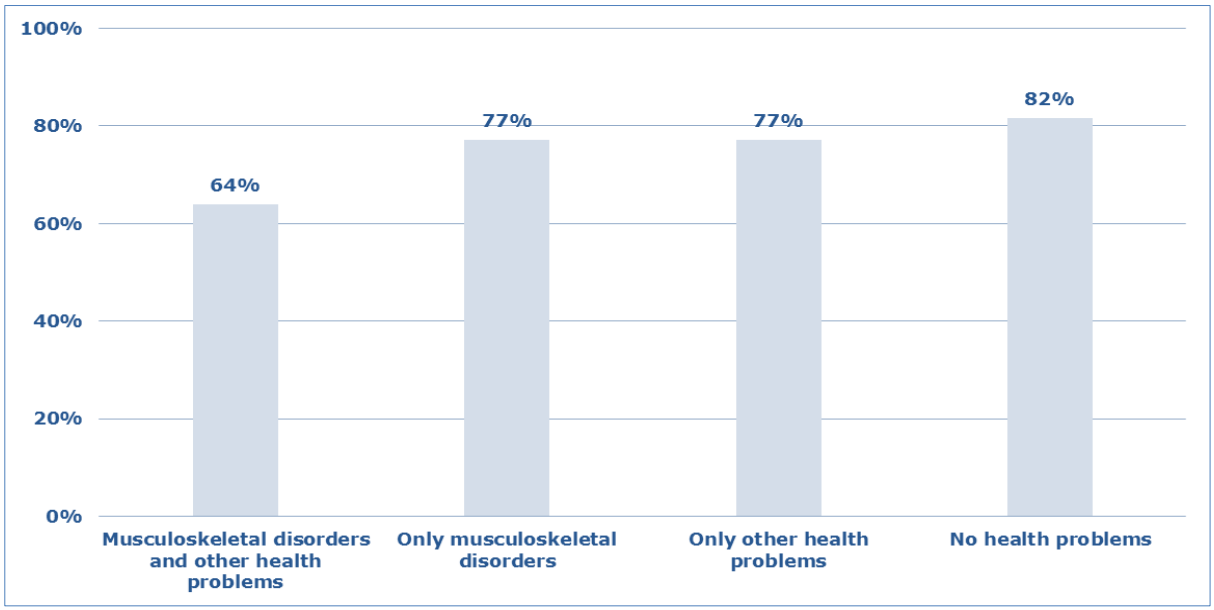
- **A third of workers with MSDs and another health issue believe that they will not be able to continue doing their job to the age of 60 years**

In the long term, workers with MSDs might not be able to continue to do their job or a similar one because of their disorders. Figure 49 underlines this fact. Specifically, almost one third of workers with MSDs who have additional health issues believe that they will not be able to do their current work by the age of 60.

Approximately 20 % of all workers in the EU-28 with health complaints believe that adaptations at work are required to accommodate their illness or health problem. This is slightly higher for workers with MSD-related health complaints than for other health complaints; the difference is, however, only small (Figure 50).

Of workers with chronic health problems, 20 % report that their workplace or work activity has indeed been changed to accommodate for their illness or health problem. This proportion is the same for workers with and without MSD-related chronic health problems (Figure 51).

Figure 49 Percentage of workers reporting that they will be able to do their current or similar job until they are 60 years old, by type of health problem, EU-28, 2015

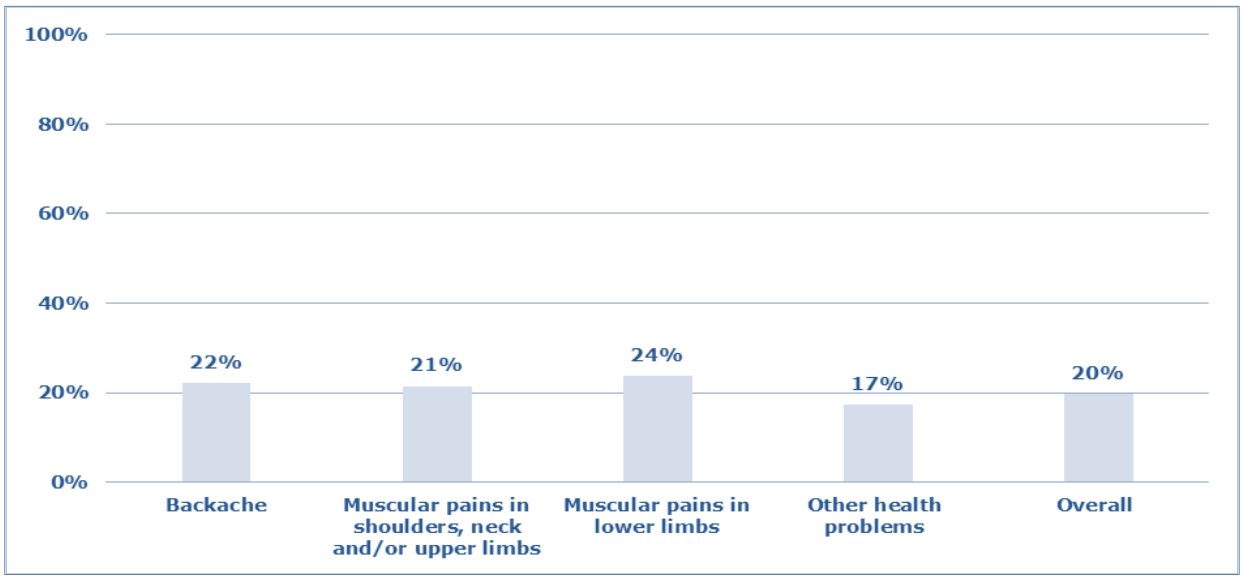


Note: 'Musculoskeletal disorders' refer to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

n = 14,987 (MSDs and other health problems); *n* = 4,590 (only MSDs); *n* = 4,603 (only other health problems); *n* = 7,941 (no health problems)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

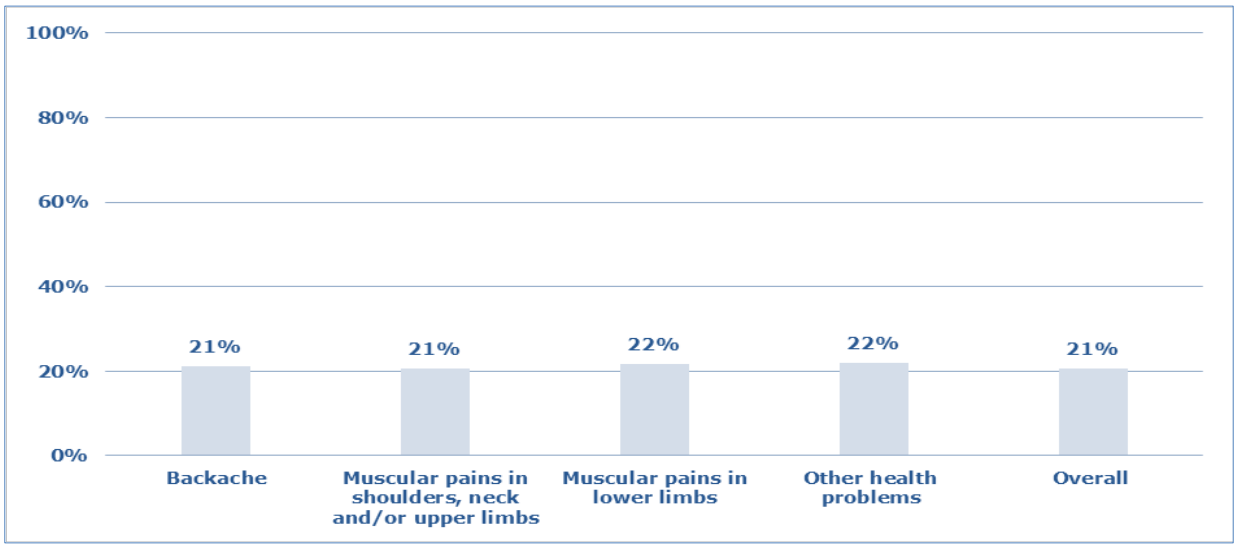
Figure 50 Percentage of workers with health complaints reporting that future adaptation at work would be needed to accommodate their illness or health problem, by type of health complaint, EU-28, 2015



N = 6,074 (total); *n* = 4,110 (backache); *n* = 4,072 (upper limbs); *n* = 3,395 (lower limbs); *n* = 761 (other health problems)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 51 Percentage of workers with chronic health complaints reporting that their workplace or work activity has been changed to accommodate their illness or health problem, by type of health complaint, EU-28, 2015



Note: Chronic health complaints refer to workers reporting any illness or health problem that has lasted, or is expected to last, for more than 6 months.

N = 6,340 (total); *n* = 4,316 (backache); *n* = 4,281 (upper limbs); *n* = 3,557 (lower limbs); *n* = 790 (other health problems)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

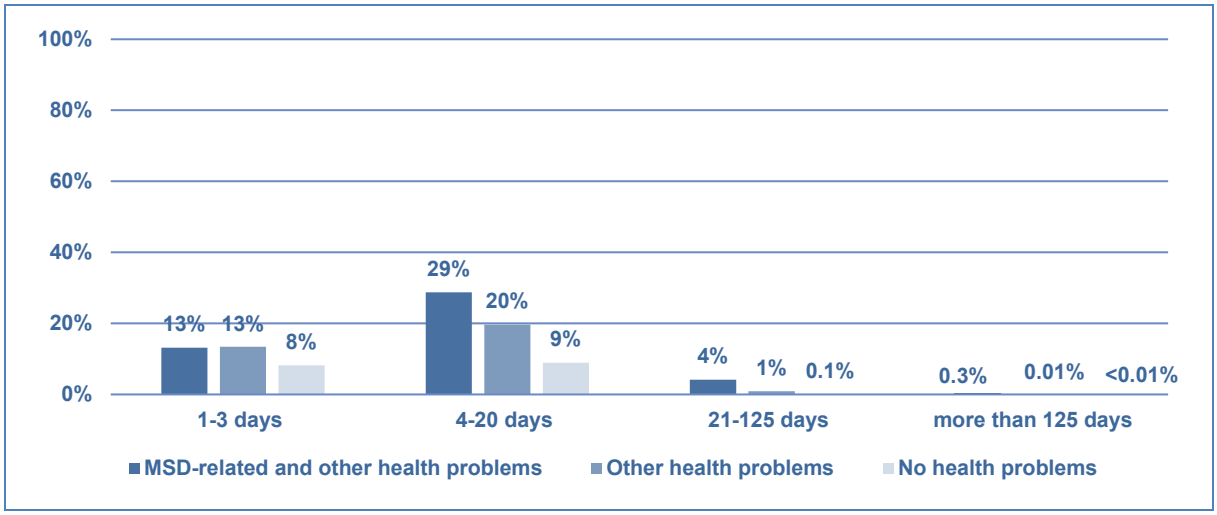
4.2.2 Presenteeism

- **Workers with MSD-related problems tend to work while they are sick more than those without health problems**

Presenteeism is the fact that in some cases people work while they consider themselves to be ill. This is more common among workers with MSDs than among workers without health problems. This becomes clear from Figure 52, which illustrates the percentages in 2015 of workers with MSDs and other health issues, workers with only other health problems and those without health problems who had worked while they were sick during the past 12 months. The percentage of workers with MSDs and other health issues reporting that they worked for 4 to 20 working days while they were sick is significantly higher than that of those with only other health problems. The difference from people without any problem is even more pronounced. It should be noted that the percentages of presenteeism for workers with only MSDs[132] do not show a significant difference from that of workers with only other health issues.

[132] They are 12 % for 1-3 days, 18 % for 4-20 days, 1 % for 21-125 days and 0.04 % for more than 125 days.

Figure 52 Percentages of workers reporting that they worked different numbers of days while sick during the past 12 months, by presence or absence of (MSD-related) health problems, EU-28, 2015



n = 16,650 (MSD-related health problems and other health problems); *n* = 5,075 (other health problems); *n* = 8,787 (no health problems).

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

4.2.3 Absenteeism

- **Workers with MSDs tend to be absent from work more often than others**

Table 4 shows the percentage of workers reporting the numbers of days absent from work for reasons of health problems during the past 12 months, by presence or absence of (MSD-related) chronic health problems. Of the workers with chronic MSDs and other health problems, 26 % report more than 8 days of absence, compared with 7 % with no health problem.

Table 4 Percentage of workers reporting the numbers of days absent from work for reasons of health problems during the past 12 months, by presence or absence of (MSD-related) chronic health problems, EU-27 (excluding Germany), 2014

Type of chronic health problem	0 days	1 to 7 days	8 to 14 days	15 to 30 days	31 to 180 days	More than 180 days	Don't know/ no answer
Chronic MSDs and other health problems	54	17	6	9	9	2	3
Only chronic MSDs	64	16	6	6	5	1	2
Only other chronic health problems	63	18	5	5	5	1	3
No chronic health problems	78	13	3	2	2	0	2
Don't know/NA	64	11	2	5	4	0	14
Total	**71**	**15**	**4**	**4**	**4**	**0**	**3**

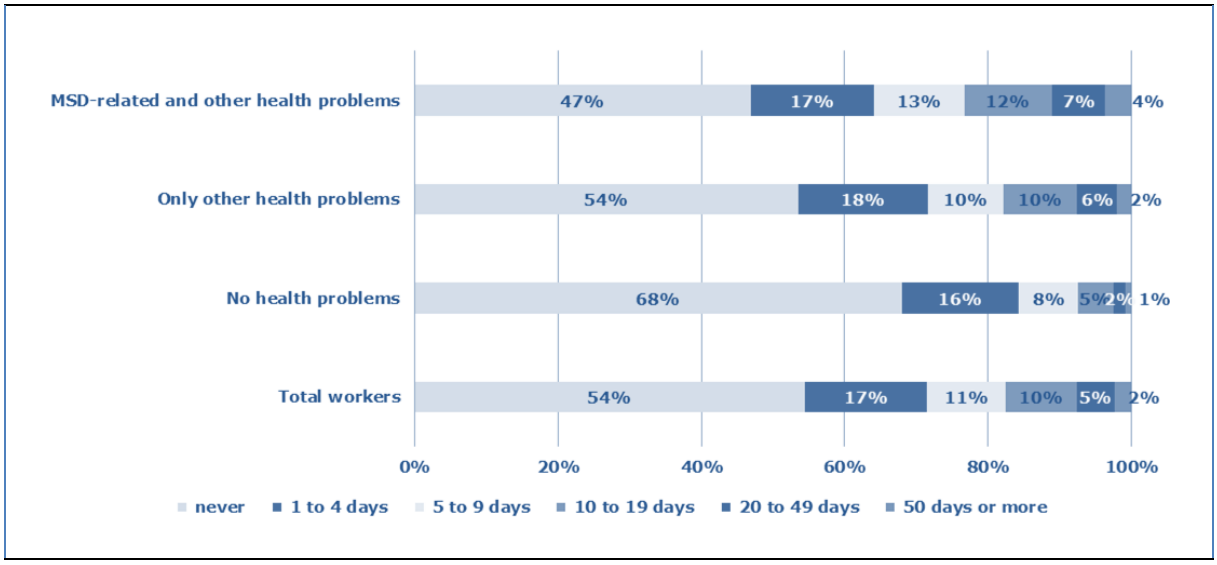
Note: The table includes all EU-28 Member States except for Germany. The results are based on individuals who carry out a job or profession, including unpaid work for a family business or holding, an apprenticeship or paid traineeship, etc.

N = 125,205 (total); *n* = 15,738 (chronic MSDs and other health problems); *n* = 27,717 (only other health problems); *n* = 68,536 (no health problems)

Source: Panteia based on the second wave (2014) of the European Health Interview Survey (EHIS)

Figure 53 shows the number of days in the past 12 months (data for 2015) that workers were absent from their work because of a health issue. More than half of the workers with MSDs and other health problems were absent from work for at least 1 day, while around 23 % were absent for at least 10 days. For workers with only other health problems and workers with no health problems, these proportions are lower. This shows that workers with MSDs tend to be absent from work more often than others.

Figure 53 Number of days absent in the past 12 months due to a health problem: distribution of workers, for workers with MSDs and/or other health problems and without health problems, EU-28, 2015



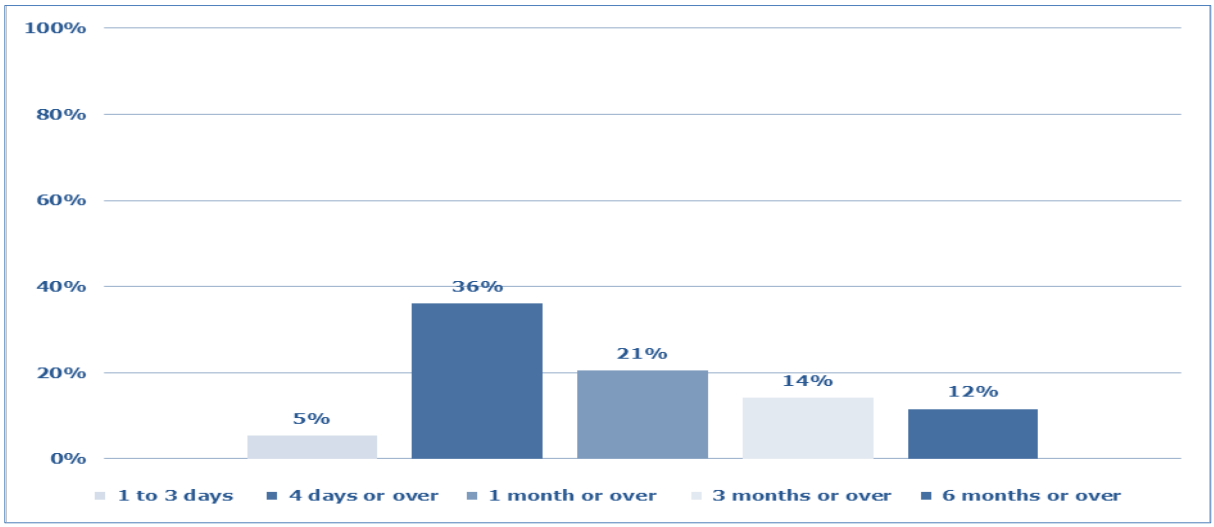
N = 32,005 (total); *n* = 15,036 (MSD-related health problems and other health problems); *n* = 4,614 (only other health problems); *n* = 7,680 (no health problems)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

In the case of work-related health problems, the majority of sick leave last 4 days or longer (Figure 54). In 2013, 5 % of the workers in the EU-28 reported that they had taken 1 to 3 days of sick leave as a result of a work-related health problem. At 36 %, the proportion of workers reporting sick leave of 4 days or more (as a result of a work-related health problem) was much higher. This is the same percentage as that of workers with MSD-related (and/or other) health problems with sick leave of 5 days or more in 2015 (based on the sixth wave of the EWCS)[133].

[133] The sum of the percentages of workers with MSD-related and/or other health problems with 5-9 days, 10-19 days, 20-49 days and 50+ days absent is 36 % (13 % + 12 % + 7 % + 4 %) (Figure 53).

Figure 54 Percentage of workers reporting a work-related health problem resulting in sick leave, by sick leave duration, EU-28, 2013



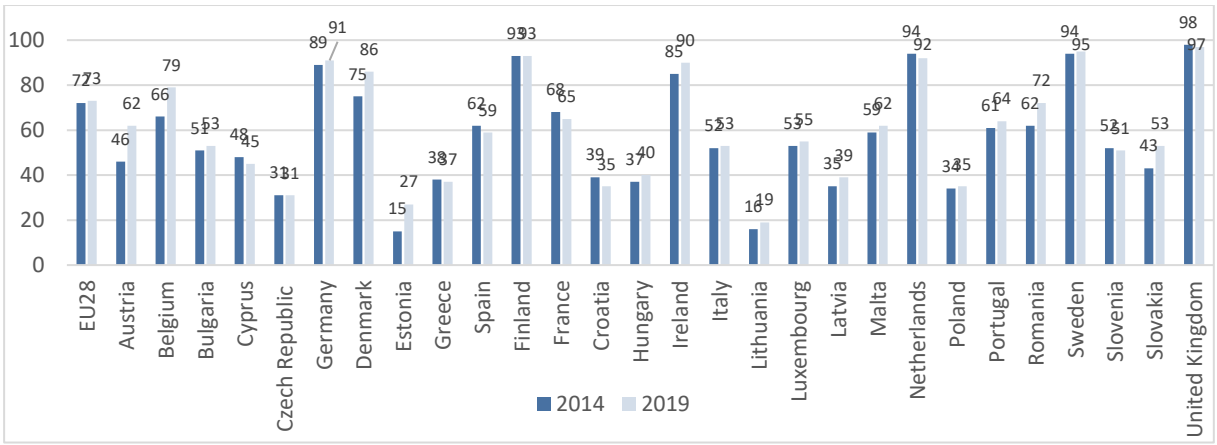
Source: Panteia based on publicly available data of Labour Force Survey ad hoc module 'Accidents at work and other work-related health problems' (2013)

4.2.4 Return to work

- **Considerable differences between EU-28 Member States on policies that support employees to return to work**

There are considerable differences between EU-28 Member States in the proportion of employees who can benefit from policies to support employees to return to work after a long-term sickness absence. As illustrated in Figure 55, in 2019 large percentages of employees in the United Kingdom (97 %), Sweden (95 %), Finland (93 %), and the Netherlands (92 %) work in enterprises where support is provided to employees returning to work after long-term sickness leave. On the other hand, in Lithuania (19 %) and Estonia (27 %), the percentages are significantly lower than the EU-28 average (73 %).

Figure 55 Percentage of employees working in establishments with support measures for employees in place to return to work after a long-term sickness, by country, 2014 and 2019



Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of employees, not to the number of establishments in the universe. *N* = 12,939 (2014) *N* = 11,879 (2019) Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

5 Exposure to risk factors

In the previous two chapters the prevalence and impact of MSDs has been discussed. This chapter focuses on possible determinants of (work-related) MSDs: physical, organisational and psychosocial risk factors at work.

Physical, organisational and psychosocial risk factors at work can play a crucial role in the appearance and prevalence of MSDs as well as other health issues. Therefore, it is of vital importance for enterprises and their employees to be aware of these risks at their establishments. For several risk factors there is already reasonable evidence of their association with MSDs (see the theoretical framework in section 2.2).

The objective of this chapter is to increase the current knowledge of the role and prevalence of various risk factors at work. The sixth wave of the EWCS not only includes questions about three different types of MSDs, but also includes various questions regarding physical, organisational and/or psychosocial risk factors. Quantitative analyses[134] have been performed on this data source to identify which physical, organisational and/or psychosocial risk factors are significantly related to the prevalence of three different types of MSD complaints (back, upper limbs and lower limbs). The results of these analyses are discussed in section 5.1 (physical factors) and section 5.2 (organisational and psychosocial risk factors). Both sections follow the same structure. First, the risk factors that are significantly related to the prevalence of MSDs are identified. Next, the prevalence of these risk factors is discussed, followed by a discussion on the strength of the relationship between these risk factors and MSDs. Finally, a search for specific combinations of risk factors that often occur together is conducted.

5.1 Physical factors at work

5.1.1 Physical risk factors related to MSD prevalence

Previous studies (see section 2.2.3) have found reasonable evidence for an association between different types of MSDs and the following physical risk factors[135]:

- posture;
- working in awkward positions;
- heavy physical work;
- lifting;
- repetitive work;
- prolonged computer work.

Consistent with these findings, analyses on EWCS data show that prevalence of MSDs is associated with working in tiring or painful positions, carrying or moving heavy loads and repetitive hand or arm movements. This applies to all three types of MSDs that are distinguished in the EWCS (back, upper limbs and lower limbs). In addition, being exposed to vibrations from hand tools also increases the likelihood of reporting any of these three types of MSDs[136]. Being exposed to low temperatures is associated with a higher prevalence of MSDs in upper limbs and lower limbs. The results of the analyses on the sixth wave of the EWCS are summarised in Table 5.

[134] These concern logistic regressions with self-reported MSD complaints as the dependent variable, and gender, age, country, occupation, sector and various physical, organisational and psychosocial risk factors among the independent variables. These regressions have been applied separately for MSDs in upper limbs, lower limbs and back. See Annex 2 for an elaborate discussion of these regressions, and specifically Annex 2.3 for the estimation results.

[135] This list contains only risk factors that are included in the sixth wave of the EWCS. See Chapter 2, section 2.2.3 for references.

[136] This appears to be an indirect relationship: in a logistic model that does not include other risk factors, being exposed to vibrations from hand tools is significantly related to MSD prevalence. Once other physical risk factors are taken into account, the relationship becomes insignificant.

Table 5 Associations between self-reported MSDs and physical risk factors

Body area	Significant relationship identified	No significant relationship identified
Back	▪ Vibrations from hand tools ▪ Working in tiring or painful positions ▪ Carrying or moving heavy loads ▪ Repetitive hand or arm movements	▪ Lifting or moving people ▪ Working with computers, laptops, etc. ▪ Sitting ▪ Being exposed to low temperatures
Lower limbs	▪ Vibrations from hand tools ▪ Working in tiring or painful positions ▪ Carrying or moving heavy loads ▪ Repetitive hand or arm movements ▪ Being exposed to low temperatures ▪ Sitting*	▪ Lifting or moving people ▪ Working with computers, laptops, etc.
Upper limbs	▪ Vibrations from hand tools ▪ Working in tiring or painful positions ▪ Carrying or moving heavy loads ▪ Repetitive hand or arm movements ▪ Being exposed to low temperatures	▪ Lifting or moving people ▪ Working with computers, laptops, etc. ▪ Sitting

Note: This table is based on the results of various binary logistic regressions that have been estimated to explain the prevalence of self-reported MSD complaints in the sixth (2015) wave of the EWCS.

* For prolonged sitting, the relationship to the prevalence of self-reported MSDs (in the lower limbs) is negative. For all other risk factors mentioned in the second column of this table, the relationship to the prevalence of self-reported MSDs is positive.

Source: Panteia, 2019

- **No significant relationship identified with lifting or moving people or computer work**

While the analyses conducted for this study support the presence of a relationship between MSD prevalence and carrying or moving heavy loads, there is no support for a relationship to the extent to which the main paid job involves lifting or moving people. A possible explanation is that each of these risk factors actually combines two different risks (as discussed in section 2.2)[137]:

- Carrying a heavy load involves different types of muscle activities from moving a heavy load (which may involve pushing or pulling a cart or operating a forklift).

[137] A high correlation between carrying or moving heavy loads and lifting or moving people could be another explanation: in the event of a high correlation, the relationship between lifting or moving people and MSD prevalence is difficult to distinguish from the relationship between carrying or moving heavy loads and MSD prevalence. This is, however, not the case: the extent to which workers' main job involves lifting or moving people is only weakly correlated to the extent to which workers' main job involves carrying or moving heavy loads (Spearman's rank-order correlation equals 0.18).

- Lifting people involves different types of muscle activities from moving people (which may involve pushing or pulling a bed or wheelchair).

'Carrying or moving heavy loads' may therefore represent a very different kind of activity from 'lifting or moving people', and the results suggest that only the first risk factor can be related to MSD prevalence.

The analyses on EWCS data also offer no support for a relationship between MSD complaints and the amount of time that workers spend on computers, laptops, smartphones, etc. A possible explanation is that the types of MSD complaints distinguished in the EWCS are too general: previous studies have found a relationship between prolonged computer work and MSD complaints in the wrist and/or hand[138], while MSD complaints in upper limbs also include other body areas (shoulders, elbow and forearm). Another possibility is that working with computers and laptops involves different postures from working with smartphones. Combining these different types of activities into a single question makes it impossible to disentangle the different effects that they might have on the development of MSD complaints.

In addition, the use of computers at work may result in health complaints associated with MSDs. Thus, according to another study[139], one in three Dutch people using computers at work on a regular basis suggest that they experience arm, wrist, hand, shoulder or neck complaints on a 'regular'/'persistent' basis, basically in terms of pain, stiffness and tingling/numbness, and a proportion of these people may develop chronic complaints.

- **Negative relation found between sitting and MSD complaints in lower limbs**

One of the objectives of this study is to contribute to the earlier identification of emerging trends and risks at work, by determining the prevalence and impact of prolonged sitting and prolonged standing at work.

The possible relationship between prolonged standing and MSD complaints has not been examined, because data on prolonged standing are not available in the sixth wave of the EWCS. For sitting, analyses on EWCS data find that, the more time workers are sitting during their work, the less likely they are to report MSD complaints in the lower limbs. The analyses do not show a significant relationship between prolonged sitting and MSD complaints in the back and upper limbs. This is a noteworthy finding that does not seem to be in line with the outcomes of other studies on the relationship between prolonged sitting and MSD complaints.

According to a literature review from 2017, self-reported time spent sitting is positively related to chronic diseases and mortality. When looking more specifically at the relationship between sitting at work and MSDs, the results are less clear: 'A systematic review devoted to detrimental health effects of occupational sitting found limited evidence for an independent association with musculoskeletal pain' (Holtermann *et al*., 2017, p. 42)[140]. As a possible explanation for this lack of evidence, the authors argue that the extent of (prolonged) sitting is very difficult to measure using self-reported surveys: if data on the amount of time spent sitting are collected through questionnaires, they are not a reliable measure of the actual amount of time spent sitting, and are 'therefore generally regarded to have severe limitations when used in studies of occupational sedentary behavior' (Holtermann *et al*., 2017, p. 42).

What complicates the research on the effects of sitting is that sitting for short periods of time may also have positive effects, such as relieving the load on the hip joints and legs. Especially after standing for a long time, a short period of sitting can have a beneficial effect, because it relieves the load from

[138] See Chapter 2, section 2.2.2, Table 2 for references.

[139] Health Council of the Netherlands, *Beeldschermwerken* (Computer use at work), Commissie Signalering Arbeidsomstandighedenrisico's, The Hague, 2012. Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2012/12/20/beeldschermwerken/dossier-beeldschermwerken.pdf

[140] Holtermann, A., Schellewald, V., Mathiassen, S., Gupta, N., Pinder, A., Punakallio, A., Veiersted, K., Weber, B., Takala, E., Draicchio, F., Enquist, H., Desbrosses, K., Penahora García Sanz, M., Malinska, M., Villar, M., Wichtl, M., Strebl, M., Forsman, M., Lusa, S., Tokarski, T., Hendriksen, P. & Ellegast, R., 'A practical guidance for assessments of sedentary behavior at work: a PEROSH initiative', *Applied Ergonomics*, Vol. 63, 2017, pp. 41-42. Available at: http://dx.doi.org/10.1016/j.apergo.2017.03.012

standing so long (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, 2008, p. 18)[141]. This indicates that, in the case of sitting (and probably also in the case of standing), a certain threshold exists: the amount of time people need to sit (without standing up) before their risk of health problems increases. Such threshold values have not yet been established (Holtermann *et al.*, 2017, p. 42).

Given the findings from these studies, the results of the analysis on the EWCS data regarding sitting should be interpreted with caution. Generally speaking, data on sitting obtained through questionnaires may not be reliable enough. More specifically, the questions included in the survey ask about the proportion of total working time that workers are sitting. This may not be a good indicator of prolonged sitting (sitting without moving or standing up for a long time). Especially if sitting for a short period of time has opposite health effects from sitting for a prolonged time[142], this makes the results of the analysis on the EWCS data regarding sitting less reliable. More importantly, however, the sixth wave of the EWCS does not include questions on standing. Measures of prolonged sitting are likely to be negatively correlated with measures of prolonged standing. In the absence of the latter, it cannot be determined whether the negative relationship between sitting and MSD complaints in the lower limbs represents a causal relationship, or whether it is due to an unmeasured positive causal relationship between standing and MSD complaints in the lower limbs.

The impact of MSDs and sitting and standing is further addressed in the study of EU-OSHA on MSDs associated with prolonged static postures (sitting/standing) and lower limb disorders (EU-OSHA, forthcoming, b)[143]. The findings regarding MSDs and sitting will be further analysed in this study.

5.1.2 Prevalence of physical risk factors

The fact that a specific physical risk factor has a significant relationship to the prevalence of MSDs does not mean that this relationship is important. Whether it is important or not also depends on how many workers are affected by the risk factor (its prevalence) and on the strength of the relationship to MSD prevalence.

This section discusses the prevalence of the physical risk factors. In particular, it focuses on the physical risk factors that were found to have a significant impact on MSD complaints. In addition, the following three physical factors are considered, since these are of particular interest for this study: prolonged sitting, prolonged standing and working with computers.

Figure 56 shows the trends in the prevalence of these physical risk factors between 2005 and 2015. For prolonged standing and sitting, fewer data are available (Figure 57).

- **Most prevalent risk factors are standing, repetitive hand movements and working with computers**

The most recent year for which data on prolonged standing are available is 2010. In that year, 69 % of workers across the EU had to stand at least a quarter of the time, which made it the most prevalent risk factor. The top three most prevalent risk factors for that year are completed by repetitive hand or arm movements (64 % of workers across the EU) and working with computers, laptops, smartphones, etc. (53 %).

[141] Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, *The ups and downs of sitting: sitting at work and elsewhere*, 2008. Available at: https://www.baua.de/DE/Angebote/Publikationen/Praxis/A66.pdf?__blob=publicationFile&v=1

[142] The positive effects of sitting for a short period of time are actually in line with the finding of the analysis on the EWCS data (the more time workers are sitting during their work, the less likely they are to report MSD complaints in the lower limbs). This could indicate that many workers who report that they sit for a long time remain below the threshold for prolonged sitting, and/or that sitting relieves the stress from standing (which is what their posture may be when they are not sitting).

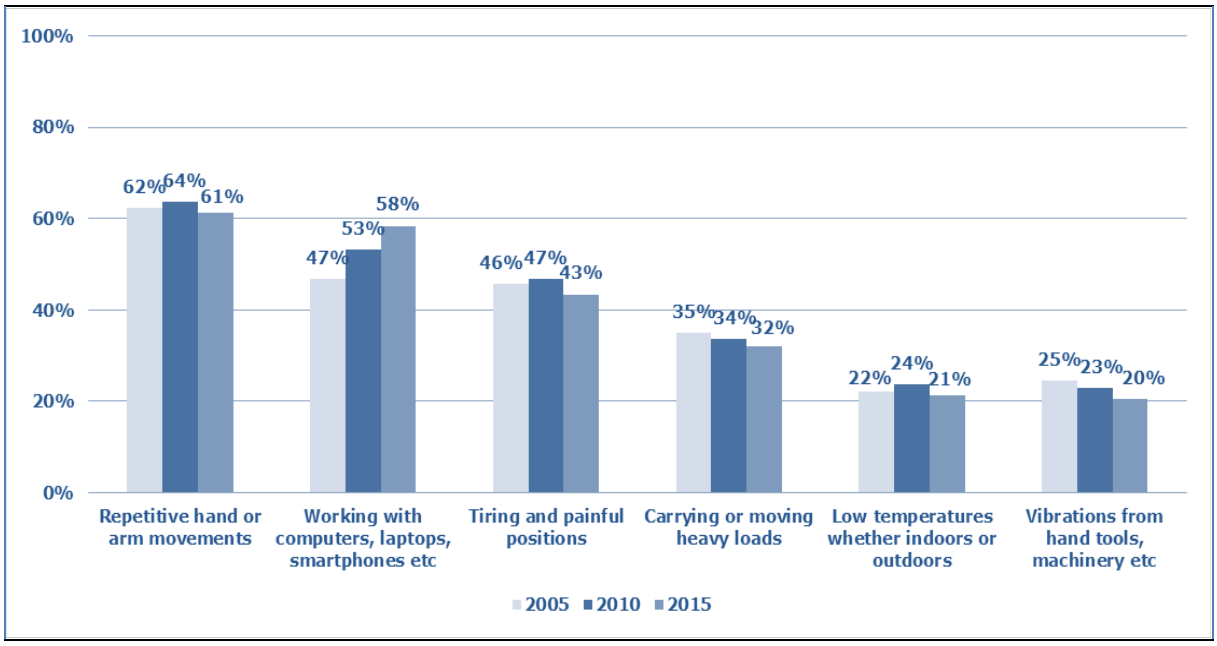
[143] EU-OSHA — European Agency for Safety and Health at Work, *MSDs associated with prolonged static postures (sitting/standing) and lower limb disorders* (working title), forthcoming. To be available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

- **For most risk factors, prevalence is decreasing**

Working with computers, laptops, smartphones, etc. is becoming increasingly prevalent in Europe. According to the EWCS the percentage of people working with computers for at least a quarter of their working day increased from 47 % in 2000 to 53 % in 2010 and 58 % in 2015. For sitting (60 % in 2015) it is not possible to determine a trend, but it is likely that this has increased as well (assuming that most of the work done on computers, laptops, etc. is done sitting[144]). For all other risk factors, the prevalence in 2015 was slightly less than in 2005 and 2010.

These findings are consistent with the slight decrease in MSD prevalence between 2010 and 2015 (see section 3.1): for most risk factors the prevalence has decreased, and the only physical risk factor for which prevalence has increased does not seem to be related to MSD prevalence.

Figure 56 Percentage of workers reporting that they are exposed to different physical risk factors at their work at least a quarter of the time, EU-28, 2005, 2010 and 2015



Note: Data concern workers who work at least 12 hours per week.

For 2005: *n* = 24,878 (repetitive hand or arm movements); *n* = 24,906 (working with computers, laptops, smartphones, etc.); *n* = 24,951 (tiring and painful positions); *n* = 24,910 (carrying or moving heavy loads); *n* = 24,918 (low temperatures whether indoors or outdoors); *n* = 24,966 (vibrations from hand tools, machinery, etc.)

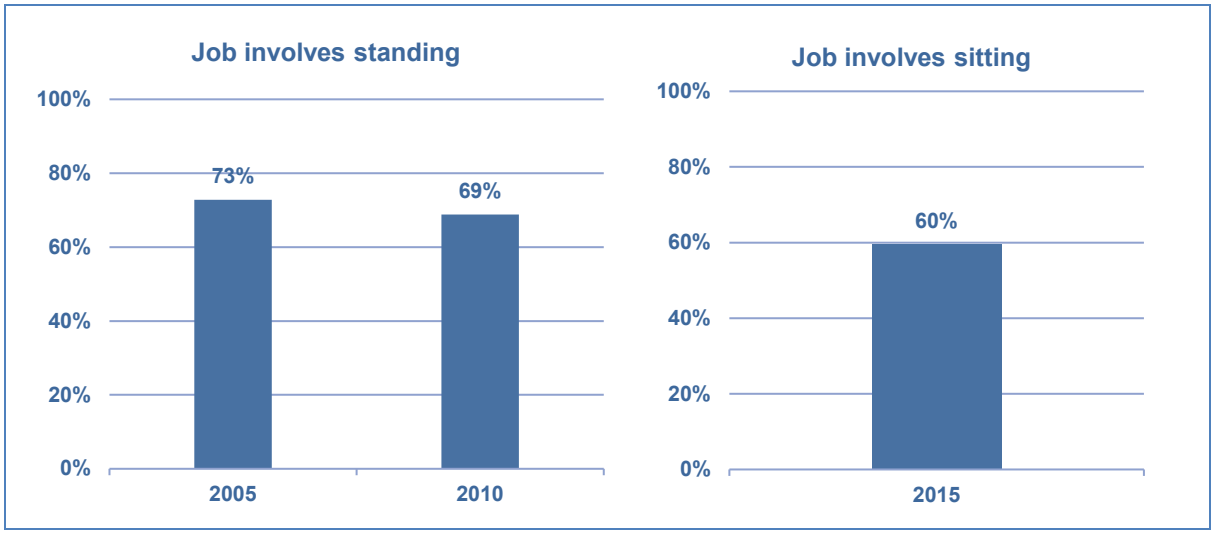
For 2010: *n* = 33,955 (repetitive hand or arm movements); *n* = 34,017 (working with computers, laptops, smartphones, etc.); *n* = 33,998 (tiring and painful positions); *n* = 34,025 (carrying or moving heavy loads); *n* = 33,979 (low temperatures whether indoors or outdoors); *n* = 34,036 (vibrations from hand tools, machinery, etc.)

For 2015: *n* = 32,649 (repetitive hand or arm movements); *n* = 32,685 (working with computers, laptops, smartphones, etc.); *n* = 32,646 (tiring and painful positions); *n* = 32,701 (carrying or moving heavy loads); *n* = 32,662 (low temperatures whether indoors or outdoors); *n* = 32,671 (vibrations from hand tools, machinery, etc.)

Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

[144] This assumption is confirmed by the positive correlation between working with computers, laptops, smartphones etc. and sitting in 2015: Spearman's rank-order correlation between these two risk factors equals 0.58.

Figure 57 Percentage of workers reporting that their job involves standing or sitting at least a quarter of the time, EU-28, 2005, 2010 and 2015



Note: Data concern workers who work at least 12 hours per week.

n = 24,950 (standing, 2005); *n* = 34,016 (standing, 2010); *n* = 32,683 (sitting, 2015)

Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

The prevalence of these physical risk factors will now be discussed in more detail, by considering differences between workers with and without MSD complaints, and by gender and occupation. This will be done for the most recent year for which data are available.

Figure 58 compares the prevalence of the physical risk factors among workers with and without MSD complaints, and among male and female workers[145]. For most of the risk factors, the prevalence is higher among workers with MSD complaints than among workers without any MSD complaints. The difference is especially high (more than 10 percentage points, for men as well as for women) for working in tiring positions, carrying or moving heavy loads and repetitive hand or arm movements.

- **Sitting and working with computers: more often reported by workers without MSDs**

For sitting, the opposite applies: the prevalence of sitting (for at least a quarter of the time) is actually lower among workers reporting MSDs than among workers without MSD complaints. This is consistent with the finding that prolonged sitting reduces the likelihood of reporting MSDs in the lower limbs.

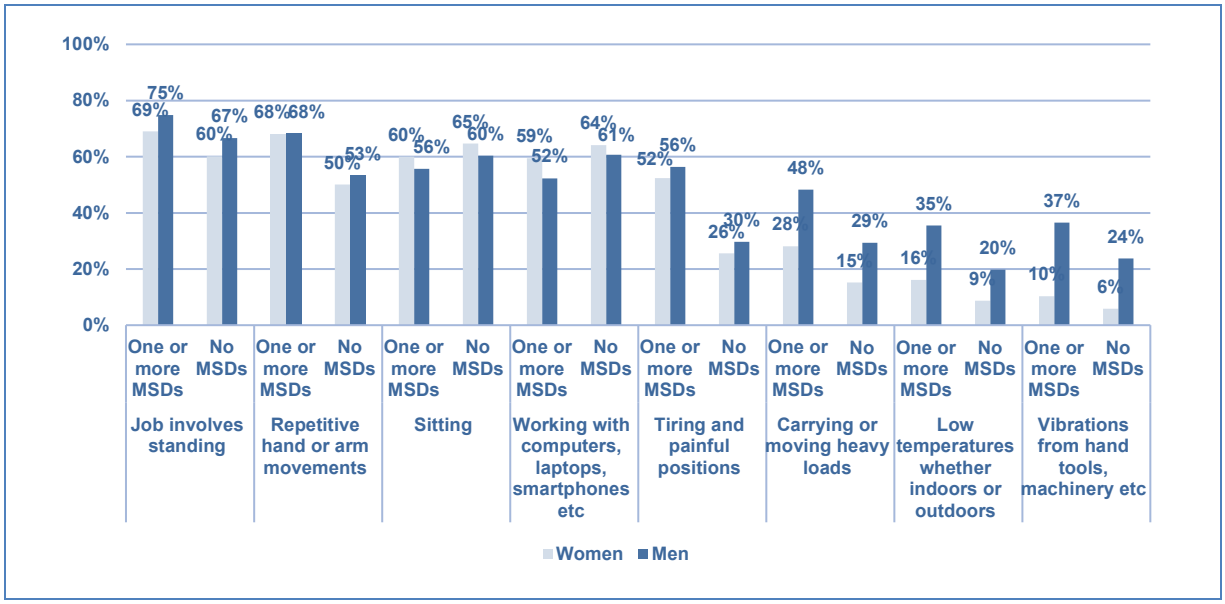
Prolonged sitting and prolonged standing are likely to be negatively correlated with each other. To the extent that this is the case, the relationship between MSD complaints and sitting might reflect a relationship between MSD complaints and standing: the prevalence of standing (for at least a quarter of the time) might be higher among workers reporting MSDs than among workers without MSD complaints. Since the sixth EWCS data do not include information on prolonged standing, it is not possible to confirm if this is indeed the case.

The prevalence of working with computers (for at least a quarter of the time) is also lower among workers reporting MSDs than among workers without MSD complaints. This is consistent with the fact that this risk factor is positively correlated with sitting[146], and with the finding that working with computers does not increase the prevalence of MSD complaints. Note, however, that reverse causality cannot be ruled

[145] The prevalence rates for the risk factors included in this figure are approximately the same for the three types of MSDs that are distinguished (back, upper limbs, lower limbs). The figure therefore does not differentiate between the three MSD types.
[146] Spearman's rank-order correlation between these two risk factors equals 0.58.

out. This would occur if workers with MSD complaints reacted to these complaints by reducing the amount of time they spend working with computers, etc. That would also result in a lower prevalence of working with computers among workers reporting MSDs. It is also not clear to what extent working with computers, etc. is negatively correlated with prolonged standing, and how these risks interact with each other.

Figure 58 Percentage of workers with and without MSDs reporting that they are exposed to different physical risk factors at least a quarter of the time, EU-28, by gender, 2015 (2010 for standing)



n = 33,923 (job involves standing); *n* = 32,619 (repetitive hand or arm movements); *n* = 32,654 (sitting); *n* = 32,645 (working with computers, laptops, smartphones, etc.); *n* = 32,602 (tiring and painful positions); *n* = 32,660 (carrying or moving heavy loads); *n* = 32,625 (low temperatures whether indoors or outdoors); *n* = 32,632 (vibrations from hand tools, machinery, etc.)

Source: Data on standing are obtained from the fifth (2010) wave of the EWCS. Data on the other risk factors are obtained from the sixth (2015) wave of the EWCS. Data concern workers who work at least 12 hours per week.

- **Gender differences especially for carrying or moving heavy loads, vibrations from hand tools and working at low temperatures**

For the following risk factors, the difference in prevalence between male and female workers is larger than the difference between workers with and without MSD complaints:

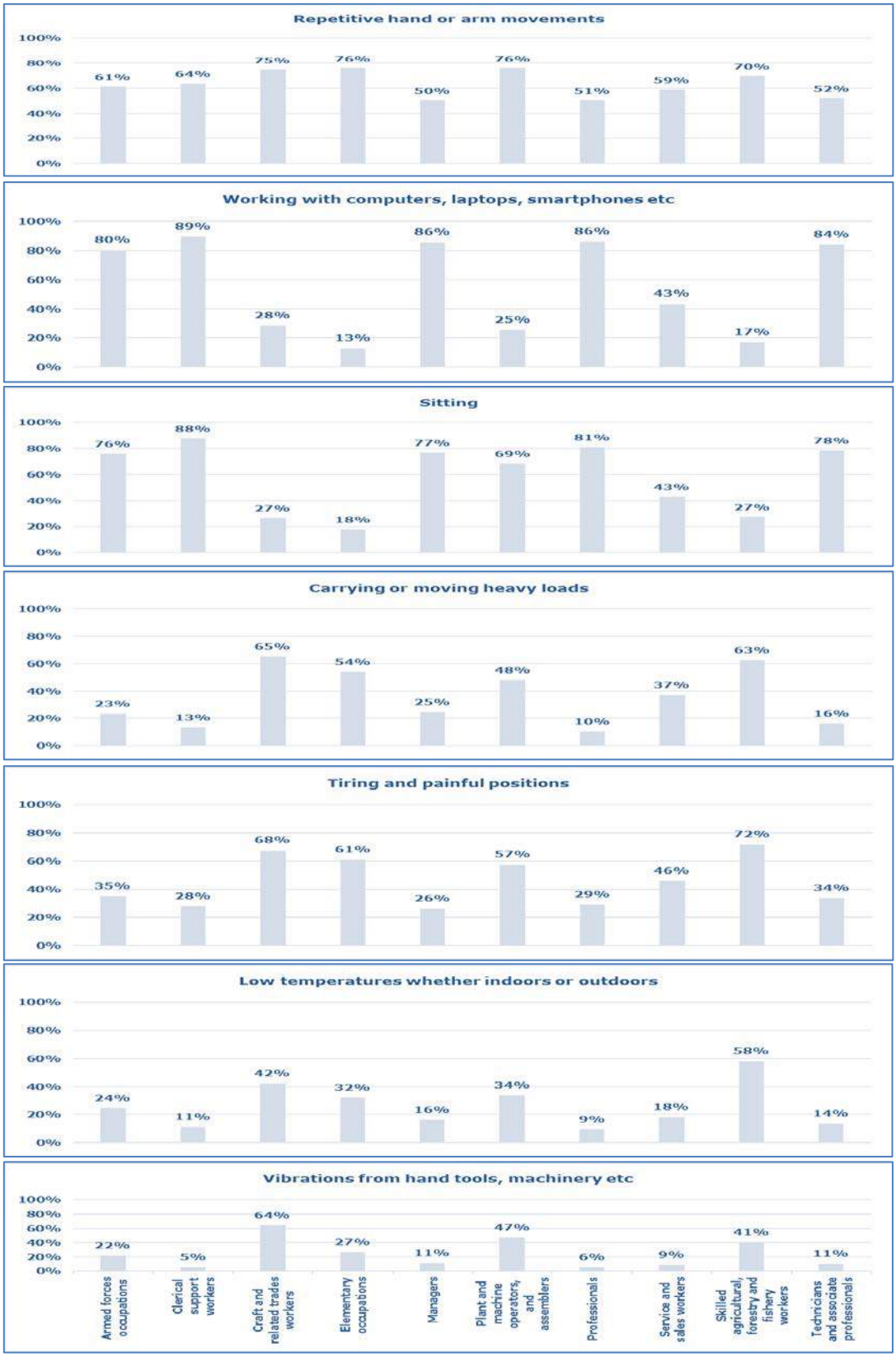
- carrying or moving heavy loads (for at least a quarter of the time);
- working at low temperatures (for at least a quarter of the time);
- vibrations from hand tools, machinery, etc. (for at least a quarter of the time).

