

## NEW FORMS OF WORK IN THE DIGITAL ERA: IMPLICATIONS FOR PSYCHOSOCIAL RISKS AND MUSCULOSKELETAL DISORDERS

### Box 1: Context

The contextual basis for this work is provided by the Healthy Workplaces Campaign 2020-2022 focusing on MSDs (musculoskeletal disorders), organised by the European Agency for Safety and Health at Work (EU-OSHA).

This article will present the current state of scientific knowledge on the way in which psychosocial factors influence the genesis of work-related MSDs (WRMSDs), their development and their impact on work.

### 1. Introduction

The digitalisation of the economy has already considerably changed the nature and organisation of work across Europe, including working time, place of work, use of information and communications technologies (ICTs) (e.g. teleworking, platform work, ICT-based mobile work) and the forms of employment status (EU-OSHA, 2018; McKinsey Global Institute, 2020). The so-called Industry 4.0 relies on further digitalisation and the automation of tasks and integration of ICTs, such as the internet of things (IoT; interconnection between objects and people through communication networks), artificial intelligence (AI), cloud-based systems, collaborative robotics (cobots), additive manufacturing, big data analytics and cyber-physical systems (Neumann et al., 2021). These systems allow new forms of working organisation and new ways of working, such as 'smart factories' and 'online platforms', in which humans, machines and products communicate with each other through both physical and virtual means (EU-OSHA, 2019c).

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According to an EU-OSHA foresight study (EU-OSHA, 2018) and continuing research in the area of digitalisation and occupational safety and health (OSH) (EU-OSHA, 2021a, 2021b), digitalisation and new forms of work may be a Janus-like process in 2025, for which it is difficult to predict the relative part of the positive and negative faces. Such revolution may potentially expand productivity and economic growth in Europe, but it may also increase the social and health inequalities in the working population. Likewise, there could be major gains in higher-skilled jobs but also significant losses in medium-skilled jobs. Major changes to the nature of work and the distribution of jobs between sectors are expected, rendering the workforce more diverse and dispersed, with frequently changing jobs and teleworking.

**Box 2:** An interdisciplinary methodological approach has been chosen to synthesize findings on WRMSDs and psychosocial factors at work in the scientific literature from various disciplines (biomechanics, neurobiology, psychology, epidemiology, sociology, management, and ergonomics). Due to the relatively small number of studies on the impact of new forms of work and digitalisation on, on the one hand, the exposure to psychosocial risk factors at work and, on the other hand, WRMSDs, a narrative review will be performed. The main databases (PubMed, Web of Sciences, Scopus, Psych Info, Google scholar) has been studied (articles in English and French), as the grey literature from the main international agencies on economics, statistics, work (OECD, ILO, Eurofound, European Commission, European Trade Union Institute, Eurostat), and occupational health and safety (EU-OSHA, HSE, IRSST, INRS, NIOSH)

## 2. Context of digitalisation and new forms of work

### 2.1. The digitalisation of the economy

**The digitalisation of the economy** is a complex and protean phenomenon covering a wide range of jobs and working conditions following the spread of robotisation in all its forms (material and virtual), new forms of work (e.g. remote work and virtual work including telework), new forms of employment or 'platformisation' of employees'/employers' 'standard' forms of work (e.g. digital platforms to 'intermediate' between individual suppliers (platform workers) and buyers of labour, or to allocate tasks to employees and monitor their performance) and new business models (e.g. the platform economy) (Degryse, 2017; Bérastégui, 2021). Depending on the pace of automation adoption, 22 % of current work activities (equivalent to 53 million jobs) in the EU could be automated by 2030, assuming a midpoint scenario. More than half of Europe's workforce will face significant job transitions requiring the acquisition of new skills (McKinsey Global Institute, 2020).

**Robotisation** includes all the computerisation and automation phenomena to carry out routine, and non-routine, manual and cognitive tasks (smart factories, driverless cars, three-dimensional (3D) printers, algorithmic production process management and control systems, AI, etc.) (Degryse, 2017). The robotisation in the production sector and the digitalisation of the supply chain will profoundly modify the way in which products are designed and produced and, consequently, the work organisation and working environment. Industry 4.0 may open opportunities for the improvement of OSH by reducing physically demanding work and removing workers from hazardous environments; however, it may also create more challenges by increasing social isolation and psychosocial stressors (EU-OSHA, 2018; Robelski and Sommer, 