Each of these risk factors is mentioned more by male workers than by female workers. The prevalence of these risk factors is even higher among male workers without MSD complaints than among female workers with MSD complaints.

As Figure 59 shows, the prevalence of the physical risk factors varies considerably between occupations. The risks from working with computers, laptops, smartphones, etc. or from sitting for at least a quarter of the time predominantly occur for clerical support workers, managers, professionals, and technicians and associate professionals[147].

[147] Data on armed forces occupations are included in the graph but not discussed in the main text (given the low number of observations and the specific characteristics of this occupation).

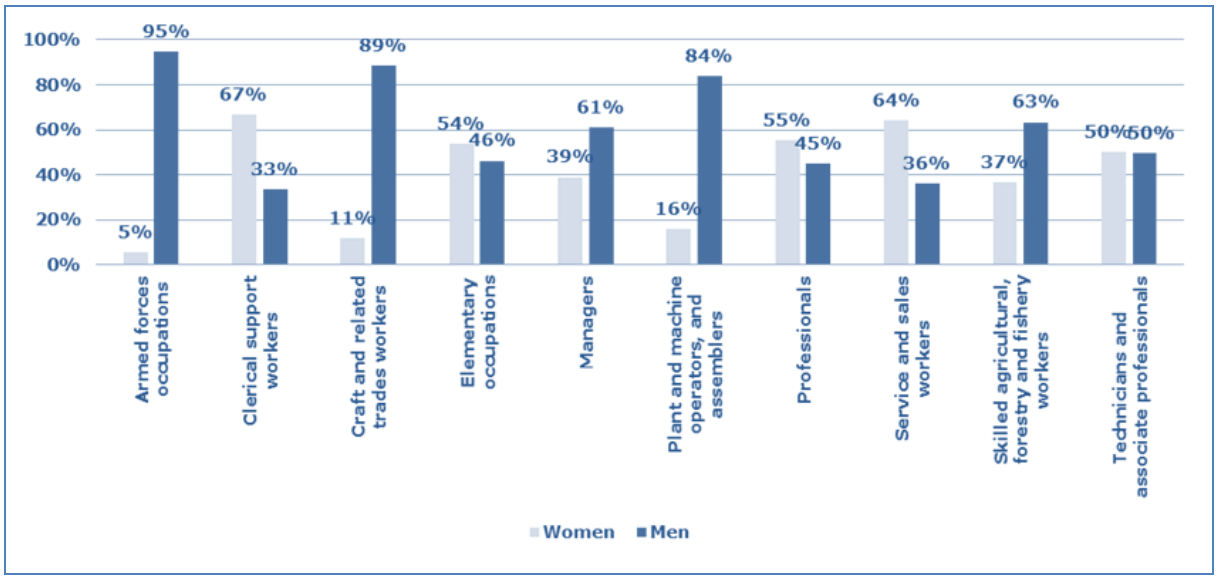
Figure 59 Percentage of workers reporting that they are exposed to different physical risk factors at least a quarter of the time, EU-28, by occupation, 2015



Note: Data concern workers who work at least 12 hours per week.
N = 32,701
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

In contrast, the risks from carrying or moving heavy loads, working at low temperatures and vibrations from hand tools, machinery, etc. are mainly found among craft and related trades workers, elementary occupations, plant and machine operators, assemblers, and skilled agricultural, forestry and fishery workers. Except for elementary occupations, these are all occupations in which the (large) majority of all workers are male (Figure 60). This gender difference by occupations may explain the gender difference in the prevalence of the three risk factors associated with these occupations.

Figure 60 Gender distribution of workers, by occupation, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week.

N = 32,701

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

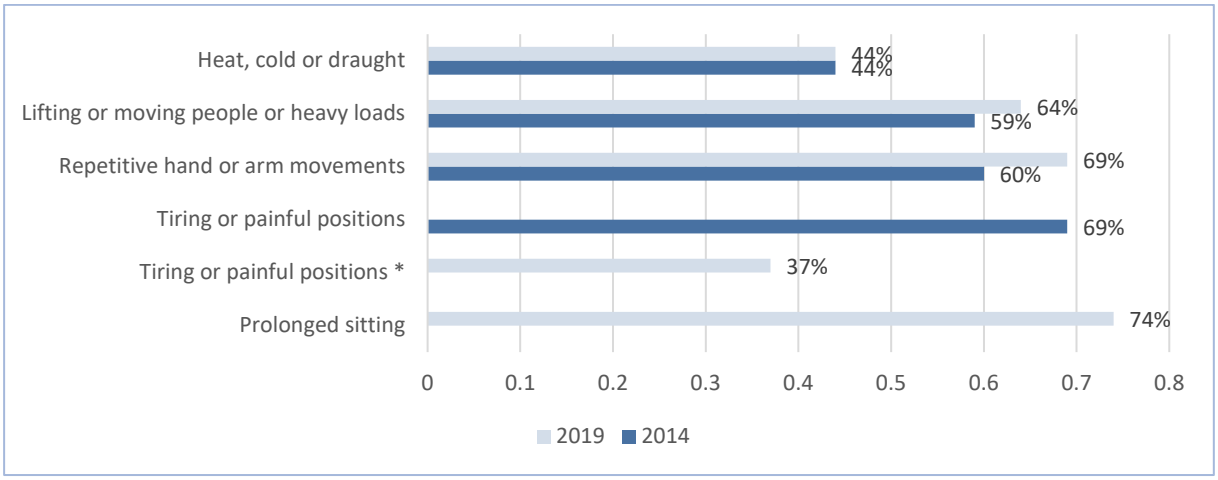
For several physical risk factors, estimates of their prevalence can also be based on enterprise surveys (in particular, ESENER for those employees in establishments with five or more workers). Enterprise surveys can be used to determine the proportion of employees that work in enterprises where these risk factors are present[148]. Across the EU-28, most employees (74 %) work in enterprises where prolonged sitting positions are present[149]. Approximately 70 % of employees work in establishments where repetitive hand or arm movements occur (significant increased between 2014 and 2019). The percentage (64%) of employees lifting or moving people or heavy loads[150] has also increased over the last years. A large minority of employees work in establishments where employees may be subjected to heat, cold or draughts (Figure 61).

[148] Similar figures are also presented by EU-OSHA — European Agency for Safety and Health at Work, *Second European Survey of Enterprises on New and Emerging Risks (ESENER-2): first findings*, 2018. Available at: https://osha.europa.eu/en/tools-and-publications/publications/reports/esener-ii-first-findings.pdf. An important difference is that figures of EU-OSHA (2018) are based on an establishment-proportional weighting factor (to present statistics that are representative of the enterprise population), whereas the figures presented in the current report are based on an employee-proportional weighting factor (to present statistics that are representative of the population of employees). Consequently, figures presented in the current report may be different from figures presented by EU-OSHA (2018).

[149] Not all employees in these establishments necessarily work in prolonged sitting positions. This number is therefore an upper boundary of the percentage of employees working in prolonged sitting positions.

[150] The ESENER-2 survey does not distinguish between carrying or moving heavy loads and lifting or moving people.

Figure 61 Percentage of employees working in establishments where different physical risk factors are in place, EU-28, 2014 and 2019



Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of employees, not to the number of establishments in the universe.

Question changed in ESENER-3. 'Tiring or painful positions, including sitting for long periods' (in ESENER 2) replaced by 'Tiring or painful positions' (in ESENER 3). New item: prolonged sitting

N = 40,584 (2014) *N* = 39,711 (2019)

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

5.1.3 Relationship between physical risk factors and MSDs

Besides establishing the prevalence of relevant physical risk factors, it is also informative to establish the strength of their relationship to MSD prevalence, and whether or not this relationship varies between different sociodemographic groups of workers. This is actually the case for most of these physical risk factors:

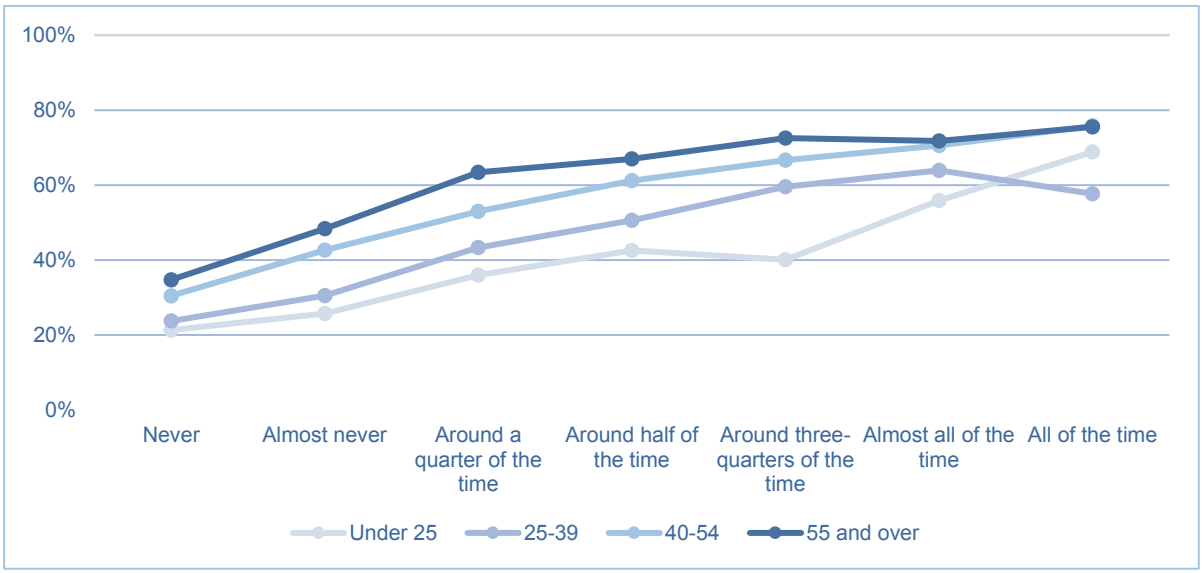
- Working in tiring or painful positions: the relationship to MSDs affecting the back varies between age groups.
- Carrying or moving heavy loads: the relationship to MSDs in the upper limbs is different for male and female workers; the relationship to MSDs in the back varies between age groups.
- Repetitive hand or arm movements: the relationship to MSDs in the back is related to country of birth.
- Sitting: the relationship to MSDs in the lower limbs is different for male and female workers.

▪ Working in tiring or painful positions

Of all the physical risk factors identified for this study, working in tiring or painful positions appears to have the strongest relationship to MSD prevalence[151]. Of all the workers whose main paid job never involves tiring and painful positions, around 28 % report having MSDs affecting the back. This varies from 21 % for workers less than 25 years of age to 34 % for workers aged 55 or more. For all age groups, this percentage increases with the amount of time workers have to work in tiring or painful positions, but for the eldest age group this increase appears to be somewhat less strong than for the other age groups (Figure 62).

[151] In this respect, the strength of the relationship is measured as the difference in MSD prevalence between the highest and lowest scores for the risk factor.

Figure 62 Percentage of workers having backache problems in the past 12 months, by proportion of working time that main paid job involves tiring and painful positions, by age group, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week.

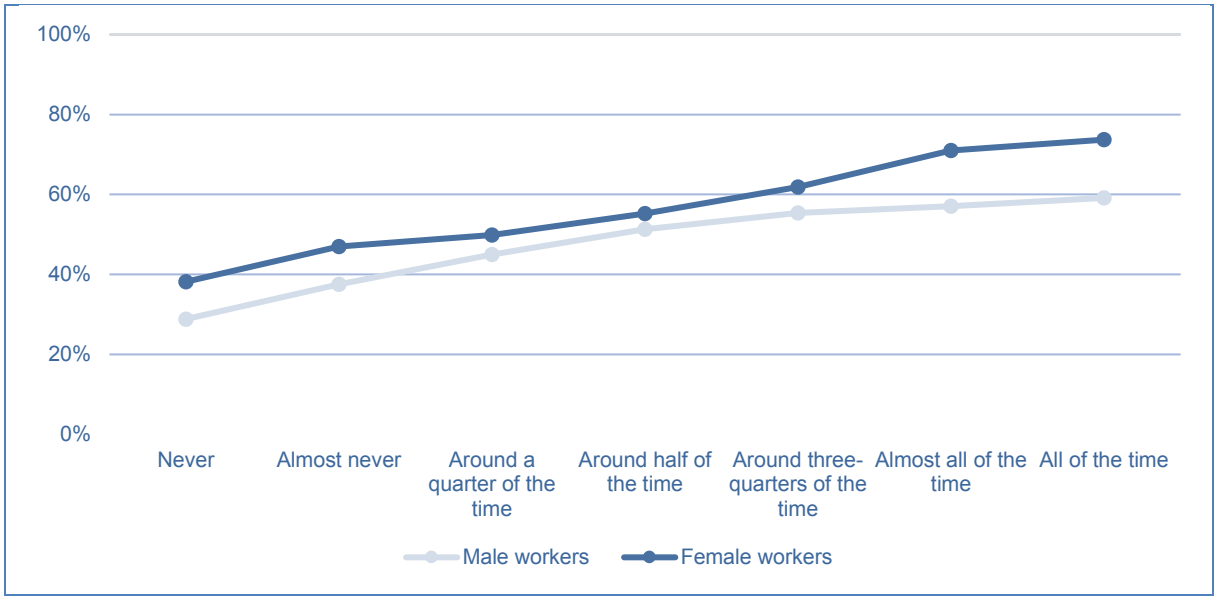
N = 32,664

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Carrying or moving heavy loads

Carrying or moving heavy loads is also strongly related to MSD prevalence. Of all the workers whose main paid job never involves carrying or moving heavy loads, around 34 % report having MSDs. This increases to approximately 63 % for workers whose main paid job always involves carrying or moving heavy loads. The percentages differ between MSD types, between genders (Figure 63, Figure 64) and between age groups (Figure 65). The gender differences are not very large, but it is clear that carrying or moving heavy loads is more likely to be associated with MSD complaints for female workers than for male workers.

Figure 63 Percentage of workers having muscular pains in upper limbs, by proportion of working time involving carrying or moving heavy loads, by gender, EU-28, 2015

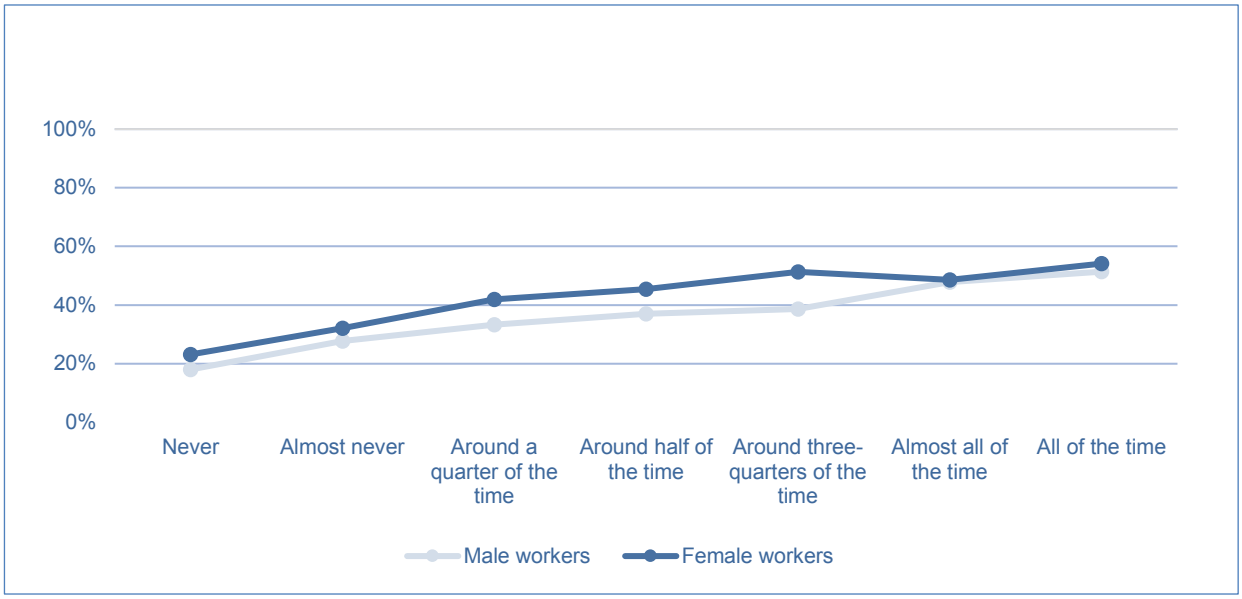


Note: Data concern workers who work at least 12 hours per week.

N = 32,714

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 64 Percentage of workers having muscular pains in lower limbs, by proportion of working time involving carrying or moving heavy loads, by gender, EU-28, 2015

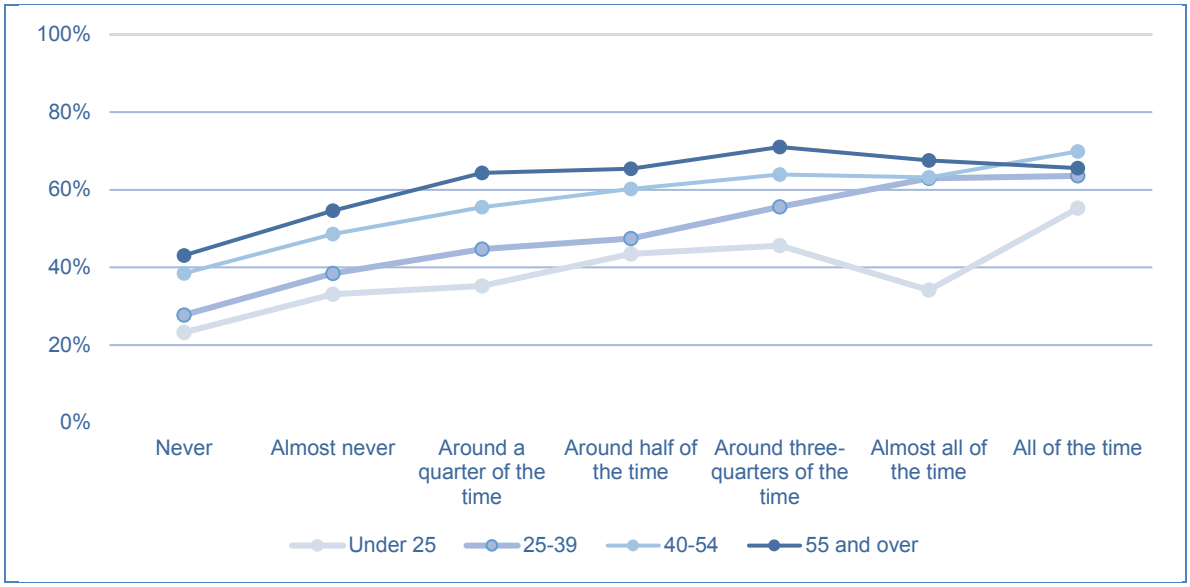


Note: Data concern workers who work at least 12 hours per week.

N = 32,714

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 65 Percentage of workers having backache, by proportion of working time involving carrying or moving heavy loads, by age, EU-28, 2015

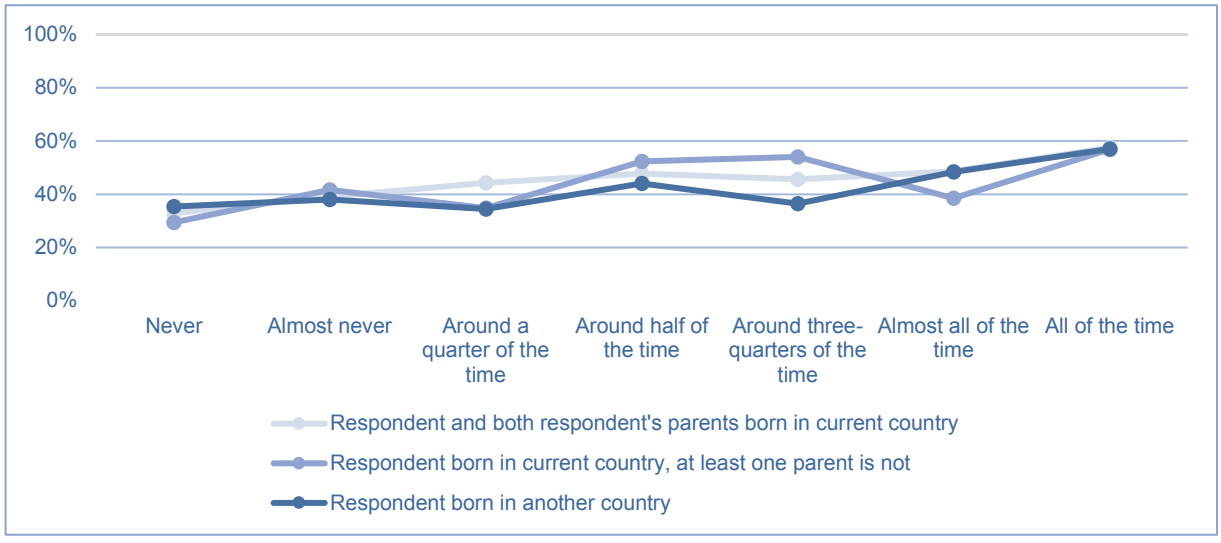


Note: Data concern workers who work at least 12 hours per week.
N = 32,772.
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Repetitive hand or arm movements**

Repetitive hand or arm movements are related to MSD prevalence, but less strongly than the previously discussed risk factors. The prevalence of backache increases from around 33 % of all the workers whose main paid job never involves repetitive hand or arm movements, to approximately 57 % of workers whose main paid job always involves repetitive hand or arm movements. These percentages do not depend on gender or age, but country of birth appears to matter (Figure 66).

Figure 66 Percentage of workers having backache problems, by proportion of working time involving repetitive hand or arm movements, by country of birth, EU-28, 2015

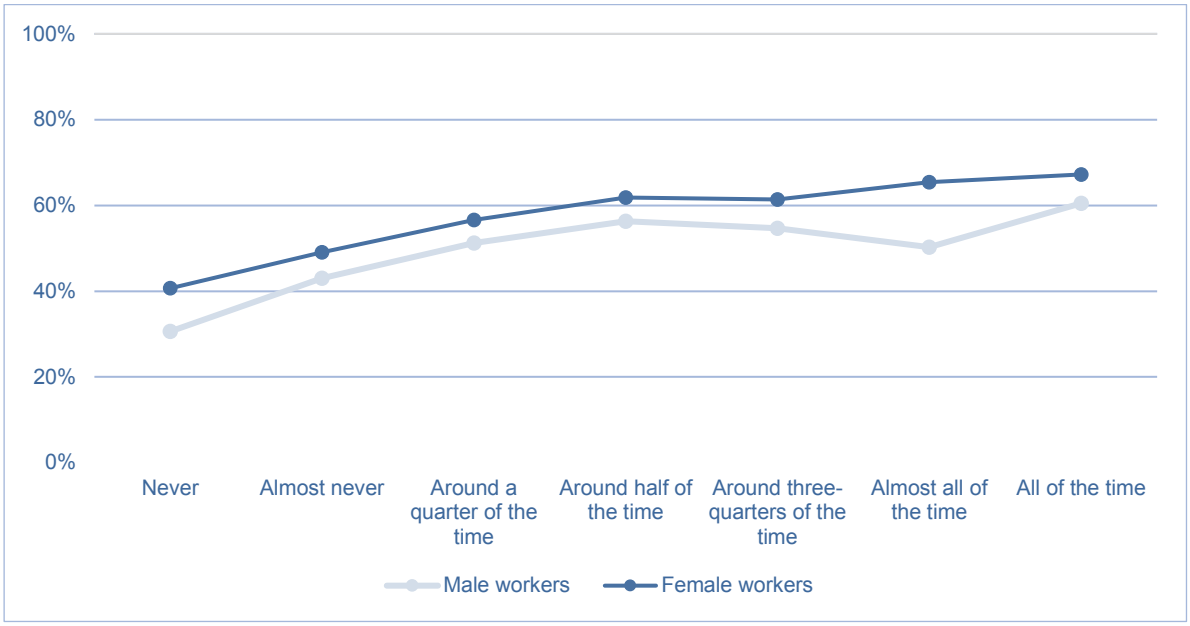


Note: Data concern workers who work at least 12 hours per week.
N = 32,492.
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Being exposed to low temperatures

Low temperatures lead to decreased blood flow, which hampers proper muscle functioning. Less blood flow means less oxygen, less nutrition and more acidification of muscles. Being more exposed to low temperatures is, in general, related to higher prevalence of MSDs. This relationship does not depend on sociodemographic factors such as age, gender, education level and country of birth (Figure 67).

Figure 67 Percentage of workers having muscular pains in shoulders, neck and/or upper limbs, by proportion of working time exposed to low temperatures whether indoors or outdoors, by gender, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week.

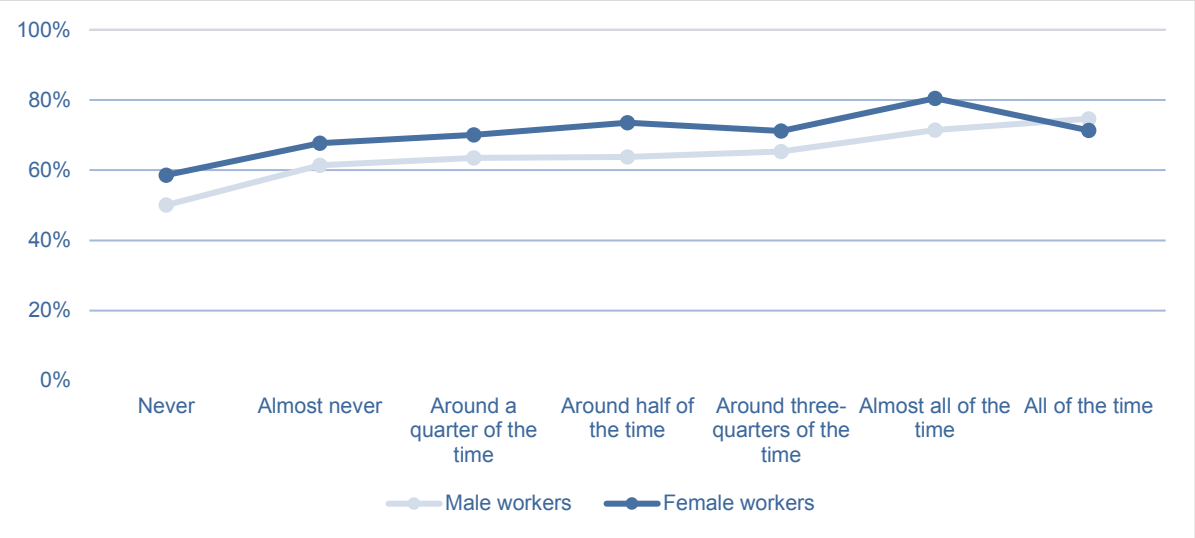
N = 32,680

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Vibrations from hand tools

The more time workers are exposed to vibrations from hand tools, the more likely they are to report MSDs. This applies to all three types of MSD considered (Figure 68). The analysis indicates that the strength of this relationship does not depend on sociodemographic factors such as age, gender, education level and country of birth.

Figure 68 **Percentage of workers having one or more MSDs the past 12 months, by proportion of working time that main paid job involves vibrations from hand tools, machinery, etc., by gender, EU-28, 2015**



Note: Data concern workers who work at least 12 hours per week.

N = 32,686.

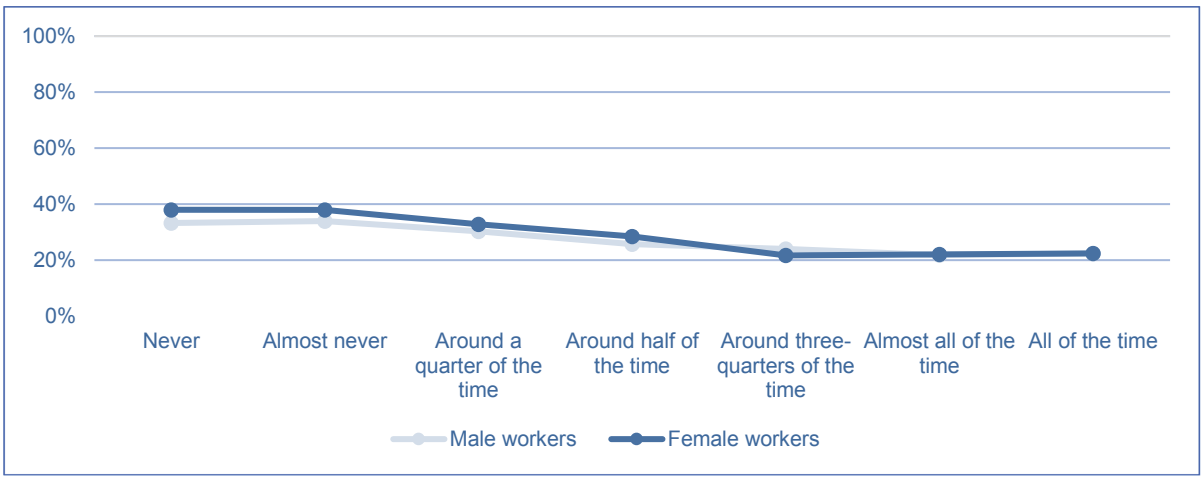
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Sitting**

As mentioned at the beginning of this chapter, the more time workers have to sit during their work, the less likely they are to report MSD complaints in the lower limbs. For female workers this effect is stronger than for male workers, but this gender effect is very small (Figure 69).

As discussed earlier, the results of the analysis on the EWCS data regarding sitting should be interpreted with caution, since the data on sitting obtained through questionnaires may not be reliable enough.

Figure 69 **Percentage of workers having muscular pains in lower limbs, by proportion of working time involving sitting, by gender, EU-28, 2015**



Note: Data concern workers who work at least 12 hours per week.
N = 32,707
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

5.1.4 Combined exposure to physical factors

Certain combinations of physical, organisational and psychosocial risk factors may occur more often than other combinations. If this is the case, future studies may examine which workers are exposed to these combinations of risk factors, and what the effect on MSD prevalence is of being exposed to these specific combinations of risk factors (in particular, to what extent different risk factors reinforce each other and increase the risk of developing MSDs).

Searching for combinations (or clusters) of risk factors is an exploratory analysis, aiming to generate hypotheses rather than testing hypotheses. Based on the sixth wave of the EWCS, a cluster analysis has been performed[152] on the following physical risk factors[153]:

- extent to which main paid job involves:
  - working in tiring or painful positions,
  - carrying or moving heavy loads,
  - sitting,
  - repetitive hand or arm movements;
- extent of exposure at work to:
  - vibrations from hand tools, machinery, etc.,
  - low temperatures (whether indoors or outdoors).

The outcomes suggest that workers can be grouped into four different clusters:

- cluster 1: no physical risk factors;
- cluster 2: one physical risk factor;
- cluster 3: sitting and other factor(s);
- cluster 4: heavy loads and other factor(s).

- **Cluster 1: no physical risk factors**

For a small proportion of all workers (7 %), none of the six physical risk factors applies[154]. For all three types of MSDs considered, the prevalence is lowest for this group. Likewise, only relatively few workers from this group (9 %) report that their health or safety is at risk because of their work (Figure 70).

- **Cluster 2: one physical risk factor**

For about a quarter of all workers (24 %), one of the six physical risk factors applies[155]. The prevalence of MSDs is slightly higher than for cluster 1, but the differences are not very significant. Also in this cluster, relatively few workers (12 %) report that their health or safety is at risk because of their work (Figure 70).

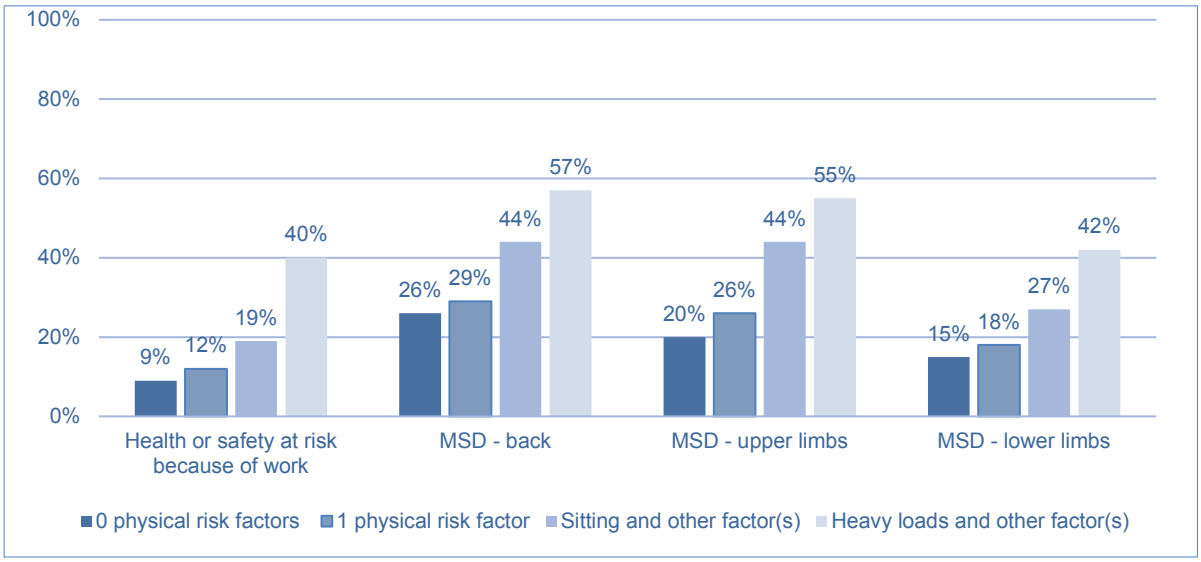
The workers to whom two or more of the six physical risk factors apply[156] are classified into the remaining two clusters. The main characteristic distinguishing between these two clusters is whether these risk factors include sitting (cluster 3) or carrying or moving heavy loads (cluster 4).

- **Cluster 3: sitting and other factor(s)**

Approximately 36 % of workers belong to this group, which consists of workers whose job often involves sitting for around a quarter of the time or more (to be more precise, this applies to 88 % of the workers in this group). Consequently, most of the workers from this group do not often carry or move heavy loads[157]. On average, 2.5 of the 6 risk factors apply to workers from this group.

[152] See Annex 3 for more details on the methodological aspects of this analysis.
[153] These are all physical risk factors that were found to be significantly related to at least one of the three MSD types distinguished.
[154] Each of these risk factors occurs (almost) never.
[155] One risk factor occurs at least a quarter of the time; the remaining five risk factors occur (almost) never.
[156] At least two risk factors occur at least a quarter of the time.
[157] Only 4 % of the workers in this group report that their job involves carrying or moving heavy loads for around a quarter of the time or more.

Figure 70 Percentage of workers reporting that health or safety is at risk because of work, and prevalence of different MSD types, by four clusters of workers, EU-28, 2015



N = 31,470

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Overall, the prevalence of MSDs among workers from this group is considerably higher than in the first two groups, and almost one in every five workers (19 %) report that their health or safety is at risk because of their work (Figure 70).

- **Cluster 4: heavy loads and other factor(s)**

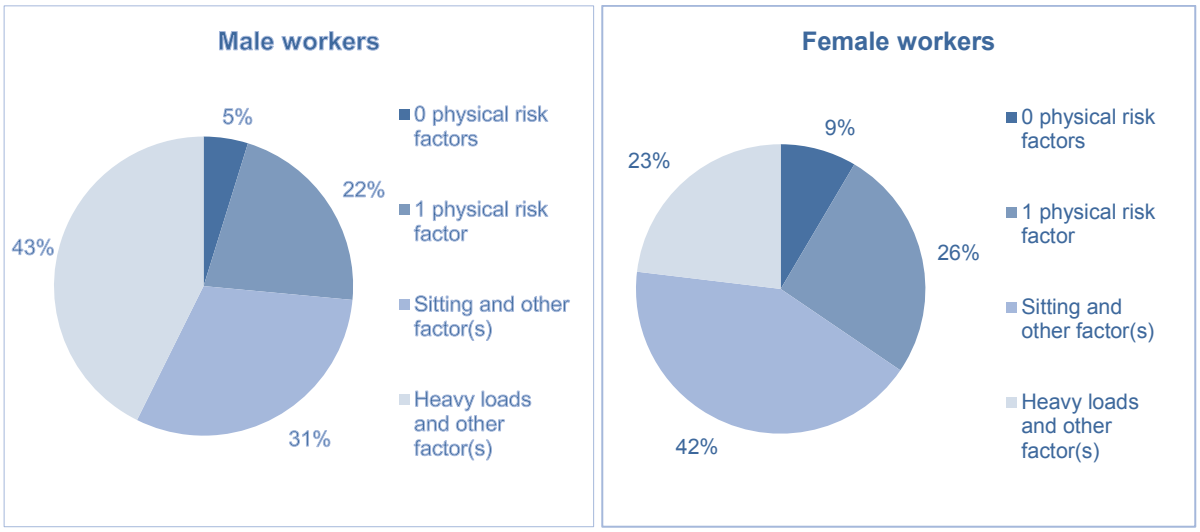
This cluster accounts for 33 % of all workers and consists of workers who have to carry or move heavy loads for at least a quarter of the time or more (this applies to approximately 88 % of the workers in this group). Consequently, prolonged sitting does not apply to most workers from this group[158].

In addition to carrying or moving heavy loads, workers from this group are also more likely to be faced with vibrations from hand tools, etc., to be exposed to low temperatures (whether indoors or outdoors) or to be working in tiring or painful positions. On average, 3.7 of the 6 risk factors apply to workers from this group. All of these risk factors are associated with a higher risk of MSDs, so it is not surprising that the prevalence of MSDs is highest for this cluster. This applies to all three MSD types considered. In addition, 40 % of the workers report that their health or safety is at risk because of their work (Figure 70).

The distribution across these four clusters is different for male and female workers: in particular, female workers more often combine sitting with (an)other factor(s) and less often carrying heavy loads with (an)other factor(s) (Figure 71). This is consistent with the finding that male workers are more likely to report carrying or moving heavy loads, working at low temperatures and/or vibrations from hand tools, machinery, etc. for at least a quarter of the time (Figure 58).

[158] Approximately 80 % of the workers from this group report sitting for around a quarter of the time or less.

Figure 71 Percentage of workers exposed to different numbers/combinations of physical risk factors, by gender, EU-28, 2015



N = 31,470

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Data from Member States

These findings can be complemented by data obtained from several national sources.

France

The Medical Surveillance of Occupational Risk Exposures Survey (Sumer)[159] shows the numbers of workers exposed to different occupational risks in France. The most frequent occupational risk is postural and joint constraints, which affect 74.6 % of men and 73.9 % of women, followed by standing or working upright in a fixed location (48.6 % of men and 42.9 % of women), walking during work (47.5 % of men and 34.5 % of women) and manual load handling (44.1 % of men and 29.0 % of women). In all cases, the number of workers affected by each risk is higher among men than among women, except for fixed position of the head and neck, where the number of women exposed is higher (32.4 % of women versus 26.4 % of men). Regarding age differences, the exposure to risks decreases as age increases. The most exposed group is workers under 25 years of age, followed by the age group from 25 to 29 years old. The only exception is fixed position of the head and neck, to which the most exposed group is the age group from 30 to 39 years old, and the least exposed is the group less than 25 years old.

Another important French study (Petit-Le Manac'h *et al.*, 2011)[160] related to physical risk factors and MSDs concludes that de Quervain's disease (DQD) is a significant cause of musculoskeletal pain among workers[161]. The aim of the study is to assess the relative importance of personal and occupational risk factors for DQD in a working population. The main results of the study show that personal risk factors for DQD are mainly age and female gender. Work-related factors are (i) workpace dependent on technical organisation, (ii) repeated or sustained wrist bending in extreme posture and (iii) repeated movements associated with the twisting or driving of screws.

[159] Data retrieved from: https://dares.travail-emploi.gouv.fr/dares-etudes-et-statistiques/enquetes/article/surveillance-medicale-des-expositions-aux-risques-professionnels-sumer-edition (retrieved in March 2019).

[160] Petit-Le Manac'h, A., Roquelaure, Y., Ha, C., Bodin, J., Meyer, G., Bigot, F., Veaudor, M., Descatha, A., Goldberg, M. & Imbernon, E., 'Risk factors for de Quervain's disease in a French working population', *Scandinavian Journal of Work, Environment & Health*, Vol. 37, No 5, 2011, pp. 394-401.

[161] De Quervain's disease is inflammation of two tendons that control movement of the thumb and their tendon sheath.

Germany

Bödeker *et al*. (2006)[162] calculate the relative risks of the occupational burdens along several exposure factors using a case-control approach methodology. According to the available data, little space for working is the risk with the highest impact on the probability of having an MSD-related labour incapacity. More precisely, employees with little space for working are 5.67 times more likely to have an MSD-related labour incapacity. The second most important risk is the ERI (effort-reward imbalance) model[163] (5.15), followed by physical stress (4.12) and heavy work (3.55).

According to the Bundesinstitut für Berufsbildung (BIBB)/BAuA Employee Survey 2012[164], 54.4 % of German employees report working frequently in an upright position, 48.4 % report that their work process repeats itself over and over again in detail and 41.8 % regularly work with their hands, demanding very rapid movements or a good amount of strength.

Finally, it is possible to look at some specific working conditions that particularly bother employees. Of the employees who lift and carry heavy goods, 53.8 % indicate that they are troubled by this (22.3 % of employees do this frequently), whereas 53.6 % of employees exposed to vibrations and waves indicate the same (4.3 % of employees work in this situation frequently). Furthermore, 49 % of those frequently working in a constrained posture are troubled by it (16.6 % of employees work in such a posture frequently), whereas 28.3 % of those who work regularly in an upright position report the same (54.4 % of employees work in this position on a frequent basis).

Netherlands

The survey of working conditions among employers (WEA)[165] provides information on the main physical health risks that are present in companies, as suggested by company managers (2016 data). The risk with the highest presence is physical workload (pushing, pulling and lifting), identified by 34.6 % of company managers, followed by VDU work (28.6 %) and static working posture (14.1 %).

In addition, the survey of working conditions among workers (NEA, 2017) offers data on physical factors affecting work among Dutch workers (excluding the self-employed). It finds that 4.3 % of workers consider that their job is regularly dangerous, whereas 19 % say that it is dangerous sometimes. As many as 21 % say that they regularly have to apply a lot of force and 20.3 % sometimes. Furthermore, 9.5 % use equipment or machinery that causes vibrations regularly (8.4 % sometimes); 10.8 % need to work regularly in awkward body positions (25.7 % sometimes); 34.2 % make repetitive movements at work regularly (20.6 % sometimes); and 7.5 % regularly need to speak loudly to be understood (18.1 % sometimes). Finally, on average, Dutch workers spend 4.01 hours a day doing VDU work.

The Health Council of the Netherlands has carried out studies on occupational risks covered by the Dutch Working Conditions Act and its associated regulations. Several results from these studies are related to MSDs. For instance, a study on repetitive actions during work (Health Council of the Netherlands, 2013)[166] shows that repetitive movements at work form a health risk as far as specific disorders of the upper extremities, such as carpal tunnel syndrome and lateral epicondylitis ('tennis elbow'), are concerned. There are also indications that repetitive movements are a health risk for types of non-specific complaints to the upper extremities. Another report, regarding pushing, pulling and

[162] Bödeker, W., Friedel, H., Friedrichs, M. & Röttger, C., *Kosten der Frühberentung: Abschätzung des Anteils der Arbeitswelt* (Cost of early retirement: estimation of the proportion of the Working Population), Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Dortmund, 2006.

[163] Effort-reward imbalance is a mismatch between high efforts spent at work and low rewards received in return (salary, promotion prospects, job security, esteem, recognition), resulting in negative emotions and stress reactions.

[164] Wittig, P., Nöllenheidt, C. & Brenscheidt, S., *Grundauswertung der BIBB/BAuA-Erwerbstätigenbefragung 2012* (Basic evaluation of the BIBB/BAuA Employment Survey 2012*)*, Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Dortmund, 2012. Available at: https://www.baua.de/DE/Angebote/Publikationen/Berichte/Gd73.pdf?__blob=publicationFile

[165] van Emmerik, M. L., de Vroome, E. M. M., Kraan, K. O. & van den Bossche, S. N. J., *Werkgevers Enquête Arbeid 2016: Methodologie en beschrijvende resultaten* (*Employers Labor Survey 2016: Methodology and descriptive results*), TNO, Leiden, 2017. Available at: https://www.monitorarbeid.tno.nl/dynamics/modules/SFIL0100/view.php?fil_Id=195

[166] Health Council of the Netherlands, *Repeterende handelingen tijdens werk* (Repetitive actions during work), Health Council of the Netherlands, The Hague, 2013. Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2013/04/19/repeterende-handelingen-tijdens-werk-risicos-voor-de-gezondheid/dossier-repeterende-handelingen-tijdens-werk-risico_s-voor-de-gezondheid.pdf

applying force in work situations (Health Council of the Netherlands, 2012a)[167], shows that applying force, pushing and pulling act as a health risk for lower back pain as well as for shoulder complaints. A study regarding manual lifting at work (Health Council of the Netherlands, 2012b)[168] finds that low-back pain and complaints of the hips, knees, neck-shoulder region or arms might develop as a result of occupational lifting. Finally, a study on standing, kneeling and squatting at work (Health Council of the Netherlands, 2011)[169] finds that working in a standing position can result in pain in the lower back, legs, knees and feet. Working in a squatting position can cause lower-back pain and pain in the knees, while working in a kneeling position can lead to lower-back pain complaints and osteoarthritis of the knee joint.

Sweden

According to the Swedish Work Environment Authority (Arbetsmiljöverket, 2017a), around 50 % of men and 47 % of women stated that they work with physically exhausting job assignments. Two out of 10 work in a forward leaning position, without support from the hands. Some 7 % work with tasks that make the entire body shake, and around 50 % had been in physical pain when finishing work at least once per week during the past 3 months. It is worth mentioning that, according to that report, one third of the entire working population answered that they suffered from pain in the back or neck after work at least once per week, 45 % of women and 28 % of men.

5.2 Organisational and psychosocial factors at work

5.2.1 Organisational and psychosocial risk factors related to MSD prevalence

Previous studies have found reasonable evidence for an association between different types of MSDs and various physical risk factors[170]. This is much less the case for organisational and psychosocial risk factors. Many hypotheses regarding the effect of these risk factors on MSD prevalence have not been properly tested.

One of the objectives of this study is to establish for which of these risk factors a statistical relationship to MSD prevalence can be found, based on existing European data sources.

To this end, several regression models have been estimated to examine to what extent the prevalence of different types of MSDs can be related to sociodemographic characteristics and different physical, organisational and psychosocial risk factors. These are explorative models, aiming to identify relationships between available indicators on MSD prevalence and available data on various other factors. The outcomes of these analyses may be used to generate new hypotheses and suggestions for future research.

The estimated regression models have used the sixth wave of the ESWC to identify which organisational and/or psychosocial risk factors are significantly related to the prevalence of three different types of MSD complaints (back, upper limbs and lower limbs)[171].

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[167] Health Council of the Netherlands, *Kracht zetten, duwen en trekken in werksituaties* (Pushing, pulling and applying force in work situations), Health Council of the Netherlands, The Hague, 2012. Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2012/12/20/kracht-zetten-duwen-en-trekken-in-werksituaties/dossier-kracht-zetten-duwen-en-trekken-in-werksituaties.pdf

[168] Health Council of the Netherlands, *Tillen tijdens werk* (Manual lifting at work), Health Council of the Netherlands, The Hague, 2012. Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2012/12/20/tillen-tijdens-werk/dossier-tillen-tijdens-werk.pdf

[169] Health Council of the Netherlands, *Staand, geknield en gehurkt werken* (Standing, kneeling and squatting work), Health Council of the Netherlands, Available at: https://www.gezondheidsraad.nl/binaries/gezondheidsraad/documenten/adviezen/2011/12/23/staand-geknield-en-gehurkt-werken/dossier-staand-geknield-en-gehurkt-werken.pdf

[170] See Chapter 2 for references.

[171] These concern logistic regressions with self-reported MSD complaints as the dependent variable, and gender, age, country, occupation, sector and various physical, organisational and psychosocial risk factors among the independent variables. These regressions have been applied separately for MSDs in upper limbs, lower limbs and back. More information about these analyses can be found in Annex 2.

The results of these analyses indicate that several psychosocial risk factors are associated with an increased likelihood of workers reporting MSDs. The following risk factors are found to be significantly related to all three types of MSDs:

- anxiety;
- overall fatigue;
- sleeping problems;
- low level of mental well-being;
- being subjected to verbal abuse at work.

High levels of anxiety, overall fatigue and sleeping problems may cause MSD complaints or worsen already existing MSD complaints. In this respect, they are considered potential risk factors and are therefore discussed in this chapter. Anxiety, overall fatigue and sleeping problems are, however, also health problems, and workers can suffer from these health problems alongside MSD problems. For that reason, they have also been discussed in section 4.1.2 (MSDs and comorbidities). The direction can also go the other way: having serious MSD complaints might increase levels of anxiety, overall fatigue and sleeping problems. The results presented in section 4.1.2 and in this section merely reflect associations or relationships without making any claims about the causality of these relationships.

For the following organisational and psychosocial risk factors, an association with two of the three MSD types has been found:

- being subjected to unwanted sexual attention at work;
- feeling energised[172],
- enough time to get the job done;
- knowing what is expected at work.

There are also several organisational and psychosocial risk factors for which an association with only one MSD type has been found. One of these factors is employee voice (or simply 'voice'). Employee voice has been defined as 'the discretionary provision of information intended to improve organizational functioning to someone inside an organization with the perceived authority to act, even though such information may challenge and upset the status quo of the organization and its power holders' (Detert and Burris, 2007, p. 869)[173]. Several questions included in the sixth wave of the EWCS have been used to construct a scale that indicates the amount of employee voice, focusing on the perceived authority to act upon the available information[174].

A complete overview of all 21 organisational and psychosocial risk factors that are significantly related to at least one of the three MSD types considered is summarised in Table 6.

[172] The sixth wave of the EWCS contains three questions on how energetic workers are feeling ('How often do you feel this way: at my work I feel full of energy; I am enthusiastic about my job; time flies when I am working?'). The answers to these three questions have been combined into a single scale. Cronbach's alpha for these three questions is 0.72, which indicates that this is a valid option.

[173] Detert, J. R. & Burris, E. R., 'Leadership behavior and employee voice: is the door really open?' *Academy of Management Journal*, Vol. 50, No 4, 2007, pp. 869-884.

[174] The sixth wave of the EWCS contains five questions that are related to the concept of employee voice ('Which best describes your work situation: you are consulted before objectives are set for your work; you are involved in improving the organisation or processes; you have a say in the choice of your work colleagues; you are able to apply your own ideas in your work; you can influence decisions that are important for your work?'). The answers to these five questions have been combined into a single scale. Cronbach's alpha for these five questions is 0.83, which indicates that this is a valid option.

Table 6 Associations between self-reported MSDs and organisational and psychosocial risk factors

Body area	Significant relationship identified	No significant relationship identified
Back	• Anxiety • Overall fatigue • Sleeping problems • Mental well-being • At work subjected to: - verbal abuse; - unwanted sexual attention; - bullying/harassment • Feeling energised • Knowing what is expected at work • Pace of work dependent on: - direct demands from customers, etc.; - direct control by management	• At work subjected to: - threats; - physical violence • Able to choose or change order of tasks • Job gives the feeling of work well done • Employee voice • Take a break when you wish • Fairly treated at workplace • Job requires hiding of feelings • Work-related stress Working at very high speed
Lower limbs	• Anxiety • Overall fatigue • Sleeping problems • Mental well-being • At work subjected to - verbal abuse; - unwanted sexual attention • Feeling energised • Knowing what is expected at work ▪ Able to choose or change order of tasks	• At work subjected to - threats; - bullying/harassment; - physical violence • Pace of work dependent on: - direct demands from customers, etc.; - direct control by management • Employee voice • Job gives the feeling of work well done • Take a break when you wish • Fairly treated at workplace • Job requires hiding of feelings • Work-related stress ▪ Working at very high speed
Upper limbs	▪ Anxiety ▪ Overall fatigue ▪ Sleeping problems ▪ Mental well-being ▪ At work subjected to: - verbal abuse - threats - physical violence ▪ Employee voice ▪ Job gives the feeling of work well done ▪ Take a break when you wish ▪ Fairly treated at workplace ▪ Job requires hiding of feelings ▪ Work-related stress ▪ Working at very high speed	▪ At work subjected to: - bullying/harassment - unwanted sexual attention ▪ Pace of work dependent on: - direct demands from customers, etc.; - direct control by management ▪ Feeling energised ▪ Knowing what is expected at work ▪ Able to choose or change order of tasks

Note: This table is based on the results of various binary logistic regressions that have been estimated to explain the prevalence of self-reported MSD complaints in the sixth (2015) wave of the EWCS. - Source: Panteia, 2019

5.2.2 Prevalence of organisational and psychosocial risk factors

The fact that a specific organisational or psychosocial risk factor has a significant relationship to the prevalence of MSDs does not mean that this relationship is important. Whether or not it is important also depends on how many workers are affected by the risk factor (its prevalence) and by the strength of the relationship to MSD prevalence.

This section discusses the prevalence of the organisational and psychosocial risk factors that were found to have a significant impact on at least one of the three MSD types distinguished.

- **Prevalence of most organisational and psychosocial risk factors is decreasing**

For several organisational and psychosocial risk factors, a trend can be established for the period 2005-2015. The prevalence of these risk factors is either stable or decreasing (Figure 72 and the first variable in Figure 73). For other organisational and psychosocial risk factors, it is possible to compare the prevalence for only two years (2010 and 2015) (the second variable in Figure 73 and Figure 74). Three of these risk factors show an increase in prevalence: requiring hiding of feelings (from 49 % in 2010 to 55 % in 2015), overall anxiety (from 9 % in 2010 to 16 % in 2015) and bullying/harassment (from 1 % in 2010 to 5 % in 2015). The prevalence of the other seven risk factors is either stable or decreasing.

- **Many risk factors identified, but for many prevalence is low**

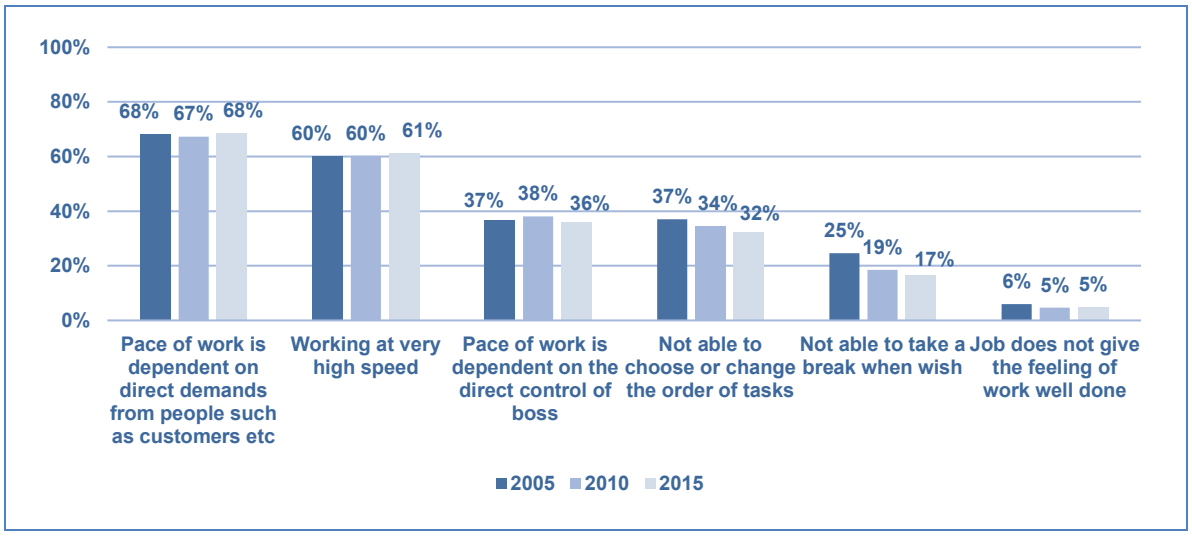
The following four identified risk factors apply to more than half of all workers:

- work-related stress (68 % in 2015);
- the pace of work being dependent on direct demands from customers etc (68 % in 2015);
- working at high speed (61 % in 2015);
- the job requiring hiding feelings (55 % in 2015).

The other 17 identified risk factors, however, apply to fewer than half of all workers. Eight of them even apply to fewer than 10 % of all workers in the EU-28:

- a lack of mental well-being (6 % in 2015);
- bullying/harassment (5 % in 2015);
- the job not giving the feeling of work well done (5 % in 2015);
- a lack of feeling energised by the job (4 % in 2015);
- not knowing what is expected at work (2 % in 2015);
- being subjected to:
  - threats (5 % in 2015),
  - physical violence (2 % in 2015),
  - unwanted sexual attention (2% in 2015).

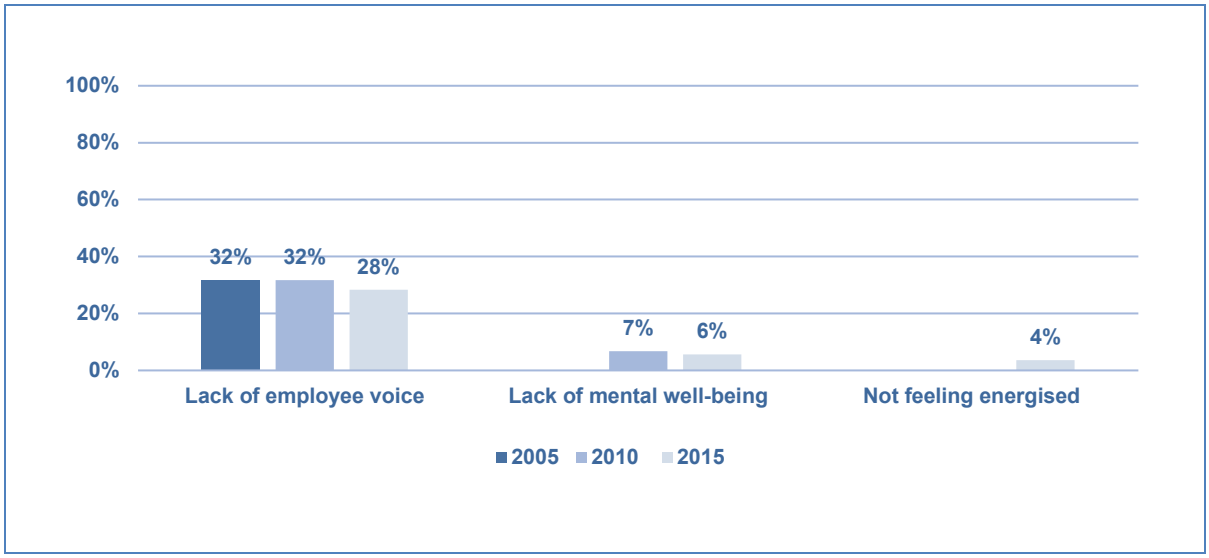
Figure 72 Percentage of workers reporting different organisational and psychosocial risks, EU-28, 2005, 2010 and 2015



Note: Working at high speed at least a quarter of the time.
For 2005: *n* = 24,778 (pace of work is dependent on direct demands from people such as customers, etc.); *n* = 24,752 (working at very high speed); *n* = 24,565 (pace of work is dependent on the direct control of boss); *n* = 24,778 (able to choose or change the order of tasks); *n* = 24,749 (able to take a break when wish); *n* = 24,744 (job gives the feeling of work well done)
For 2010: *n* = 33,815 (pace of work is dependent on direct demands from people such as customers, etc.); *n* = 33,860 (working at very high speed); *n* = 31,665 (pace of work is dependent on the direct control of boss); *n* = 33,781 (able to choose or change the order of tasks); *n* = 33,900 (able to take a break when wish); *n* = 33,780 (job gives the feeling of work well done)
For 2015: *n* = 32,169 (pace of work is dependent on direct demands from people such as customers, etc.); *n* = 32,634 (working at very high speed); *n* = 31,045 (pace of work is dependent on the direct control of boss); *n* = 32,603 (able to choose or change the order of tasks); *n* = 32,499 (able to take a break when wish); *n* = 32,464 (job gives the feeling of work well done)
Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

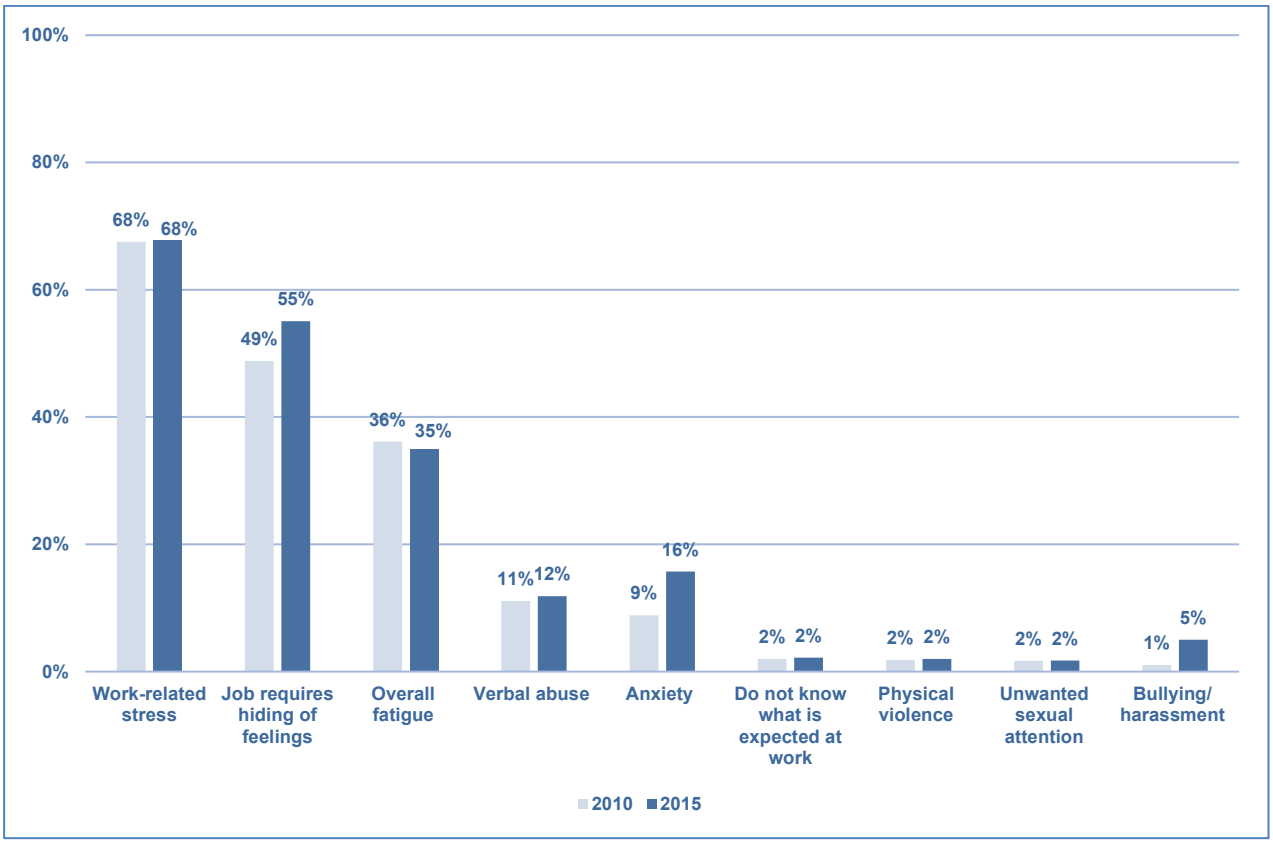
Finally, for some organisational and psychosocial risk factors that are related to MSD complaints, the prevalence could be established only for 2015 (the third variable in Figure 73 and Figure 75).

Figure 73 Percentage of workers reporting different organisational and psychosocial risks, EU-28, 2005, 2010 and 2015



For 2005: *n* = 24,868 (employee voice)
For 2010: *n* = 34,029 (employee voice); *n* = 33,995 (mental well-being)
For 2015: *n* = 32,653 (employee voice); *n* = 32,723 (mental well-being); *n* = 32,740 (feeling energised)
Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

Figure 74 Percentage of workers reporting different organisational and psychosocial risks, EU-28, 2010 and 2015



Note: Trend for anxiety is modified (in 2010 the question included the word 'depression'; in 2015 this word was removed).

For 2010: *n* = 33,924 (work-related stress); *n* = 33,418 (job requires hiding of feelings); *n* = 33,957 (overall fatigue); *n* = 33,955 (verbal abuse); *n* = 33,952 (anxiety); *n* = 33,894 (know what is expected at work); *n* = 34,027 (physical violence); *n* = 34,005 (unwanted sexual attention); *n* = 34,018 (bullying/harassment)
For 2015: *n* = 32,469 (work-related stress); *n* = 31,813 (job requires hiding of feelings); *n* = 32,651 (overall fatigue); *n* = 32,659 (verbal abuse); *n* = 32,671 (anxiety); *n* = 32,279 (know what is expected at work); *n* = 32,697 (physical violence); *n* = 32,676 (unwanted sexual attention); *n* = 32,661 (bullying/harassment)
Source: Panteia based fifth (2010) and sixth (2015) waves of European Working Conditions Survey (EWCS)

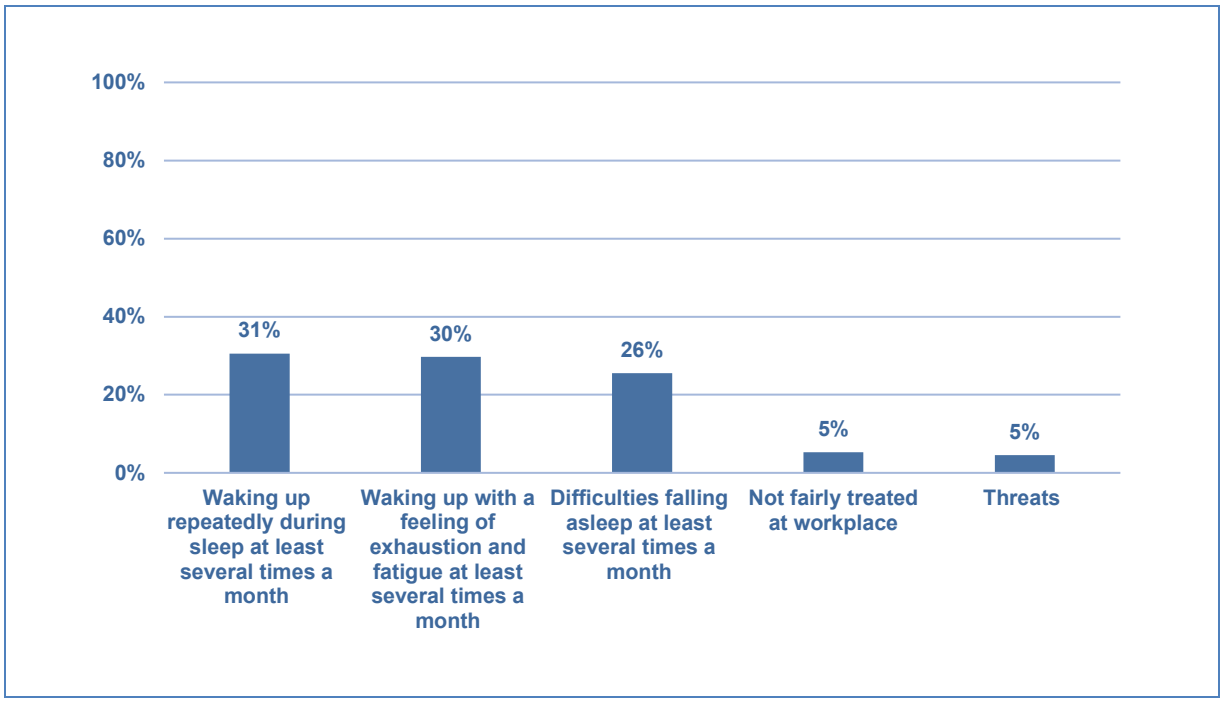
- **Prevalence related to occupations**

The prevalence of the identified organisational and psychosocial risk factors varies between occupations, as is illustrated in Figure 76 to Figure 80. For some risk factors (such as sleeping problems, overall fatigue and feelings of anxiety) the differences between occupations appear to be modest, but some risk factors show remarkable differences.

It is not surprising that managers are most able to take a break when they wish (only 4 % indicate this is not the case). For most occupations, 8 % to 18 % of the workers indicate they cannot take a break when they wish. The highest score is found for plant and machine operators and assemblers, 30 % of whom indicate they cannot take a break when they wish. Workers with these occupations are also often not able to change the order of their tasks.

Likewise, it is also not surprising that service and sales workers are most likely to report that their pace of work is dependent on direct demands from customers, etc. (82 % in 2015). For skilled agricultural, forestry and fishery workers this is only 34 %.

Figure 75 Percentage of workers reporting different organisational and psychosocial risks, EU-28, 2015



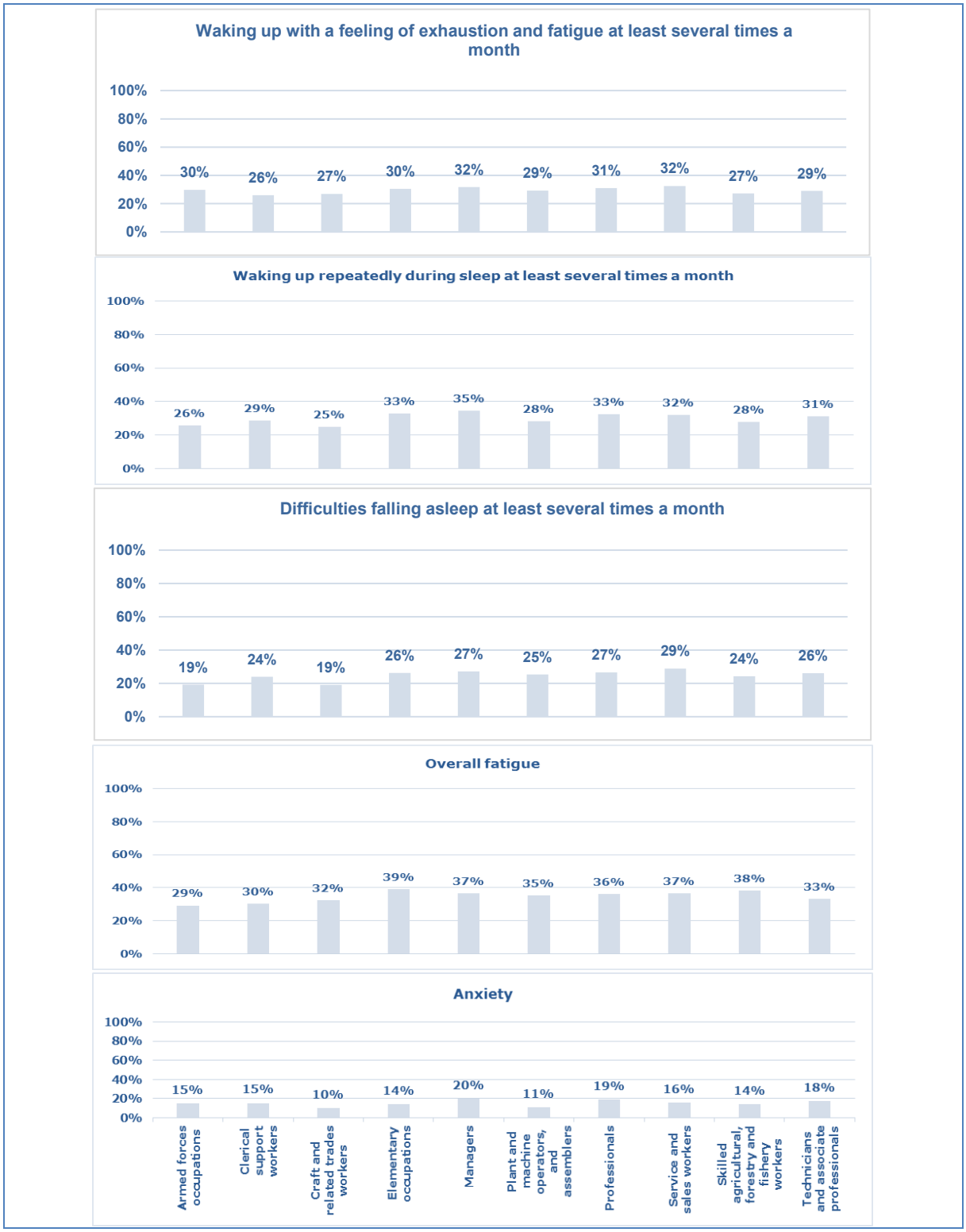
n = 32,695 (waking up repeatedly during sleep); *n* = 32,693 (waking up with a feeling of exhaustion and fatigue); *n* = 32,716 (difficulties falling asleep); *n* = 27,801 (fairly treated at workplace); *n* = 32,675 (threats)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 76 Percentage of workers reporting different organisational and psychosocial risks, by occupation, EU-28, 2015

Note: Data concern workers who work at least 12 hours per week.
N = 32,701
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 77 Percentage of workers reporting different organisational and psychosocial risks, by occupation, EU-28, 2015

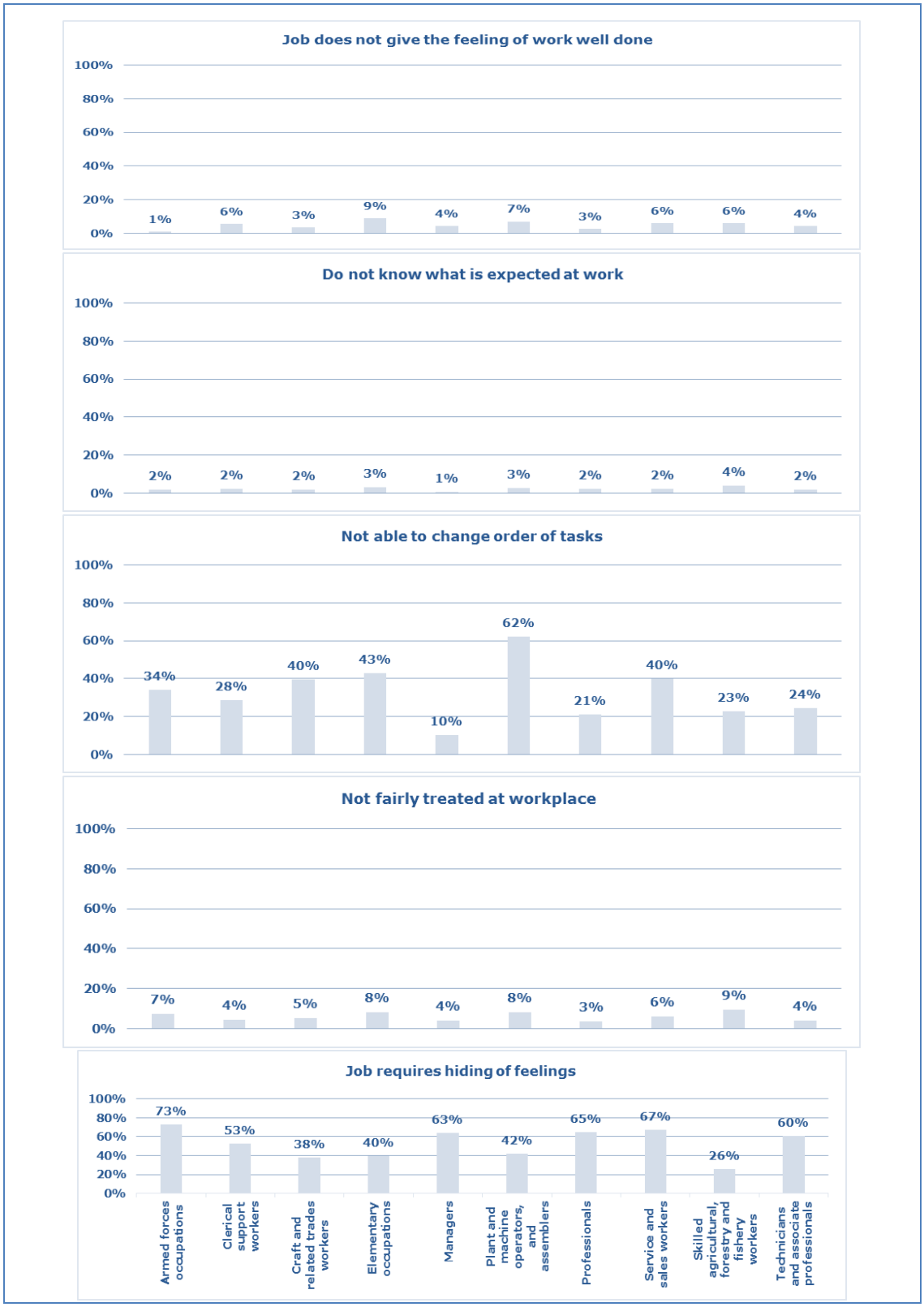


Note: Data concern workers who work at least 12 hours per week.

N = 32,701

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

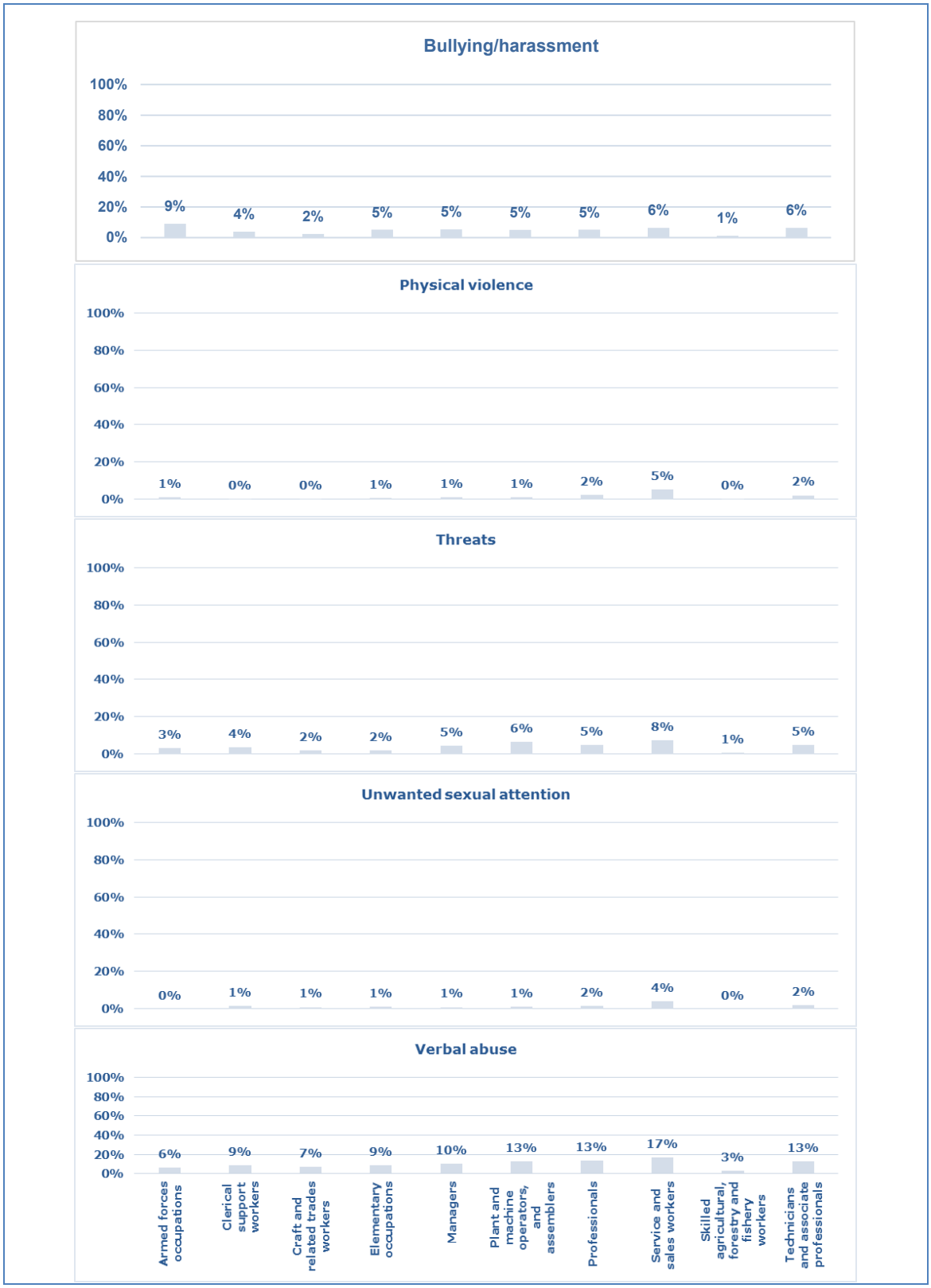
Figure 78 Percentage of workers reporting different organisational and psychosocial risks, by occupation, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week.

N = 32,701 - Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

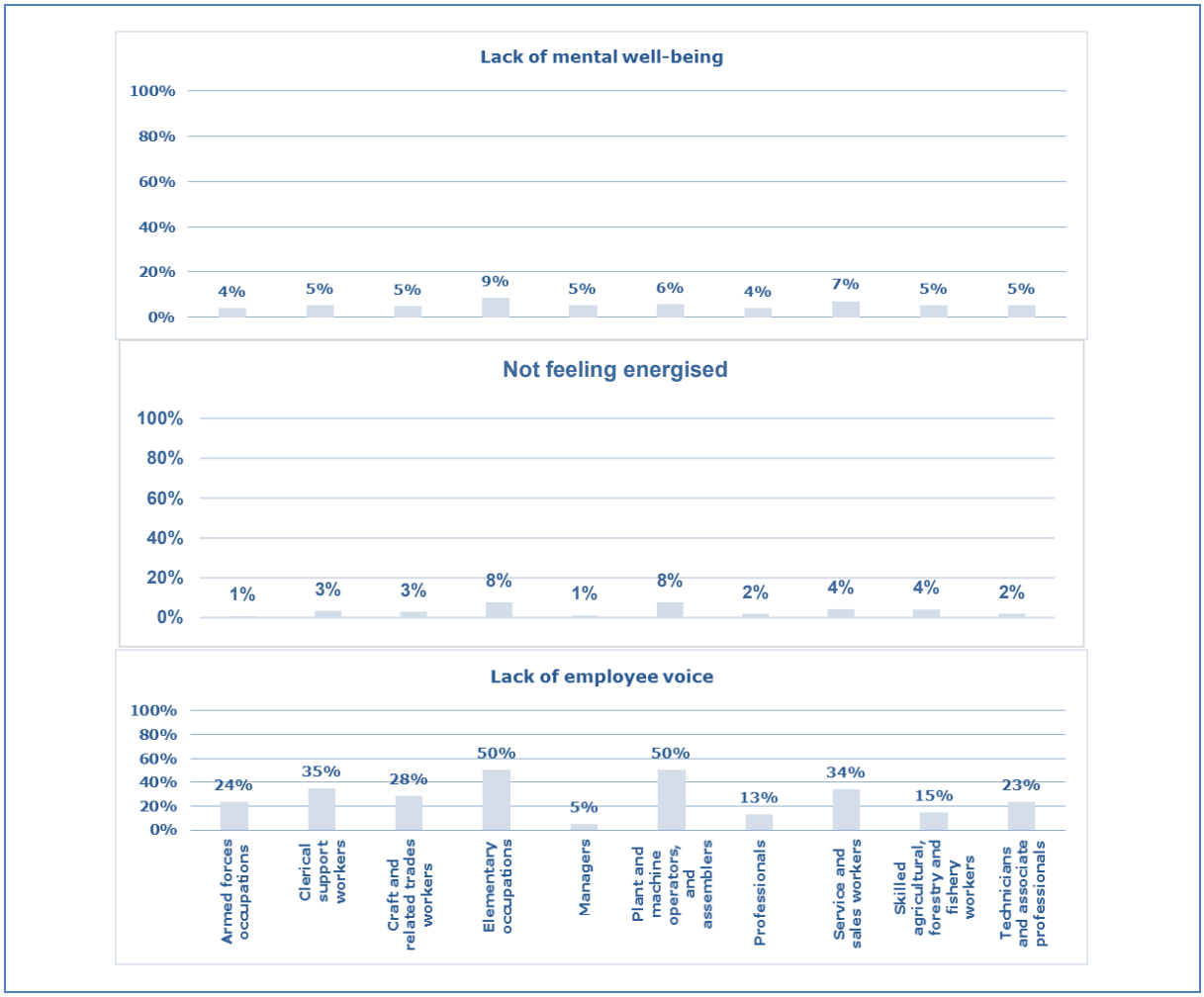
Figure 79 Percentage of workers reporting that they have been subjected at work to one of the following types of physical or psychological violence, by occupation, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week.

N = 32,701 - Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 80 Percentage of workers reporting different organisational and psychosocial risks, by occupation, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week.

N = 32,701

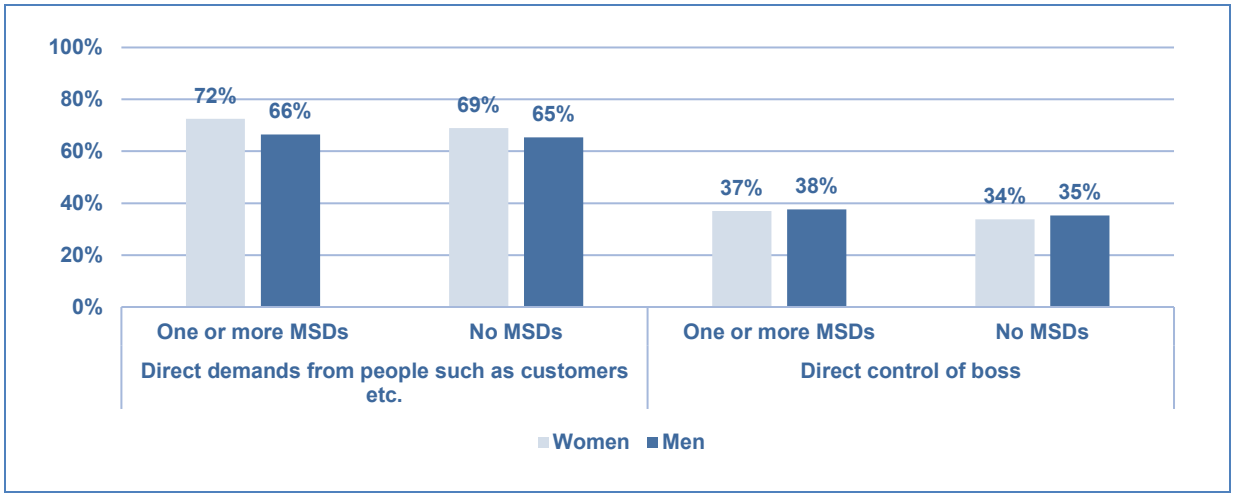
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

In the next part of this section, the prevalence of organisational and psychosocial risk factors (those that are found to be significantly related to the prevalence of self-reported MSDs) will be compared for workers with and without MSD complaints.

▪ Pace of work

One of the most prevalent risk factors is the lack of control over the pace of work. This risk factor is mentioned more often by workers with MSD complaints than by workers without MSD complaints, but the differences are small. This applies to the pace of work being dependent on direct demands from people such as customers, etc., as well as on direct control of the boss. Male workers are more likely to report that the pace of their work is dependent on direct demands from people such as customers, etc., but the difference from female workers is only small (Figure 81).

Figure 81 Percentage of workers with and without MSDs reporting that their pace of work is dependent on different factors, by gender, EU-28, 2015

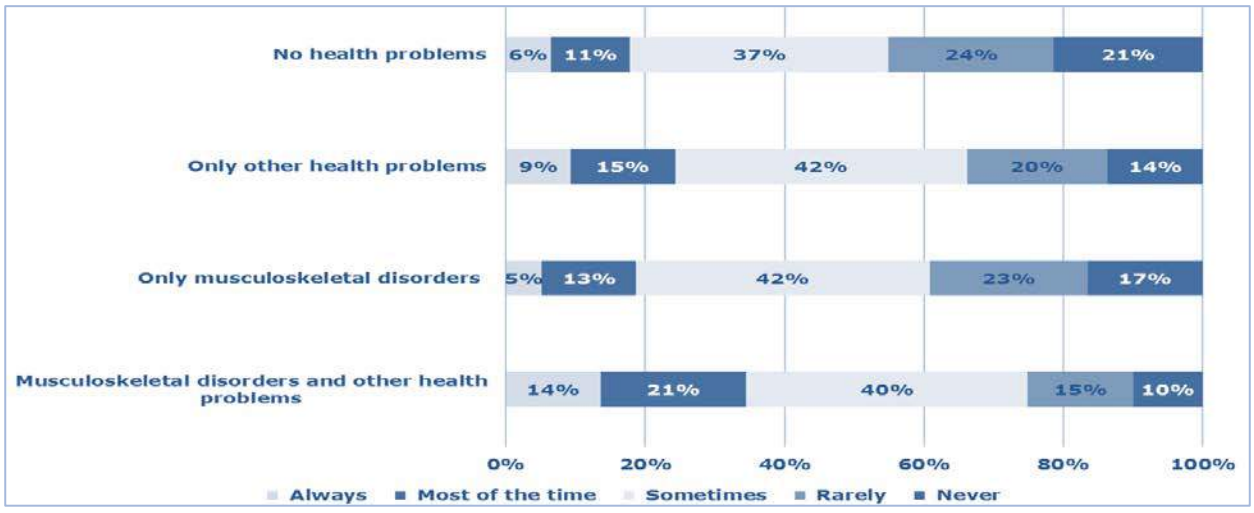


Note: Data concern workers who work at least 12 hours per week. 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).
n = 32,169 (pace of work is dependent on direct demands from people such as customers, etc.); *n* = 31,045 (pace of work is dependent on the direct control of boss)
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Work-related stress, overall fatigue and anxiety**

Stress is mentioned most often by workers who report both MSD complaints and other health complaints. For this group of workers, the proportion that experiences stress most of the time or always is higher than for all other groups. For workers who report only MSD complaints, the differences from workers without any health problems are very small (Figure 82).

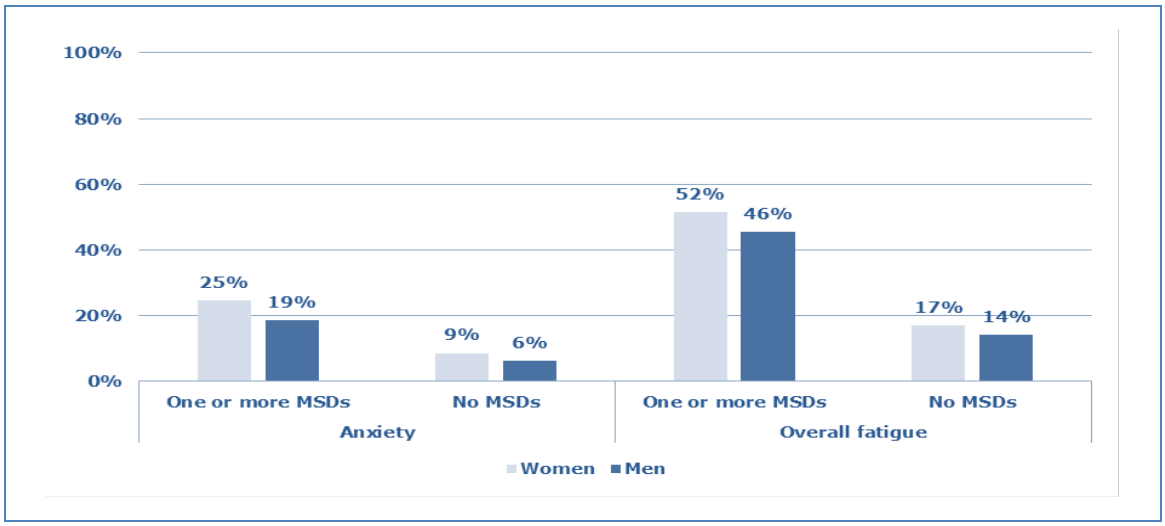
Figure 82 Percentage of workers experiencing stress in their work, by presence or absence of different types of health problems, EU-28, 2015



Note: 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).
n = 34,009 (MSDs and other health problems); n = 9,675 (only MSDs); n = 10,487 (only other health problems); n = 16,933 (no health problems)
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

The prevalence of overall fatigue is higher than the prevalence of anxiety. This applies to workers both with and without MSD complaints (Figure 83). Irrespective of the number of MSD complaints, female workers are more likely to report overall fatigue and anxiety than male workers[175].

Figure 83 Percentage of workers with and without MSDs reporting they suffered from anxiety or overall fatigue in the past 12 months, by gender, EU-28, 2015

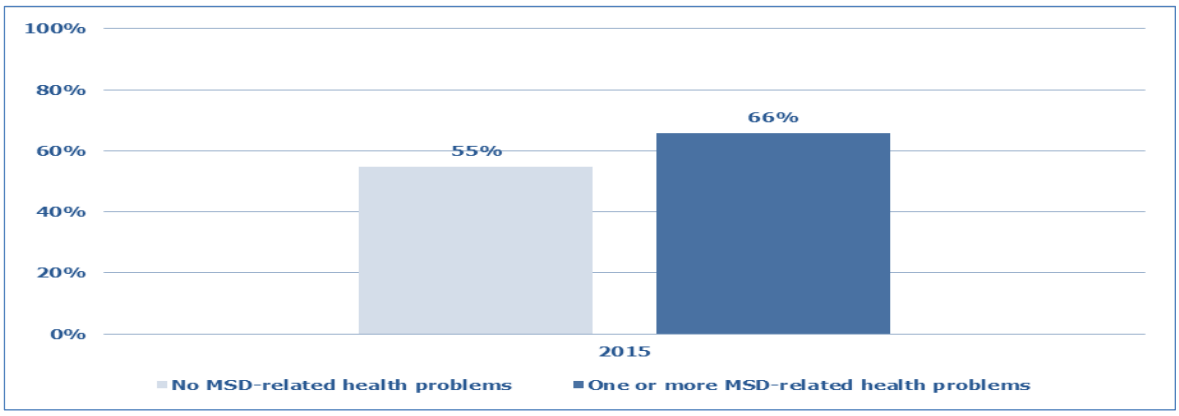


Note: Data concern workers who work at least 12 hours per week. 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).
N = 32,671 (anxiety); *N* = 32,651 (overall fatigue)
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Working at high speed**

Working at very high speed is more common among workers with MSD complaints than among workers without MSD complaints (Figure 84).

Figure 84 Percentage of workers reporting that they need to work at very high speed at their job at least a quarter of the time, EU-28, 2015



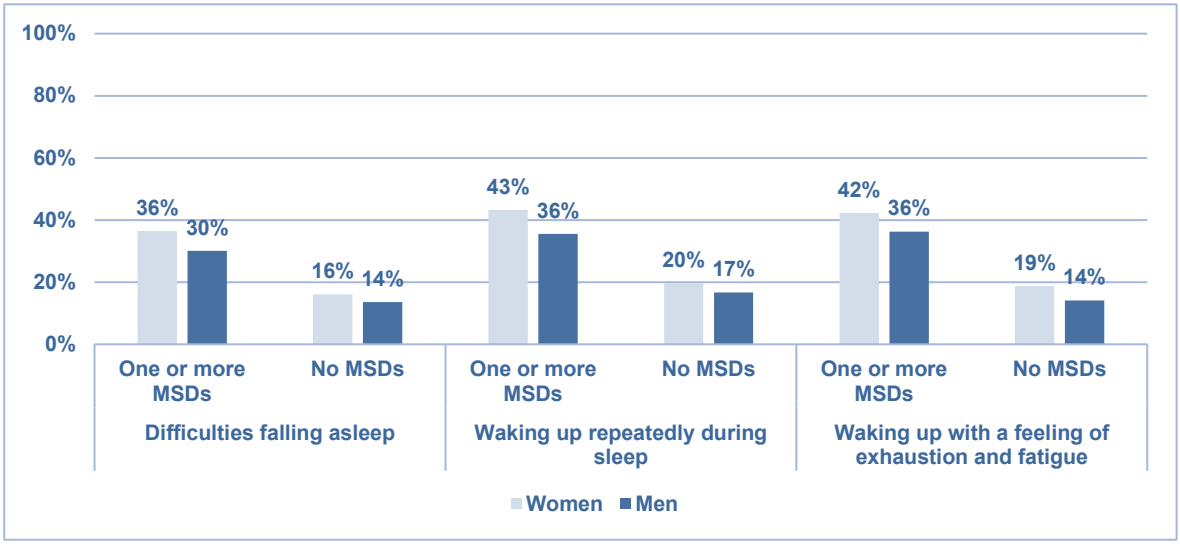
Note: Data concern workers who work at least 12 hours per week. 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).
N = 32,581
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

[175] In the EWCS, stress, overall fatigue and anxiety are measured differently. The amount of stress is measured on a five-point scale (from 'always' to 'never'), whereas overall fatigue and anxiety (during the past 12 months) can be either present or absent.

▪ Sleeping problems

The prevalence of sleeping problems is closely related to the prevalence of anxiety and overall fatigue, suggesting that these health problems may reinforce each other. These three health problems are in turn all positively related to MSD complaints, and Figure 85 depicts this relationship for three kinds of sleeping problems. Each of these sleeping problems is more prevalent among workers with MSDs than among those without, and each of these problems is reported more often by female workers than by male workers (just as with anxiety and overall fatigue).

Figure 85 Percentage of workers with and without MSDs reporting different sleeping issues at least several times a month, by gender, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week. 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

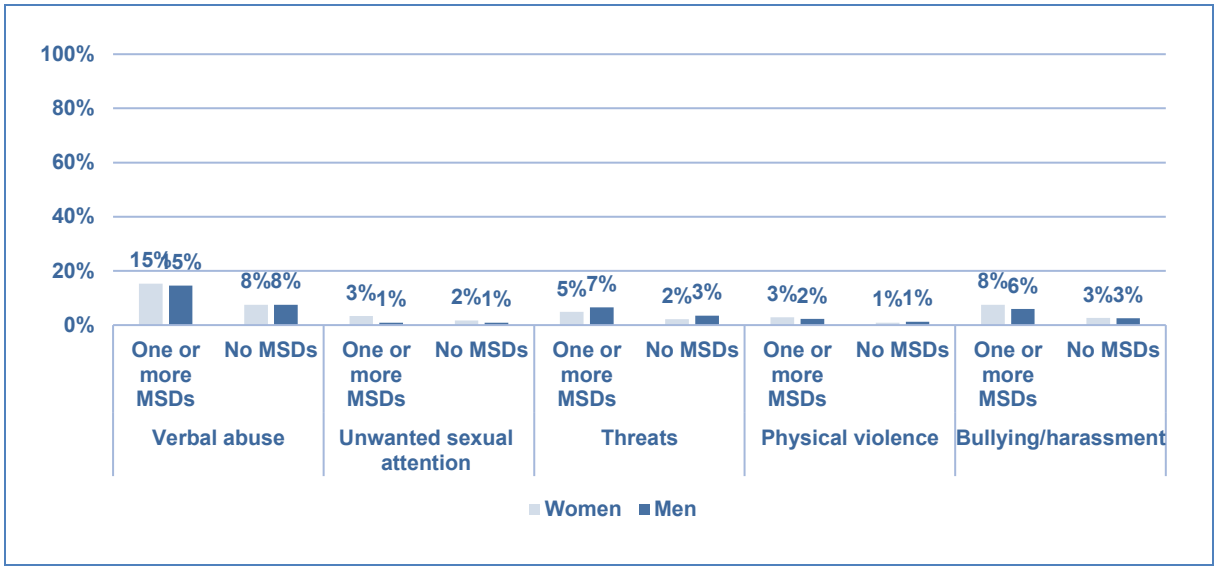
n = 32,695 (waking up repeatedly during sleep); *n* = 32,693 (waking up with a feeling of exhaustion and fatigue); *n* = 32,716 (difficulties falling asleep)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Subjected to physical and non-physical violence

Various types of physical and non-physical violence (such as harassment, threats and verbal abuse) are found to be related to MSD prevalence. The prevalence of these risk factors is, however, small. Even though some of these risk factors are more prevalent among workers with MSD complaints than among workers without MSD problems (in particular, verbal abuse, threats, and bullying or harassment), the prevalence of these risk factors is also low among workers with MSDs (Figure 86).

Figure 86 Percentage of workers with and without MSDs reporting that they have been subjected at work to different types of physical or psychological violence, by gender, EU-28, 2015



Note: Data concern workers who work at least 12 hours per week. 'Musculoskeletal disorders' refers to backache and/or muscular pains in shoulders, neck, upper limbs and/or lower limbs (hips, legs, knees, feet, etc.).

n = 32,659 (verbal abuse); *n* = 32,676 (unwanted sexual attention); *n* = 32,675 (threats); *n* = 32,697 (physical violence); *n* = 32,661 (bullying/harassment)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

5.2.3 Relationship between organisational and psychosocial risk factors and MSDs

Besides establishing the prevalence of relevant organisational and psychosocial risk factors, it is also important to establish the strength of their relationship to MSD prevalence, and whether or not this relationship varies between different sociodemographic groups of workers. For most of these risk factors the relationship indeed varies between different sociodemographic groups:

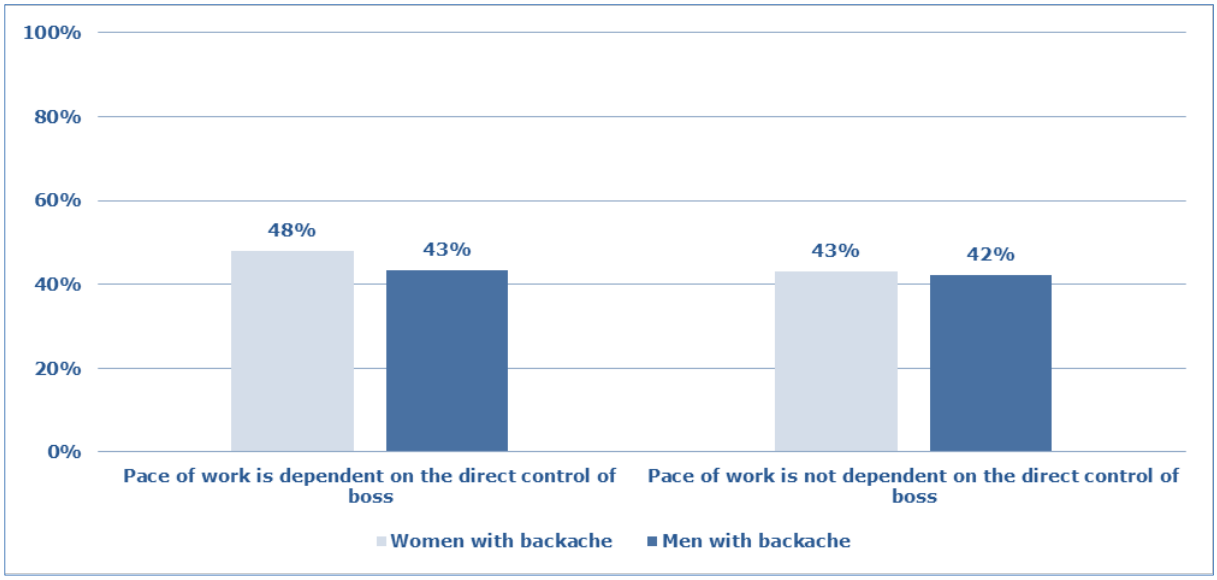
- gender:
  - MSDs in the back: interaction with pace of work (dependent on direct control of the boss);
- age:
  - MSDs in the back: interaction with complaints of anxiety and overall fatigue,
  - MSDs in upper limbs: interaction with voice,
  - MSDs in upper limbs: interaction with complaints of anxiety, experiencing stress,
  - MSDs in lower limbs: interaction with choosing order of tasks,
  - MSDs in lower limbs: interaction with overall fatigue;
- education level:
  - MSDs in the back: interaction with verbal abuse and knowing what is expected at work,
  - MSDs in upper limbs: interaction with voice,
  - MSDs in upper limbs: interaction with overall fatigue,
  - MSDs in lower limbs: interaction with sleeping problems;
- country of birth:
  - MSDs in the back: interaction with waking up repeatedly during sleep,
  - MSDs in upper limbs: interaction with being subjected to threats,
  - MSDs in upper limbs: interaction with overall fatigue,
  - MSDs in lower limbs: interaction with being subjected to unwanted sexual attention.

In this section various graphs are used to illustrate the strength of the relationship between the significant risk factors and MSD prevalence.

- **Pace of work and working at very high speeds**

Among workers with backache, female workers are more likely than male workers to report that their pace of work is dependent on the direct control of their boss. Although statistically significant, the difference is, however, not large (5 percentage points; see Figure 87).

Figure 87 Percentage of workers having backache problems, by direct control of their boss on pace of work, by gender, EU-28, 2015

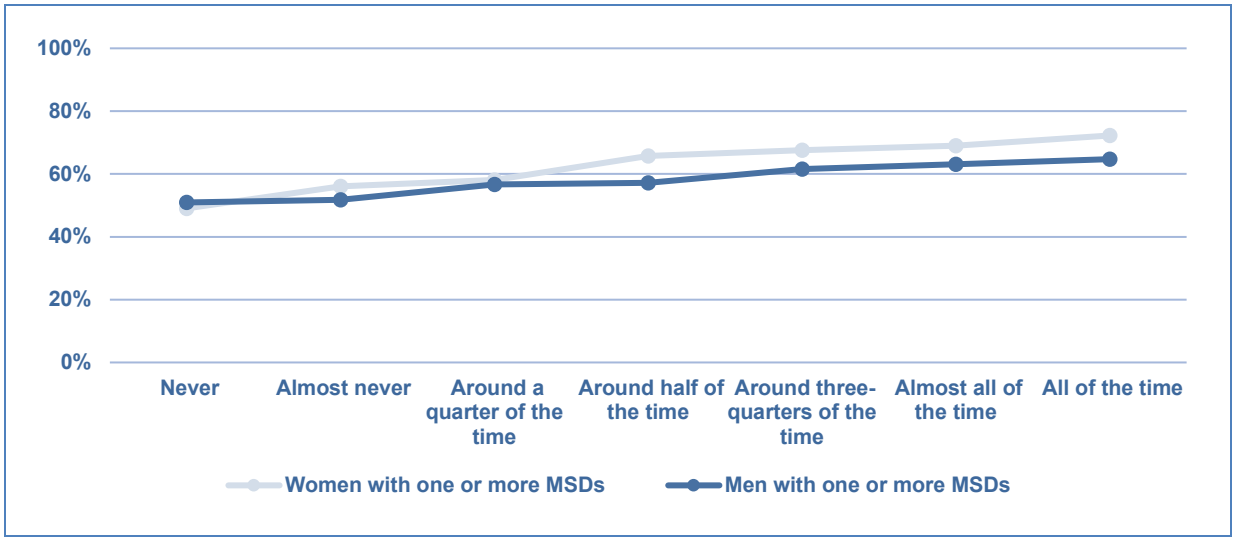


N = 32,411

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Around 50 % of all the workers who never have to work at high speed report having one or more MSDs. This increases to more than 60 % for male workers and more than 70 % for female workers who have to work at high speed all of the time (Figure 88).

Figure 88 Percentage of workers having one or more MSDs, by proportion of working time that they work at very high speed, by gender, EU-28, 2015



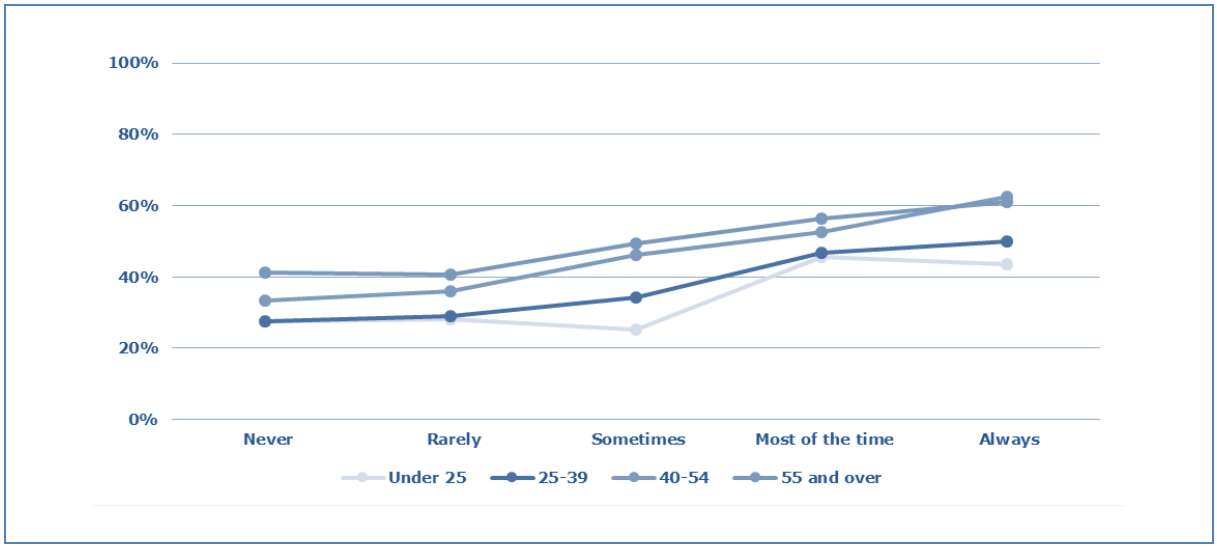
N = 32,626

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Work-related stress, overall fatigue and anxiety

Of workers aged 55 or more who never report work-related stress, around 40 % report MSDs in the upper limbs. This increases to more than 60 % for workers aged 55 or more who report work-related stress all of the time (Figure 89). The same positive relationship between work-related stress and prevalence of MSDs in the upper limbs applies to the other age groups, although the pattern is slightly erratic for the youngest age group.

Figure 89 Percentage of workers having muscular pains in shoulders, neck and/or upper limbs, by prevalence of work-related stress, by age, EU-28, 2015



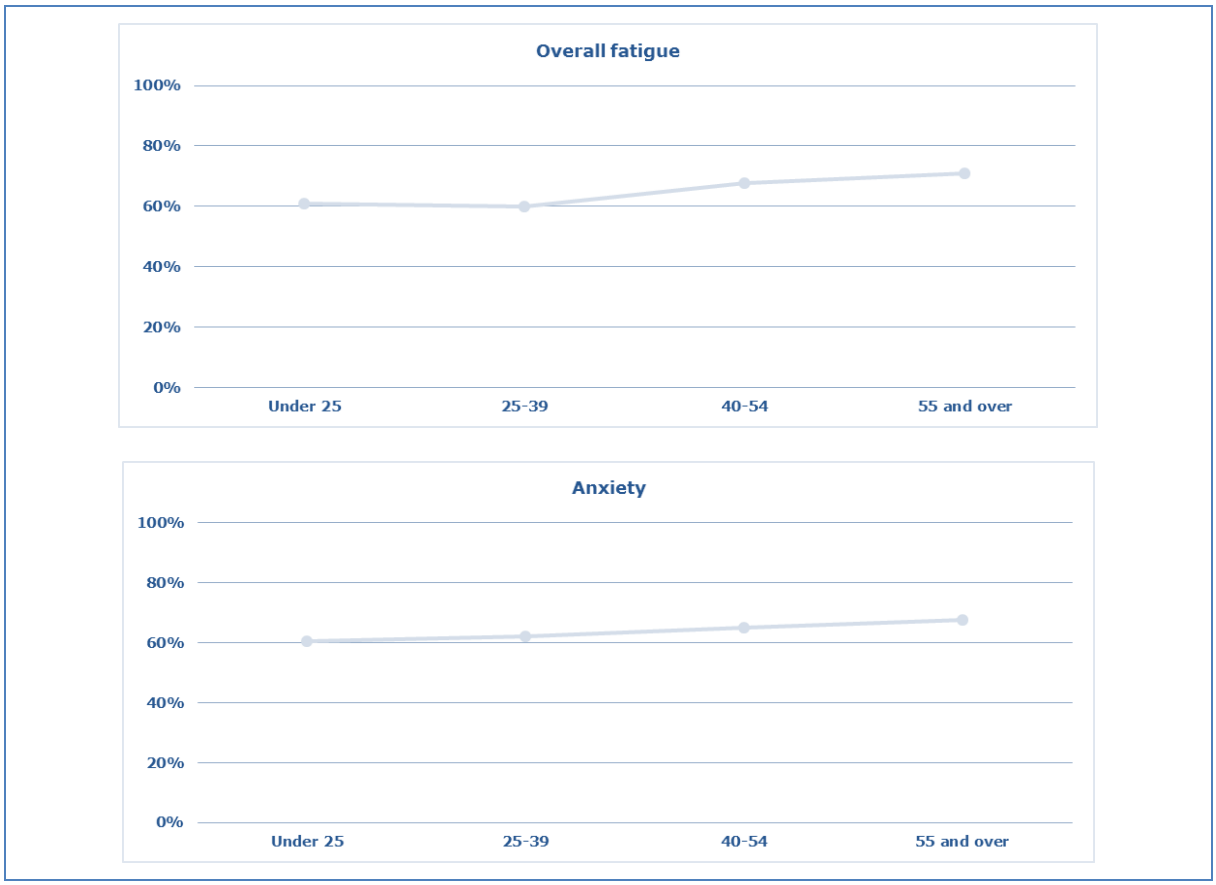
N = 32,630

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

For backache, the relationship between overall fatigue and MSD complaints is different for different age groups: among workers aged 55 or more who report overall fatigue, more than 70 % also report MSDs in the back; by comparison, among workers aged less than 25 who report overall fatigue, 60 % do (Figure 90). A similar age difference applies to anxiety, although the difference between age groups is less great.

Similar differences between age groups are also present regarding overall fatigue and MSD complaints in the lower limbs (Figure 91) and regarding anxiety and MSD complaints in the upper limbs (Figure 92).

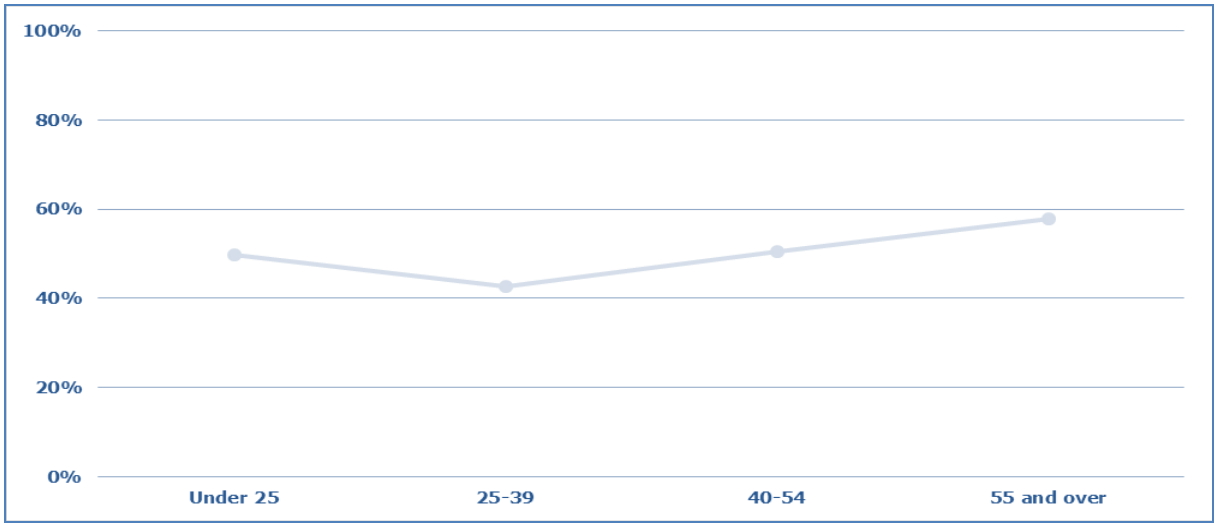
Figure 90 Percentage of workers with overall fatigue and anxiety reporting backache problems, by age group, EU-28, 2015



n = 32,671 (anxiety); *n* = 32,651 (overall fatigue)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

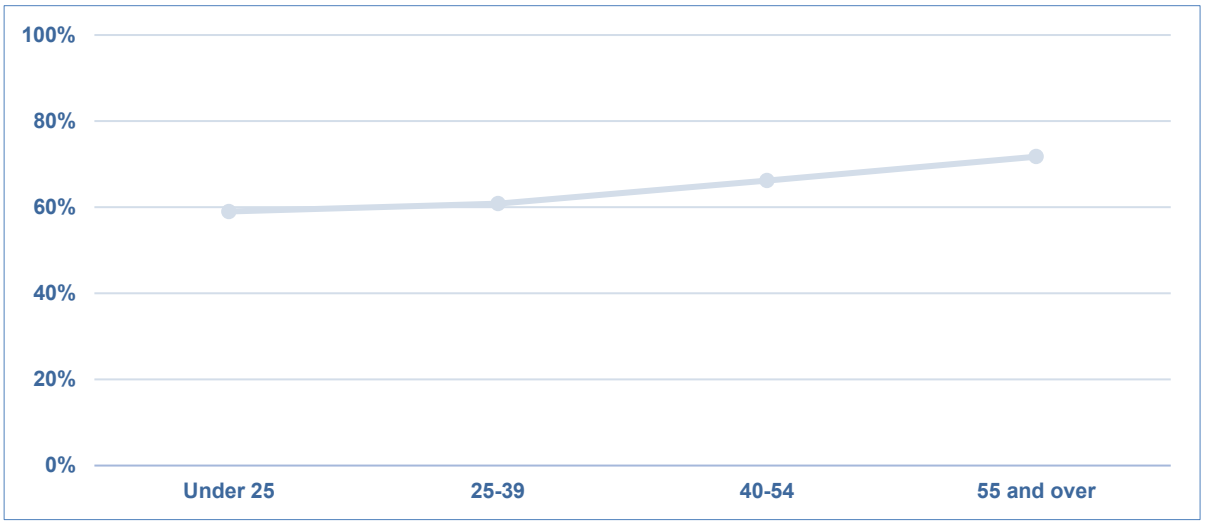
Figure 91 Percentage of workers with overall fatigue reporting muscular pains in lower limbs, by age group, EU-28, 2015



N = 32,651

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 92 Percentage of workers with anxiety reporting muscular pains in shoulders, neck and/or upper limbs, by age group, EU-28, 2015



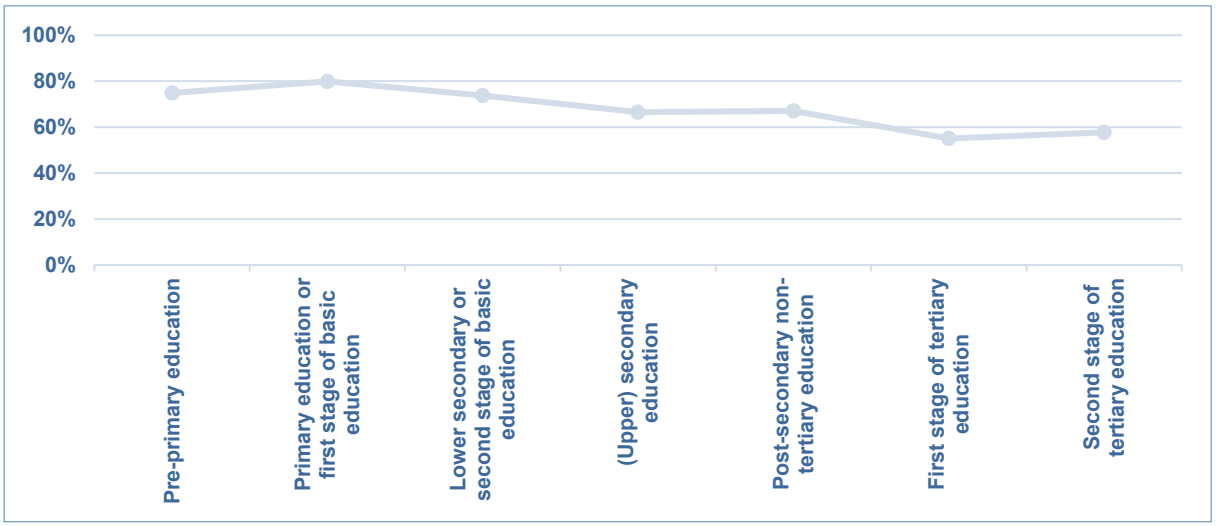
N = 32,671

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

The relationship between overall fatigue and MSD complaints also varies with education level and country of birth. For example, among workers with pre-primary, primary or lower secondary education level who report overall fatigue, 70-80 % also report MSDs in the upper limbs. By comparison, this is less than 60 % among workers with tertiary education levels (Figure 93).

The difference between first-generation immigrants and native workers is smaller than the difference between workers with lower and higher education levels. Among immigrant workers who report overall fatigue, 66 % also report MSDs in the upper limbs, compared with 64 % among native workers who report overall fatigue (Figure 94).

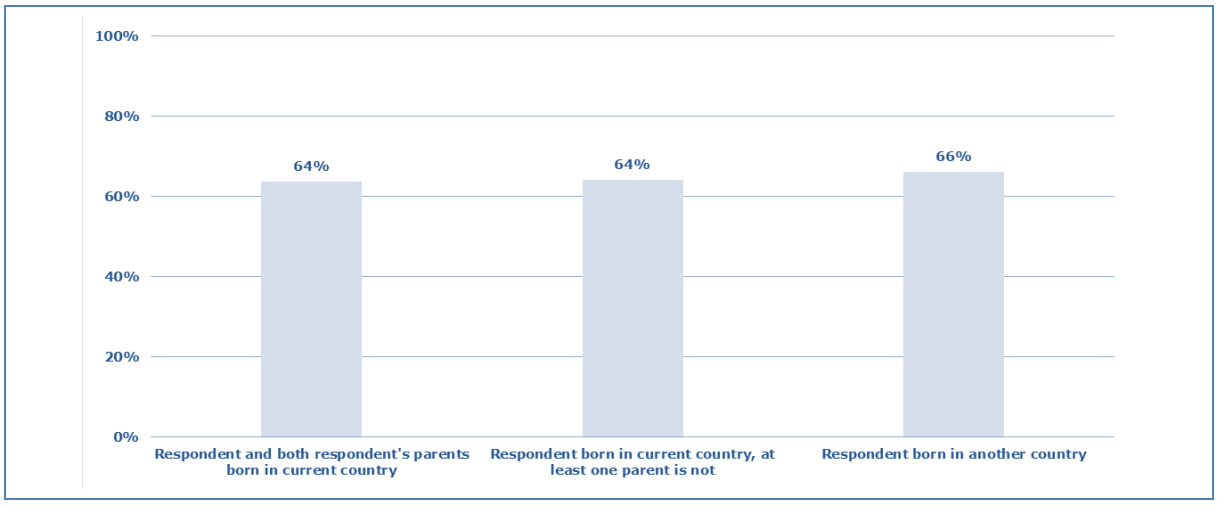
Figure 93 Percentages of workers with overall fatigue reporting pains in shoulders, neck and/or upper limbs, by education level, EU-28, 2015



N = 32,545

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 94 Percentage of workers with overall fatigue reporting muscular pains in shoulders, neck and/or upper limbs, by country of birth, EU-28, 2015



N = 32,462

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

▪ Sleeping problems

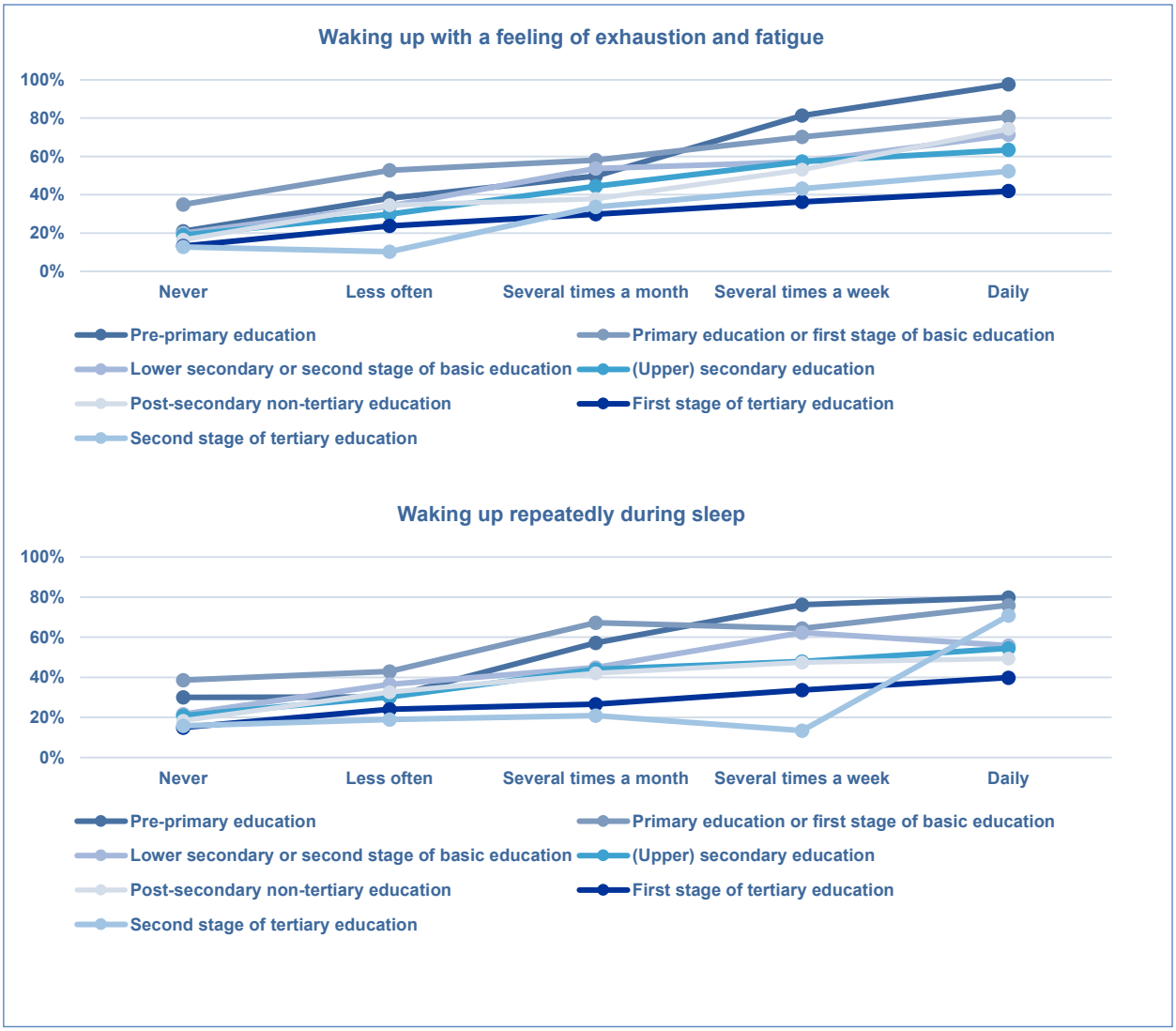
Of all the organisational and psychosocial risk factors identified for this study, sleeping problems appear to have the strongest relationship to MSD prevalence[176]. For example, among workers with pre-primary education level who report that they never wake up with a feeling of exhaustion and fatigue, 20 % also

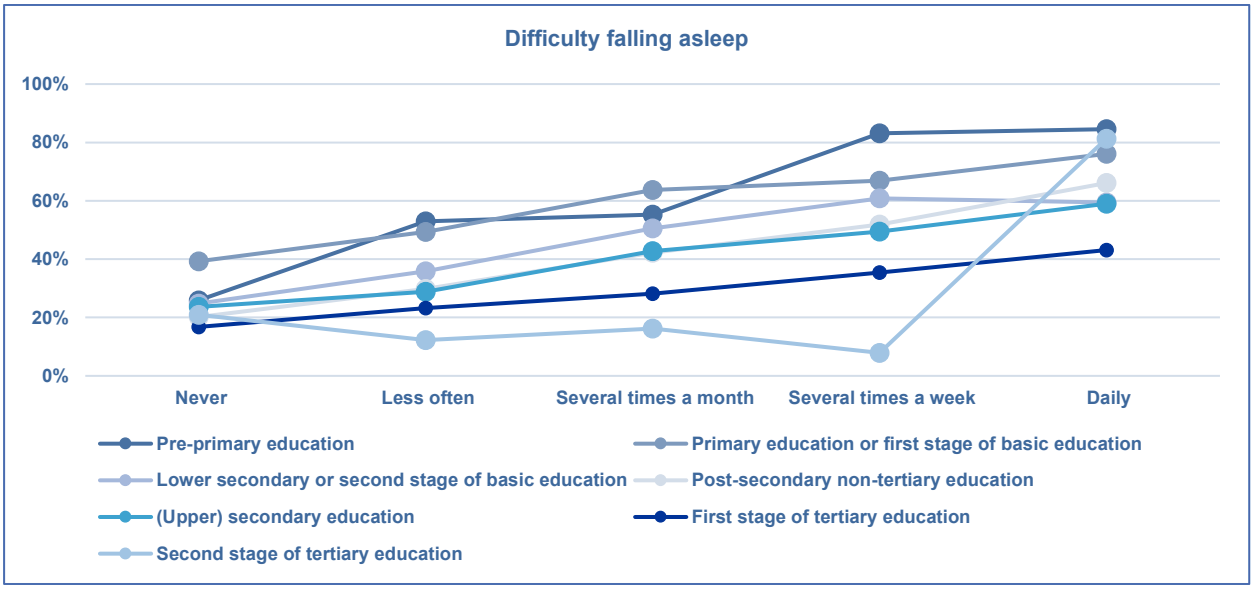
[176] In this respect, the strength of the relationship is measured as the difference in MSD prevalence between the highest and lowest scores for the risk factor.

report MSDs in the lower limbs. By comparison, this is closer to 100 % among workers with pre-primary education who always wake up with a feeling of exhaustion and fatigue (Figure 95).

In addition, the strength of this relationship is different for different education levels and for native workers, first-generation immigrants and second-generation immigrants (Figure 96).

Figure 95 Percentage of workers having muscular pains in lower limbs, by prevalence of different types of sleeping problems, by education level, EU-28, 2015

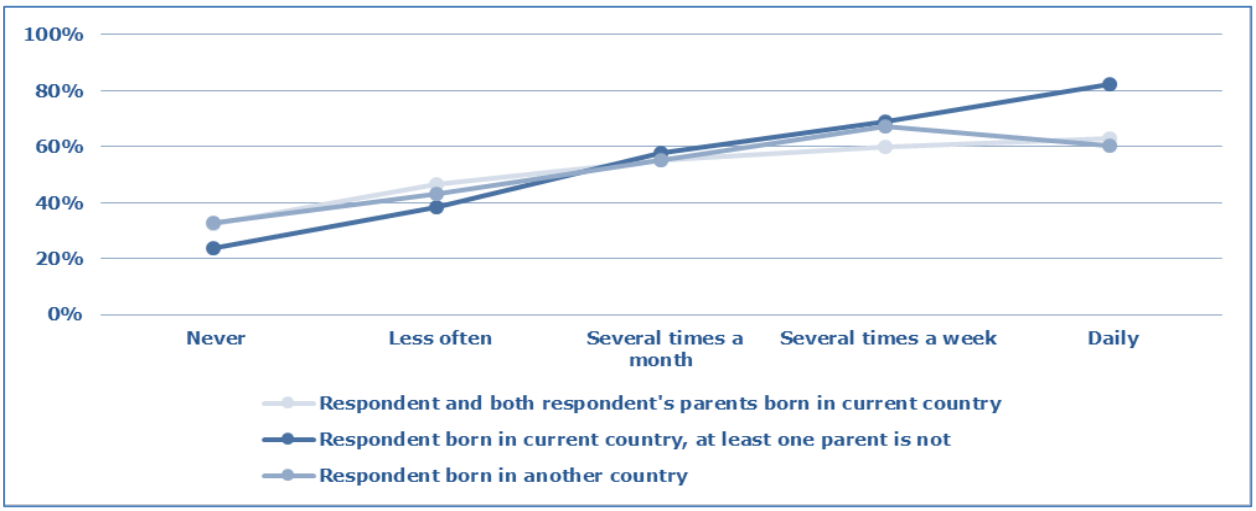




n = 32,609 (difficulty falling asleep); *n* = 32,588 (waking up repeatedly during sleep); *n* = 32,586 (waking up with a feeling of exhaustion and fatigue)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 96 Percentage of workers having backaches, by prevalence of waking up repeatedly during sleep, by country of birth, EU-28, 2015



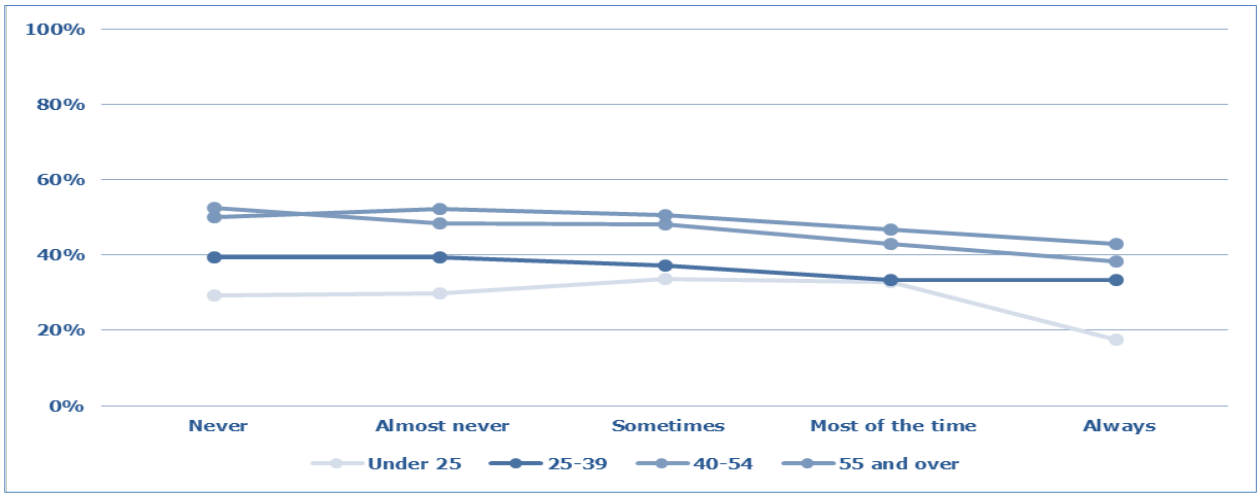
N = 32,506

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Employee voice, possibility of taking a break, having to hide feelings at work**

The level of employee voice, the possibility of taking a break and the necessity to hide one's feelings at work are all significantly related to MSD complaints, and the strength of these relationships differs between age groups, education levels (in the case of employee voice) and genders (in the case of the possibility of taking a break). The strength of these relationships is, however, small, as can be seen in Figure 97, Figure 98 (employee voice), Figure 99 (possibility of taking a break) and Figure 100 (having to hide feelings at work).

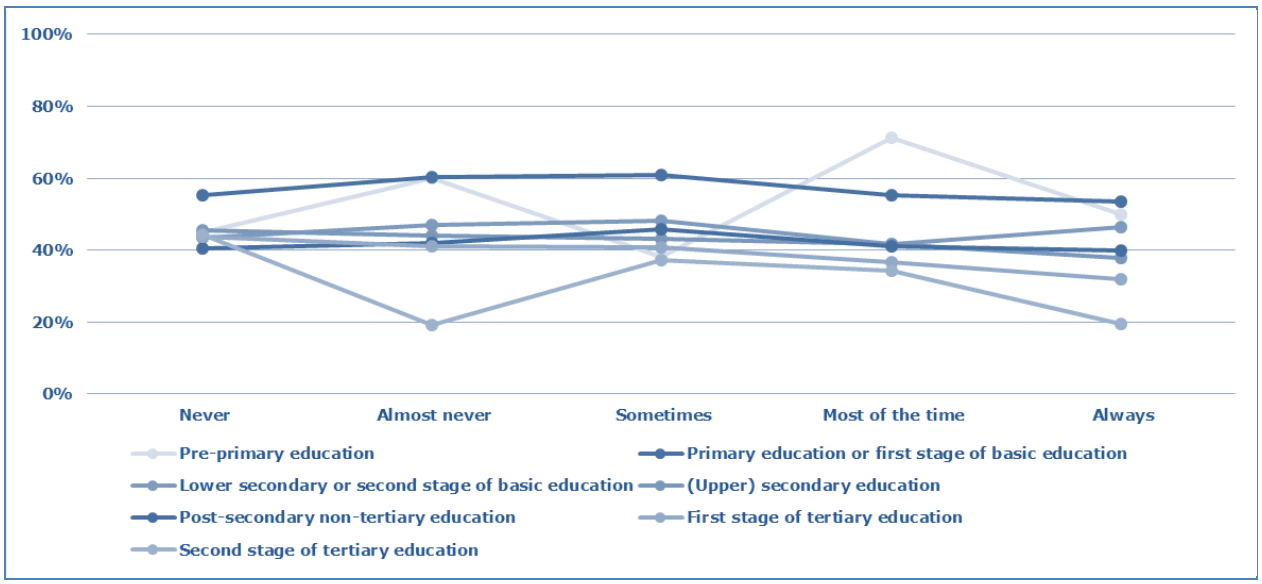
Figure 97 Percentage of workers having muscular pains in shoulders, neck and/or upper limbs, by level of employee voice, by age group, EU-28, 2015



N = 32,653

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

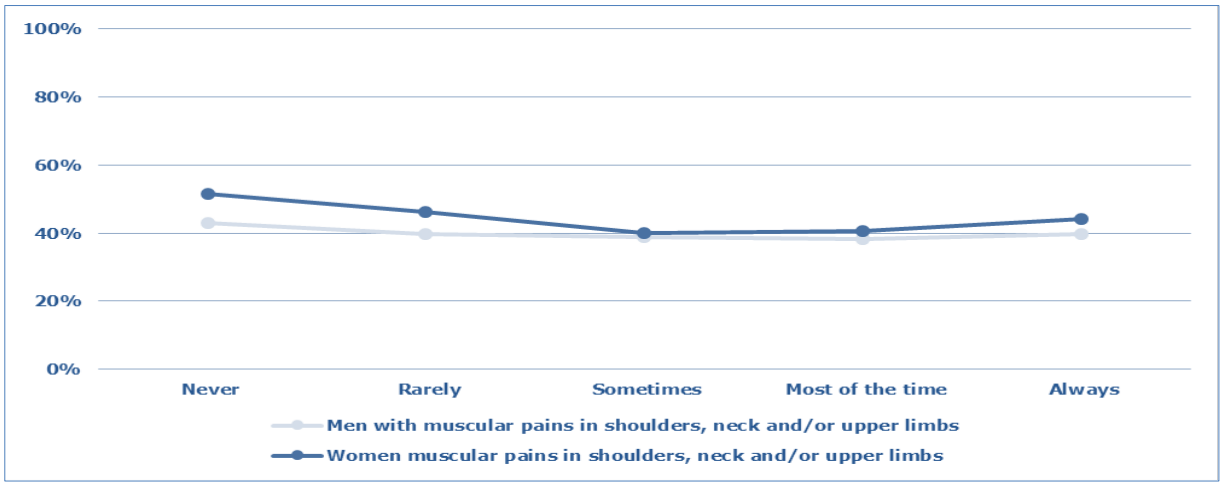
Figure 98 Percentage of workers having muscular pains in shoulders, neck and/or upper limbs, by level of employee voice, by educational level, EU-28, 2015



N = 32,542

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

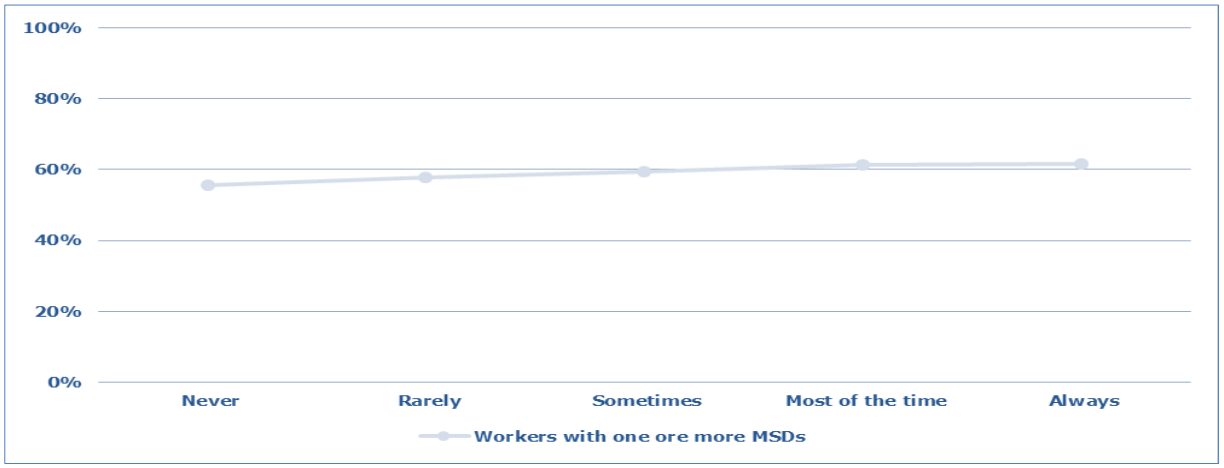
Figure 99 Percentage of workers having muscular pains in shoulders, neck and/or upper limbs, by possibility of taking a break when you wish, by gender, EU-28, 2015



N = 32,647

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 100 Percentage of workers with one or more MSDs, by need to hide feelings at work, EU-28, 2015



N = 32,344

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

5.2.4 Combined exposure to organisational and psychosocial factors

Based on the prevalence of relevant physical risk factors, it was possible to distinguish four different groups of workers (see section 5.1.4). A similar analysis has been conducted to classify workers in different groups based on the prevalence of relevant organisational and psychosocial risk factors. The number of relevant[177] organisational and psychosocial risk factors is, however, much larger (21). The average number of risk factors that apply to workers is 7.7 and for almost all workers (> 99.9 %) at least

[177] Significantly related to the prevalence of at least one MSD type.

two risk factors apply[178]. A cluster analysis could not identify meaningful clusters based on these organisational and psychosocial risk factors[179].

5.3 Workers' opinions on the relationship between work and health

So far, this chapter has discussed the prevalence of various physical, organisational and psychosocial risk factors, and the extent to which these risk factors are associated with MSD prevalence. The underlying assumption is that these risk factors may have a negative effect on workers' health.

In addition to using statistical analyses to examine the relationships between these risk factors and MSD-related health complaints, it is also possible to examine workers' opinions regarding the relationship between their work and their health condition. The EWCS includes two related questions about the relationship between work and health. The more general question is if workers believe that their work is affecting their health. This has remained more or less stable between 2005 and 2015 at slightly more than a third of all workers. The more specific question is if workers believe that their health or safety is at risk because of their work. The answers to this question show a decline, from 29 % in 2005 to 23 % in 2015 (Figure 101).

Compared with workers without any health problems, workers with MSDs are less positive about the relationship between their work and their health. While MSDs in lower limbs occur less often than MSDs in upper limbs and in the back (see Chapter 3), workers with MSDs in lower limbs are even less positive about this relation than workers with other types of MSDs (Figure 102 and Figure 103).

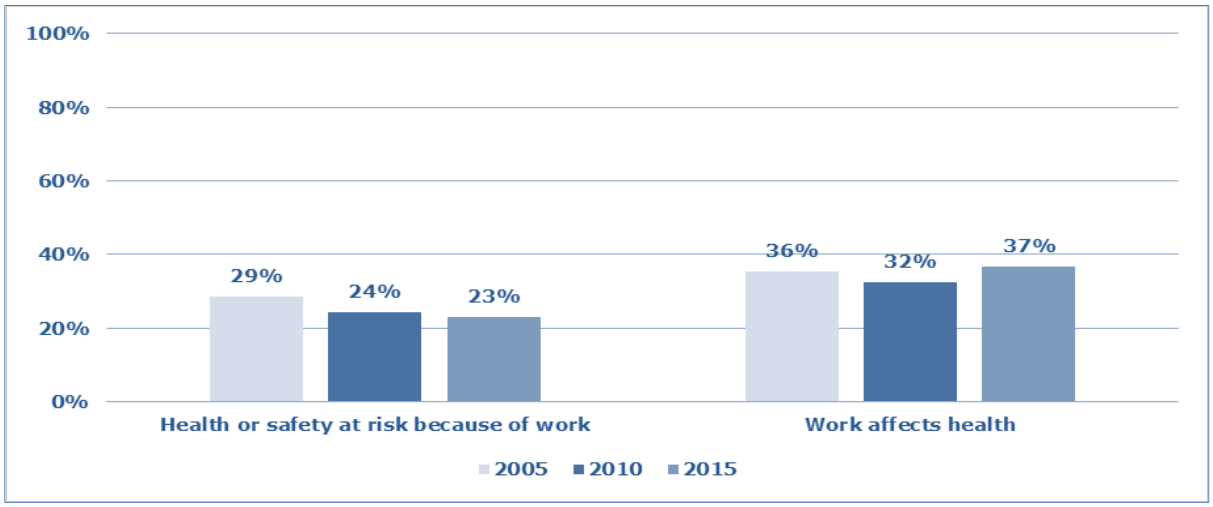
- **Male workers less positive about health and safety risks than female workers**

Male workers are more likely to believe that their health or safety is at risk than female workers are. This applies to workers with MSDs as well as to workers without any health problems (Figure 102). This might be related to the fact that male workers are more exposed to several physical risk factors that have a strong relationship to MSD complaints, in particular carrying or moving heavy loads (for at least a quarter of the time), working at low temperatures (for at least a quarter of the time), and being subject to vibrations from hand tools, machinery, etc. (for at least a quarter of the time).

[178] A risk factor applies if it occurs at least a quarter of the time.

[179] This is based on the silhouette measure of cohesion and separation, an indicator for the goodness of fit of the outcome of a cluster analysis. Several cluster analyses have been performed, but the silhouette measure of cohesion never exceeded 0.1. This is considered to be a poor solution.

Figure 101 Percentage of workers reporting that their work affects their health, EU-28, 2005, 2010 and 2015



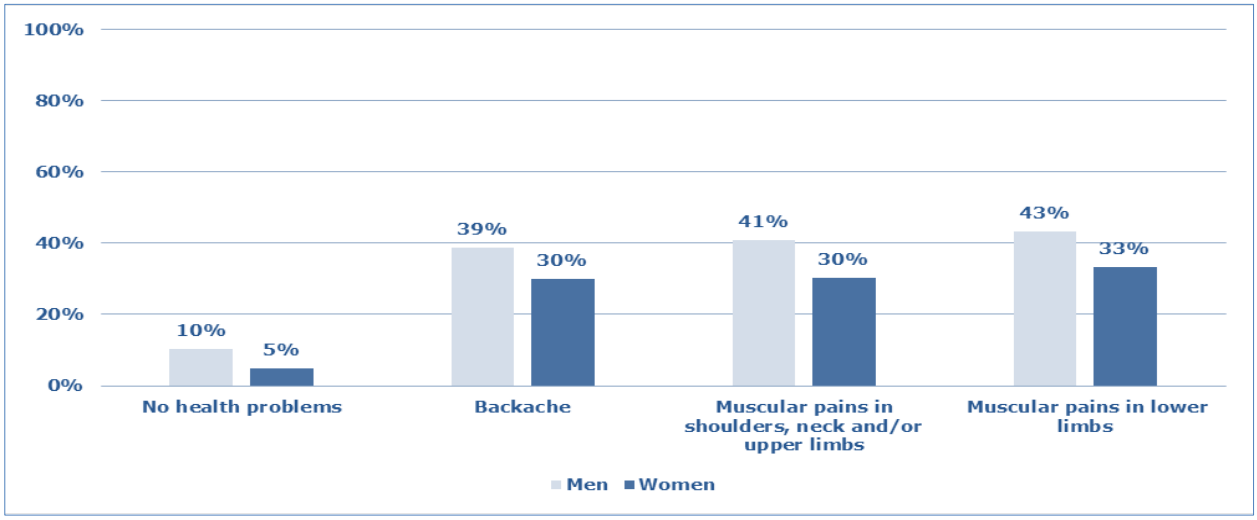
For 2005: *n* = 26,010 (health or safety at risk because of work); *n* = 26,087 (work affects health)

For 2010: *n* = 35,742 (health or safety at risk because of work); *n* = 35,141 (work affects health)

For 2015: *n* = 35,083 (health or safety at risk because of work); *n* = 34,606 (work affects health)

Source: Panteia based on the fourth (2005), fifth (2010) and sixth (2015) waves of the European Working Conditions Survey (EWCS)

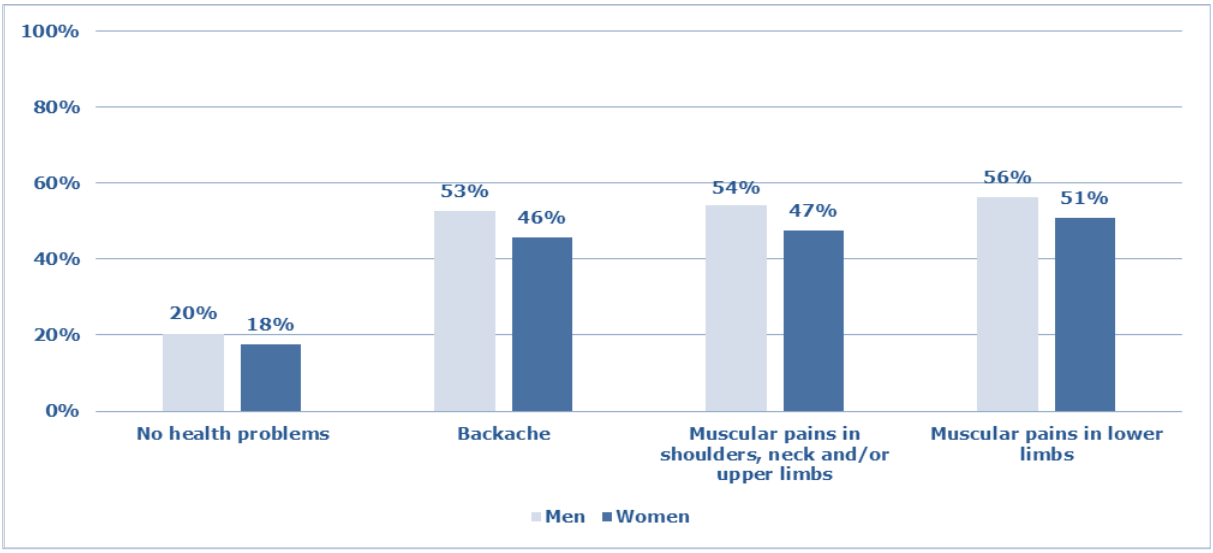
Figure 102 Percentage of workers reporting that their health or safety is at risk because of their work, by MSD type, by gender, EU-28, 2015



n = 8,683 (no health problems); *n* = 35,016 (backache); *n* = 35,009 (muscular pains in shoulders, neck and/or upper limbs); *n* = 35,003 (muscular pains in lower limbs)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

Figure 103 Percentage of workers reporting that their work affect their health, by MSD type, by gender, EU-28, 2015



n = 8,597 (no health problems); *n* = 34,543 (backache); *n* = 34,537 (muscular pains in shoulders, neck and/or upper limbs); *n* = 34,531 (muscular pains in lower limbs)

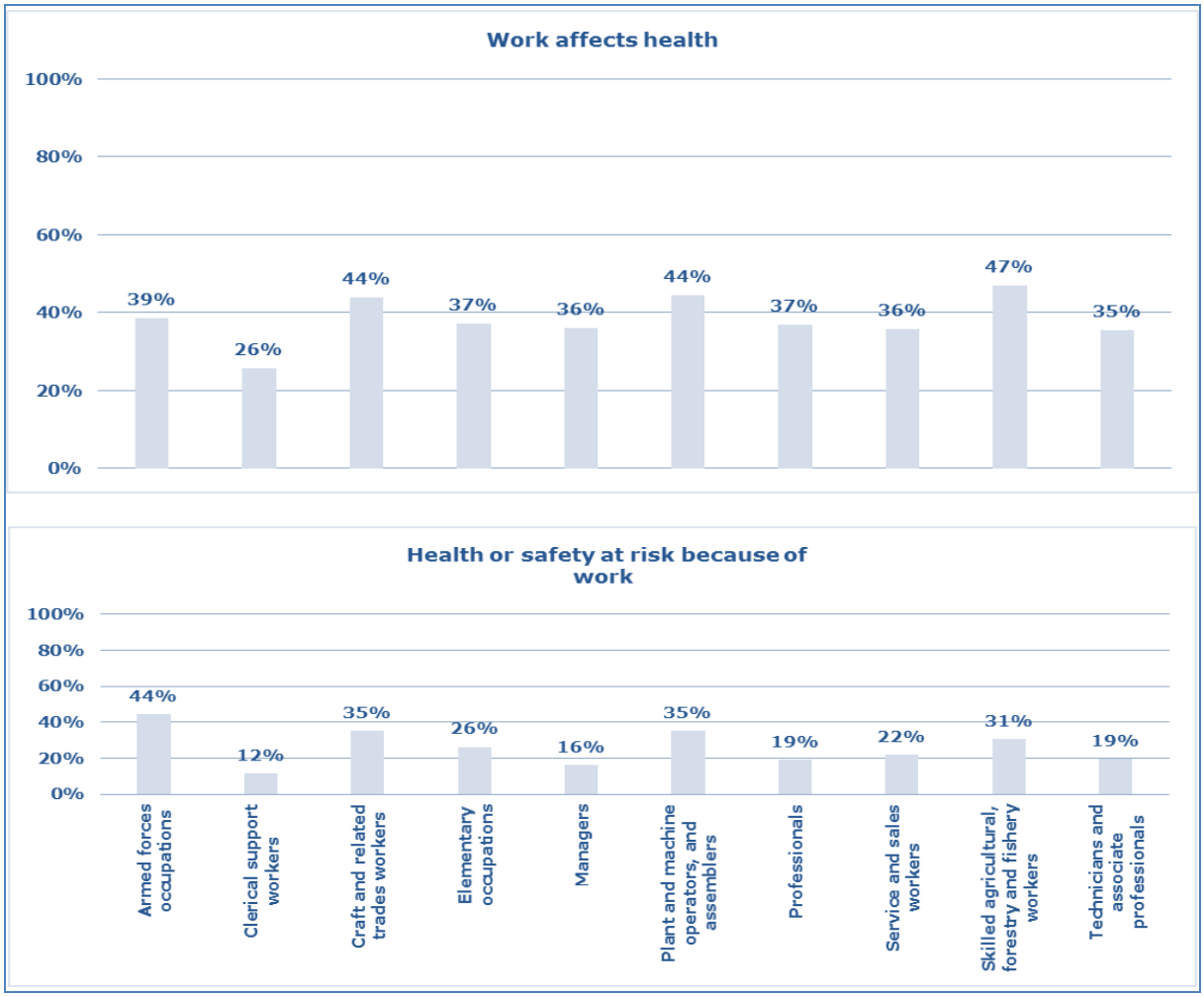
Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

- **Health and safety at risk, especially for blue-collar workers**

In 2015, 23 % of workers in the EU-28 believed that their health or safety was at risk because of their work (Figure 101). As can be seen in Figure 104, this percentage was highest among typical blue-collar occupations, such as plant and machine operators and assemblers (35 %), craft and related trades workers (35 %) and skilled agricultural, forestry and fishery workers (31 %)[180]. The high percentages for blue-collar workers are consistent with the high proportion of MSD complaints for these occupations (see section 3.2.3).

[180] Data on armed forces occupations are included in the graph but not discussed in the main text (given the specific characteristics of this occupation).

Figure 104 Percentage of workers reporting that their work affects their health, by occupation, EU-28, 2015



n = 34,819 (health or safety at risk because of work); *n* = 34,334 (work affects health)

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS)

6 Prevention of MSDs

This chapter provides more insight into the prevention of work-related MSDs. Data are presented on the extent to which enterprises have developed policies to improve the health situation of workers and consequently prevent or reduce the impact of MSDs. In addition, data are presented on the type of measures that have been taken by these enterprises.

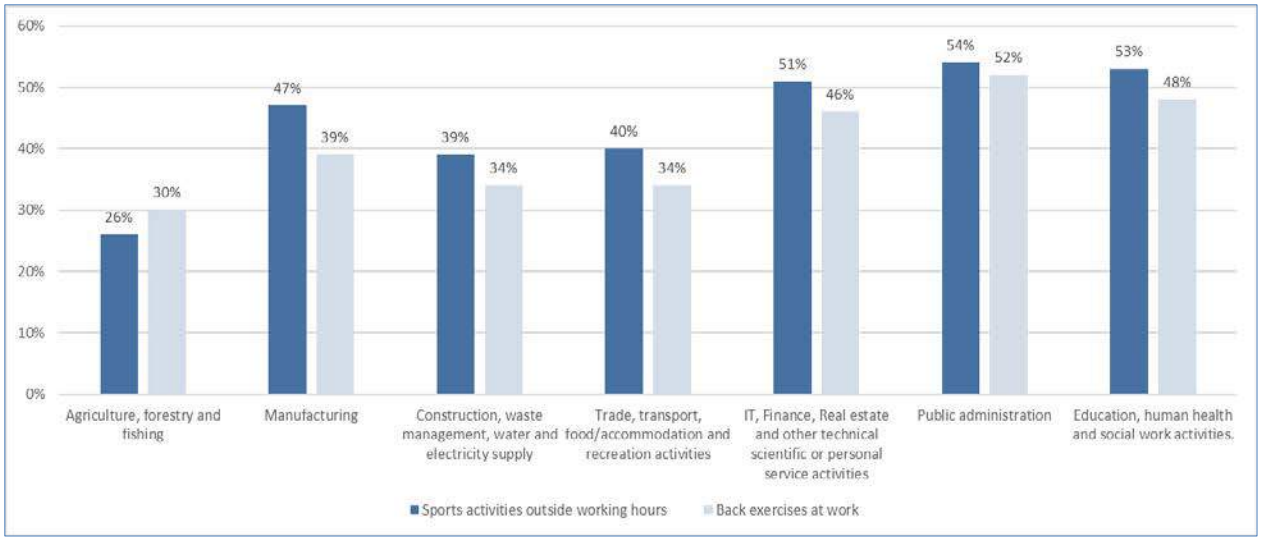
6.1 Prevention by establishments

EU establishments may take several measures in order to prevent their employees from getting work-related health issues such as MSDs. The most common measures (based on ESENER data) are presented in this section.

- **Health promotion activities mainly found in public administration and large establishments**

Figure 105 and Figure 106 provide information regarding the promotion of back exercises at work and of sports activities out of working hours, by sector and size of establishments, respectively. As can be seen, employees in the public administration and social activities sectors and employees working in large establishments are most likely to work in an establishment where such health promotion activities are provided.

Figure 105 Percentage of employees working in establishments where different measures for health promotion are in place, by sector, EU-28, 2019

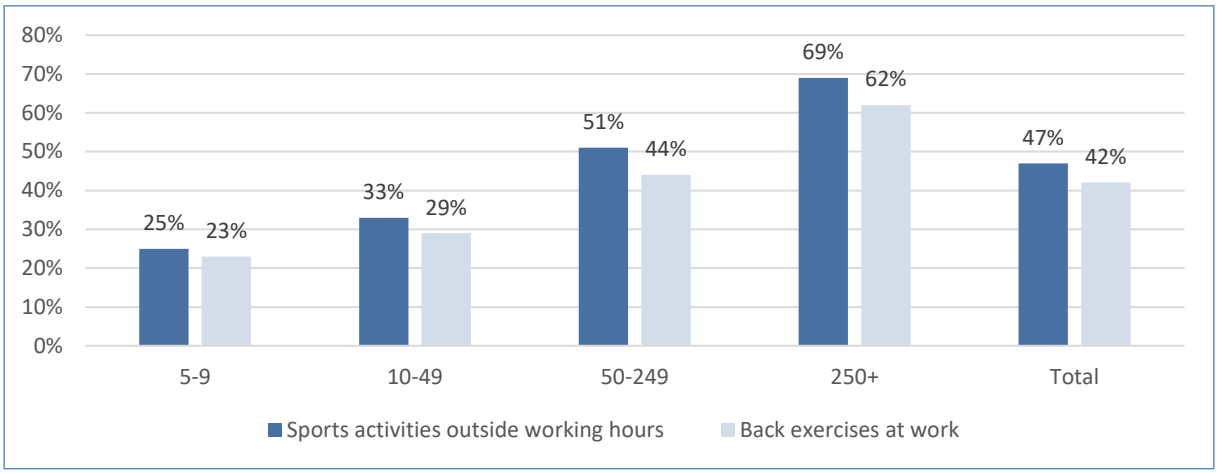


Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of interviews, not to the number of establishments in the universe.

N = 39,711

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

Figure 106 Percentage of employees working in establishments where different measures for health promotion are in place, by establishment size, EU-28, 2019



Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of interviews, not to the number of establishments in the universe.

N = 39,711

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

- **Equipment for lifting and moving most common preventive measure**

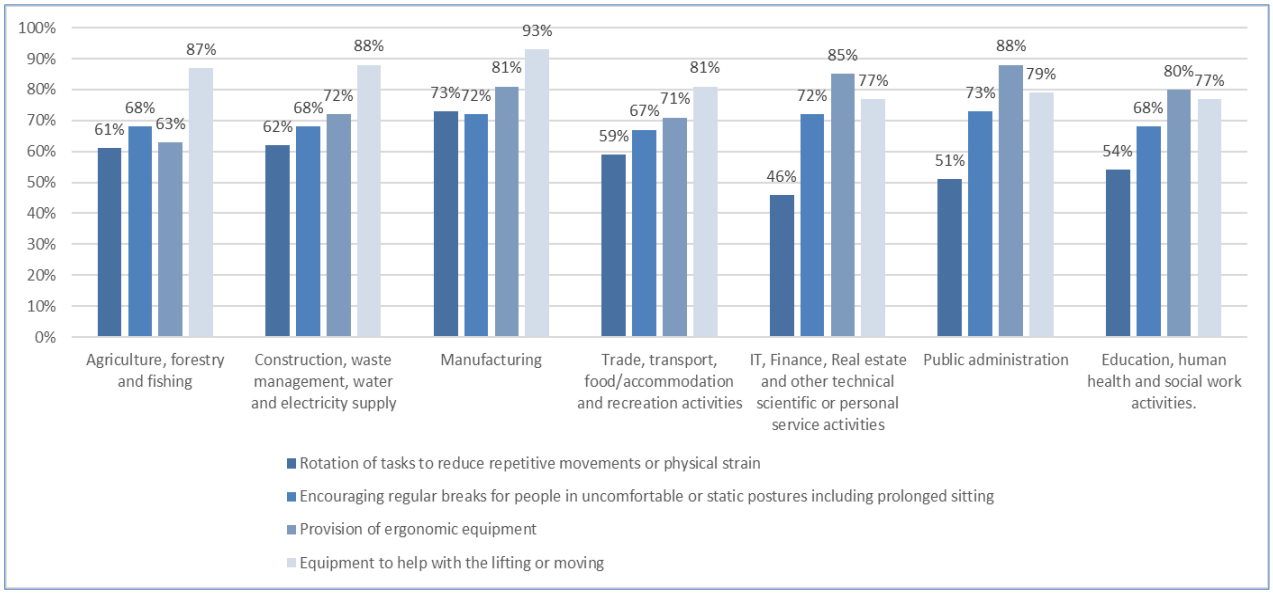
Figure 107 and Figure 108 present information on four different kinds of preventive measures regarding MSDs, by sector and company size, respectively. These preventive measures are rotation of tasks to reduce repetitive movements, encouraging regular breaks for people in uncomfortable working positions, the provision of ergonomic equipment and the provision of equipment to help lifting or moving. One has to take into account that the figure for equipment to help lifting or moving might grow in the next decade because of technical developments, such as the growing number of cobots (people and robots working together) and exoskeletons.

As figure 107 shows, the great majority of employees across all sectors work in establishments where equipment to help with lifting or moving is provided. Provision of ergonomic equipment and encouraging regular breaks for people in uncomfortable working positions follow, while the least promoted measure across sectors is the rotation of tasks to reduce repetitive movements.

- **Size class effect confirmed: preventive measures are less common among smaller establishments**

This rank order can be found among all size classes, although employees from large establishments are more likely to have these preventive measures in their establishment than employees from small establishments (Figure 108). This is consistent with many prior studies that identified this size class difference.

Figure 107 Percentage of employees working in establishments where different preventive measures are in place, by sector, EU-28, 2019

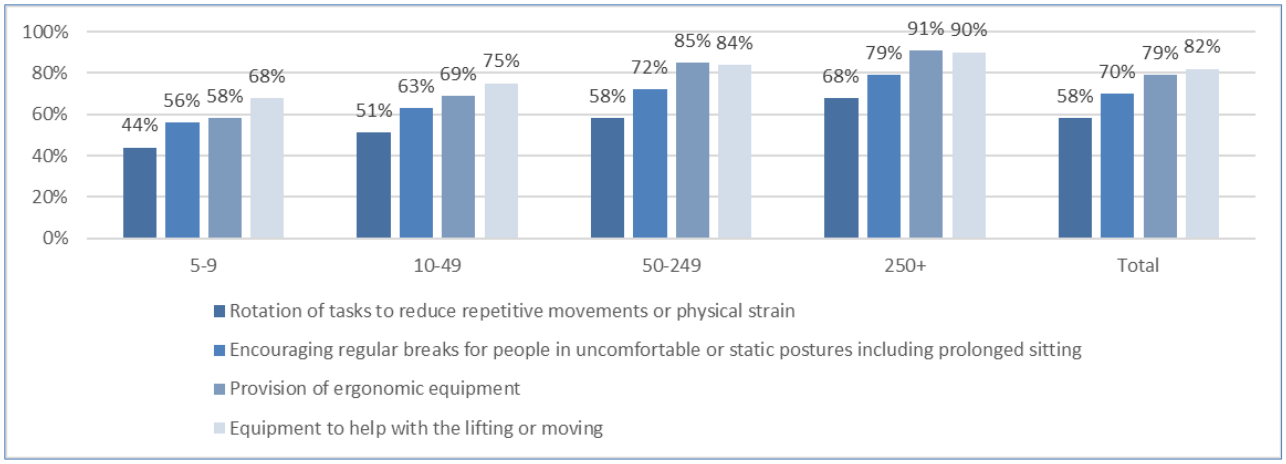


Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of employes, not to the number of establishments in the universe.

n = 22,251 (equipment to help with lifting or moving); n = 26,039 (rotation of tasks to reduce repetitive movements); n = 39,711 (encouraging regular breaks for people in uncomfortable working position); n = 39,711 (provision of ergonomic equipment)

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

Figure 108 Percentage of employees working in establishments where different preventive measures are in place, by establishment size, EU-28, 2019



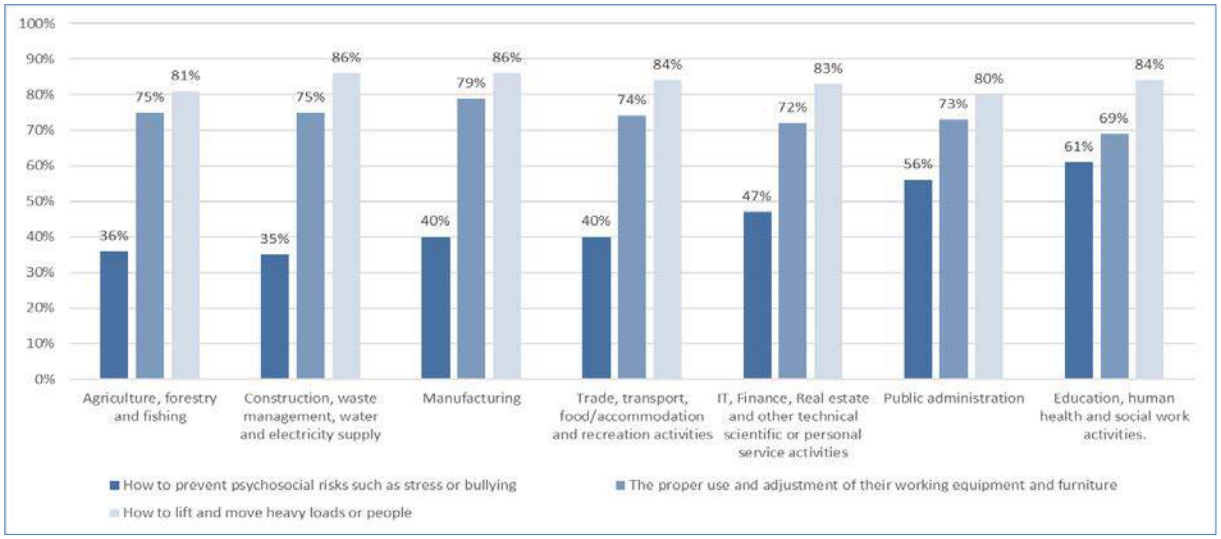
Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of employees, not to the number of establishments in the universe.
n = 22,251 (equipment to help with lifting or moving); n = 26,039 (rotation of tasks to reduce repetitive movements); n = 39,711 (encouraging regular breaks for people in uncomfortable working position); n = 39,711 (provision of ergonomic equipment)

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

- **Training on prevention of psychosocial risks is not common in many sectors and size classes**

As far as the provision of training is concerned, Figure 109 and Figure 110 show that most employees across the EU-28 work in establishments that provide training on how to lift and move heavy loads and on how to properly use and adjust their employees' equipment. A significantly lower proportion of employees work in establishments where training on how to prevent psychosocial risks is provided. This applies in particular to sectors associated with blue-collar workers (such as agriculture, manufacturing and construction) and among micro (5-9) and small (10-49) establishments, where fewer than 40 % of all employees work in establishments that provide training on the prevention of psychosocial risks.

Figure 109 Percentage of employees working in establishments where different preventive training programmes are provided, by sector, EU-28, 2019

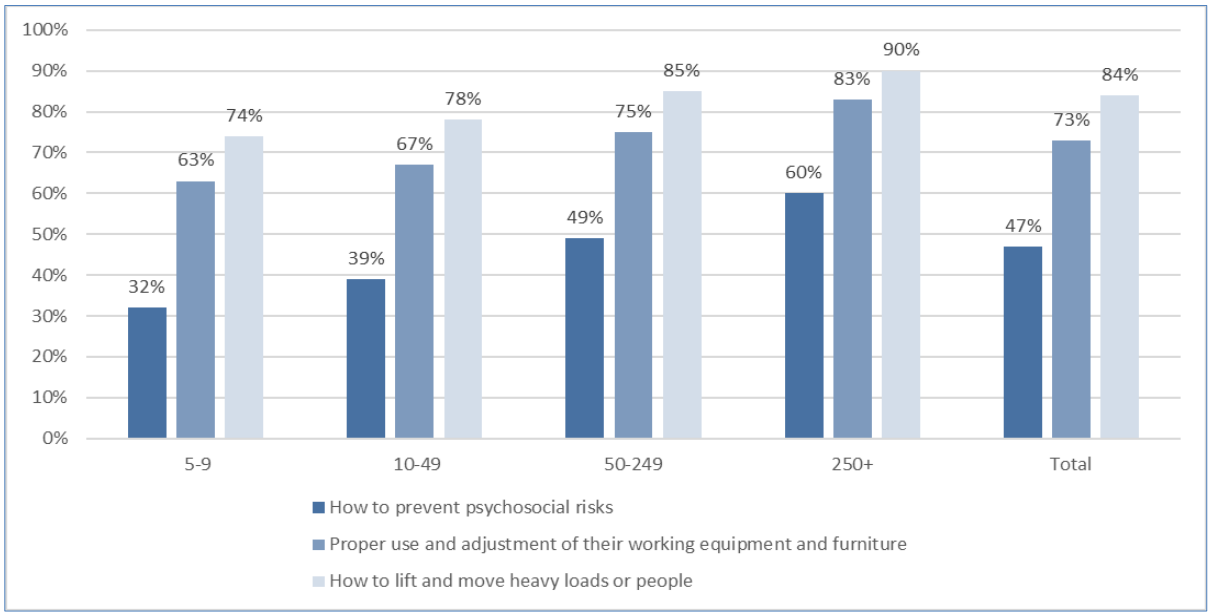


Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of interviews, not to the number of establishments in the universe.

n = 39,711 (proper use and adjustment of their working equipment); *n* = 39,711 (how to prevent psychosocial risks); *n* = 22,251 (how to lift and move heavy loads)

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

Figure 110 Percentage of employees working in establishments where training is provided, by establishment size, EU-28, 2019



Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of interviews, not to the number of establishments in the universe.

n = 39,711 (proper use and adjustment of their working equipment); *n* = 39,711 (how to prevent psychosocial risks); *n* = 22,251 (how to lift and move heavy loads)

Source: EU-OSHA based on the third European Survey of Enterprises on New and Emerging Risks (ESENER-3)

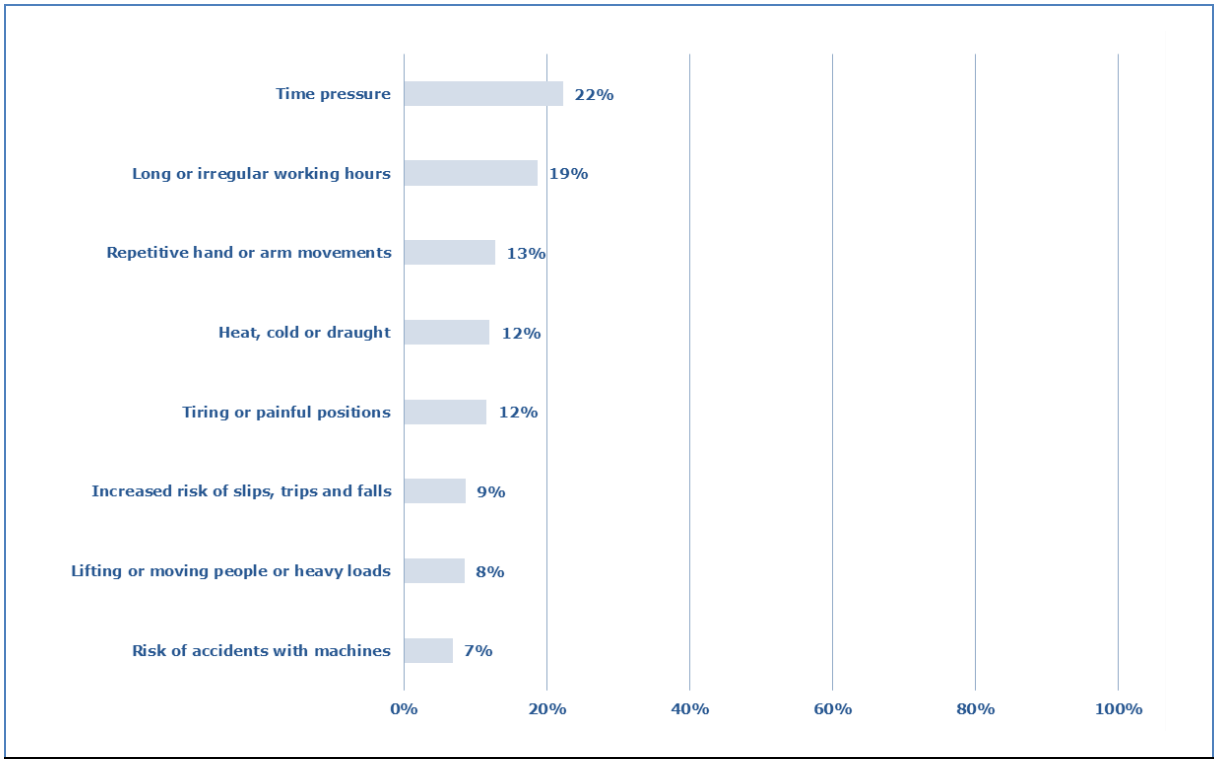
▪ Adequate preventive tools and information available for most employees

Figure 111 and Figure 112 contain data regarding lack of information or adequate preventive tools concerning physical and psychosocial risk factors in establishments. These are most often lacking for the two organisational or psychosocial issues included in the survey: regarding time pressure or working long or irregular hours, approximately 20 % of EU workers are working in establishments where information about or adequate preventive tools for these risks is lacking (Figure 111).

In the case of physical risk factors, such as repetitive hand or arm movements, tiring or painful positions, or lifting or moving people or heavy loads, even fewer employees are working in establishments where information or adequate preventive tools are missing.

Figure 112 provides the same information by size of establishments. For most of the risk factors, a larger proportion of micro and small enterprises lack information or adequate preventive tools than of larger enterprises; the size class difference is, however, not very large.

Figure 111 Percentage of employees working in establishments where information or adequate preventive tools are missing for different risks, EU-28, 2014

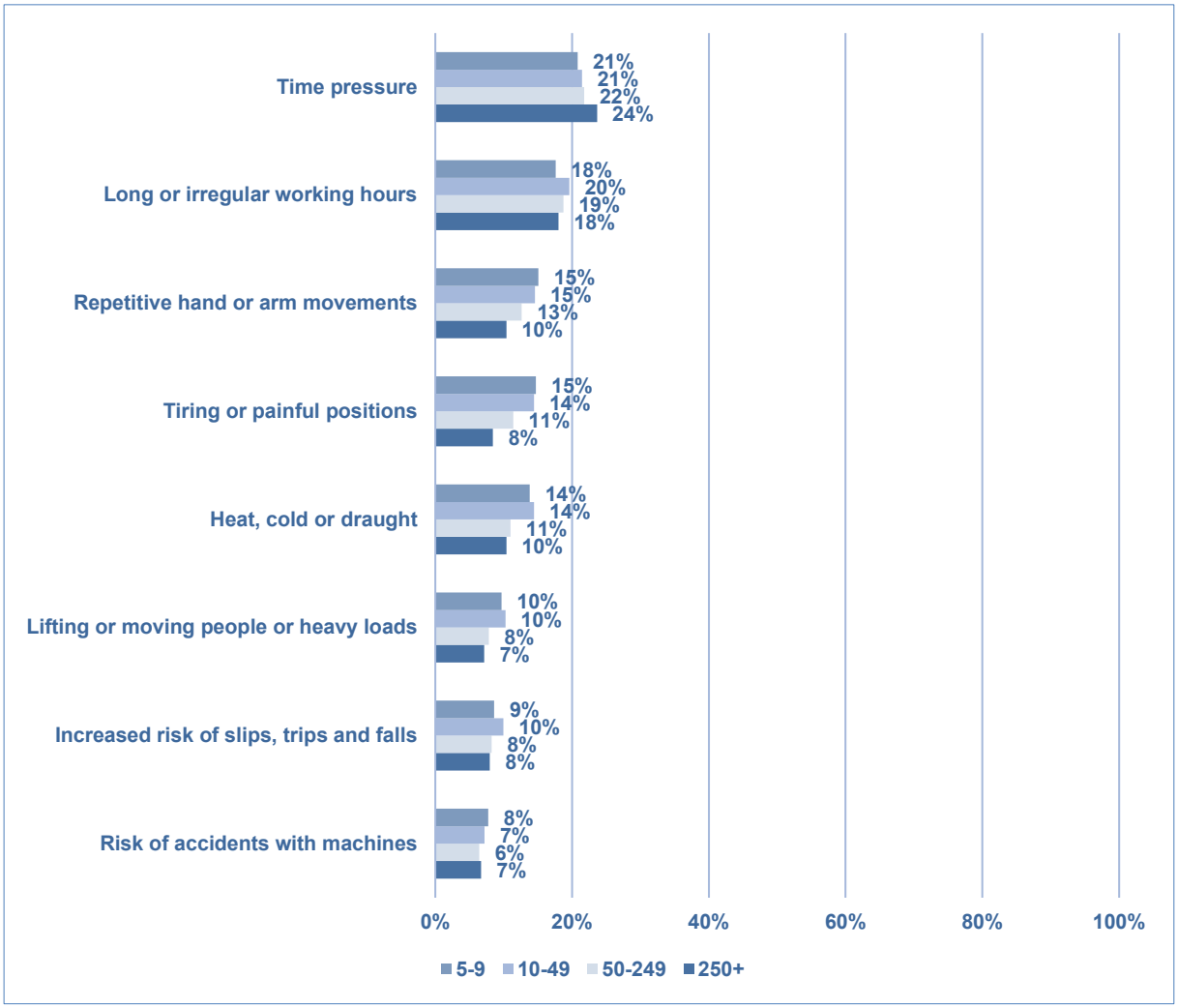


Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of interviews, not to the number of establishments in the universe.

n = 19,584 (time pressure); *n* = 10,119 (long or irregular working hours); *n* = 22,504 (repetitive hand or arm movements); *n* = 24,934 (tiring or painful positions); *n* = 16,571 (heat, cold or draught); *n* = 20,997 (lifting or moving people or heavy loads); *n* = 16,531 (increased risk of slips, trips and falls); *n* = 21,907 (risk of accidents with machines)

Source: Panteia based on the second European Survey of Enterprises on New and Emerging Risks (ESENER-2)

Figure 112 Percentage of employees working in establishments where information or adequate preventive tools are missing for different risks, by establishment size, EU-28, 2014



Note: Data are weighted with the employee-proportional weighting factor, which adjusts for the disproportionality of the national sample sizes for international analysis. It is scaled to the number of interviews, not to the number of establishments in the universe.

n = 19,584 (time pressure); *n* = 10,119 (long or irregular working hours); *n* = 22,504 (repetitive hand or arm movements); *n* = 24,934 (tiring or painful positions); *n* = 16,571 (heat, cold or draught); *n* = 20,997 (lifting or moving people or heavy loads); *n* = 16,531 (increased risk of slips, trips and falls); *n* = 21,907 (risk of accidents with machines)

Source: Panteia based on the second European Survey of Enterprises on New and Emerging Risks (ESENER-2)

▪ Data from Member States

Netherlands

The country report for the Netherlands provides additional findings.

According to the WEA (van Emmerik *et al.*, 2017), 35.1 % of company managers suggest that no measures have been taken to improve working circumstances in the previous 2 years. However, personal protective equipment has been introduced by 20.3 % of the companies, 17.2 % have implemented technical measures and 14.8 % have introduced organisational measures. The introduction of measures to improve working conditions increases as the size of the company increases. In some cases companies with 50-99 workers have a higher percentage of measure implementation than companies with 100 workers and more (for instance, 33.5 % of the companies with 50-99 workers

have introduced personal protective equipment in the past 2 years, compared with 28.8 % of the companies with 100 and more workers).

Furthermore, the WEA provides information regarding measures implemented to reduce risks at work. A large number of Dutch company supervisors hold appraisal meetings with individual workers (as confirmed by 73.7 % of company managers), and many use a sector-specific catalogue[181] on health and safety (as stated by 68.2 % of managers). Moreover, 48.3 % of company managers confirm that their companies perform risk assessments at work, and 20.7 % say that their sector has a sector-specific catalogue on health and safety that includes information, agreements and solutions. These percentages increase as company size increases. For instance, 65.5 % of companies with 2-4 workers hold appraisal meetings with individual workers, compared with 97.8 % of companies with 100 or more workers.

6.2 Impact of awareness on self-reported MSD prevalence

- **More prevention measures by enterprises associated with lower MSD prevalence**

The main purpose for establishments implementing preventive measures is to actually prevent their employees from getting work-related health issues such as MSDs. Analysis of a combination of data from two different surveys suggests that preventive measures may indeed reduce the prevalence of MSDs.

The indicators from the ESENER-2 survey described in the previous section have been used to construct two indicators regarding the proportion of workers in a certain country and sector who may benefit from certain preventive measures:

- the percentage of employees (within each country and sector) who are working in establishments where at least one of the following preventive measures for MSDs is provided:
  - encouraging regular breaks for people in uncomfortable working positions,
  - provision of ergonomic equipment;
- the average number of preventive measures provided in establishments (weighted by the number of employees involved).

These indicators have been combined with the data from the sixth wave of the EWCS, after which they could be used as additional explanatory variables in a model explaining the prevalence of MSDs (whether workers report one or more MSD types)[182]. The results show that workers in countries and sectors where more preventive measures are in place are less likely to report MSD complaints. Although this analysis can identify only a relationship (and not a causality), it does suggest that preventive measures may indeed reduce the risk of acquiring MSDs.

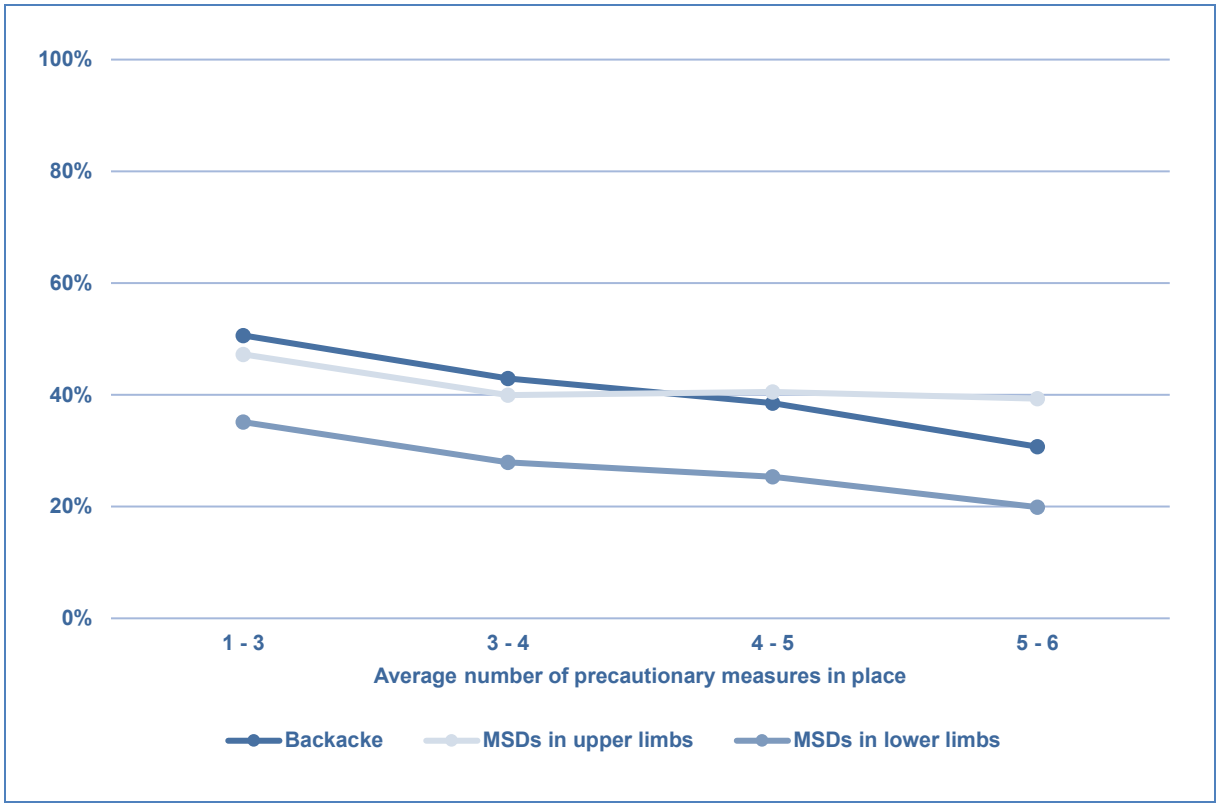
These findings are illustrated in Figure 113. The average number of preventive measures is at least one, for all countries and sectors in the EU-28. For backache as well as MSDs in the upper limbs, the figure shows that more preventive measures are associated with lower MSD prevalence. The percentage of workers reporting backache drops from 51 % (for workers in countries and sectors where on average between one and three preventive measures are in place) to 31 % (for workers in countries and sectors where on average between five and six preventive measures are in place). The prevalence of MSDs in the lower limbs shows a comparable development, from 35 % (for workers in countries and sectors where on average between one and three preventive measures are in place) to 20 % (for

[181] In a health and safety catalogue, employers and employees — on their own initiative — describe how they will meet target government requirements for healthy and safe workplaces. The catalogue should describe techniques and methods, good practices, standards and practical manuals for a safe and healthy work environment. More information about these catalogues is available at: https://www.arboportaal.nl/.

[182] These analyses concern logistic regressions with self-reported MSD complaints as the dependent variable, and gender, age, country, occupation, sector and the prevention indicators from ESENER among the independent variables. These regressions have been applied for MSDs in general (whether at least one of the three distinguished MSD types is reported). More information about these analyses can be found in Annex 12. The estimation results can be found in Annex 2.3.

workers in countries and sectors where on average between five and six preventive measures are in place). For MSDs in the upper limbs, the relationship is less strong.

Figure 113 Percentage of workers having MSDs in back, upper limbs and lower limbs, by average number of precautionary measures in place, EU-28, 2015



Notes: Data on MSDs concern workers who work at least 12 hours per week. *N* = 31,143. The average number of precautionary measures is determined for each country and sector (rather than for individual workers) and varies between 1.25 and 5.86. Given the low number of workers in countries and sectors with an average number of precautionary measures between one and two (123) this category has been combined with workers wih an average number between two and three.

Source: Panteia based on the sixth (2015) wave of the European Working Conditions Survey (EWCS) and the second European Survey of Enterprises on New and Emerging Risks (ESENER-2)

7 Main results

The main objective of this report is **to provide an updated quantitative overview of the current European situation in relation to MSDs.** In this chapter, the main findings of this study are summarised. For the reader's easy reference, the results are presented in line with the set-up of the report and consequently are in line with the theoretical framework that is described in detail in Chapter 2, 'Causes and consequences of MSDs'. The main conclusions and policy points are described in Chapter 8. The results cover all 28 Member States of the European Union.

Relevant data from national sources of Denmark, Germany, Spain, France, Italy, Hungary, the Netherlands, Austria, Finland and Sweden are presented in separate national reports and a synthesis report[183].

The data presented in this report are based on descriptive and advanced statistical analysis of various surveys carried out at the European level, and administrative data (accidents, occupational diseases, etc.) relating to MSDs collected at EU level and at national level.

Most of the results are based on the EWCS. In interpreting these data, it is important to take into account that the respondents to the survey are workers. This means that it measures the perception of workers of what MSD complaints are and their exposure to physical, organisational and psychosocial risk factors.

7.1 Prevalence of MSDs

Chapter 3 deals with the prevalence of MSDs among the working population in the EU. Two main data sources are used: self-reporting through surveys (sections 3.1. and 3.2) and administrative data (section 3.3).

- **MSD prevalence among the working population in the EU-28**

The EWCS distinguishes three types of MSDs: back (back area), upper limbs (shoulders, neck, upper limbs) and lower limbs (hips, legs, knees, feet, etc.).

In 2015, roughly three out of every five workers in the EU-28 report MSD complaints. The most common MSD types reported by workers are backache and muscular pains in the upper limbs (43 % and 41 %, respectively). Muscular pains in the lower limbs are reported less often (29 % in 2015).

Workers often report more than one type of MSD.

- **Work-related MSD prevalence among the working population in the EU-28**

In 2015, more than a third (37 %) of all workers in the EU-28 reported that their work affects their health negatively.

The proportion of all workers who report that their work affects their health negatively remained more or less stable between 2005 and 2015.

Of workers with work-related health problems, 60 % mention MSD complaints as their most serious health problem. The figures range from around 40 % in Bulgaria, Hungary and Romania to around 70 % in the Czech Republic, Cyprus, Poland and Finland. The second most mentioned health problem (mentioned by 16 %) is stress, depression and anxiety.

In all EU Member States for which data are available, a large majority of all workers report MSD-related complaints and stress, depression and anxiety as their most serious health problems. This ranges from 46 % in Romania to 80 % or more in Denmark, Ireland, Austria, Sweden and the UK.

[183] These reports are available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

- **MSD prevalence rates at Member State level**

The MSD prevalence rate at Member State level varies a lot. In 2015, the highest percentages were found in Finland (79 %), France (75 %) and Denmark (73 %) and the lowest percentages in Hungary (40 %), Ireland (46 %) and the United Kingdom (52 %). Additional analyses show that differences in age distribution of the workforce and the sector/occupation structure of economies cannot account for these country differences.

- **MSD prevalence rates between sectors**

MSDs in the back, upper limbs and lower limbs are most often mentioned by workers employed in the construction, water supply, and agriculture, forestry and fishing sectors. MSD prevalence is also above average among workers in human health and social work activities. The sectors where MSDs are least often reported are financial and insurance activities, professional, scientific and technical activities, education, and arts, entertainment and recreation.

- **Prevalence of chronic MSDs among the working population in the EU-28**

EHIS gives an indication of the prevalence of two types of chronic MSDs (chronic back defects and chronic neck defects) in the EU-28. In 2014, one out of five workers in the EU-28 had suffered from a chronic back or neck disorder in the past year. The proportion of people reporting chronic MSD complaints also varies a lot between countries, from 6 % in Bulgaria and 7 % in Romania to 46 % in Finland and 38 % in Latvia and in Slovenia.

- **MSD prevalence rates between occupations**

The prevalence of self-reported MSDs shows significant differences between occupational sectors. In 2015, around 69 % of skilled agricultural, forestry and fishery workers reported having one or several MSDs. Among plant and machine operators and assemblers (66 %), craft and related trades workers (65 %) and workers in elementary occupations (64 %), the proportions are also relatively high.

The proportion of workers reporting one or more MSDs is relatively low among professionals (52 %).

Within each of the occupational groups, cases of backache are mentioned most often, followed by muscular pains in the shoulders, neck and/or upper limbs, with muscular pains in the lower limbs in third place. For many occupations, the difference between backache and MSDs in upper limbs is small (not more than 3 percentage points).

- **Sociodemographic factors**

The sociodemographic factors covered include gender, age, country of birth and education level.

Gender

The likelihood of female workers in the EU-28 reporting MSD complaints in the upper limbs, lower limbs or back is significantly higher than for male workers. This gender difference remains significant if country, sector and occupation of the respondents are taken into account, as well as differences in exposure to physical, organisational and psychosocial risk factors.

Women are also more likely to report chronic MSD disorders in the neck and in the back.

Already at a young age (less than 25 years of age) the MSD prevalence rate is higher for women than for men. The differences reduce over the next few age categories, but increase again after the age of 55.

Age

Higher age is associated with a significant higher probability of reporting MSDs (upper limbs, lower limbs and back). This applies to all MSDs and also to chronic MSDs, and to MSDs in the upper limbs, lower limbs and back. These age differences are also present within sectors and within occupations. Additional analyses show that the likelihood of reporting MSDs increases significantly with age, even when differences between countries, sector and occupation and differences in physical, organisational and psychosocial risk factors are taken into account. This conclusion is supported by national data.

Country of birth

Second-generation immigrants are more likely to report MSD disorders in the upper limbs, lower limbs and back than native workers.

Education level

There is also a clear relationship between MSD risk and the education level of workers: workers with only pre-primary or primary education are more likely to report muscular pains in the upper limbs, lower limbs and/or back, and are also more likely to report chronic MSDs.

- **Employment status**

The prevalence of MSDs hardly varies based on employment status (self-employed or employed).

Data for 2015 indicate that self-employed workers do not report significantly more or fewer work-related MSDs than employees.

- **Development of the prevalence rates**

To get insight into the development of the prevalence of MSDs, data from 2015 are compared with those from 2010. The main results of this comparison are:

- The proportion of workers in the EU-28 who reported MSD complaints in the back, upper limbs and/or lower limbs decreased slightly between 2010 and 2015.
- In 2010 and 2015, muscular pains in the lower limbs were reported less often than muscular pains in the upper limbs or in the back. This differs from the situation in 2000/2001, when (work-related) muscular pains in the lower limbs were found to be just as prevalent as (work-related) muscular pains in the upper limbs (EU-OSHA, 2010).

A direct comparison with prevalence rates in 2005 is not possible, since the 2005 data of the EWCS refer to work-related MSDs, and the data from 2010 and 2015 to MSDs in general. Other types of comparison between 2015 and 2005 are, however, possible, such as comparing rankings or the amount of variance:

- The ranking of the different occupations in terms of prevalence of MSDs is very similar for 2015 and 2005.
- Similarly to 2010, the MSD prevalence rate at Member State level varied considerably in both 2005 and 2015. This holds also for the development between 2010 and 2015. In 15 Member States the rate was stable whereas in eight Member States it increased and in six it decreased.
- The variation in prevalence rates between sectors was similar in 2015 to that in 2005, except for the prevalence rates in transport, storage and communication, which were no longer above average, except for backache in transport and storage.

- **Administrative data and MSDs**

Accidents at work linked to MSDs

Within the different types of accidents that are distinguished in ESAW, the following types may be considered most likely to lead to MSD complaints: dislocations, sprains and strains, bone fractures and traumatic amputations (loss of body parts). In 2016, these three types of accidents accounted for 39 % of all fatal and non-fatal serious accidents at work. In particular, dislocation, sprains and strains are the second most common work-related injuries in the EU-28 after wounds and superficial injuries, accounting for 27 % of the total fatal and non-fatal work-related injuries. Bone fractures are lower, at 11 %, while traumatic amputations (loss of body parts) account for less than 1 % of the total.

During the period 2010-2016, the percentage of fatal and non-fatal accidents at work due to bone fractures and traumatic amputations did not change significantly. The percentage of accidents due to work-related dislocation, sprains and strains showed a downward trend until 2013, with a small increase in later years, without however, reaching the percentage of 2010.

National data from Sweden indicate that, for men, work-related MSDs are the main cause of accidents at work. For women, they are the second most important cause. In Spain, musculoskeletal overload was consistently the main cause of work accidents for the period 2014-2017.

Occupational diseases related to MSDs

Comparative administrative data for EU countries has been collected in the past. As described in section 3.3, no update is currently available for EODS. A pilot to update EODS is currently taking place, organised by Eurostat. Until then, comparable EU data are not available.

MSDs are the most commonly recognised ODs in France, Italy and Spain.

There is a higher proportion of women than men and a higher proportion of older workers than younger ones among the total cases of recognised MSD-related occupational diseases (based on the data gathered at Member State level and despite differences between countries).

7.2 Impact of MSDs

Chapter 4 focuses on the impact of MSDs. Health problems, including suffering from MSDs, entail consequences for workers, for the enterprises they work at, for society at large and for their personal life (irrespective of whether MSDs are work-related or not).

- **MSDs and general health condition**

Workers with MSD complaints not only often report more than one type of MSD, but also often report other health problems.

The majority of workers report that their general health is good or very good. Both EHIS and the EWCS show that the proportion of workers with (very) good health is smaller for workers who suffer from MSDs (in the upper limbs, lower limbs and/or back) and even smaller for workers suffering from chronic MSDs (in the back and/or neck).

In addition, a large proportion of workers with self-reported MSDs report that they are in good or very good health, which means that self-reported MSD complaints include not only severe cases of MSDs but also less severe cases (in the sense that the general health is still considered to be (very) good). This also applies to chronic MSDs in the back and/or neck, although to a lesser extent.

On average, 16 % of the workers with work-related health problem indicate that their most serious health problem is related to stress, depression and anxiety. Additional analyses show that higher levels of anxiety and overall fatigue of workers are associated with a higher likelihood of reporting MSDs. The causality (if any) of these relationships has not been established.

Prevalence of MSDs is associated not only with higher levels of anxiety and overall fatigue of workers, but also with higher levels of sleeping problems and lower levels of mental well-being of workers. These relationships apply to MSDs in the upper limbs, lower limbs and back.

Levels of anxiety, sleeping problems, headaches, eyestrain and overall fatigue affect the lives of most workers who suffer from one or more musculoskeletal disorders.

- **Costs and burdens of MSDs**

Comparable data at EU level on the costs and burdens of MSDs are not available.

DALYs reflect the effect of diseases on general population in terms of quality of life and death. Even though DALYs do not indicate economic values directly, the impact on productivity could be linked to economic loss. At 25 %, cancer accounts for the main part of the cost in the EU-28, and musculoskeletal disorders follow at approximately 15 %.

At national level some studies are available that show the impact of MSDs in economic terms and on society:

- Finland incurred EUR 63.8 million in medicine expenses related to MSDs, of which EUR 28.6 million was reimbursed by the Finnish social security system (KELA). In total, more than 1.4 million recipients benefited from 3.1 million MSD-related prescriptions; the cost per MSD-related prescription was EUR 20.90 and the average reimbursement per prescription was EUR 9.40.
- In Sweden, approximately 20-30 % of all visits to Swedish public health care were caused by MSDs. In 2012, MSDs accounted for 11 % of total healthcare costs.
- In France, estimates of the direct annual costs borne by enterprises exceed EUR 1 billion per year through their contributions to occupational accidents and diseases, while more than half (EUR 580 million) is related to sick day compensation. Caisse primaire d'assurance maladie (CPAM) of the Loire Region provides information regarding the costs of different types of MSDs for French companies. In particular, it is estimated that the average cost for companies is EUR 17,000 for a back-related MSD, EUR 12,780 for a carpal tunnel-related MSD, EUR 52,759 for a rotator cuff tendinitis-related MSD and EUR 18,220 for an epicondylitis-related MSD. These estimations do not include the days of sick leave for the affected worker, which for back disorders are approximately 220 days, for carpal tunnel 151 days, for rotator cuff tendinitis 298 days and for epicondylitis 195 days.
- In Germany, musculoskeletal and connective tissue disorders accounted in 2016 for EUR 17.2 billion of production loss (production loss costs based on labour costs) and EUR 30.4 billion in loss of gross value added (loss of labour productivity), which represent 0.5 % and 1.0 % of Germany's GDP, respectively.

Restrictions in daily activities

In the long term, workers with MSDs might not be able to continue to do their job or a similar one because of their disorders. In 2015, 36 % of workers in the EU with MSDs and one or more health issues believed that they would not be able to continue doing their current work to the age of 60, compared with 23 % of workers reporting only MSDs and 18 % of workers with no health problems.

Around 20 % of workers with health complaints report that future adaptation at work would be needed to accommodate their illness or health problem. This proportion is almost the same for all health problems but slightly higher for workers with backache and muscular pains in the lower limbs.

Of workers with chronic health problems, 20 % report that their workplace or work activity has indeed been changed to accommodate their illness or health problem. This proportion is the same for workers with and without MSD-related chronic health problems.

Presenteeism

Around 13 % of workers with MSDs and other health problems reported that they had worked 1-3 days in the past 12 months while they were sick. This percentage is slightly higher than that of workers with no health problems (8 %). The percentage of workers with MSDs and other health problems who worked 4 to 20 days while sick is much higher (29 % compared with 9 % for workers with no health problems). This means that workers with MSDs and other health problems work much more often while sick than workers with no health problems.

It should be noted that the percentage of presenteeism for workers who are affected by only MSDs does not show a significant difference from that of workers with only other health issues.

Absenteeism

Absence from work due to MSDs accounts for a high proportion of working days lost in EU Member States. In 2015, more than half (53 %) of the workers with MSDs (including those with other health problems) reported being absent from work during the past year, which is considerably higher than the proportion of workers without health problems (32 %). Workers with MSDs are not only more likely to be absent from work, but (given absence) on average are also absent for a longer period of time. For example, 26 % of workers with chronic MSDs and other health problems report being absent for more

than eight days during the past year, which is considerably higher than the 7 % for workers with no health problems.

- **Return to work**

On average, 73 % of the workers in the EU-28 work in establishments that have measures in place for employees to support return to work after long-term sickness. The differences between the EU-28 Member States are considerable. More than 90 % of employees in the United Kingdom (97 %), the Netherlands (92 %), Sweden (95 %) and Finland (93 %) work in enterprises where this support is provided. In Lithuania (19 %) and Estonia (27 %), the percentages are the lowest.

7.3 Exposure to risk factors

As described in Chapter 5, MSDs can be caused by many different (combinations of) factors in the workplace and may have many different consequences. The risk factors at the workplace include:

- physical factors;
- organisational and psychosocial factors;
- sociodemographic factors.

This first part of this section focuses on the physical risk factors and the second on the organisational and psychosocial factors. Sociodemographic characteristics of the workers (such as age, gender, level of education) are discussed where relevant.

7.3.1 Physical factors

Exposure to physical risk factors at work can play a crucial role in the appearance and prevalence of MSDs (back area, lower limbs or upper limbs) as well as in other health issues. Table 7 presents an overview of all physical risk factors that are included in the EWCS and shows for which of these a significant relationship to self-reported prevalence of MSDs has been identified, per type of MSDs (back, lower limbs or upper limbs):

- The analyses of the available data show that exposure to vibrations from hand tools, working in tiring or painful positions, carrying or moving heavy loads and repetitive hand or arm movements are associated with an increased likelihood of workers reporting all types of MSDs (upper limbs, lower limbs or back).
- The analyses of the available data do not show a significant relationship between the prevalence of self-reported MSDs and being involved in a job that requires working with computers, laptops, smartphones, etc., or lifting or moving people. In the case of lifting and moving people, this may be because lifting people and moving people involve different types of muscle activities, and therefore constitute two different types of risk factors.
- Several studies have shown that prolonged sitting has negative health effects. Some of these studies also find that prolonged sitting increases the risk of MSDs. The analysis of the EWCS data do not support these findings (the more time workers have to sit during their work, the less likely they are to report MSD complaints in the lower limbs; self-reported prevalence of MSDs in the back and upper limbs is not related to sitting). This may be because of the difficulties of accurately measuring prolonged sitting and the absence of data on prolonged standing. More research is needed to clarify the relationship between sitting and MSDs.
- The relationship between the prevalence of self-reported MSDs and prolonged standing has not been examined, for lack of data.

Table 7 Associations between self-reported MSDs (back, lower limbs or upper limbs) and physical risk factors

Body area	Significant relationship identified	No significant relationship identified
Back	• Vibrations from hand tools • Working in tiring or painful positions • Carrying or moving heavy loads • Repetitive hand or arm movements	• Lifting or moving people • Working with computers, laptops, etc. • Sitting • Being exposed to low temperatures
Lower limbs	• Vibrations from hand tools • Working in tiring or painful positions • Carrying or moving heavy loads • Repetitive hand or arm movements • Being exposed to low temperatures • Sitting*	• Lifting or moving people • Working with computers, laptops, etc.
Upper limbs	• Vibrations from hand tools • Working in tiring or painful positions • Carrying or moving heavy loads • Repetitive hand or arm movements • Being exposed to low temperatures	• Lifting or moving people • Working with computers, laptops, etc. • Sitting

Note: This table is based on the results of various binary logistic regressions that have been estimated to explain the prevalence of self-reported MSD complaints in the sixth (2015) wave of the EWCS.

* For prolonged sitting, the relationship to the prevalence of self-reported MSDs (in the lower limbs) is negative. For all other risk factors mentioned in the second column of this table, the relationship to the prevalence of self-reported MSDs is positive.
Source: Panteia, 2019

The fact that a specific physical risk factor does not have a significant relationship to the prevalence of self-reported MSDs does not mean that this risk factor is not important. There may be various reasons why a relationship is not supported by analyses of the EWCS data, related to how MSDs are measured:

- The EWCS measures MSDs in general rather than work-related MSDs.
- When measuring MSDs through surveys, it is customary to ask about the location of health complaints and not about the clinical nature of the complaint. This makes it difficult to separate health complaints caused by musculoskeletal overstrain and health complaints caused by other factors.
- Surveys measure self-perceptions of MSDs. Perceived prevalence rates may therefore be partly determined by respondents' awareness and attitudes (which might also explain some of the country differences in self-reported MSD prevalence). This reduces the reliability of the measure, making it more difficult to establish relationships with other variables.
- In addition, for specific risk factors (such as prolonged sitting), the reliability of survey questionnaires has also been called into question.

The fact that a specific physical risk factor has a significant relationship to the prevalence of self-reported MSDs does not mean that this relationship is important. Whether it is important or not also depends on how many workers are affected by the risk factor (its prevalence) and on the strength of the relationship to MSD prevalence. Results show that:

- In 2015, 61 % of the workers in the EU-28 were exposed to repetitive and arm movements, 58 % were exposed to working with computers, laptops, smartphones, etc., 43 % had to work in tiring and painful positions, 32 % carried or moved heavy loads, 21 % worked in low temperatures indoors or outdoors and 20 % were exposed to vibrations of hand tools, machinery, etc.

- Because of changes in the survey questionnaire, it is difficult to measure the development over time. In 2010, 69 % of workers across the EU had to stand at least a quarter of the time, which made prolonged standing the most prevalent risk factor that year, followed by repetitive hand or arm movements (64 %) and working with computers, laptops, smartphones, etc. (53 %). For 2015, no data are available on the proportion of workers standing at least a quarter of the time.
- Over the period 2010-2015, for most risk factors the prevalence slightly decreased, except for working with computers, laptops, smartphones, etc.
- Over the period 2000-2015, the proportion of workers who work with computers, laptops, smartphones, etc. for at least a quarter of their working day increased (47 % in 2000, 53 % in 2010 and 58 % in 2015).
- Previous studies have reported that prolonged computer work may increase the risk of developing MSD complaints. Analysis of the sixth wave of the EWCS, however, could not find a significant relationship between the amount of time working with computers, laptops, smartphones, etc. and the three types of MSDs that are distinguished in the data (back, upper limbs and lower limbs).

- **Exposure to physical risk factors between workers with and without MSD complaints**

Workers reporting MSD complaints are more often exposed to physical risk factors than workers not reporting MSD complaints. The difference is especially high (more than 10 percentage points) for workers working in tiring positions, carrying or moving heavy loads and repetitive hand or arm movements.

Workers with MSD complaints work less frequently in a sitting position (for at least a quarter of the time) than workers without MSD complaints.

Workers reporting MSD complaints also work less with computers (for at least a quarter of the time) than workers without MSD complaints.

- **Occupation**

Exposure to physical risk factors varies considerably between occupations. The risks from working with computers, laptops, smartphones, etc. or of sitting for at least a quarter of the time predominantly occur for clerical support workers, managers, professionals, and technicians and associate professionals.

In contrast, the risks from carrying or moving heavy loads, working at low temperatures and vibrations from hand tools, machinery, etc. are mainly found among workers in craft and related trades, elementary occupations, plant and machine operators, assemblers and skilled agricultural, forestry and fishery workers. Except for elementary occupations, these are all occupations where the (large) majority of all workers are male.

- **Gender**

The following risk factors are more frequently mentioned by male than female workers:

- carrying or moving heavy loads (for at least a quarter of the time);
- working at low temperatures (for at least a quarter of the time);
- vibrations from hand tools, machinery, etc. (for at least a quarter of the time).

The prevalence of these three risk factors is even higher among male workers without MSD complaints than among female workers with MSD complaints. This gender difference might be explained by the occupations in which male and female workers are active.

For female workers, carrying or moving heavy loads is more likely to be associated with MSD complaints in upper and lower limbs than for male workers.

The more time workers have to sit during their work, the less likely they are to report MSD complaints in the lower limbs. For female workers this effect is stronger than for male workers, but this gender effect is very small.

For the other physical risk factors examined in this study, the relationship between those risk factors and reporting MSDs does not appear to differ between male and female workers.

- **Relationship between physical factors, type of MSDs and sociodemographic characteristics of workers**

The relationship between most of the physical risk factors and the prevalence of MSDs varies with some of the sociodemographic characteristics of workers. For example, the extent to which working in tiring or painful positions is related to reporting MSDs in the back varies between age groups. Similar interactions have been identified for gender and country of birth.

Around 28 % of all the workers whose main paid job never involves tiring and painful positions report having MSDs in the back. This percentages increases to around 70-80 % for workers whose main paid job involves frequently working in tiring and painful positions. This increase is visible for all age groups.

Carrying or moving heavy loads is also strongly related to MSD prevalence. Around 34 % of all the workers whose main paid job never involves carrying or moving heavy loads report MSD complaints. This increases to approximately 63 % for workers whose main paid job frequently involves carrying or moving heavy loads. The percentages differ between MSD types, between genders and between age groups but these differences are not very large.

Repetitive hand or arm movements are related to MSD prevalence, but less strongly than the previously discussed risk factors. The prevalence of backache increase from around 33 % of all the workers whose main paid job never involves repetitive hand or arm movements, to approximately 57 % of workers whose main paid job all the time involves repetitive hand or arm movements. These percentages do not differ between gender or age category, but differ depending on the country of birth of the worker.

Being more exposed to low temperatures is, in general, related to higher prevalence of MSDs. The relationship between being exposed to this risk factor and reporting MSDs is not related to any of the different sociodemographic factors.

The more time workers are exposed to vibrations from hand tools, the more likely they are to report MSDs. This applies to all three types of MSD considered. This relationship does not depend on sociodemographic factors such as age, gender, education level and country of birth.

7.3.2 Organisational and psychosocial risk factors related to MSD prevalence

Organisational and psychosocial risk factors at workplaces have an influence on the prevalence of MSDs. Analysis based on the EWCS finds that the following risk factors are significantly related to the likelihood of workers reporting MSDs, and this impact holds for all types of MSDs (back, lower limb, upper limb):

- anxiety;
- overall fatigue;
- sleeping problems;
- low level of mental well-being;
- being subjected to verbal abuse at work.

The first three of these risk factors concern health problems of workers. These health factors should be interpreted not only as possible risk factors (in the sense that health problems such as these may increase the risk of developing MSDs), but also as possible health outcomes of MSDs (in the sense that having MSDs may cause or worsen these health problems).

A complete overview of all organisational and psychosocial risk factors that are significantly related to at least one of the three types of MSDs is presented in Table 8.

As mentioned before, the fact that a specific risk factor does not have a significant relationship to the prevalence of self-reported MSDs does not mean that this risk factor is not important. There may be various reasons why a relationship is not supported by analyses of the EWCS data, related to how MSDs are measured. This applies just as much to organisational and psychosocial risk factors as to physical risk factors.

Table 8 Associations between self-reported MSDs and organisational and psychosocial risk factors

Body area	Significant relationship identified	No significant relationship identified
Back	• Anxiety • Overall fatigue • Sleeping problems • Mental well-being • At work subjected to: - verbal abuse; - unwanted sexual attention; - bullying/harassment • Feeling energised • Knowing what is expected at work • Pace of work dependent on: - direct demands from customers, etc.; - direct control by management	• At work subjected to: - threats; - physical violence • Able to choose or change order of tasks • Job gives the feeling of work well done • Employee voice • Take a break when you wish • Fairly treated at workplace • Job requires hiding of feelings • Work-related stress • Working at very high speed
Lower limbs	• Anxiety • Overall fatigue • Sleeping problems • Mental well-being • At work subjected to - verbal abuse; - unwanted sexual attention • Feeling energised • Knowing what is expected at work • Able to choose or change order of tasks	• At work subjected to - threats; - bullying/harassment; - physical violence • Pace of work dependent on: - direct demands from customers, etc.; - direct control by management • Employee voice • Job gives the feeling of work well done • Take a break when you wish • Fairly treated at workplace • Job requires hiding of feelings • Work-related stress • Working at very high speed
Upper limbs	▪ Anxiety ▪ Overall fatigue ▪ Sleeping problems ▪ Mental well-being ▪ At work subjected to: - verbal abuse - threats - physical violence ▪ Employee voice ▪ Job gives the feeling of work well done ▪ Take a break when you wish ▪ Fairly treated at workplace ▪ Job requires hiding of feelings ▪ Work-related stress ▪ Working at very high speed	▪ At work subjected to: - bullying/harassment - unwanted sexual attention ▪ Pace of work dependent on: - direct demands from customers, etc.; - direct control by management ▪ Feeling energised ▪ Knowing what is expected at work ▪ Able to choose or change order of tasks

Note: This table is based on the results of various binary logistic regressions that have been estimated to explain the prevalence of self-reported MSD complaints in the sixth (2015) wave of the EWCS.- Source: Panteia, 2019

- **Exposure to most organisational and psychosocial risk factors**

In 2015, the following four identified risk factors applied to more than half of all workers:

- work-related stress (68 %);
- the pace of work being dependent on direct demands from customers, etc. (68 %);
- working at high speed (61 %);
- the job requiring hiding feelings (55 %).

The other 17 identified risk factors, however, apply to fewer than half of all workers. Eight of them even apply to fewer than 10 % of all workers in the EU-28: a lack of mental well-being (6 %), bullying/harassment (5 %), the job not giving the feeling of work well done (5 %), a lack of feeling energised by the job (4 %), not knowing what is expected at work (2 %), and being subjected to threats (5 %), physical violence (2 %) and unwanted sexual attention (2 %).

The following factors are associated with MSD complaints in the upper limbs: sleeping problems, being subjected to verbal abuse at work, threats and physical violence, lack of mental well-being, lack of voice, not having the feeling of work well done, not taking a break whenever wanted, being unfairly treated at the workplace, needing to hide one's feelings and experiencing stress.

MSD complaints in the lower limbs are associated with inability to choose or change order of tasks, sleeping problems, being subjected to verbal abuse and unwanted sexual attention at work, lack of mental well-being, not feeling energised, not enough time to do the job and not knowing what is expected at work.

During the period 2005-2015 the prevalence of the following organisational/psychosocial risk factors decreased: not being able to choose or change the order of the tasks and not being able to take a break when you wish.

In the same period, the following risks remained stable: the pace of work being dependent on direct demands from customers, etc., working at high speed, pace of work being dependent on the direct control of the boss, job not giving the feeling of work well done and lack of employee voice.

Three of the risk factors show an increase in prevalence: needing to hide one's feelings, overall anxiety and bullying/harassment. These factors are significantly related to reporting MSDs (the first, however, is related to MSDs in only the upper limbs and the last one to MSDs in only the back area).

- **Occupations**

The prevalence of the identified organisational and psychosocial risk factors varies between occupations. For some risk factors (such as sleeping problems, overall fatigue and feelings of anxiety) the differences between occupations appear to be modest, but some risk factors show remarkable differences.

For most occupations, 8 % to 18 % of the workers indicate they cannot take a break when they wish. The highest score is found for plant and machine operators and assemblers, 30 % of whom indicate they cannot take a break when they wish. Workers with these occupations are also often not able to change the order of their tasks.

Likewise, service and sales workers are most likely to report that their pace of work is dependent on direct demands from customers, etc. (82 % in 2015). For skilled agricultural, forestry and fishery workers this is only 34 %.

- **Exposure to organisational and psychosocial risk factors, workers with MSDs compared with workers without MSDs**

Lack of control over the pace of work is mentioned more often by workers with MSD complaints than by workers without MSD complaints, but the differences are small.

The prevalence of overall fatigue is higher than the prevalence of anxiety. This applies to workers both with and without MSD complaints.

Working at very high speed is more common among workers with MSD complaints than among workers without MSD complaints.

Various types of physical and non-physical violence (such as harassment, threats and verbal abuse) are found to be related to MSD prevalence. The prevalence of these risk factors is, however, small. Even though some of these risk factors are more prevalent among workers with MSD complaints than among workers without MSD problems (in particular, verbal abuse, threats, and bullying or harassment), the prevalence of these risk factors is also low among workers with MSDs.

- **Gender**

Irrespective of the number of MSD complaints, female workers are more likely to report overall fatigue and anxiety than male workers. Women also report various kinds of sleeping problems more frequently than men.

Male workers with MSD complaints report more often than female workers that their pace of work depends on direct demands from customers, etc., but the difference from female workers is only small. Direct control by their boss is mentioned less frequently by male workers.

- **Age**

The prevalence of MSDs is higher among older workers, even if various organisational factors are controlled for.

The ability to choose the order of tasks has a different relationship to MSD complaints in the lower limbs for younger workers than for older workers. Among younger workers this ability is associated with a higher likelihood of reporting MSDs in the lower limbs, whereas among older workers it is associated with a lower likelihood of reporting MSDs in the lower limbs.

Around 40 % of workers aged 55 or more who never report work-related stress report MSDs in the upper limbs. This increases to more than 60 % for workers aged 55 or more who report work-related stress all of the time. The same positive relationship between work-related stress and prevalence of MSDs in the upper limbs applies to the other age groups, although the pattern is slightly erratic for the youngest age group.

For MSDs in the back area, the relationship between overall fatigue and MSD complaints is different for different age groups: among workers aged 55 or more who report overall fatigue, more than 70 % also report MSDs in the back; by comparison, among workers aged less than 25 who report overall fatigue, 60 % do. A similar age difference applies to anxiety, although the difference between age groups is less great.

Similar differences between age groups are also present regarding overall fatigue and MSD complaints in the lower limbs and regarding anxiety and MSD complaints in the upper limbs.

- **Country of birth**

Sleeping problems are associated with MSD prevalence. There are indications that the strength of this relationship is different for first-generation immigrants from that for native workers. This relationship seems, however, less strong for second-generation immigrants than for native workers and first-generation immigrants.

Second-generation immigrants are more likely to report MSD disorders in the upper limbs, lower limbs and back because they have to deal with worse working conditions. Once physical, organisational and psychosocial risk factors are controlled for, the variable ‘country of birth’ is no longer significant.

- **Education level**

The relationship between overall fatigue and MSD complaints varies by education level. For example, among workers with pre-primary, primary or lower secondary education level who report overall fatigue, 70-80 % also report MSDs in the upper limbs. By comparison, this is less than 60 % among workers with tertiary education levels.

Among workers with pre-primary education level who report that they never wake up with a feeling of exhaustion and fatigue, 20 % also report MSDs in the lower limbs. By comparison, this is closer to 100 % among workers with pre-primary education who always wake up with a feeling of exhaustion and fatigue.

7.3.3 Workers' opinions on the relationship between work and health

In addition to using statistical analyses to examine the relationships between these risk factors and MSD-related health complaints, it is also possible to examine workers' opinions regarding the relationship between their work and their health condition.

Compared with workers without any health problems, workers reporting MSD complaints are less positive about the relationship between their work and their health. While MSDs in lower limbs occur less often than MSDs in upper limbs and in the back, workers with MSDs in lower limbs are even less positive about this relationship than workers with other types of MSDs.

Relatively more men than women indicate that their work affects their health (39 % and 35 %, respectively). This applies to workers with MSDs as well as to workers without any health problems. This might be related to the fact that male workers are more exposed to several physical risk factors that have a strong relationship to MSD complaints, in particular carrying or moving heavy loads (for at least a quarter of the time), working at low temperatures (for at least a quarter of the time) and being subject to vibrations from hand tools, machinery, etc. (for at least a quarter of the time).

The percentage of workers who believe that their health or safety is at risk because of their work is highest among typical blue-collar occupations, such as plant and machine operators and assemblers (35 %), craft and related trades workers (35 %) and skilled agricultural, forestry and fishery workers (31 %). The high percentages for blue-collar workers are consistent with the high proportion of MSD complaints for these occupations.

7.4 Preventive measures

A part of the organisation of work is what kind of measures enterprises take to prevent their workers from developing MSDs, such as workplace risk assessments and interventions. As described in Chapter 6, these preventive measures can either lower the presence of certain risk factors (for example by reducing the levels of stress at work) or lower the impact of certain risk factors on the health of employees (for example by providing training courses on how to deal with stress at work).

Employees who work in the public administration and social activities sectors benefit more from these preventive measures than employees employed in other sectors.

The majority of employees who benefit from prevention measures are working in large establishments, with 250 or more employees. The availability of preventive measures increases by enterprise size.

- **Type of preventive measures**

A large majority of employees in the EU-28 work in establishments where equipment to help with lifting or moving is provided. Provision of ergonomic equipment and encouraging regular breaks for people in uncomfortable working positions are the next most important measures. The least promoted measure across sectors is the rotation of tasks to reduce repetitive movements. This sequence holds for employees who work in establishments of different sizes.

Most employees work in establishments that provide training on how to lift and move heavy loads and on how to properly use and adjust their employees' equipment. A significantly lower proportion of employees work in establishments where training on how to prevent psychosocial risks is provided.

Other preventive measures in place are rotation of tasks to reduce repetitive movements, encouraging regular breaks for people in uncomfortable working positions, provision of ergonomic equipment and provision of equipment to help lifting or moving.

Almost a quarter of all EU employees work in establishments that lack information about or adequate preventive tools for dealing with time pressure. The availability of this type of information increases with the enterprise size.

- **Effect of prevention measures**

Workers in countries and sectors where more preventive measures are in place are less likely to report MSD complaints. The percentage of workers reporting backaches drops from 51 % (for workers in countries and sectors where on average between one and three preventive measures are in place) to 31 % (for workers in countries and sectors where on average between five and six preventive measures are in place). The prevalence of MSDs in the lower limbs shows a comparable development, from 35 % (for workers in countries and sectors where on average between one and three preventive measures are in place) to 20 % (for workers in countries and sectors where on average between five and six preventive measures are in place).

8 Main conclusions and policy points

Chapter 7 on the main results presents the key findings of this study in a comprehensive way. The purpose of this chapter is to provide a short summary of the main findings and subsequently a series of possible points of policy actions in research and prevention. The analysis and conclusions presented here also include pointers for future policy on this topic.

8.1 High prevalence of MSDs

MSDs are the most prevalent work-related health problem at the EU level. Millions of European workers are affected by MSDs through their work. MSDs are a major occupational health issue and for this reason MSD risk prevention has been described as a priority in recent European and national OSH strategies. The process of developing MSDs is also related to — among other things — matters such as age, gender, type of sector, type of occupation, level of education and country of birth. In this way, MSDs are associated with the more general issue of health inequalities.

According to the findings of the 2013 LFS ad hoc module, MSDs continue to be the most prevalent type of work-related health problem. Among respondents in the EU who declared they had a work-related health problem, 60 % pointed to MSDs as their most serious issue. The second most mentioned health problems (mentioned by 16 %) are stress, depression and anxiety. In all EU Member States for which data are available, a large majority of all respondents report MSD-related complaints, as well as stress, depression and anxiety, as their most serious health problems.

According to the EWCS, the proportion of workers suffering from MSDs in the back or back area, upper limbs (shoulders, neck, arms, hands) and/or lower limbs (hips, legs, knees, feet) is substantial. In 2015, roughly three out of every five workers in the EU-28 reported MSD complaints. The most common types of MSD reported by workers are backache and muscular pains in the upper limbs (43 % and 41 %, respectively). Muscular pains in the lower limbs were reported less often (29 %).

EHIS shows that in 2014 one in five people in the EU-28 had suffered from a chronic back and/or neck disorder in the past year.

Over the period 2010 to 2015, the proportion of workers in the EU-28 reporting MSD complaints showed a slight decrease. These figures indicate that, although many actions have been taken, policies at the governmental and business levels targeting workers with MSD complaints and the prevention of such complaints are still necessary and relevant[184].

The proportions of workers reporting MSD complaints at the Member State level differ substantially between countries. Additional analyses show that differences in the age distribution of the national workforce and in the sectoral or occupation structure of economies do not explain these national differences. National differences in the number of preventive measures implemented by enterprises cannot explain these country differences either. Looking more closely at types of MSDs, the proportions of people suffering from chronic MSDs (chronic back defects and chronic neck defects) in the EU-28 vary significantly as well. The differences between Member States in rates of MSDs among workers must also be explained in terms of different social, political, and economic environments. Policies and strategies to prevent MSDs must be tailored and adapted to the specific national circumstances of a country.

The prevalence of self-reported MSDs shows significant differences between occupations. For example, in 2015 approximately 69 % of skilled agricultural, forestry and fishery workers reported having one or several MSDs, whereas for professionals this was the case for 52 % of workers. Differentiating between the main types of MSDs, the top three types of occupations reporting both lower and upper limb MSDs were skilled agricultural, forestry and fishery workers, elementary occupations, and workers in crafts

[184] Why prevalence of work-related MSDs remains high despite EU wide policies, prevention and risk reduction is the topic of a separate study (EU-OSHA — European Agency for Safety and Health at Work, *Exploratory literature review on MSDs* (working title)' (forthcoming), to be available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

and related trades. Looking at backache specifically, this type of MSD is most prevalent among skilled agricultural, forestry and fishery workers, and plant and machine operators and assemblers. These occupational differences can be explained by the various risk factors these workers are exposed to: OSH policies should take this into consideration when designing more targeted strategies to prevent MSDs.

The prevalence of self-reported MSDs shows significant differences across sectors. MSDs in the back, upper limbs and lower limbs are most often mentioned by workers employed in the construction, water supply, and agriculture, forestry and fishing sectors. MSD prevalence is also above average among workers in human health and social work activities. The sectors where MSDs are reported least often are financial and insurance activities, professional, scientific and technical activities, education, and arts, entertainment and recreation.

Given the differences among sectors in prevalence, type of MSDs and severity of MSDs, it appears logical to design sector-specific approaches for addressing MSDs. Such approaches would include the introduction of specific sectoral standards, risk assessment tools and sector-specific MSD risk catalogues[185] (compiling preventive and protective measures adapted to the specific MSD risks of the sector).

- **MSDs and gender**

Recent EWCS data indicate that the percentage of female workers in the EU-28 reporting MSD complaints in upper limbs, lower limbs or back is higher than the percentage of male workers reporting such complaints. The MSD prevalence rate is already higher for women than for men at a young age, namely at 25 years of age or under. The difference reduces as individuals get older, but increases again after the age of 55. This gender difference is also present within sectors and within occupations; additional analyses show that the likelihood of women reporting MSDs remains higher than for men, even when the analysis includes differences by sector, occupation, country of birth and the extent to which they are faced with physical, organisational and psychosocial risk factors (this applies to upper limb, lower limb and back problems).

Given these results, the overall picture suggests that, for MSDs in general, prevalence rates are higher for female workers than for male workers. It cannot be ruled out, however, that, for other, more specific types of MSDs or for work-related MSDs, an opposite gender gap (or no gender gap) exists.

The gender differences identified in this report (and in previous EU publications) justify a more specific study to further analyse these differences when it comes to MSD exposure and prevention, considering the horizontal and vertical segregation within the workplace and the dual role of women as workers with caring responsibilities outside work[186].

- **MSDs and ageing**

Greater age is associated with a significantly higher probability of reporting MSDs (in the upper limbs, lower limbs and back). This applies to all MSDs, including chronic MSDs, and applies to all sectors and occupations. The likelihood of reporting MSDs increases significantly with age, even when the results are controlled for sector, occupation and country of birth as well as for differences in exposure to physical, organisational and psychosocial risk factors.

Preventing exposure to risk factors that contribute to work-related MSDs is important for the sustainability of work, especially in the context of the ageing workforce and the policy goal of increasing employment rates among older age groups, in line with the Europe 2020 strategy. It is important to

[185] In a health and safety catalogue, employers and employees — on their own initiative — describe how they will meet target government requirements for healthy and safe workplaces. The catalogue should describe techniques and methods, good practices, standards and practical manuals for a safe and healthy work environment. More information about these catalogues is available at: https://www.arboportaal.nl/

[186] EU-OSHA — European Agency for Safety and Health at Work, 'Workforce diversity and MSDs: review of facts, figures and case examples (working title)', forthcoming. To be available at: https://osha.europa.eu/en/themes/musculoskeletal-disorders/eu-osha-research-activity-work-related-musculoskeletal-disorders

underline that ageing is not inevitably accompanied by illness and disease. It is not age in itself, but rather the workers' physical capability, that should be used to determine their capacity for performing a specific job. It is possible that a younger worker could have experienced more years of exposure to certain MSD risk factors during work than an older worker, meaning that age in itself is not necessarily decisive in causing MSDs. OSH strategies should therefore pay particular attention to the cumulative exposure of workers to physical and psychological hazards, as this affects the sustainable employability of all workers.

- **MSDs and level of education**

There is also a clear relationship between MSD prevalence and the education level of workers: workers with only pre-primary or primary education (less qualified workers) are more likely to report muscular pains in the upper limbs, lower limbs and/or back, and are also more likely to report chronic MSDs. OSH strategies should take this into consideration when designing more targeted strategies to prevent MSDs.

The differentiation of the prevalence of MSDs by gender, age and level of education underlines that there is a need for group or diversity-sensitive approaches to better prevent and manage MSDs. Prevention of MSDs should ideally follow an inclusive and differentiated approach that adapts to an increasingly diverse working population. Such an encompassing approach will most likely include actions to increase awareness of the need for these approaches to tackle MSDs, and to develop specific guidance and practical tools that address this issue in order to support and guide employers and workers at the workplace. The development of policies and schemes supporting such initiatives is highly recommended.

- **Recognised MSDs occupational diseases vary considerably between Member States**

MSDs are the most common ODs in some Member States and workers in all sectors and occupations are affected by them. In a generic way, following the cause and effect model, the process leading to MSD-related occupational diseases always include some form of strain on musculoskeletal structures (physical factors). This is influenced by organisational and psychosocial factors, and is related to sociodemographic and individual factors. When an MSD is acquired and not cured, it persists, and when an MSD persists it may eventually lead to an OD. Following this process, an MSD leading to an OD can potentially mean the proverbial end of the line for the worker in his or her job. For the worker with an OD, this means pain, loss of income and loss of (a part of) his or her working life. For the employer, this results in the loss of a skilled worker, substantial administrative work, the need to replace a (skilled) worker and high costs. When we look at DALYs due to MSDs, including the YLD, we see that ODs need to be avoided. This is why it is important to have data on ODs, because, while it is important to prevent MSDs, it is even more important to prevent MSDs that may lead to ODs.

Unfortunately, there are no recently updated data available for the EODS, so no EU overview is available for this topic. However, information collected at the national level shows that:

- MSDs are the most commonly recognised occupational diseases in some countries in Europe (France, Spain and Italy);
- recognised diseases and recognition practices vary considerably between Member States;
- there is a higher proportion of women than men and a higher proportion of older workers than younger ones among the total cases of recognised MSD-related occupational diseases (based on the data gathered at Member State level and despite differences between countries);
- the pattern and distribution of occupational diseases currently recognised and compensated is far from reflecting the actual health impairment of workers through MSDs caused by their work.

Because of institutional differences between the national compensation and reporting systems used to register (the cause of) occupational diseases, these data are also not comparable between countries. Country differences are less likely to reflect country differences in the prevalence of occupational diseases themselves than to be related to:

- the reporting systems (list of recognised diseases, etc.);
- the consequences of reporting;
- the institutional context;

- claimants' knowledge of these issues (the chances of the disease being recognised as work-related, the benefits and compensation of recognition, changes in legislation, etc.).

- **Accidents at work linked to MSDs**

Among the different types of accidents that are distinguished in ESAW, the following types may be considered the most likely to lead to MSD complaints: dislocations, sprains and strains and bone fractures, and traumatic amputations (loss of body parts). In 2016, these types of accidents accounted for 39 % of all fatal and non-fatal serious accidents at work. In particular, dislocations, sprains and strains are the most common work-related injuries in the EU-28 after wounds and superficial injuries, which accounts for 27 % of all fatal and non-fatal work-related injuries. Bone fractures are lower, at 11 %, while traumatic amputations account for less than 1 % of the total.

In some countries, data on accidents also address acute episodes of musculoskeletal problems. This information is important because data then show that in these countries MSDs are the most common type of work accident.

National data from Sweden show that MSDs are the most common work-related source of work accidents for men (40 % of reported work accidents correspond to MSDs). Meanwhile, for women, psychosocial factors are considered the most important cause of accidents (42 %), followed by work-related MSDs accidents (28 %). For Spain, national data show the important role that MSD-related work accidents play in relation to the total of work accidents. In particular, in 2017 in Spain there were a total of 515,082 work accidents resulting in sick leave. Around 38 % of these accidents (or 192,029 in absolute terms) were caused by musculoskeletal overload, well above the prevalence for other causes. Musculoskeletal overload was systematically the main cause of work accidents during the period 2014-2017. An opposite causal relationship may also exist: MSD complaints may increase the risk of having a (work) accident. It is considered important to know what proportion of work accidents may be expected to result in MSD complaints: a high proportion of MSDs resulting from work accidents suggests that reducing accidents at work may have not only an important direct effect (fewer accidents) but also an important indirect effect, namely fewer work-related MSD complaints.

Concerning the relationships between accidents and MSDs and vice versa, there is a tendency to address safety at work and MSDs in separate programmes, and not usually in a combined programme. National data shows that there is a strong relationship between accidents (workplace safety) and MSDs (ergonomics, workstation design, work involving physical workload, etc.). A recommendation is to invest in understanding how this relationship works and to consequently work on combined programmes focusing on preventive measures for both accidents and MSDs.

8.2 Exposure to risk factors

Causes of work-related MSDs are multifactorial. There are numerous work-related risk factors for the various types of MSDs. The main risk factors include physical factors, organisational factors, psychosocial factors, sociodemographic factors and individual factors. These factors contribute to the genesis of MSDs. This report contributes to improving the understanding and knowledge of MSDs and their multifactorial dimensions. It does so by analysing in more detail the physical risk factors as well as the organisational, psychosocial and sociodemographic factors, by focusing on the ways in which they influence MSDs.

Because MSDs affect (combinations of) musculoskeletal structures such as tendons, nerves, muscles, joints and/or spinal discs, it should be clear how the preventive measures taken can protect these musculoskeletal structures. This is not possible per individual structure, but it is possible in a more generic manner: preventive measures cannot protect one specific ligament or one specific muscle, but they can protect a functional unit. For example: kneeling affects the knee joint, the patella, the knee collateral ligaments, the internal cross ligaments and the quadriceps muscle. By using soft knee padding less stress is put on all these structures.

Since no MSD diagnosis is possible without such a physical component (as MSDs usually involve parts of the musculoskeletal system), there is also no effective preventive measure if it does not contribute to

protecting these same structures. This is why the physical factors component in the cause and effect model needs to be highlighted. This model implies that in any cluster approach the physical risk factors need to be at the heart of the analysis. At the same time there are other factors that influence the trajectory of how a person develops MSDs, and these have also been incorporated in the cause and effect model (see Figure 11).

Preventive measures could — and should — be primarily directed at one of more of the three main categories of specific MSDs (in the back, upper limbs and lower limbs). These measures should therefore protect the upper limbs, lower limbs and/or back, depending on the type of MSD risk that occurs (which can vary across specific types of work and sectors). However, besides this, preventive measures should also be directed towards organisational, psychosocial and sociodemographic factors such as age and gender, and other factors that are known to contribute to the process of developing an MSD. Furthermore, how preventive measures may work on so-called non-specific MSDs should also be taken into account. Non-specific MSDs essentially consist of muscle tension and localised or multiple pain syndromes.

- **Exposure to several MSD risk factors at the same time**

The analyses carried out show that workers are usually exposed to a combination of MSD risk factors. For instance, a cluster analysis on physical risk factors performed in this study shows that certain combinations of risk factors occur more often than others. These kinds of findings could have important consequences in terms of prevention and recognition of MSDs as occupational diseases. Future studies should further examine these specific combinations of risk factors (and also health problems) related to MSDs. For instance, an area of further research could be to what extent these different risk factors (or health problems) reinforce each other, and how this reinforcing effect could be inhibited.

- **MSDs and health problems such as stress, anxiety, depression and psychosocial risk factors in general**

According to quantitative analyses based on the EWCS data, the prevalence of MSDs is associated with higher levels of anxiety, sleeping problems and overall fatigue of workers. MSD prevalence is also related to the mental well-being of workers (indeed MSDs are more prevalent among workers with lower levels of mental well-being). These relationships apply to MSDs in the upper limbs, lower limbs and back.

Anxiety, overall fatigue, sleeping problems and (lack of) mental well-being in particular are considered health problems. However, this certainly does not mean that they should not also be considered psychosocial risk factors influencing MSD development at the same time. On the contrary, these factors are significant in (a) developing MSD complaints, (b) worsening already existing MSD complaints and/or (c) slowing down recovery from MSDs.

The causality of these relationships needs more clarification. On the one hand, anxiety, overall fatigue, sleeping problems and lack of mental well-being can be considered health problems, and workers can suffer from these health problems alongside MSD problems. In some cases, MSDs may even cause these health problems, or make them worse. The causality could, however, also work in reverse: high levels of anxiety, overall fatigue and sleeping problems may cause MSD complaints or worsen already existing MSD complaints. In this respect, psychosocial factors are considered potential risk factors.

The study carried out has not formulated and rigorously tested a hypothesis on the relationship between psychosocial risk factors and the prevalence of self-reported MSDs. Nevertheless, the associations between several of these risk factors and the three main types of MSDs were examined. According to analyses of the EWCS data, the following psychological risk factors were found to be significantly related to at least one of the three MSD types considered in our report: being subject to verbal abuse at work, unwanted sexual attention, bullying and harassment, lack of employee voice, the job not giving the feeling of work well done, unfair treatment at the workplace, the need to hide feelings at work, anxiety and work-related stress.

- **MSDs and physical risk factors**

Previous studies have found reasonable evidence for an association between different types of MSDs and the following physical risk factors:

- posture;
- working in awkward positions;
- heavy physical work;
- lifting;
- repetitive work;
- prolonged computer work.

Consistent with these findings, analyses on EWCS data show that prevalence of MSDs is associated with working in tiring or painful positions, carrying or moving heavy loads and repetitive hand or arm movements. This applies to all three types of MSDs that are distinguished in the EWCS (back, upper limbs and lower limbs). In addition, being exposed to vibrations from hand tools also increases the likelihood of reporting any of these three types of MSDs. Being exposed to low temperatures is associated with a higher prevalence of MSDs in the upper limbs and lower limbs. The results of the analyses on the sixth wave of the EWCS are summarised in Table 5.

- **MSDs and psychosocial risk factors**

The exploratory analyses carried out in the framework of this report should be followed by further analyses in order to better explore the nature of these interrelationships between MSDs and psychosocial factors. Epidemiological studies along with recent theoretical biopsychosocial models of MSDs, in which the interrelationships between psychosocial factors at work and MSDs are addressed, should help guide the process.

An effort in terms of research and communication is suggested to provide evidence and to explain in a more accessible manner the several possible processes through which psychosocial factors could lead to MSDs (and vice versa). One process usually mentioned in the literature on this topic is that of stress: work-related psychosocial factors can increase workers' stress levels, which, in turn, will evoke physiological responses such as increased muscular tension and sensitivity to feeling pain, or undermine mechanisms used to cope with pain.

These results and the existing research evidence regarding the interrelation between MSDs and psychosocial factors have many implications in terms of prevention. Very often, when psychosocial risks are assessed at the workplace level, this is done in isolation, focusing purely on the mental health consequences of 'stress' without considering their impact on other risks or other health problems, such as musculoskeletal pain. As workers are exposed to several MSD risk factors at the same time, one dimensional risk-outcome approaches (based on the relation between a single risk factor and a single outcome measure), should be avoided as part of the risk assessment process, opting instead for more holistic approaches. The challenge is to transfer the existing knowledge into workplaces in order to bridge the silos of MSD risk assessment and psychosocial risk assessment. Guidance and risk management tools that integrate these dimensions should be put at the disposal of employers and workers at the workplace.

An important message is that preventing exposure to psychosocial risks also has a preventive effect on MSDs at the same time (and the other way round). As they are related, a preventive measure put in place aimed at one type of risk can also help to prevent another. For example, giving workers more control over their work (the chance to take breaks when needed or the opportunity to switch between different tasks during the working day) can prevent or reduce stress. However, it can also help workers to adopt good working postures, work at an optimal pace and recover from heavy tasks, and, in doing so, it can also prevent or help manage MSDs.

The psychosocial factors and mental health problems mentioned above (stress, anxiety, sleeping problems, lack of mental well-being) may play a role in the onset of MSDs. However, where they play an especially important role (according to research evidence) is in the process of the chronicity of MSDs, from acute (reversible problems) to chronic. This means that psychosocial risk factors have to be taken into account when assessing and preventing MSD risks (primary prevention), but above all when the first symptoms of musculoskeletal pain appear. Secondary and tertiary prevention (early intervention, rehabilitation, return to work) have to be considered and must also manage these psychosocial factors and not only focus on the physical or physiological dimension of MSDs. OSH professionals and major

players at the workplace level need to be aware of the importance of psychosocial risks in order to better prevent MSDs' chronicity and long-term disability.

- **MSDs and work organisational risk factors**

The statistical analysis carried out has also not formulated and rigorously tested a hypothesis on the relationship between organisational risk factors and the prevalence of self-reported MSDs. Nevertheless, the associations between several of these risk factors and the three different types of MSDs (upper limb, lower limb, back) have been examined. According to quantitative analyses of the EWCS data, the following organisational risk factors were significantly related to at least one of the MSD types distinguished: not enough time to get the job done, not knowing what is expected at work, pace of work dependent on direct demand from customers or direct control by management, not being able to choose or change order of tasks and not being able to take a break when you wish. The exploratory analyses should be followed by further analyses in order to better explore the nature of the interrelationships between MSDs and these organisational risk factors in statistical terms.

By improving the work environment, the way work is organised and the social climate, enterprises also contribute to MSD prevention. It is important to increase awareness at the workplace level about this interrelationship and to encourage those in the field to consider the prevention of MSDs when introducing changes in the work organisation.

- **New and emerging MSD risks related to sedentary work (computer work, sitting)**

The impact of new ways of working — for example the increase in digitalisation and computer work — along with social trends such as the increase in a sedentary lifestyle and the increase in screen use should be taken into account when assessing the prevalence of MSDs among the working population.

Analyses of EWCS data show that prevalence of MSDs is associated with working in tiring or painful positions, and repetitive hand or arm movements, which occur during computer work. The analyses, however, offer no support for a relationship between MSD complaints and the amount of time that workers spend on computers, laptops, smartphones, etc. These same analyses have not shown a significant relationship between MSDs in general and sitting either. In the case of lower limb disorders, the results show that, the more workers sit, the less likely they are to report MSD complaints in the lower limbs. These results do not support some other research evidence and epidemiological studies mentioned in the report showing that seated computer work (in particular) and other sedentary behaviour (in general) lead to MSDs.

The association between sitting and computer work and MSDs remains unclear because of poor and diverse methods for assessing sedentary behaviour. Existing studies have already pinpointed the limitations of the self-reported sitting time measured by questionnaires showing the limitations (because they are imprecise) of the surveys carried out with questionnaires in studies of occupational sedentary behaviour. Further analyses in order to improve the exploration of the nature of the interrelationships between MSDs and computer work and sitting are needed (some work in this area will be carried out by EU-OSHA). Having said this — regardless of the specific nature of the relationship between MSDs and sitting and computer work — sedentary behaviour at work can be hazardous to health (cardiovascular pathologies, cancer, diabetes, etc.) and this occupational risk needs to be prevented, especially in a context in which sitting at the workplace is increasing (the tendency shown in the statistics is self-explanatory).

8.3 Economic impact and social costs of MSDs

MSDs are a cause of concern not only because of the health effects for individual workers, but also because of the economic impacts on enterprises and the social costs to European countries. The true extent of costs and burdens of MSDs is difficult to assess and compare at EU level.

Workers with MSD-related problems are likely to report that their daily activities are restricted by their health problems. Apart from musculoskeletal pain, suffering from MSDs is associated with other health problems such as anxiety, sleeping problems and overall fatigue, and with lower levels of mental well-

being. In the long term, workers with MSDs might not be able to continue to do their job or a similar one because of these disorders.

Although comparable data at EU level on the costs and burdens of MSDs are not available, the EU data available at the EU level, measured in DALYs, reflect the effect of diseases on the general population in terms of quality of life and death. Even though DALYs do not indicate economic values directly, the impact on productivity can be linked to economic loss. Musculoskeletal disorders add up to a total of 15 % of these losses. Furthermore, at the national level some studies are available that show the impact of MSDs in economic terms (loss of productivity and higher social expenses). In Germany, for example, musculoskeletal and connective tissue disorders accounted for EUR 17.2 billion in loss of production (production loss costs based on labour costs) in 2016, and EUR 30.4 billion in loss of gross value added (loss of labour productivity). This represents 0.5 % and 1.0 % of Germany's GDP, respectively.

- **Absenteeism and presenteeism**

Absences from work due to MSDs accounts for a high proportion of working days lost in EU Member States. In 2015, more than half (53 %) of the workers with MSDs (including those with other health problems) reported being absent from work during the past year, which is considerably higher than the proportion of workers without health problems (32 %). Workers with MSDs are not only more likely to be absent from work, but (given absence) on average are also absent for a longer period of time. For example, 26 % of workers with chronic MSDs and other health problems report being absent for more than eight days during the past year, which is considerably higher than the 7 % for workers with no health problems.

Around 13 % of workers with MSDs and other health problems reported that they had worked 1 to 3 days in the past 12 months while they were sick (presenteeism). This percentage is slightly higher than for workers with no health problems (8 %). The percentage of workers with MSDs and other health problems who worked 4 to 20 days while sick is much higher than for workers with no health problems (29 %, respectively 9 %). This means that workers with MSDs and other health problems work while sick much more often than workers with no health problems.

The high prevalence of MSDs causing absenteeism stresses the importance of actions aimed at prevention. However, if sickness occurs, measures focusing on rehabilitation and return to work are also important in avoiding or minimising sickness absence leading to disability and/or ODs.

Occupational safety and health has an important role in supporting workers with chronic MSD conditions to continue in work and ensure that work does not make those painful conditions worse. A driver for developing rehabilitation and return to work systems common to EU Member States is the cost of sickness absence and of disability benefit schemes, as these are a major burden on social security systems.

Another important dimension to stress is the importance of early intervention, rapid referral, early mobilisation, recommendations for physical activity and support for returning to work. Early intervention to minimise disability and restore health can lead to tangible savings in health and social welfare, and reduced absenteeism. A large percentage of MSDs are short-term (or acute), so workers could recover by taking simple measures as soon as the first symptoms appear. The sooner an MSD is managed, the less likely it is that there will be long-term work loss.

8.4 MSDs: a preventive approach

The data and evidence provided in this report confirm that MSDs are multifactorial. A preventive approach to MSDs will therefore have to address the exposure to physical, psychosocial and organisational risk factors, while at the same time considering sociodemographic factors such as age and gender. ESENER provides some insight into the prevention of work-related MSDs:

- The majority of employees who benefit from prevention measures work in large establishments, with 250 or more employees. The availability of preventive measures increases by enterprise size, which means that micro and small enterprises need further policy attention.

- Investing in prevention measures is especially rewarding, since they prove to be effective. Workers in countries and sectors where more preventive measures are in place are less likely to report MSD complaints. The percentage of workers reporting backaches drops from 51 % (for workers in countries and sectors where on average between one and three preventive measures are in place) to 31 % (for workers in countries and sectors where on average between five and six preventive measures are in place). The prevalence of MSDs in lower limbs shows a comparable development.
- There are considerable differences between EU-28 Member States regarding the proportion of establishments that have policies to support employees to return to work after a long-term sickness absence. Large percentages of employees in the United Kingdom (97 %), Sweden (95%), Finland (93%) and the Netherlands (92 %) work in enterprises where support is provided to employees to help them to return to work after a long-term sickness. In Lithuania (19 %) and Estonia (27 %), the percentages are significantly lower than the EU-28 average (73 %). These percentages most likely also give an indication of the changes that workers with MSDs benefit from return-to-work measures in their country.

As has been mentioned previously, MSDs can be caused by physical, work organisation, psychosocial and individual factors, and most of the time these factors interact with each other. Because of these multiple causes, the best way to tackle MSDs is through a combined approach. An integrated approach to prevention seems the most promising strategy. This strategy must start by identifying the MSD risk factors. Policy-makers should focus on providing risk assessment tools and guides, which can be quite simple, consisting of items that connect risk factors established in this report. These tools and guides should target micro and small enterprises more specifically.

Research has shown that interventions based on single measures appear to be unlikely to prevent MSDs. Actions addressing one risk factor in isolation will probably be less effective than a combination of actions targeting several factors. These kinds of interventions are often described as holistic or integrated. A successful and integrated approach can be especially fruitful when set up as a participatory approach including the workers themselves.

The promotion and dissemination of these new (more integrated) approaches requires actions in terms of increased awareness and in terms of knowledge transfer regarding MSDs (their causes, their impact and preventive measures). The Healthy Workplaces Campaign 2020-22 on the theme of the 'Prevention of work-related musculoskeletal disorders (MSDs)' (HWC 2020-22) or any equivalent initiative should be an opportunity for this.

The results from the analyses carried out for this report show that workers in countries and sectors where more preventive measures are in place are less likely to report MSD complaints. Although this analysis can identify only a relationship (and not a causality), it does suggest that preventive measures may indeed reduce the risk of developing MSDs. In other words, it proves that MSDs can be prevented.

More evidence on what works (and does not work) in terms of MSD prevention should be gathered. Given this, more research in this field, including further evaluation of MSD interventions and tools available to assess MSD risks, is required.

An effective preventive approach to MSDs will also include accident prevention.

MSD prevention cannot take place exclusively at workplace level. An approach to MSDs including social (regulatory dimensions, health policies) and economic (market conditions, organisation of the economic sector, etc.) factors also plays a key role. The variations in prevalence of MSDs between countries can be explained only by these different environments.

Primary prevention — enshrined in the Framework Directive management system — should guide the efforts to prevent MSDs, based on the principles of the hierarchy of prevention, the participation of workers, etc. It should also focus on the promotion of good musculoskeletal health. Taking into account that millions of workers already suffer from MSDs, primary prevention should go hand in hand with secondary and tertiary prevention.

8.5 The need to get a more complete data picture on MSDs

The information and consequently the analysis in this report shows that existing data on MSDs are mostly based on various surveys (based on questionnaires) and that these surveys (like any other research instrument) have their own limitations. In interpreting the data, it is important to take into account that the respondents to the two surveys most often used in this study (EWCS and EHIS) are workers. This means that it measures the perception and the interpretation of the worker regarding what MSD complaints are and how they are caused. Important additional information to get a better and more comprehensive picture could be derived from information provided from the following sources:

- Occupational physicians can provide a valid expert-based diagnosis, and workplace assessment experts can deliver expert-based information on the cause and effect relationship between the working environment, workstations and MSDs.
- Another important source of information is administrative data on occupational accidents and diseases. More cumulative figures, such as the number of all (workers with) recognised and compensated MSDs at a certain moment in time, would probably help to provide more detailed information.
- Targeted epidemiological studies (focusing on sectors, specific categories of workers, etc.) could help in the process of improving knowledge of the risk factors leading to MSDs and health outcomes, as well as knowledge of the kind of intervention that is needed to prevent MSDs and helps workers suffering from MSDs to stay at work or to return to work.

These different sources of information would help not only in providing a more complete picture of MSDs and a better understanding of these disorders, but also in guiding organisations regarding the best possible preventive measures, where and when to apply them and how to evaluate them. Any initiative to make it possible to gather and disseminate more of these types of information is welcome.

8.6 MSDs are in need of targeted interventions

Besides the fact that workers regularly report more than one type of MSD, one should consider that the cause and effect model for each generic type of MSD probably works in a different way. Upper limb MSDs, lower limb MSDs and back MSDs are three kinds of MSDs that add up to a total percentage of MSD prevalence. However, the way they arise, the degree of risk, the type of health damage and consequently the type of measures required to prevent them differ. When developing policy, this should be taken into account. In practice, this means that we need targeted interventions depending on the effects of the MSD on the different parts of the body.

For example, lower limb targeted preventive measures need to focus mostly on preventing the effect of static workload due to prolonged standing (and possibly kneeling or squatting), whereas in preventing upper limb MSDs there is usually a need for a combination of preventing static workload (neck and shoulders) and repetitive work (elbow, wrist, fingers) and, at the same time, in back-related MSDs there is usually a need to focus on preventing a high biomechanical load on the spine.

8.7 Promoting musculoskeletal health among the working population in collaboration with other policy areas (public health sector, education sector, etc.)

The main focus of the report has been put on gathering and analysing data and information with the aim of supporting occupational risk prevention of MSDs by increasing knowledge of the topic, and by pinpointing priority areas or priority groups. Bearing in mind the multifactorial nature of MSDs, this approach of focusing on work-related MSD prevention should be integrated and complemented with an occupational health promotion approach focusing on the promotion of good musculoskeletal health at work, including from a more public health point of view. The strategies and policies to prevent MSDs

and to ensure good musculoskeletal health have to influence the main determinants of musculoskeletal health as far as possible (and this also entails going beyond the workplaces and OSH policies):

- the occurrence of diseases and other health conditions;
- intrinsic individual/personal factors (such as genetics, obesity, smoking, sedentary habits/lack of physical activity);
- work-related factors (biomechanical, organisational, psychosocial, etc.);
- contextual and environmental factors (health, social, education systems/interventions).

In order to properly understand and prevent MSDs, the focus should not be put only on the percentage of prevalence and on the combination of work-related factors (physical factors, psychosocial factors and sociodemographic factors). It also needs to go beyond the world of work or the OSH sector in order to consider the other relevant dimensions of the process, such as those included in the theoretical framework presented in the report (Figure 11).

8.8 Improving data

Developing good policy involves drawing the right conclusions by analysing the right data. Therefore, it is important to have good and consistent data on MSDs that highlight the main issues and provide a firm foundation for an evidence-based approach to help policy-makers, researchers, the OSH community and enterprises to guide their work(ers) and their own activities in preventing and better managing this ill-health problem.

However, the most recent empirical information on the prevalence of work-related MSDs at the EU level dates back to 2013, (LFS ad hoc module). The data from the 2010 and 2015 EWCSs focus on MSDs in general, and not on work-related MSDs as was the case in the 2005 wave. These changes to the questionnaire make it difficult to measure developments over a longer time period. Having consistent data available over time is necessary to monitor the prevalence of MSDs over time, to measure the impact and to evaluate the policies taken. The present authors raise the following issues for attention and make the following recommendations for the improvement of statistics relating to MSDs:

- Data are preferably gathered every 3 to 5 years and are preferably focused on both MSDs in general and work-related MSDs. The instruments used should be consistent over time.
- The MSD risk factors included in the EWCS are not exhaustive. This limits the possibility of exploring all the MSD risk factors and their associations.
- The existing statistical data should be complemented with information and data from other sources in order to have a better and a more comprehensive picture related to MSDs.
- Both the data and the subsequent theoretical framework of this report show that risk factors for MSDs are multifactorial and can be divided into physical, organisational and psychosocial risk factors. There is a need for instruments that cover all three categories mentioned.
- There are questions to be raised about the relationship between MSDs and accidents at work. These questions work both ways: accidents influence MSDs and MSDs influence accidents, so this relationship should be covered and explored in the instrumentation. In EU-wide surveys these types of questions are not asked.
- In the past, the EODS collected comparative administrative data for EU countries. Currently, no update is available for the EODS data so there is no recent EU-based data source available. Looking at the next level, namely national data from various Member States on the number of recognised cases of MSDs occupational diseases, it has been concluded that, because of institutional differences between the national systems used to register (the causes of) occupational diseases, these data are not comparable across countries. At present a pilot for a new EODS is being carried out.
- In this report, four main EU surveys (EWCS, EHIS, ESENER and LFS) have been used. This report proposes the implementation of some measures to facilitate the joint analysis of the main outcomes and maybe even make combined constructs.

For each of the factors distinguished in the EWCS, this report indicates whether or not the data show a relationship to reported MSDs. Where possible, information has been provided on the relationship between the risk factor and one of the three types of MSDs distinguished, and the extent to which workers are exposed to a risk factor over time. The three types of MSDs considered here are upper limb MSDs, lower limb MSDs and back-related MSDs. This report provides relevant information to provide further detail regarding the measures that ought to be taken by enterprises to prevent MSDs, or to support workers already suffering from MSDs.

9 Annexes

Annex 1 - Identification and analysis of relevant data sources

This annex discusses how the European data sources that were used for this study were identified and analysed.

Identification

Relevant data sources were identified through the following steps:

1. determination of criteria for data sources;
2. preparation of longlist of data sources;
3. inventory of characteristics of each data source;
4. selection of data sources that meet all criteria.

Determination of criteria for data sources

- **Topics covered by the data source**

The data sources should contain data on (types of) MSDs and topics related to MSDs that were included in a preliminary version[187] of the theoretical framework of work-related MSDs (Figure 11):

- MSDs:
  - different types of MSDs.
  - Work-related or not
  - Chronic or not:
- economic environment:
  - sector;
- organisation of work:
  - prevention activities,
  - occupation,
  - physical, organisational and psychosocial risk factors at the workplace;
- sociodemographic and individual factors:
  - gender, age, education level, country of birth;
- impact of MSDs:
  - health and safety outcomes,
  - economic costs and burden.

Only a few data sources were expected to cover all of these topics. The criterion was therefore that each data source should include information on a sufficient number of these topics.

- **Origin of the data**

The data sources should be based on surveys or administrative data at EU level. Only existing and available sources should be used.

[187] The version that was available at the beginning of the project.

- **Preference for recent data and trends**

Data sources that contain comparable data for several years were preferred, since these offer the possibility of identifying and analysing trends over time.

Preparation of longlist of sources

At the start of the project, a shortlist of possibly relevant data sources was made available. Among other things, this shortlist included the data sources that were used for the previous EU-OSHA report on work-related MSDs (EU-OSHA, 2010). Additional data sources were identified by:

- requesting the scientific committee and the researchers involved in this project to review the shortlist of data sources and add potentially relevant additional data sources;
- asking experts from EU-OSHA to indicate potentially relevant additional data sources;
- scanning the results of the literature review for potentially relevant additional data sources.

The resulting longlist was discussed with experts from EU-OSHA.

Inventory of characteristics of each source

For all data sources from the longlist, an inventory was made of relevant characteristics. To structure this process, a data source template was designed and discussed with EU-OSHA. This template registered the following characteristics:

1. Name of the data source.
2. Internet access.
3. Characteristics of the data source.
4. Period/years covered by the data source.
5. In the case of administrative data records:
   - units of measurement;
   - definitions used.
6. In the case of surveys:
   - methodology of the data collection;
   - type of persons interviewed (for example employees or inhabitants);
   - survey sample and size;
   - availability of specific MSD-related information on the following elements and associated specific question and answer options on MSDs:
     - prevalence of (types of) MSDs,
     - different risk factors for MSDs,
     - presence of prevention activities for MSDs,
     - labour market outcomes related to MSDs,
     - public health outcomes related to MSDs,
     - impacts and economic costs/burdens as a consequence of MSDs,
     - likely expectations regarding future prevalence pf MSDs, by different types of MSD,
     - information on expected impacts derived from MSDs in the medium and long terms.
7. General assessment of the data source:
   - comparability, quality and reliability of the data;
   - availability of up-to-date information;
   - data collection methods;

- coverage, assessment of whether there might be under- or overrepresentation of specific groups;
- possibility of analysing trends;
- operationalisation issues;
- quality.

After approval, the template was used to collect relevant characteristics from all data sources from the longlist.

Selection of final data sources

The final inventory of characteristics for all data sources from the longlist indicated that not all data sources from the longlist met all relevant criteria. For example, some data sources are based on secondary data only (rather than on surveys or administrative data), while other data sources do not contain any information regarding MSD prevalence. The final list of data sources that was used for this study is presented in Table 9 (as well as in Chapter 1 of this report).

Table 9 Characteristics of data sources used for this study

Data source	Nature of data	Supplier
Labour Force Survey (LFS) ad hoc modules 2013)	Survey	Eurostat
European Health Interview Survey (EHIS)	Survey	Eurostat
European Survey of Enterprises on New and Emerging Risks (ESENER)	Survey	EU-OSHA
European Working Conditions Survey (EWCS)	Survey	Eurofound
ESAW	Administrative data	Eurostat
WHO European Health for All database	Administrative data	WHO
WHO European Mortality Database	Administrative data	WHO

Source: Panteia, 2019

Analysis

For all of the selected data sources, microdata were obtained for further analysis. For most data sources it was possible to obtain microdata for all Member States. For two data sources (EHIS and LFS), however, this was not possible. These data sources are supplied by Eurostat. In the case of requests for microdata from surveys, individual Member States have to approve the data request. The request for microdata from EHIS and LFS for this project was accepted by the statistical offices of all Member States, except for Germany.

With the exception of graphs on hospital discharges and deaths per 100,000 persons (based on WHO data), all graphs show percentages of workers: pie charts, bar charts and/or line charts are used to show the percentages of workers with specific characteristics for different groups.

Most of these percentages are straightforward descriptive statistics, calculated as the (weighted) percentage of workers in the dataset with certain characteristics (by gender, age, occupation, country, etc., depending on the topic of the graph).

In addition to these descriptive statistics, several multivariate analyses were performed:

- Logistic regressions were performed to identify significant relationships between risk factors and MSD prevalence.
- Cluster analyses were used to search for common combinations of risk factors, and for MSDs and other health problems.
- These analyses are discussed in separate annexes.

Annex 2 - Exploratory logistic regressions explaining MSD prevalence

Introduction

MSDs can be caused by many different (combinations of) factors and may have many different consequences. Previous studies have examined to what extent the prevalence of MSDs is related to sociodemographic characteristics such as gender, age, education level and country of birth, and to what extent MSDs can be caused by different physical, organisational and psychosocial factors. The relationship between MSDs and physical risk factors has been studied before, but only relatively few empirical studies exist that examine the relationship between MSDs and organisational and psychosocial risk factors.

One of the objectives of this study is to fill this knowledge gap, by using existing European datasets to examine these relationships. Therefore, different regression models were estimated to examine to what extent the prevalence of MSDs can be related to sociodemographic characteristics and different physical, organisational and psychosocial risk factors. The objective of the logistic regressions described in this annex were to identify relationships between available indicators on MSD prevalence and available data on various other factors. The outcomes of these analyses were meant to fill the current knowledge gap, and also to generate new hypotheses and suggestions for future research.

These analyses were of an exploratory nature. Testing hypotheses regarding possible causal relationships would require a derivation of hypotheses that take the multifactorial nature of the relationship between risk factors and MSDs into account, and longitudinal data to test these hypotheses. It is beyond the scope of this study to conduct this kind of analysis for all risk factors discussed in this study.

Methodology

Which data were used

The sixth wave of the EWCS includes indicators on three different types of MSDs as well as indicators for many different risk factors and relevant control variables. In many ways, this is the most complete dataset available at EU level. For this reason, the analyses were performed on the outcomes of this survey.

The analyses were conducted on the subsample of all respondents residing in an EU-28 Member State, aged 18 to 65 years old, who worked at least 12 hours per week in their main job. This subsample contains 31,662 respondents.

Which dependent variables were examined

Previous studies showed that the relationship between potential determinants and MSDs varies between different types of MSDs (see Chapter 2). Therefore, analyses were conducted separately for each of the three MSD indicators available in the EWCS:

- MSD_back: a dummy variable indicating whether or not a respondent has reported backaches during the past 12 months;
- MSD_upper: a dummy variable indicating whether or not a respondent has reported muscular pains in the shoulders, neck and/or upper limbs during the past 12 months;
- MSD_lower: a dummy variable indicating whether or not a respondent has reported muscular pains in the lower limbs during the past 12 months.

Which explanatory variables were included

Many variables included in the sixth wave of the EWCS were used for these regression models. Most of the time, the original variables from the survey were used. In some cases, however, the answers to several questions concerning related subjects could be used to construct a single scale[188]. Using Cronbach's alpha to establish the scale reliability, four scales were constructed with an acceptable level of reliability (Cronbach's alpha 0.6 or higher):

Support (the amount of help and support from colleagues and managers). This scale was calculated as the average score of the answers to the following two questions on which best describes the respondent's work situation:

- your colleagues help and support you;
- your manager helps and supports you.

Cronbach's alpha for these two questions is 0.72.

Mental well-being (the mental well-being of respondents during the past 2 weeks). This scale was calculated as the average score for the answers to the following questions on how respondents had been feeling over the past 2 weeks:

- cheerful and in good spirits;
- calm and relaxed;
- active and vigorous;
- waking up fresh and rested;
- daily life has been filled with things that interest me.

Cronbach's alpha for these five questions was 0.88.

Energetic (feeling energetic at work). This scale was calculated as the average score for the answers to the following questions on how often respondents feel this way:

- at my work I feel full of energy;
- I am enthusiastic about my job;
- time flies when I am working.

Cronbach's alpha for these three questions was 0.72.

Employee voice (having a role in the organisation of work). This scale was calculated as the average score for the answers to the following questions on which best describes the respondent's work situation:

- consulted before objectives are set for your work;

[188] All of the questions used to construct these scales are measured on a five-point ordinal scale.

- involved in improving the organisation or processes;
- have a say in the choice of your work colleagues;
- able to apply your own ideas in your work;
- influence decisions that are important for your work.

Cronbach's alpha for these five questions was 0.83.

The analyses examined the relationship between the prevalence of MSDs and the following risk factors:

Physical risk factors[189]:

- extent of being exposed to:
  - vibrations from hand tools,
  - low temperatures (whether indoors or outdoors);
- main paid job involves:
  - working in tiring or painful positions,
  - carrying or moving heavy loads,
  - repetitive hand or arm movements,
  - lifting or moving people,
  - working with computers, laptops, etc.,
  - sitting.

Organisational and psychosocial risk factors:

- extent to which job involves:
  - working at very high speed,
  - working to tight deadlines;
- pace of work is dependent on:
  - work done by colleagues,
  - direct demands from people such as customers, etc.,
  - numerical production targets or performance targets,
  - automatic speed of a machine or movement of a product,
  - the direct control of your boss;
- able to choose or change:
  - order of tasks,
  - methods of work;
- extent to which following descriptions apply to your work situation:
  - taking a break when you wish,
  - having enough time to get the job done,
  - job giving the feeling of work well done,
  - having the feeling of doing useful work,
  - knowing what is expected of you at work,
  - treated fairly at the workplace,
  - experiencing stress in your work,
  - job requires hiding feelings;
- the constructed scales:
  - mental well-being,
  - energetic,
  - employee voice,
  - support;
- past month, at work subject to:

[189] All physical risk factors are measured at a seven-point scale. For the analyses, these were reduced to a three-point scale: (almost) never/a quarter to three quarter of the time/(almost) all of the time.

    - verbal abuse,
    - unwanted sexual attention,
    - threats,
    - humiliating behaviours;
- past 12 months, at work subject to:
    - physical violence,
    - sexual harassment,
    - bullying/harassment.

Comorbidities (health problems that may also be interpreted as risk factors):

- past 12 months, suffering from the following health problems:
    - anxiety,
    - overall fatigue;
- past 12 months, sleep-related problems:
    - difficulties falling asleep,
    - waking up repeatedly during the sleep,
    - waking up with a feeling of exhaustion and fatigue.

While the focus was on the role of these risk factors, the analyses also included various control variables that were related to different elements of the framework presented in Chapter 2:

- Social and political environment:
    - country dummies;
- Economic environment:
    - sector dummies (based on the Statistical Classification of Economic Activities in the European Community, NACE, rev. 2 sector classification at 1-digit level, which distinguishes 22 sectors).
- Organisation of work:
    - employment status:
        - five different employment relationships were distinguished: self-employed; employee with indefinite contract; employee with fixed-term contract; temporary employment agency, apprenticeship or other training scheme; other,
        hours worked;
    - occupations:
        - occupation dummies (based on the ISCO 2008 classification of occupations, which distinguishes 44 occupations);
    - prevention activity:
        - two indicators on the proportion of workers in a certain country and sector that may benefit from certain preventive measures (based on the second wave of ESENER, which is explained below).
- Sociodemographic and individual factors:
    - gender (dummy variable);
    - age (the log of a respondent's age);
    - education level (four levels);
    - country of birth (three groups).

The two prevention indicators were based on the second wave of ESENER. Among others, this survey includes the following six questions on the presence of various preventive measures in establishments:

- General preventive measures (including health promotion):
    - sports activities out of working hours,
    - back exercises at work,
    - training on proper use and adjustment of their working equipment,
    - training on how to prevent psychosocial risks;

- MSD-specific preventive measures:
  - encouraging regular breaks for people in uncomfortable working position,
  - provision of ergonomic equipment.

Initially, the following three prevention indicators were calculated:

- the percentage of employees (per country and sector) working in establishments where one or more preventive measures are provided (general and MSD-specific);
- the percentage of employees (per country and sector) working in establishments where one or two specific MSD measures are provided;
- the average number of measures provided in establishments (weighted by number of employees involved).

The first of these three indicators applies to 97 % of all employees, so there was hardly any variance. This lack of variance rendered it useless as an indicator for prevention measures. The remaining two indicators were added to the EWCS data and included in the models explaining the prevalence of the three MSD types.

Interaction effects

One of the characteristics of the framework discussed in Chapter 2 is that it assumes that sociodemographic characteristics act as moderators: the extent to which physical, organisational and psychosocial risk factors increase the risk of MSDs may differ between individuals with different sociodemographic characteristics.

To examine whether or not this is the case, the regression models included interaction effects between each of the four sociodemographic variables mentioned and various risk factors. To limit the number of interaction terms, the models were first estimated without interaction effects. In a next step, interaction terms were included between the four sociodemographic variables and all risk factors that were found to be significantly related to MSDs.

Which regression technique to use

The dependent variables for the models to be estimated are dichotomous. This implies that standard regression techniques (which assume that the dependent variable is continuous) would result in biased parameter estimates. This problem can be solved by estimating logistic regressions[190].

Logit regressions can be used to estimate the probability that a person reports a specific type of MSD, as a function of the risk factors and control variables discussed before. One of the characteristics of a logistic regression is that the interpretation of the parameter estimates is rather complicated. The estimated parameters represent the effect of changes in a specific variable not on the probability of reporting MSDs, but on the so-called logit transformation of that probability. This logit transformation renders the log of the odds, where the odds are the probability of reporting MSDs relative to the probability of not reporting MSDs.

Logistic regressions do not perform well if the probability that is to be explained (such as the probability of reporting MSDs) is below 20 % or above 80 %. Since the prevalence of the three types of MSDs considered lies between these boundaries, logistic regressions are a valid methodology.

Which models were estimated

First, logistic regressions were estimated including all risk factors and control variables discussed before (except for the interaction effects). This was done for all three types of MSDs individually and also for MSDs in general (prevalence of at least one of the three types of MSDs).

Several of these risk factors and control variables were not significantly related to any of the three MSD risks. These were the following risk factors:

[190] Alternatively, a probit model could be estimated. Generally speaking, logit and probit estimations lead to the same conclusions.

- Extent to which main paid job involves:
  - lifting or moving people,
  - working with computers, laptops, smartphones, etc.;
- Extent to which job involves working to tight deadlines;

- Whether pace of work is dependent on:
  - work done by colleagues,
  - numerical production targets or performance targets,
  - automatic speed of a machine or movement of a product;
- Whether respondent is able to choose or change order of tasks;

- Descriptions of the work situation:
  - support,
  - having the feeling of doing useful work;
- Past month, at work subjected to humiliating behaviours;
- Past 12 months, at work subjected to sexual harassment.

For each of the three MSD types, the models were then re-estimated with the explanatory variables entered into the model in consecutive steps:

1. First, only dummies indicating country, sector and occupation were included.
2. Next, sociodemographic factors and indicators for employment status were added.
3. Next, one physical risk factor was added that is known to affect MSD prevalence: the extent to which the main paid job involves lifting or moving people.
4. Next, all physical, organisational and psychosocial risk factors and control variables were added that were significantly related to MSD prevalence (this list of variables has been identified in a separate analysis).
5. Next, two indicators were added on how respondents perceive the relationship between work and health
6. In the final step, the remaining physical, organisational and psychosocial risk factors were included.

For each of the three MSD types, this procedure resulted in a model that served different purposes:

- It examined to what extent sociodemographic factors and risk factors could explain differences in MSD prevalence between countries, sectors and occupations (by examining to what extent steps 2, 3, 4 and 5 discussed above changed the parameter estimates for the country, sector and occupation dummies included in step 1).
- It examined to what extent risk factors could explain gender differences in MSD prevalence (by examining to what extent steps 3, 4 and 5 discussed above changed the parameter estimates for the gender dummy included in step 2).
- Step 3 was included to check if the risk factor ‘lifting or moving people’ would be significantly related to MSD prevalence in a model with only a few explanatory variables. This step was prompted by the finding that in models with more explanatory variables (as in step 4 and step 5) this risk factor is not significantly related to MSD prevalence. The results (not reported here) confirmed that this was indeed the case (for each of the three MSD types considered, the risk factor ‘lifting or moving people’ was significantly related to the prevalence of MSDs in step 3, but no longer in steps 4, 5 and 6).
- It tested the joint hypothesis that adding the group of risk factors included in step 6 did not significantly increase the model fit. For each of the three MSD types, this joint hypothesis could not be rejected.
- The variables included in the model after step 5 could be used as a starting point from which to identify significant interaction terms.

To prevent the model from becoming too complex, interaction terms were identified separately for each of the four sociodemographic variables (gender, age, country of birth, education level). This was done for each of the three MSD types, resulting in 12 different models. Each of these models started with the model that resulted after step 5 discussed above. For each of the sociodemographic variables, all possible interactions with the significant risk factors were then included, to identify which of these were significantly related to MSD prevalence.

Results

The main outcomes are presented in Table 10 (regarding MSDs in the back), Table 11 (regarding MSDs in the upper limbs) and Table 12 (regarding MSDs in the lower limbs). Each table includes the regression results from five related models for a specific MSD type: first the outcomes of step 5 of the model without interaction terms, and then the outcomes of the models with interaction terms, for the four different sociodemographic variables that this study has focused on.

Most of the explanatory variables are either dummy variables (such as gender), nominal variables (such as country, sector and occupation) or ordinal variables (such as the extent to which the main paid job involves repetitive hand or arm movements). All of these variables were treated as categorical variables in the logistic regression, which implies that separate dummy variables were estimated for each answer category (except for the default category).

In the case of nominal or ordinal variables (i.e. categorical variables with three or more answer categories) the tables show not only the parameter estimates and significance levels for the estimated dummy variables, but also the significance level of the Wald test statistic for the joint hypothesis that all dummy variables related to this categorical variable do not differ significantly from zero. The column ‘df’ (degrees of freedom) shows the number of dummy variables that are associated with this test. For example, the sample includes workers from all Member States. This results in 27 different country dummies that were estimated. The Wald test for the significance of the variable ‘country’ therefore had 27 degrees of freedom. Since this test statistic is not related to individual parameter estimates, the column ‘B’ (containing the parameter estimates) is empty.

The main findings from these logistic regressions are discussed in the main text of this report.

Table 10 Logistic regressions on the prevalence of self-reported MSDs in the back

Variable	Model 1 (no interactions)				Model 2 (interactions with gender)				Model 3 (interactions with age)				Model 4 (interactions with education level)				Model 5 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Constant	-8.15	**	1	0.000	-8.09	**	1	0.000	-9.22	**	1	0.000	-8.25	**	1	0.000	-8.19	**	1	0.000
Country, sector and occupation dummies																				
Country (dummies included)		**	27	0.000		**	27	0.000		**	27	0.000		**	27	0.000		**	27	0.000
Sector (dummies included)		**	20	0.001		**	20	0.002		**	20	0.002		**	20	0.001		**	20	0.001
Occupation (dummies included)		**	42	0.000		**	42	0.000		**	42	0.000		**	42	0.000		**	42	0.000
Sociodemographic factors and employment status																				
Gender																				
male (default)																				
female	0.13	**	1	0.000	0.02		1	0.654	0.13	**	1	0.000	0.13	**	1	0.000	0.13	**	1	0.000
Ln(age)	0.86	**	1	0.000	0.86	**	1	0.000	1.16	**	1	0.000	0.87	**	1	0.000	0.86	**	1	0.000
Highest education level		**	6	0.006		**	6	0.006		**	6	0.005			6	0.605		**	6	0.006
pre-primary	0.45	*	1	0.049	0.46	*	1	0.044	0.46	*	1	0.043	0.28		1	0.720	0.46	*	1	0.043
primary	0.05		1	0.567	0.06		1	0.561	0.05		1	0.569	0.47		1	0.352	0.06		1	0.550
lower secondary	0.03		1	0.553	0.03		1	0.542	0.03		1	0.520	0.52		1	0.110	0.03		1	0.528
upper secondary (default)																				
post-secondary non-tertiary	-0.01		1	0.846	-0.01		1	0.823	-0.01		1	0.875	-0.24		1	0.469	-0.01		1	0.830
first stage tertiary	-0.13	**	1	0.001	-0.13	**	1	0.001	-0.13	**	1	0.001	0.04		1	0.859	-0.13	**	1	0.001
second stage tertiary	-0.24		1	0.105	-0.23		1	0.113	-0.25		1	0.090	-0.04		1	0.964	-0.25		1	0.092
Country of birth			2	0.543			2	0.532			2	0.450			2	0.559		**	2	0.001
respondent and parents native born (default)																				
respondent native born, at least one parent not	0.06		1	0.359	0.06		1	0.349	0.07		1	0.318	0.06		1	0.370	-0.13		1	0.283
respondent not native born	0.04		1	0.474	0.04		1	0.471	0.05		1	0.378	0.04		1	0.486	0.31	**	1	0.001
Hours worked per week			7	0.777			7	0.748			7	0.788			7	0.728			7	0.783
9-16	0.08		1	0.363	0.09		1	0.311	0.08		1	0.369	0.09		1	0.337	0.08		1	0.360
17-24	0.05		1	0.377	0.06		1	0.307	0.05		1	0.383	0.05		1	0.342	0.05		1	0.408
25-32	-0.03		1	0.633	-0.02		1	0.703	-0.03		1	0.609	-0.03		1	0.613	-0.03		1	0.615
33-39	-0.01		1	0.860	0.00		1	0.917	-0.01		1	0.820	-0.01		1	0.860	-0.01		1	0.843
40 (default)																				
41-50	0.05		1	0.217	0.05		1	0.208	0.05		1	0.242	0.05		1	0.203	0.05		1	0.221
51-60	-0.01		1	0.926	-0.01		1	0.926	-0.01		1	0.936	0.00		1	0.993	-0.01		1	0.935
> 60	0.02		1	0.871	0.02		1	0.869	0.02		1	0.877	0.06		1	0.671	0.03		1	0.849
Employment status			4	0.492			4	0.446			4	0.504			4	0.462			4	0.494
self-employed	-0.06		1	0.250	-0.07		1	0.201	-0.06		1	0.243	-0.07		1	0.210	-0.06		1	0.245
employee, indefinite contract (default)																				
employee, fixed term contract	0.03		1	0.555	0.03		1	0.568	0.03		1	0.563	0.03		1	0.580	0.03		1	0.561
temporary employment agency, apprenticeship	-0.09		1	0.437	-0.09		1	0.406	-0.09		1	0.443	-0.09		1	0.417	-0.09		1	0.443
other	-0.07		1	0.296	-0.07		1	0.306	-0.07		1	0.315	-0.07		1	0.303	-0.07		1	0.299

Variable	Model 1 (no interactions)				Model 2 (interactions with gender)				Model 3 (interactions with age)				Model 4 (interactions with education level)				Model 5 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Physical risk factors																				
Exposed to vibrations from hand tools etc.			3	0.325			3	0.273			3	0.373			3	0.283			3	0.347
(almost) never (default)																				
1/4 to 3/4 of the time	0.09		1	0.076	0.09		1	0.055	0.08		1	0.093	0.09		1	0.065	0.08		1	0.083
almost all of the time	-0.01		1	0.882	0.00		1	0.968	-0.01		1	0.882	-0.02		1	0.843	-0.01		1	0.885
all of the time	0.03		1	0.737	0.05		1	0.565	0.02		1	0.830	0.03		1	0.709	0.02		1	0.763
Job involves tiring or painful positions		**	2	0.000		**	2	0.000			2	0.698		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.62	**	1	0.000	0.58	**	1	0.000	-0.37		1	0.397	0.62	**	1	0.000	0.62	**	1	0.000
(almost) all of the time	0.83	**	1	0.000	0.73	**	1	0.000	-0.20		1	0.731	0.83	**	1	0.000	0.83	**	1	0.000
Job involves carrying or moving heavy loads		**	2	0.000		**	2	0.000		**	2	0.001		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.23	**	1	0.000	0.23	**	1	0.000	0.45		1	0.323	0.23	**	1	0.000	0.23	**	1	0.000
(almost) all of the time	0.35	**	1	0.000	0.36	**	1	0.000	2.55	**	1	0.000	0.35	**	1	0.000	0.35	**	1	0.000
Job involves repetitive hand or arm movements		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.13	**	1	0.000	0.13	**	1	0.000	0.13	**	1	0.000	0.13	**	1	0.000	0.16	**	1	0.000
(almost) all of the time	0.20	**	1	0.000	0.19	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000	0.21	**	1	0.000
Pace of work depends on direct demands from customers etc.	0.06		1	0.063	0.06		1	0.056	0.06		1	0.057	0.06		1	0.065	0.06		1	0.078
Pace of work depends on direct control of boss	-0.07	*	1	0.028	-0.16	**	1	0.000	-0.07	*	1	0.028	-0.07	*	1	0.029	-0.07	*	1	0.026
Organisational and psychosocial risk factors																				
Anxiety last 12 months	0.23	**	1	0.000	0.22	**	1	0.000	1.73	**	1	0.001	0.23	**	1	0.000	0.23	**	1	0.000
Overall fatigue last 12 months	0.81	**	1	0.000	0.81	**	1	0.000	1.83	**	1	0.000	0.81	**	1	0.000	0.81	**	1	0.000
Difficulties falling asleep last 12 months		**	2	0.003		**	2	0.003		**	2	0.004		**	2	0.003		**	2	0.002
less often/never (default)																				
several times a week/month	0.14	**	1	0.001	0.14	**	1	0.001	0.14	**	1	0.001	0.14	**	1	0.001	0.14	**	1	0.001
daily	0.09		1	0.331	0.09		1	0.355	0.09		1	0.318	0.09		1	0.336	0.10		1	0.295
Waking up repeatedly last 12 months		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
less often/never (default)																				
several times a week/month	0.20	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000
daily	0.36	**	1	0.000	0.36	**	1	0.000	0.37	**	1	0.000	0.36	**	1	0.000	0.40	**	1	0.000
Waking up feeling exhausted last 12 months		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
less often/never (default)																				
several times a week/month	0.24	**	1	0.000	0.24	**	1	0.000	0.23	**	1	0.000	0.23	**	1	0.000	0.24	**	1	0.000
daily	0.15		1	0.082	0.15		1	0.082	0.14		1	0.117	0.15		1	0.076	0.16		1	0.070
Last month at work subjected to verbal abuse	0.22	**	1	0.000	0.22	**	1	0.000	0.21	**	1	0.000	0.36	**	1	0.000	0.22	**	1	0.000
Last month at work subjected to unwanted sexual attention	0.27	*	1	0.012	0.27	*	1	0.014	0.27	*	1	0.015	0.26	*	1	0.016	0.28	*	1	0.011
Last month at work subjected to threats	-0.19	*	1	0.013	-0.19	*	1	0.013	-0.20	**	1	0.010	-0.19	*	1	0.016	-0.20	*	1	0.012
Past 12 months at work subjected to bullying/harassment	-0.18	*	1	0.015	-0.17	*	1	0.016	-0.17	*	1	0.018	-0.17	*	1	0.017	-0.17	*	1	0.018

Variable	Model 1 (no interactions)			Model 2 (interactions with gender)			Model 3 (interactions with age)			Model 4 (interactions with education level)			Model 5 (interactions with country of birth)		
	B	df	Sig.	B	df	Sig.	B	df	Sig.	B	df	Sig.	B	df	Sig.
Mental well-being during past two weeks	0.19 **	1	0.000	0.19 **	1	0.000	0.19 **	1	0.000	0.19 **	1	0.000	0.19 **	1	0.000
Feeling energetic at work	0.08 **	1	0.001	0.08 **	1	0.001	0.08 **	1	0.001	0.08 **	1	0.001	0.08 **	1	0.001
Having enough time to get the job done	**	2	0.008	**	2	0.006	**	2	0.008	**	2	0.009	**	2	0.007
rarely or never (default)															
sometimes/most of the time	0.16 **	1	0.002	0.16 **	1	0.001	0.16 **	1	0.002	0.16 **	1	0.002	0.16 **	1	0.002
all of the time	0.15 **	1	0.009	0.15 **	1	0.006	0.15 **	1	0.009	0.15 **	1	0.009	0.15 **	1	0.008
Knowing what is expected at work	**	2	0.000	**	2	0.000	**	2	0.000	**	2	0.000	**	2	0.000
rarely or never (default)															
sometimes/most of the time	0.20 *	1	0.047	0.21 *	1	0.044	0.21 *	1	0.044	0.21	1	0.176	0.20	1	0.053
all of the time	0.33 **	1	0.001	0.33 **	1	0.001	0.33 **	1	0.001	0.42 **	1	0.006	0.32 **	1	0.001
Perceived relation work-health															
Health or safety at risk because of work	0.14 **	1	0.001	0.14 **	1	0.001	0.15 **	1	0.000	0.14 **	1	0.001	0.14 **	1	0.001
Does your work affect your health	**	2	0.000	**	2	0.000	**	2	0.000	**	2	0.000	**	2	0.000
yes, mainly positive	0.02	1	0.599	0.02	1	0.595	1.62 **	1	0.007	0.03	1	0.577	0.02	1	0.598
yes, mainly negative	0.49 **	1	0.000	0.49 **	1	0.000	2.25 **	1	0.000	0.49 **	1	0.000	0.49 **	1	0.000
no (default)															
Interaction effects															
Gender × Job involves tiring or painful positions					2	0.090									
(almost) never (default)															
1/4 to 3/4 of the time				0.08	1	0.193									
(almost) all of the time				0.18 *	1	0.037									
Gender × Pace of work depends on direct control of boss				0.17 **	1	0.003									
Ln(age) × Job involves tiring or painful positions							*	2	0.042						
(almost) never (default)															
1/4 to 3/4 of the time							0.27 *	1	0.022						
(almost) all of the time							0.28	1	0.076						
Ln(age) × Job involves carrying or moving heavy loads							**	2	0.004						
(almost) never (default)															
1/4 to 3/4 of the time							-0.06	1	0.630						
(almost) all of the time							-0.60 **	1	0.001						
Ln(age) × Does your work affect your health							**	2	0.000						
yes, mainly positive							-0.43 **	1	0.007						
yes, mainly negative							-0.47 **	1	0.000						
no (default)															
Ln(age) × Anxiety last 12 months							-0.40 **	1	0.005						
Ln(age) × Overall fatigue last 12 months							-0.27 *	1	0.012						
Education × Verbal abuse										**	6	0.001			
pre-primary × verbal abuse										-2.29 **	1	0.003			
primary × verbal abuse										-0.33	1	0.368			

Variable	Model 1 (no interactions)			Model 2 (interactions with gender)			Model 3 (interactions with age)			Model 4 (interactions with education level)			Model 5 (interactions with country of birth)			
	B		df	Sig.	B	df	Sig.	B	df	Sig.	B		df	Sig.	B		df	Sig.
lower secondary × verbal abuse											-0.15		1	0.305				
upper secondary (default)																		
post-secondary non-tertiary × verbal abuse											-0.31		1	0.058				
first stage tertiary × verbal abuse											-0.19		1	0.052				
second stage tertiary × verbal abuse											-1.64	**	1	0.001				
Education × Knowing what is expected at work												*	12	0.014				
pre-primary × sometimes/most of the time											0.32		1	0.716				
pre-primary × all of the time											0.43		1	0.604				
primary × sometimes/most of the time											0.18		1	0.727				
primary × all of the time											-0.63		1	0.218				
lower secondary × sometimes/most of the time											-0.45		1	0.179				
lower secondary × all of the time											-0.50		1	0.129				
post-secondary non-tertiary × sometimes/most of the time											0.25		1	0.460				
post-secondary non-tertiary × all of the time											0.29		1	0.395				
first stage tertiary × sometimes/most of the time											-0.04		1	0.874				
first stage tertiary × all of the time											-0.21		1	0.399				
second stage tertiary × sometimes/most of the time											-0.07		1	0.936				
second stage tertiary × all of the time											0.04		1	0.961				
Country of birth × Repetitive hand or arm movements																*	4	0.039
respondent native born, at least one parent not × 1/4 to 3/4 of the time															0.17		1	0.323
respondent native born, at least one parent not × (almost) all of the time															0.09		1	0.571
respondent not native born × 1/4 to 3/4 of the time															-0.37	**	1	0.003
respondent not native born × (almost) all of the time															-0.18		1	0.106
Country of birth × waking up repeatedly																**	4	0.000
respondent native born, at least one parent not × several times a week/month															0.28		1	0.062
respondent native born, at least one parent not × daily															0.53		1	0.063
respondent not native born × several times a week/month															-0.21		1	0.057
respondent not native born × daily															-0.65	**	1	0.001
Model statistics																		
Number of observations				27391			27391			27391				27391				27391
Percentage predicted correctly				71.1			71.3			71.2				71.3				71.2
Nagelkerke R^2				0.292			0.292			0.294				0.294				0.293

Table 11 Logistic regressions on the prevalence of self-reported MSDs in the upper limbs

Variable	Model 6 (no interactions)				Model 7 (interactions with gender)				Model 8 (interactions with age)				Model 9 (interactions with education level)				Model 10 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Constant	-5.92	**	1	0.000	-5.94	**	1	0.000	-4.36	**	1	0.000	-6.02	**	1	0.000	-5.93	**	1	0.000
Country, sector and occupation dummies																				
Country (dummies included)		**	27	0.000		**	27	0.000		**	27	0.000		**	27	0.000		**	27	0.000
Sector (dummies included)			20	0.503			20	0.522			20	0.499			20	0.493			20	0.533
Occupation (dummies included)		**	42	0.000		**	42	0.000		**	42	0.000		**	42	0.000		**	42	0.000
Sociodemographic factors and employment status																				
Gender																				
male (default)																				
female	0.35	**	1	0.000	0.38	**	1	0.000	0.35	**	1	0.000	0.36	**	1	0.000	0.35	**	1	0.000
Ln(age)	0.90	**	1	0.000	0.90	**	1	0.000	0.48	**	1	0.008	0.90	**	1	0.000	0.90	**	1	0.000
Highest education level			6	0.244			6	0.253			6	0.245			6	0.069			6	0.244
pre-primary	0.13		1	0.605	0.13		1	0.585	0.14		1	0.572	1.63	*	1	0.035	0.12		1	0.614
primary	-0.01		1	0.953	0.00		1	0.974	0.00		1	0.991	-0.39		1	0.228	-0.01		1	0.948
lower secondary	-0.03		1	0.514	-0.03		1	0.509	-0.03		1	0.536	0.12		1	0.447	-0.03		1	0.506
upper secondary (default)																				
post-secondary non-tertiary	0.05		1	0.462	0.05		1	0.470	0.05		1	0.464	0.39	*	1	0.029	0.05		1	0.452
first stage tertiary	-0.09	*	1	0.046	-0.09	*	1	0.049	-0.09	*	1	0.045	0.01		1	0.946	-0.09	*	1	0.050
second stage tertiary	-0.25		1	0.118	-0.25		1	0.121	-0.25		1	0.126	-0.06		1	0.905	-0.26		1	0.110
Country of birth			2	0.692			2	0.711			2	0.678			2	0.749			2	0.169
respondent and parents native born (default)																				
respondent native born, at least one parent not	-0.01		1	0.837	-0.01		1	0.836	-0.01		1	0.877	-0.01		1	0.893	0.16		1	0.087
respondent not native born	-0.05		1	0.395	-0.05		1	0.413	-0.05		1	0.379	-0.04		1	0.448	-0.04		1	0.531
Hours worked per week			7	0.402			7	0.418			7	0.386			7	0.385			7	0.407
9-16	0.06		1	0.528	0.06		1	0.530	0.07		1	0.517	0.07		1	0.499	0.06		1	0.543
17-24	0.15	*	1	0.014	0.15	*	1	0.015	0.16	*	1	0.012	0.15	*	1	0.013	0.15	*	1	0.014
25-32	0.08		1	0.177	0.08		1	0.177	0.08		1	0.188	0.08		1	0.174	0.08		1	0.167
33-39	0.03		1	0.551	0.03		1	0.546	0.03		1	0.555	0.03		1	0.526	0.03		1	0.551
40 (default)																				
41-50	0.00		1	0.945	0.00		1	0.953	0.00		1	0.929	0.00		1	0.940	0.00		1	0.938
51-60	0.02		1	0.836	0.02		1	0.856	0.02		1	0.832	0.02		1	0.786	0.01		1	0.867
> 60	0.13		1	0.479	0.14		1	0.467	0.13		1	0.480	0.13		1	0.471	0.13		1	0.494
Employment status			4	0.798			4	0.796			4	0.825			4	0.743			4	0.790
self-employed	-0.06		1	0.827	-0.05		1	0.838	-0.05		1	0.848	-0.06		1	0.812	-0.06		1	0.813
employee, indefinite contract (default)																				
employee, fixed term contract	0.00		1	0.941	0.00		1	0.948	0.00		1	0.966	0.00		1	0.972	0.00		1	0.933
temporary employment agency, apprenticeship	-0.08		1	0.507	-0.08		1	0.517	-0.07		1	0.567	-0.08		1	0.500	-0.08		1	0.505
other	-0.08		1	0.263	-0.08		1	0.256	-0.08		1	0.271	-0.09		1	0.216	-0.08		1	0.256

Variable	Model 6 (no interactions)				Model 7 (interactions with gender)				Model 8 (interactions with age)				Model 9 (interactions with education level)				Model 10 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Physical risk factors																				
Exposed to vibrations from hand tools etc.		*	3	0.025		*	3	0.031		*	3	0.026		*	3	0.025		*	3	0.027
(almost) never (default)																				
1/4 to 3/4 of the time	0.06		1	0.260	0.05		1	0.352	0.06		1	0.278	0.06		1	0.253	0.06		1	0.273
almost all of the time	0.26	**	1	0.003	0.26	**	1	0.003	0.26	**	1	0.003	0.26	**	1	0.003	0.26	**	1	0.003
all of the time	0.01		1	0.930	0.02		1	0.865	0.01		1	0.926	0.00		1	0.989	0.01		1	0.952
Job involves tiring or painful positions		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.61	**	1	0.000	0.61	**	1	0.000	0.61	**	1	0.000	0.61	**	1	0.000	0.61	**	1	0.000
(almost) all of the time	0.84	**	1	0.000	0.84	**	1	0.000	0.84	**	1	0.000	0.84	**	1	0.000	0.84	**	1	0.000
Job involves carrying or moving heavy loads		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.15	**	1	0.000	0.22	**	1	0.000	0.15	**	1	0.000	0.15	**	1	0.000	0.15	**	1	0.000
(almost) all of the time	0.31	**	1	0.000	0.27	**	1	0.000	0.31	**	1	0.000	0.31	**	1	0.000	0.31	**	1	0.000
Exposed to low temperatures (indoors or outdoors)		**	2	0.003		**	2	0.003		**	2	0.002		**	2	0.002		**	2	0.002
(almost) never (default)																				
1/4 to 3/4 of the time	0.13	**	1	0.003	0.13	**	1	0.004	0.13	**	1	0.003	0.13	**	1	0.003	0.13	**	1	0.003
(almost) all of the time	0.20	*	1	0.023	0.20	*	1	0.021	0.20	*	1	0.022	0.20	*	1	0.022	0.19	*	1	0.024
Job involves working at very high speed		**	2	0.001		**	2	0.001		**	2	0.001		**	2	0.001		**	2	0.001
(almost) never (default)																				
1/4 to 3/4 of the time	0.12	**	1	0.001	0.12	**	1	0.001	0.12	**	1	0.002	0.12	**	1	0.001	0.12	**	1	0.002
(almost) all of the time	0.14	**	1	0.001	0.14	**	1	0.001	0.14	**	1	0.001	0.14	**	1	0.001	0.14	**	1	0.001
Organisational and psychosocial risk factors																				
Anxiety last 12 months	0.37	**	1	0.000	0.37	**	1	0.000	1.65	**	1	0.002	0.39	**	1	0.000	0.38	**	1	0.000
Overall fatigue last 12 months	0.88	**	1	0.000	0.88	**	1	0.000	0.88	**	1	0.000	0.95	**	1	0.000	0.89	**	1	0.000
Difficulties falling asleep last 12 months		*	2	0.050		*	2	0.050			2	0.057		*	2	0.046		*	2	0.045
less often/never (default)																				
several times a week/month	0.11	*	1	0.017	0.11	*	1	0.017	0.10	*	1	0.019	0.11	*	1	0.016	0.11	*	1	0.015
daily	-0.01		1	0.933	-0.01		1	0.926	0.00		1	0.966	-0.01		1	0.885	-0.01		1	0.947
Waking up repeatedly last 12 months		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
less often/never (default)																				
several times a week/month	0.23	**	1	0.000	0.23	**	1	0.000	0.22	**	1	0.000	0.23	**	1	0.000	0.23	**	1	0.000
daily	0.23	**	1	0.004	0.23	**	1	0.004	0.23	**	1	0.004	0.23	**	1	0.004	0.23	**	1	0.004
Waking up feeling exhausted last 12 months		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
less often/never (default)																				
several times a week/month	0.28	**	1	0.000	0.28	**	1	0.000	0.28	**	1	0.000	0.28	**	1	0.000	0.28	**	1	0.000
daily	0.27	**	1	0.004	0.26	**	1	0.005	0.26	**	1	0.005	0.26	**	1	0.005	0.27	**	1	0.004
Last month at work subjected to verbal abuse	0.35	**	1	0.000	0.35	**	1	0.000	0.35	**	1	0.000	0.35	**	1	0.000	0.35	**	1	0.000

Variable	Model 6 (no interactions)				Model 7 (interactions with gender)				Model 8 (interactions with age)				Model 9 (interactions with education level)				Model 10 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Last month at work subjected to threats	-0.22	**	1	0.007	-0.22	**	1	0.007	-0.23	**	1	0.006	-0.22	**	1	0.009	-0.20	*	1	0.021
Past 12 months at work subjected to physical violence	0.26	*	1	0.027	0.26	*	1	0.027	0.27	*	1	0.024	0.26	*	1	0.030	0.26	*	1	0.026
Mental well-being during past two weeks	0.18	**	1	0.000	0.19	**	1	0.000	0.18	**	1	0.000	0.18	**	1	0.000	0.19	**	1	0.000
Employee voice	0.04	*	1	0.015	0.04	*	1	0.015	-0.32		1	0.096	0.06	*	1	0.018	0.04	*	1	0.015
Feeling of job well done		**	2	0.002		**	2	0.002		**	2	0.002		**	2	0.002		**	2	0.002
rarely or never (default)																				
sometimes/most of the time	0.25	**	1	0.001	0.25	**	1	0.001	0.25	**	1	0.001	0.26	**	1	0.001	0.25	**	1	0.001
all of the time	0.21	**	1	0.006	0.21	**	1	0.007	0.21	**	1	0.006	0.22	**	1	0.006	0.21	**	1	0.006
Knowing what is expected at work		*	2	0.013		*	2	0.011		*	2	0.011		*	2	0.018		*	2	0.012
rarely or never (default)																				
sometimes/most of the time	0.00		1	0.929	0.00		1	0.925	0.00		1	0.897	0.00		1	0.928	0.00		1	0.929
all of the time	0.12	*	1	0.013	0.12	*	1	0.011	0.12	*	1	0.012	0.11	*	1	0.017	0.12	*	1	0.012
Treated fairly at the workplace		**	2	0.004		**	2	0.004		**	2	0.003		**	2	0.004		**	2	0.003
rarely or never (default)																				
sometimes/most of the time	0.21	**	1	0.003	0.21	**	1	0.003	0.21	**	1	0.003	0.22	**	1	0.003	0.22	**	1	0.003
all of the time	0.26	**	1	0.001	0.26	**	1	0.001	0.26	**	1	0.001	0.26	**	1	0.001	0.26	**	1	0.001
Job requires hiding of feelings		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
rarely or never (default)																				
sometimes/most of the time	-0.09	*	1	0.014	-0.09	*	1	0.015	-0.08	*	1	0.016	-0.09	*	1	0.012	-0.09	*	1	0.014
all of the time	-0.25	**	1	0.000	-0.25	**	1	0.000	-0.24	**	1	0.000	-0.25	**	1	0.000	-0.25	**	1	0.000
Stress experienced at work		**	2	0.005		**	2	0.005		*	2	0.014		**	2	0.007		**	2	0.005
rarely or never (default)																				
sometimes/most of the time	0.12	**	1	0.001	0.12	**	1	0.001	-1.13	**	1	0.007	0.12	**	1	0.002	0.12	**	1	0.001
all of the time	0.08		1	0.190	0.08		1	0.195	0.04		1	0.955	0.08		1	0.181	0.08		1	0.187
Perceived relation work-health																				
Health or safety at risk because of work	0.16	**	1	0.001	0.15	**	1	0.001	0.16	**	1	0.000	0.15	**	1	0.001	0.16	**	1	0.001
Does your work affect your health		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
yes, mainly positive	0.05		1	0.331	0.05		1	0.338	0.05		1	0.320	0.05		1	0.358	0.05		1	0.348
yes, mainly negative	0.44	**	1	0.000	0.44	**	1	0.000	0.44	**	1	0.000	0.44	**	1	0.000	0.44	**	1	0.000
no (default)																				
Interaction effects																				
Gender × Job involves carrying or moving heavy loads						*	2	0.026												
1/4 to 3/4 of the time					-0.16	*	1	0.033												
(almost) all of the time					0.14		1	0.228												
Ln(age) × Anxiety last 12 months									-0.35	*	1	0.016								
Ln(age) × Stress experienced at work										**	2	0.006								
sometimes/most of the time									0.34	**	1	0.003								
all of the time									0.01		1	0.959								

Variable	Model 6 (no interactions)			Model 7 (interactions with gender)			Model 8 (interactions with age)			Model 9 (interactions with education level)			Model 10 (interactions with country of birth)		
	B	df	Sig.	B	df	Sig.	B	df	Sig.	B	df	Sig.	B	df	Sig.
Ln(age) × Employee voice							0.10	1	0.057						
Education × Overall fatigue											6	0.000			
pre-primary										-0.46	1	0.351			
primary										0.11	1	0.589			
lower secondary										0.09	1	0.392			
post-secondary non-tertiary										0.18	1	0.144			
first stage tertiary										-0.30 **	1	0.000			
second stage tertiary										0.24	1	0.448			
Education × Employee voice											6	0.029			
pre-primary										-0.39	1	0.059			
primary										0.10	1	0.255			
lower secondary										-0.06	1	0.197			
post-secondary non-tertiary										-0.14 *	1	0.014			
first stage tertiary										0.01	1	0.679			
second stage tertiary										-0.12	1	51%			
Country of birth × Overall fatigue														2	0.070
respondents native born, at least one parent not													-0.33 *	1	0.021
respondents not native born													-0.03	1	0.769
Country of birth × Last month at work subjected to threats														2	0.062
respondents native born, at least one parent not													-0.65 *	1	0.029
respondents not native born													0.17	1	0.487
Model statistics															
Number of observations			24455			24455			24455			24455			24455
Percentage predicted correctly			71.9			71.9			71.9			72.0			71.9
Nagelkerke R^2			0.316			0.316			0.317			0.318			0.316

Table 12 Logistic regressions on the prevalence of self-reported MSDs in the lower limbs

Variable	Model 11 (no interactions)				Model 12 (interactions with gender)				Model 13 (interactions with age)				Model 14 (interactions with education level)				Model 15 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Constant	-6.30	**	1	0.000	-6.33	**	1	0.000	-7.39	**	1	0.000	-6.33	**	1	0.000	-6.30	**	1	0.000
Country, sector and occupation dummies																				
Country (dummies included)		**	27	0.000		**	27	0.000		**	27	0.000		**	27	0.000		**	27	0.000
Sector (dummies included)		**	20	0.000		**	20	0.000		**	20	0.000		**	20	0.000		**	20	0.000
Occupation (dummies included)		*	42	0.011		*	42	0.043		*	42	0.011		**	42	0.009		*	42	0.011
Sociodemographic factors and employment status																				
Gender																				
male (default)																				
female	0.11	**	1	0.004	0.21	**	1	0.000	0.11	**	1	0.004	0.11	**	1	0.003	0.11	**	1	0.004
Ln(age)	1.18	**	1	0.000	1.17	**	1	0.000	1.47	**	1	0.000	1.18	**	1	0.000	1.18	**	1	0.000
Highest education level		**	6	0.000		**	6	0.000		**	6	0.000		**	6	0.005		**	6	0.000
pre-primary	0.08		1	0.695	0.09		1	0.681	0.09		1	0.678	0.12		1	0.678	0.08		1	0.709
primary	0.26	**	1	0.005	0.26	**	1	0.005	0.25	**	1	0.006	0.32	**	1	0.005	0.25	**	1	0.006
lower secondary	0.10	*	1	0.037	0.10	*	1	0.035	0.10	*	1	0.039	0.06		1	0.337	0.10	*	1	0.036
upper secondary (default)																				
post-secondary non-tertiary	0.06		1	0.287	0.06		1	0.289	0.07		1	0.272	0.10		1	0.169	0.06		1	0.296
first stage tertiary	-0.20	**	1	0.000	-0.20	**	1	0.000	-0.20	**	1	0.000	-0.11	*	1	0.045	-0.20	**	1	0.000
second stage tertiary	-0.39	*	1	0.020	-0.40	*	1	0.019	-0.39	*	1	0.020	-0.33		1	0.185	-0.40	*	1	0.019
Country of birth			2	0.192			2	0.179			2	0.193			2	0.206			2	0.087
respondent and parents native born (default)																				
respondent native born, at least one parent not	0.11		1	0.122	0.11		1	0.118	0.10		1	0.130	0.11		1	0.129	0.13		1	0.055
respondent not native born	0.06		1	0.257	0.06		1	0.239	0.06		1	0.240	0.06		1	0.272	0.07		1	0.185
Hours worked per week		*	7	0.016		*	7	0.015		*	7	0.015		*	7	0.020		*	7	0.014
9-16	0.19	*	1	0.048	0.18		1	0.054	0.19	*	1	0.047	0.18		1	0.057	0.19	*	1	0.047
17-24	0.17	**	1	0.005	0.17	**	1	0.005	0.17	**	1	0.005	0.16	**	1	0.006	0.17	**	1	0.005
25-32	0.12	*	1	0.038	0.12	*	1	0.036	0.12	*	1	0.036	0.11	*	1	0.044	0.12	*	1	0.035
33-39	0.10	*	1	0.031	0.10	*	1	0.032	0.10	*	1	0.032	0.10	*	1	0.037	0.10	*	1	0.031
40 (default)																				
41-50	0.01		1	0.746	0.01		1	0.778	0.01		1	0.749	0.02		1	0.726	0.01		1	0.759
51-60	-0.09		1	0.212	-0.09		1	0.200	-0.09		1	0.209	-0.09		1	0.190	-0.09		1	0.201
> 60	0.08		1	0.516	0.08		1	0.544	0.08		1	0.502	0.08		1	0.528	0.08		1	0.521
Employment status			4	0.165			4	0.162			4	0.152			4	0.149			4	0.171
self-employed	-0.06		1	0.237	-0.06		1	0.247	-0.06		1	0.260	-0.06		1	0.258	-0.06		1	0.239
employee, indefinite contract (default)																				
employee, fixed term contract	0.04		1	0.424	0.04		1	0.414	0.04		1	0.437	0.05		1	0.378	0.04		1	0.434
temporary employment agency, apprenticeship	0.11		1	0.367	0.11		1	0.365	0.12		1	0.334	0.11		1	0.361	0.11		1	0.348
other	0.13		1	0.077	0.13		1	0.073	0.13		1	0.064	0.13		1	0.065	0.12		1	0.082

Variable	Model 11 (no interactions)				Model 12 (interactions with gender)				Model 13 (interactions with age)				Model 14 (interactions with education level)				Model 15 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Physical risk factors																				
Exposed to vibrations from hand tools etc.			3	0.410			3	0.447			3	0.405			3	0.360			3	0.411
(almost) never (default)																				
1/4 to 3/4 of the time	-0.01		1	0.857	0.00		1	0.997	-0.01		1	0.838	-0.01		1	0.887	-0.01		1	0.859
almost all of the time	-0.13		1	0.103	-0.12		1	0.125	-0.13		1	0.102	-0.14		1	0.089	-0.13		1	0.104
all of the time	-0.06		1	0.488	-0.05		1	0.527	-0.06		1	0.463	-0.06		1	0.436	-0.06		1	0.481
Job involves tiring or painful positions		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.41	**	1	0.000	0.42	**	1	0.000	0.42	**	1	0.000	0.41	**	1	0.000	0.41	**	1	0.000
(almost) all of the time	0.71	**	1	0.000	0.71	**	1	0.000	0.71	**	1	0.000	0.71	**	1	0.000	0.71	**	1	0.000
Job involves carrying or moving heavy loads		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.16	**	1	0.000	0.16	**	1	0.000	0.16	**	1	0.000	0.16	**	1	0.000	0.16	**	1	0.000
(almost) all of the time	0.25	**	1	0.000	0.25	**	1	0.000	0.25	**	1	0.000	0.25	**	1	0.000	0.25	**	1	0.000
Job involves repetitive hand or arm movements		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.16	**	1	0.000	0.16	**	1	0.000	0.17	**	1	0.000	0.16	**	1	0.000	0.16	**	1	0.000
(almost) all of the time	0.14	**	1	0.000	0.14	**	1	0.000	0.14	**	1	0.001	0.14	**	1	0.000	0.14	**	1	0.001
Job involves sitting		**	2	0.000		*	2	0.012		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	-0.14	**	1	0.000	-0.08		1	0.130	-0.14	**	1	0.000	-0.14	**	1	0.000	-0.14	**	1	0.000
(almost) all of the time	-0.33	**	1	0.000	-0.20	**	1	0.003	-0.33	**	1	0.000	-0.33	**	1	0.000	-0.33	**	1	0.000
Exposed to low temperatures (indoors or outdoors)		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
(almost) never (default)																				
1/4 to 3/4 of the time	0.22	**	1	0.000	0.22	**	1	0.000	0.22	**	1	0.000	0.22	**	1	0.000	0.22	**	1	0.000
(almost) all of the time	0.19	*	1	0.012	0.20	*	1	0.011	0.19	*	1	0.013	0.19	*	1	0.013	0.19	*	1	0.012
Able to choose order of tasks	0.06		1	0.060	0.06		1	0.065	0.83	*	1	0.044	0.07		1	0.051	0.06		1	0.062
Organisational and psychosocial risk factors																				
Anxiety last 12 months	0.20	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000	0.20	**	1	0.000
Overall fatigue last 12 months	0.81	**	1	0.000	0.81	**	1	0.000	2.07	**	1	0.000	0.81	**	1	0.000	0.81	**	1	0.000
Waking up repeatedly last 12 months		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
less often/never (default)																				
several times a week/month	0.30	**	1	0.000	0.30	**	1	0.000	0.30	**	1	0.000	0.33	**	1	0.000	0.30	**	1	0.000
daily	0.39	**	1	0.000	0.39	**	1	0.000	0.40	**	1	0.000	0.40	**	1	0.000	0.39	**	1	0.000
Waking up feeling exhausted last 12 months		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
less often/never (default)																				
several times a week/month	0.32	**	1	0.000	0.32	**	1	0.000	0.31	**	1	0.000	0.37	**	1	0.000	0.32	**	1	0.000
daily	0.36	**	1	0.000	0.36	**	1	0.000	0.35	**	1	0.000	0.42	**	1	0.001	0.36	**	1	0.000

Variable	Model 11 (no interactions)				Model 12 (interactions with gender)				Model 13 (interactions with age)				Model 14 (interactions with education level)				Model 15 (interactions with country of birth)			
	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.	B		df	Sig.
Last month at work subjected to verbal abuse	0.11	*	1	0.017	0.11	*	1	0.015	0.11	*	1	0.018	0.11	*	1	0.016	0.11	*	1	0.018
Last month at work subjected to threats	0.29	**	1	0.006	0.29	**	1	0.006	0.29	**	1	0.006	0.29	**	1	0.006	0.41	**	1	0.000
Mental well-being during past two weeks	0.14	**	1	0.000	0.14	**	1	0.000	0.14	**	1	0.000	0.14	**	1	0.000	0.14	**	1	0.000
Feeling energetic at work	0.07	**	1	0.004	0.07	**	1	0.005	0.07	**	1	0.004	0.07	**	1	0.004	0.07	**	1	0.005
Having enough time to get the job done		*	2	0.016		*	2	0.016		*	2	0.016		*	2	0.018		*	2	0.016
rarely or never (default)																				
sometimes/most of the time	0.14	**	1	0.005	0.15	**	1	0.005	0.15	**	1	0.005	0.14	**	1	0.006	0.14	**	1	0.005
all of the time	0.15	**	1	0.008	0.15	**	1	0.009	0.15	**	1	0.009	0.15	**	1	0.009	0.15	**	1	0.008
Knowing what is expected at work		*	2	0.032		*	2	0.031		*	2	0.028		*	2	0.042		*	2	0.033
rarely or never (default)																				
sometimes/most of the time	0.20		1	0.058	0.20		1	0.055	0.20		1	0.055	0.19		1	0.068	0.20		1	0.058
all of the time	0.25	*	1	0.017	0.25	*	1	0.016	0.25	*	1	0.016	0.24	*	1	0.022	0.25	*	1	0.017
Perceived relation work-health																				
Health or safety at risk because of work	0.19	**	1	0.000	0.19	**	1	0.000	0.19	**	1	0.000	0.19	**	1	0.000	0.19	**	1	0.000
Does your work affect your health		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000		**	2	0.000
yes, mainly positive	0.11	*	1	0.029	0.11	*	1	0.028	0.11	*	1	0.030	0.10	*	1	0.038	0.11	*	1	0.029
yes, mainly negative	0.40	**	1	0.000	0.40	**	1	0.000	0.40	**	1	0.000	0.40	**	1	0.000	0.40	**	1	0.000
no (default)																				
Interaction effects																				
Gender × Job involves sitting						*	2	0.013												
1/4 to 3/4 of the time					-0.12		1	0.094												
(almost) all of the time					-0.23	**	1	0.004												
Ln(age) × Able to choose order of tasks									-0.20		1	0.061								
Ln(age) × Overall fatigue past 12 months									-0.34	**	1	0.001								
Education × Waking up repeatedly last 12 months														*	12	0.010				
pre-primary × several times a week/month													-0.38		1	0.459				
pre-primary × daily													-2.37		1	0.055				
primary × several times a week/month													0.29		1	0.193				
primary × daily													0.12		1	0.728				
lower secondary × several times a week/month													0.04		1	0.702				
lower secondary × daily													-0.06		1	0.740				
post-secondary non-tertiary × several times a week/month													0.15		1	0.293				
post-secondary non-tertiary × daily													-0.45		1	0.069				
first stage tertiary × several times a week/month													-0.11		1	0.175				
first stage tertiary × daily													0.10		1	0.527				
second stage tertiary × several times a week/month													-1.06	**	1	0.009				
second stage tertiary × daily													0.34		1	0.622				

Variable	Model 11 (no interactions)			Model 12 (interactions with gender)			Model 13 (interactions with age)			Model 14 (interactions with education level)			Model 15 (interactions with country of birth)		
	B	df	Sig.	B	df	Sig.	B	df	Sig.	B	df	Sig.	B	df	Sig.
Education × Waking up feeling exhausted last 12 months											12	0.002			
pre-primary × several times a week/month										0.07	1	0.890			
pre-primary × daily										4.72 **	1	0.004			
primary × several times a week/month										-0.43 *	1	0.041			
primary × daily										-0.57	1	0.201			
lower secondary × several times a week/month										0.08	1	0.487			
lower secondary × daily										0.18	1	0.432			
post-secondary non-tertiary × several times a week/month										-0.23	1	0.087			
post-secondary non-tertiary × daily										0.47	1	0.153			
first stage tertiary × several times a week/month										-0.13	1	0.102			
first stage tertiary × daily										-0.38 *	1	0.035			
second stage tertiary × several times a week/month										0.52	1	0.164			
second stage tertiary × daily										0.17	1	0.869			
Country of birth × Unwanted sexual attention														*	2 0.021
respondents native born, at least one parent not													-1.17	*	1 0.013
respondents not native born													-0.48		1 0.153
Model statistics															
Number of observations			28670			28670			28670			28670			28670
Percentage predicted correctly			75.3			75.2			75.2			75.4			75.3
Nagelkerke R^2			0.289			0.289			0.289			0.291			0.289

Country differences

MSD prevalence shows considerable variation between countries. Additional logistic regressions were performed to examine to what extent country differences in the prevalence of MSDs can be explained by country differences in sector, occupation, sociodemographic characteristics of the workforce, prevalence of risk factors and attention of establishments to prevention measures. This involved estimating the following models:

1 A model with prevalence of at least one type of MSDs as the dependent variable, and country as the only explanatory variable. The estimated country parameters reflect the country differences in self-reported MSD prevalence. The variance of the estimated country parameters can be interpreted as a measure of the size of the country differences.

2 Add indicators for sector and country to the model from the previous step and estimate it again.

3 Add sociodemographic variables to the model from the previous step and estimate it again.

4 Add the significant risk factors to the model from the previous step and estimate it again.

5 Add the prevention indicators to the model and estimate it again.

For each of steps 2 to 5, the variance of the estimated country parameters of the adjusted model can be computed. If the variance is smaller than in the previous model, the differences between countries have on average become smaller. The results showed that country differences in the prevalence of only risk factors could help to explain part of the country differences in MSD prevalence (because only these variables reduced the standard deviation of the country parameters), but that the country differences in the complete model were very similar to the country differences in the empty model (Table 13). This is discussed in section 3.2.1 of the main text.

Table 13 Standard deviation of estimated country dummies in a logistic regression estimating prevalence of MSDs, for different model versions

Model	Standard deviation of country parameters
Base model (only country)	0.41
plus sector and occupation	0.43
plus sociodemographic variables	0.45
plus risk factors	0.39
plus prevention indicators	0.43

Source: Panteia, 2019

Annex 3 - Exploratory cluster analysis

For some workers, MSDs may be their only (work-related) health problem, while other workers may be susceptible to several health problems. This raises the question of how often MSD health problems coincide with other health problems, and if specific combinations of health problems could be identified that occur relatively often (see section 4.1.2). If that is the case, future studies might further examine these specific combinations of health problems (for example, to what extent these different health problems reinforce each other, and how this reinforcing effect could be broken).

Likewise, it may be relevant to know if certain combinations of physical, organisational and psychosocial risk factors occur more often than other combinations (see sections 5.1.4 and 5.2.4). If this is the case, future studies might examine which employees are exposed to these combinations of risk factors, and the effect on MSD prevalence of being exposed to these specific combinations of risk factors (in particular, to what extent different risk factors reinforce each other and increase the risk of developing MSDs).

Searching for combinations (or clusters) of health problems or risk factors is an example of exploratory analysis, aiming to generate hypotheses rather than testing hypotheses. Cluster analyses were applied to identify clusters of different risk factors (the results of which are discussed in section 5.1.4) and clusters of MSDs and comorbidities (the results of which are discussed in section 4.1.2).

Cluster analysis on risk factors

Which data were used

The cluster analysis on risk factors was performed using the sixth wave of the EWCS, because this survey includes indicators of three different types of MSDs as well as indicators of many different risk factors.

The analysis was conducted on the subsample of all respondents residing in an EU-28 Member State, aged 18 to 65 years old, who worked at least 12 hours per week in their main job. This subsample contained 31,662 respondents.

Which risk factors were included

As a starting point, all variables were considered for which the logistic regressions found a significant relationship to the prevalence of at least one of the three MSD types distinguished in the EWCS. These are described in health is at risk because of, or is affected by, their work. These are not risk factors, but rather indicators of the extent to which the respondents consider their working conditions (as evident from the other indicators in Table 14) to be a health risk.

- Two of the variables (based on Q73 and Q74) concern the extent to which the respondents believe their health is at risk because of, or is affected by, their work. These are not risk factors, but rather indicators of the extent to which the respondents consider their working conditions (as evident from the other indicators in Table 1) to be a health risk.
- Six risk factors are mentioned[191] by fewer than 5 % of all respondents (Q61h, Q61k, Q80b, Q80c, Q81a and Q81c). Including these risk factors makes it more difficult to identify a limited number of clusters that each account for a considerable proportion of all workers. These risk factors were therefore excluded from the cluster analysis.

[191] In cases of a three-point or seven-point scale, we consider a risk factor not to be mentioned if the answer is ‘almost never’ or ‘never’. In all other cases, we consider the risk factor to be mentioned.

Table 14 Significant risk factors

Variable	Description	Measurement level
Psychosocial risk factors		
y15_Q29a	Are you exposed at work to vibrations from hand tools?	7-point scale
y15_Q29d	Are you exposed at work to low temperatures whether indoors or outdoors?	7-point scale
y15_q30a_cat	Does your main paid job involve tiring or painful positions?	3-point scale
y15_q30c_cat	Does your main paid job involve carrying or moving heavy loads?	3-point scale
y15_q30d_cat	Does your main paid job involve sitting?	3-point scale
y15_Q30e_cat	Does your main paid job involve repetitive hand or arm movements?	3-point scale
Organisational and psychosocial risk factors		
y15_Q50b	Is your pace of work dependent on direct demands from people such as customers etc?	Dummy
y15_Q50e	Is your pace of work dependent on the direct control of your boss?	Dummy
y15_Q54a	Are you able to choose or change your order of tasks?	Dummy
y15_Q61f_cat	Which best describes your work situation — You can take a break when you wish?	3-point scale
y15_Q61g_cat	Which best describes your work situation — You have enough time to get the job done?	3-point scale
y15_Q61h_cat	Which best describes your work situation — Your job gives you the feeling of work well done?	3-point scale
y15_Q61k_cat	Which best describes your work situation — You know what is expected of you at work?	3-point scale
y15_Q61l_cat	Which best describes your work situation — You are treated fairly at your workplace?	3-point scale
y15_Q61o_cat	Which best describes your work situation — Your job requires that you hide your feelings?	3-point scale
y15_Q61m_cat	Which best describes your work situation — You experience stress in your work?	3-point scale
Employee voice	Which best describes your work situation — You have a voice in the organisation of your work (constructed scale)	Continuous
Mental well-being	Been feeling over the last two weeks — feeling well (constructed scale)	Continuous
Energised	How often do you feel this way — energetic (constructed scale)	Continuous
y15_q73	Do you think your health or safety is at risk because of your work?	Dummy
y15_q74	Does your work affect your health?	Dummy
y15_Q78h	Last 12 months any health problems — Anxiety?	Dummy
y15_Q78i	Last 12 months any health problems — Overall fatigue?	Dummy
y15_Q79a_cat	Last 12 months sleep related problems — Difficulty falling asleep?	Dummy
y15_Q79b_cat	Last 12 months sleep related problems — Waking up repeatedly during sleep?	Dummy
y15_Q79c_cat	Last 12 months sleep related problems — Waking up with a feeling of exhaustion and fatigue?	Dummy
y15_Q80a	Last month, at work subjected to any of the following — Verbal abuse?	Dummy
y15_Q80b	Last month, at work subjected to any of the following — Unwanted sexual attention?	Dummy
y15_Q80c	Last month, at work subjected to any of the following — Threats?	Dummy
y15_Q81a	Past 12 months, at work subjected to any of the following — Physical violence?	Dummy
y15_Q81c	Past 12 months, at work subjected to any of the following — Bullying/harassment?	Dummy

Source: Panteia, 2019

After these eight variables were removed, a list of 23 risk factors remained. The number of risk factors that were mentioned by respondents in the subsample varies between 1 and 21. None of the respondents mentioned zero risk factors.

Notice that the causality of the relationship between MSD complaints and factors such as anxiety, fatigue and sleeping problems may run both ways: these variables may be risk factors as well as outcomes. Consequently, these factors could be included in the logistic regressions and the cluster analysis of risk factors, as well as in the cluster analysis on MSDs and comorbidities.

Which cluster methodology was used

Different cluster methodologies are available:

- Hierarchical cluster: this method generates a series of models with cluster solutions from 1 (all cases in one cluster) to *n* (each case is an individual cluster). In case of large datasets, this methodology requires a considerable amount of time. Hierarchical cluster analysis can handle nominal, ordinal and scale data; however, it is not recommended to mix different levels of measurement.
- K-means cluster: for this method the number of clusters has to be defined in advance (and preferably also an estimate of the average scores per cluster for each variable), after which the procedure quickly classifies all variables. This method is often combined with hierarchical cluster analysis: a hierarchical cluster analysis is performed to determine the number of clusters (and the average scores per cluster for each variable), after which K-means clustering can be applied to determine the final cluster solution.
- Two-step cluster analysis: this method identifies groupings by running pre-clustering first and then running hierarchical methods — in this respect, it can be seen as a combination of the previous two approaches. Two-step clustering can handle scale and ordinal data in the same model, and it has the option to automatically select the optimal number of clusters.

The available indicators for the different risk factors are a combination of scale variables, ordinal variables and dichotomous (dummy) variables. Hierarchical cluster analysis is not a suitable method for this combination of variables (which also applies to K-means clustering, if only because it requires a hierarchical cluster analysis first to determine an initial cluster solution). For this reason, a two-step cluster analysis was performed to cluster the data on risk factors.

To increase the quality of the outcomes, the observations in the dataset were ordered randomly before applying the two-step cluster algorithm. To identify possible clusters, the cluster analysis was performed on unweighted data. When the outcomes were presented, weights were used to arrive at a representative distribution of workers among the identified clusters.

How many clusters were distinguished

The number of clusters distinguished was based on the following three available indicators:

- Silhouette measure of cohesion and separation.
- An information criterion (IC), which is either the Bayesian information criterion (BIC) or the Akaike information criterion (AIC). Both have been used to check if the number of clusters depends on the choice for a specific IC (which has not been the case).
- The distance measure (since most of the variables involved are either ordinal or dichotomous, the only valid distance measure is the log likelihood).

The silhouette measure of cohesion and separation can be used as an indicator for the goodness of fit of the chosen solution. This indicator ranges from -1 to +1. Positive values indicate that the average distance between cases in a cluster is smaller than the average distance to cases in other clusters, and

are thus desirable. According to Finch *et al*. (2015)[192], there is no common understanding of how to interpret the values for this measure. Rather than using criteria based on theoretical arguments, criteria on when a silhouette is considered to be good enough are based on the experience of researchers in their own particular field. A generally accepted criterion is that, if the silhouette measure is < 0.2, then the quality of the average silhouette measure across the whole sample is considered poor, between 0.2 and 0.5 indicates a fair solution and > 0.5 is a good solution. These criteria are also suggested by SPSS. The silhouette measure may increase with the number of clusters that are distinguished, so this measure cannot be used on its own to determine the optimal number of clusters.

The two-step procedure offers the possibility to automatically detect the optimal number of clusters. This is based on two criteria:

- an IC;
- the distance measure.

The cluster procedure determines the value of the chosen IC for each potential number of clusters. Smaller values of the IC indicate better models, so, if a solution exists where the minimum value of the IC is reached for a limited number of clusters, this will be the optimal solution. However, there are clustering problems in which the IC will continue to decrease as the number of clusters increases, but where the improvement in the cluster solution (as measured by the change in the IC) is not worth the increased complexity of the cluster model (as measured by the number of clusters). In such situations, the changes in IC and changes in the distance measure are evaluated to determine the 'best' cluster solution.

To determine the number of clusters of risk factors, the following procedure was applied:

1. Automatically select the optimal numbers of clusters, based on the IC and distance measure.
2. Determine the silhouette measure for this solution.
    - If this is 0.2 or higher (fair solution), consider this the final cluster solution.
    - If it is less than 0.2 (a poor solution), consider the values for the IC.
        - If the IC continues to decrease if the number of clusters increases, then determine whether or not the silhouette measure increases (to levels > 0.2) if the number of clusters is manually increased. If this occurs for a reasonable number of clusters (say, no more than 12), consider this the final cluster solution. Otherwise, the conclusion should be that it is not possible to determine a meaningful clustering.
        - If the IC reaches a minimum value for this solution, conclude that it is not possible to come up with an acceptable clustering of the respondents.

No meaningful cluster solution was found for all risks combined

This procedure did not find a meaningful cluster solution for the group of 23 significant risk factors. When the two-step cluster procedure was set to automatically determine the optimal number of clusters, a four-cluster solution resulted. The silhouette measure for this solution was only 0.1, which meant that the average distance between cases in a cluster was only slightly smaller than the average distance to cases in other clusters. This was considered to be a poor solution. Manually increasing the number of clusters did not result in a noticeable increase of the silhouette measure. The conclusion was therefore that it was not possible to come up with a meaningful clustering regarding these risk factors.

[192] Finch, C. F., Stephan, K., Wong-Shee, A., Hill, K., Haines, T. P., Clemson, L. & Day, L., 'Identifying clusters of falls-related hospital admissions to inform population targets for prioritising falls prevention programmes', *Injury Prevention, V*ol. 21, No 4, 2015, pp. 254-259.

No meaningful cluster solution found for organisational and psychosocial risks

The same conclusion held for the subgroup of 17 organisational and psychosocial risks.

Four-cluster solution found for physical risks

For the subgroup of six physical risk factors, it was possible to find a meaningful cluster solution.

This cluster analysis was performed on all respondents who mentioned at least two risk physical risk factors (if no or one physical risk factor was mentioned, combinations of risk factors are by definition impossible). When the two-step cluster procedure was set to automatically determine the optimal number of clusters, this resulted in a solution with two different clusters (for both information criteria) with a reasonable silhouette measure (0.3).

In addition to these two clusters, the data also included a cluster of workers who mentioned only one physical risk factor and a cluster of workers mentioning no physical risk factors. Combined, this resulted in a classification into the following four clusters (these clusters are also presented in section 5.1.4):

- Cluster 1: no physical risk factors
  For a small percentage of all workers (7 %), none of the six physical risk factors applies[193]. For all three types of MSDs considered, the prevalence is lowest for this group. Likewise, only relatively few workers from this group (9 %) reported that their health or safety is at risk because of their work.
- Cluster 2: one physical risk factor
  For about a quarter of all workers (24 %), one of the six physical risk factors applies[194]. The prevalence of MSDs is slightly higher than for the 'zero-risk' cluster, but the differences are not very large. Also in this cluster, relatively few workers (12 %) reported that their health or safety is at risk because of their work.
- Cluster 3: sitting and other factor(s)
  Approximately 36 % of the workers belong to this group, which consists of workers whose job often involves sitting for around a quarter of the time or more (more precisely, this applies to 88 % of the workers in this group). Consequently, most of the workers from this group do not often carry or move heavy loads[195]. On average 2.5 of the 6 risk factors applies to workers from this group. While sitting was not associated with higher MSD prevalence, the other risk factors were. Overall, the prevalence of MSDs among workers from this group is considerably higher than for the first two groups, and almost one in every five workers (19 %) report that their health or safety is at risk because of their work.
- Cluster 4: heavy loads and other factor(s)
  This cluster accounts for 33 % of all workers and consists of workers who have to carry or move heavy loads for at least a quarter of the time or more (this applies to approximately 88 % of the workers in this group). Consequently, prolonged sitting does not apply to most workers from this group[196]. In addition to carrying or moving heavy loads, workers from this group are also more likely to be faced with vibrations from hand tools, etc., to be exposed to low temperatures (whether indoors or outdoors) or to be working in tiring or painful positions. On average 3.7 of the 6 risk factors apply to workers from this group. All of these risk factors are associated with a higher risk of MSDs, so it is not surprising that the prevalence of MSDs is highest for this

[193] Each of these risk factors occurs (almost) never.
[194] One risk factor occurs at least a quarter of the time; the remaining five risk factors occur (almost) never.
[195] Only 4 % of the workers in this group reports that their job involves carrying or moving heavy loads for around a quarter of the time or more.
[196] Approximately 80 % of the workers from this group report sitting for around a quarter of the time or less.

cluster. This applies to all three MSD types considered. In addition, 40 % of the workers reported that their health or safety is at risk because of their work.

The distribution across these four clusters is different for male and female workers: in particular, female workers more often combine sitting with (an)other factor(s) and less often carrying heavy loads with (an)other factor(s). This was consistent with the finding that male workers are more likely to report carrying or moving heavy loads, working at low temperatures and/or vibrations from hand tools, machinery, etc. for at least a quarter of the time.

Conclusions

Although the clustering of physical risk factors has resulted in a meaningful four-cluster solution, the main objective of this analysis was to search for specific combinations of physical, organisational and psychosocial risk factors. Such combinations were not found (the applied cluster algorithm could not identify a cluster solution with a silhouette measure of cohesion and separation of at least 0.2). No new hypotheses were formulated that could be examined in a follow-up study.

Cluster analysis on MSDs and comorbidities

Which data were used

The cluster analysis on health problems was performed using the sixth wave of the EWCS, because this survey includes indicators on various health problems (including three different types of MSDs).

The analysis has been conducted on the subsample of all respondents residing in an EU-28 Member State, aged 18 to 65 years old, who worked at least 12 hours per week in their main job. This subsample contains 31,662 respondents.

A similar cluster analysis was also performed using the second wave of EHIS, on the subsample of all respondents residing in an EU-28 Member State, aged 18 to 65 years old, whose main status is ‘working’. This subsample contains 125,464 respondents. This survey includes indicators for 15 different chronic health problems, including two types of chronic MSDs. The prevalence of these chronic health problems is, however, not very high: the highest prevalence rates are found for allergies (15 %) and chronic back problems (16 %); all other health problems are mentioned by 10 % or fewer. Overall, 54 % of all workers from the subsample report no health problems, another 25 % report only one health problem and only 21 % report two or more health problems (12 % of which group report exactly two health problems each). The outcomes of this cluster analysis were not very informative regarding the clustering of health problems and are therefore not discussed in this study.

Which health problems were included

The sixth wave of the EWCS includes two questions on the prevalence of various health problems and sleeping-related problems during the past 12 months. The cluster analysis was based on the answers to these two questions. Together, these two questions ask about 13 different health problems including three MSD types (back, upper limbs and lower limbs). Some of these health problems can also be interpreted as risk factors (to the extent that the prevalence of these health problems may increase the risk of acquiring MSDs). These health factors were therefore also included in the logistic regressions and the cluster analysis of risk factors.

Table 15 MSDs and other health problems — EWCS

Variable	Health problems during past 12 months	Measurement level
MSD_back	Backache	Dummy
MSD_upper	Muscular pains in shoulders, neck and/or upper limbs	Dummy
MSD_lower	Muscular pains in lower limbs	Dummy
Y15_Q78a	Hearing problems	Dummy
Y15_Q78b	Skin problems	Dummy
Y15_Q78f	Headaches, eyestrain	Dummy
Y15_Q78g	Injury(ies)	Dummy
Y15_Q78h	Anxiety	Dummy
Y15_Q78i	Overall fatigue	Dummy
Y15_Q78j	Other (spontaneous)	Dummy
Y15_Q79a	Difficulty falling asleep	5-point scale
Y15_Q79b	Waking up repeatedly during sleep	5-point scale
Y15_Q79c	Waking up with a feeling of exhaustion and fatigue	5-point scale

Source: Panteia, 2019

For most health problems one indicator is available. There are, however, exceptions: for MSDs and sleep problems, three indicators are available. If all of these indicators were included, MSD complaints and sleeping problems would have a larger effect on the clustering solution than the other health problems. For MSD problems this is not a problem, given the topic of this study. For sleeping problems, however, it is a problem. To solve this problem, only one indicator regarding sleeping problems was used for the cluster analysis. Since the third indicator on sleeping problems (waking up with a feeling of exhaustion and fatigue) is related to the prevalence of 'overall fatigue', a separate indicator was constructed for the remaining two sleeping problems (difficulties falling asleep and/or waking up repeatedly, at least several times a month). This indicator was used to cover sleeping problems in the cluster analysis. The cluster analysis was thus performed on 11 different indicators (the first 10 indicators from table 15 in combination with the constructed indicator for sleeping problems).

Which cluster methodology was used

All available indicators on health problems are dummy variables. These can be analyses with either a hierarchical or a two-step cluster analysis. To be consistent with the cluster analysis of risk factors, the two-step cluster analysis was used.

The observations were ordered randomly before the two-step cluster algorithm was applied, in order to increase the quality of the outcomes. To identify possible clusters, the cluster analysis was applied to

unweighted data. To describe the outcomes, weights were used to arrive at a representative distribution of workers among the identified clusters.

How many clusters were distinguished

To determine the number of clusters of risk factors, the following procedure was applied:

1. Automatically select the optimal numbers of clusters, based on the IC and distance measure.
2. Determine the silhouette measure for this solution.

   2.1 If this is 0.2 or higher (fair solution), consider this the final cluster solution.

   2.2 If it is less than 0.2 (a poor solution), consider the values for the IC.

      2.2.1 If the IC continues to decrease if the number of clusters increases, then determine whether or not the silhouette measure increases (to levels > 0.2) if the number of clusters is manually increased. If this occurs for a reasonable number of clusters (say, no more than 12), consider this the final cluster solution. Otherwise, the conclusion should be that it is not possible to determine a meaningful clustering.

      2.2.2 If the IC reaches a minimum value for this solution, conclude that it is not possible to come up with an acceptable clustering of the respondents.

Four-cluster solution found

When the two-step cluster procedure was set to automatically determine the optimal number of clusters, a four-cluster solution resulted. The silhouette measure for this solution is 0.3, which was considered to be a fair solution. Nevertheless, since a division into only two clusters may be less relevant from a policy point of view, the number of clusters was manually increased to see if a solution could be identified with more clusters that were intuitively easier to interpret, without a reduction in the silhouette measure. This turned out to be the case: a four-cluster solution could be identified with a silhouette measure of 0.3 and a meaningful interpretation of the identified clusters (these clusters are also presented in section 4.1.2):

- Cluster 1: no health problems
  This cluster includes about 23 % of all workers. It combines all workers without any reported health problems. The large majority of these workers believe that their health or safety is not at risk because of their work (92 %).
- Cluster 2: few health problems
  Workers with only a few reported health problems are combined into the second cluster, which includes about 33 % of all workers. Workers in this group report on average 2.0 different health problems (ranging from one to five). Most of these health problems are related to MSDs (45 % report back problems, 42 % report MSD problems in the upper limbs, 24 % report MSDs in the lower limbs); other health complaints that are often mentioned include headaches (36 %), sleeping problems (39 %) and overall fatigue (13 %).
- Cluster 3: MSDs and/or other physical health problems
  This cluster includes about 23 % of all workers, who on average report 4.6 different health problems (ranging from 1 to 11). All workers with hearing problems, skin problems and injuries are included in this cluster. In addition, 51 % report overall fatigue, 49 % report headaches, 55 % report sleeping problems and 32 % report anxiety. MSDs are also often mentioned: 58 % report back problems, 57 % report MSD problems in the upper limbs and 44 % report MSDs in the lower limbs.
- Cluster 4: MSDs and fatigue
  The fourth cluster includes about 21 % of all workers, who on average report 4.5 different health problems (ranging from two to seven). The main characteristic of this cluster is that it combines MSD complaints with fatigue: almost all workers in this cluster (92 %) report overall fatigue, and it also has the highest proportion of MSD complaints (74 % report back problems, 70 % report

MSD problems in the upper limbs, 52 % report MSDs in the lower limbs). In addition, 63 % report headaches, 55 % report sleeping problems and 41 % report anxiety.

The distribution of workers among these four clusters did not show large gender differences, although male workers are somewhat more likely to report no health problems, whereas female workers are more likely to report MSDs in combination with fatigue.

Conclusions

If a cluster analysis is applied to the population of all workers, these workers will be grouped based on the *number* of health problems rather than the *nature* of their health problems. That is perhaps the most important conclusion of this cluster analysis. For a better understanding of combinations of different health problems, future studies might focus on workers reporting several health problems and/or use data sources other than the sixth wave of the EWCS or the second wave of EHIS.

Annex 4 - Surveys and administrative data sources

European Working Conditions Survey

The EWCS was set up as a repeated cross-sectional study by the European Foundation for the Improvement of Living and Working Conditions. Since 1990 the EWCS has provided information about trends regarding working conditions for employees and self-employed workers throughout the European Union. In particular, it aims to assess and quantify these conditions on a harmonised basis, to analyse relationships between different aspects of these conditions, to identify groups at risk, issues of concern and areas of progress, and to contribute to European policy development with regard to the quality of work and employment problems.

The EWCS is conducted every 5 years, and in 2015 the sixth wave was conducted. In each wave, a random sample of workers is interviewed face to face. Data are collected at national level, after which Eurostat collects, checks and combines the national datasets into a single annual dataset. The number of participating countries has increased over time, and so has the number of completed interviews: from 12,800 in 1991 to more than 40,000 in each of the past three waves (2005, 2010 and 2015).

The EWCS was used in this study to collect information and monitor trends in working conditions for employees throughout the European Union. The survey provides data on the prevalence of self-reported MSDs and other work-related health risks, as well as the occurrence of exposure to risk factors in the work environment. The data that were used relate to the three last waves of the survey (2005, 2010 and 2015).

European Health Interview Survey

EHIS measures the health status (including disability), health determinants (including environment) and use of and limitations in access to healthcare services of EU citizens on a harmonised basis and with a high degree of comparability among the EU Member States. EHIS covers the general population aged 15 or over living in private households residing in the territory of the country.

So far, EHIS has been conducted twice. The first wave was conducted between 2006 and 2009. Participating countries were flexible in adapting the common questionnaire and in modes of data collection for this wave. Comparing the results between countries for this first wave is therefore not without risks.

The second wave was conducted between 2013 and 2015. For this second wave, all participating countries had to adhere to the same set of variables that had to be collected, following the Commission implementing regulation on EHIS. As a result, the data collected from this second wave are comparable across all Member States. In 10 countries, national questionnaires comprised additional questions to those specified in the Commission regulation.

In this report, data from the second wave were used to analyse the prevalence of chronic MSDs among the working population across EU Member states.

European Labour Force Survey

The LFS is a rotating random sample survey of persons in private households. The regular LFS does not include questions regarding MSDs, but three ad hoc modules were conducted that cover MSDs. These three ad hoc modules were conducted in 1999 (named ‘Accidents at work and occupational diseases’), 2007 and 2013 (named ‘Accidents at work and work-related health problems’) and cover accidents at work occurring during the past 12 months, as well as non-accidental health problems from which the respondent suffered during the past 12 months.

The target population for the LFS consists of all residents aged 15 or more who are working or have worked (this includes self-employed workers). The LFS is collected by directly interviewing sampled individuals. The national statistical institutes are responsible for selecting the sample, preparing the questionnaires, conducting the direct interviews in households and forwarding the results to Eurostat in

accordance with the requirements of the regulation. The LFS ad hoc module from 2013 covers all EU-28 Member States except the Netherlands (where the ad hoc module has not been conducted). Germany did not send micro-data to Eurostat but aggregated data in accordance with the dissemination tables published by Eurostat.

For this study, the LFS ad hoc module from 2013 was used to analyse data on the prevalence of work-related MSDs and other health issues.

European Survey of Enterprises on Emerging Risks

ESENER is an extensive survey that aims to provide nationally comparable data on how workplaces across Europe manage safety and health risks in practice.

Since 2009, ESENER has been conducted once every 5 years. Currently, three waves are available: 2009, 2014 and 2019.

For the first wave, the universe of the survey consists of all establishments in the countries covered that have 10 or more employees, across all sectors of economic activity except agriculture, forestry and fishing (and households and extraterritorial organisations).

For the second wave, the universe has been enlarged in two ways:

- it also includes establishments with 5 to 10 employees;
- it also includes establishments from the agriculture, forestry and fishing sector.

Interviews were conducted using computer-assisted telephone interviewing or computer-assisted web interviewing.

ESENER was used in this report to analyse data on preventive measures that enterprises take in order to protect their employees from these risk factors.

European Statistics on Accidents at Work

ESAW collects data on accidents at work from national sources including national public and private insurance companies and other national authorities (e.g. the labour inspectorate). ESAW is based on administrative data, except in the case of the Netherlands, for which accident data are based on survey data.

The data available begin in the reference year 1994 and include fatal and non-fatal accidents involving more than 3 calendar days of absence from work.

ESAW was used in this report to analyse data on the prevalence of fatal and non-fatal accidents at work and to monitor the trends in fatal and non-fatal accidents that can lead to MSDs.

World Health Organisation European Health for All database

WHO collects data on discharges after hospitalisation due to different types of accidents or diseases. This database is one of the four databases of the European Health Information Gateway. HFA data are collected from several sources including WHO and Europe's technical programmes, partner organisations (for instance Eurostat), UN agencies, the Organisation for Economic Co-operation and Development and a network of country experts.

In this report, HFA data have been used regarding discharges per 100,000 after hospitalisation due to diseases of the musculoskeletal system and connective tissue diseases.

World Health Organisation European Mortality Database

WHO annually collects mortality data from all Member States. These mortality data are based on the civil registration systems of each country and includes mortality data by age, gender and cause of death. Data for Europe are made available through the European Mortality Database, which is part of the European Health Information Gateway.

In this report, Mortality Database data were used to collect information on the number of deaths per 100,000 persons due to diseases of the musculoskeletal system and connective tissue.

The European Agency for Safety and Health at Work (EU-OSHA) contributes to making Europe a safer, healthier and more productive place to work. The Agency researches, develops, and distributes reliable, balanced, and impartial safety and health information and organises pan-European awareness raising campaigns. Set up by the European Union in 1994 and based in Bilbao, Spain, the Agency brings together representatives from the European Commission, Member State governments, employers' and workers' organisations, as well as leading experts in each of the EU Member States and beyond.

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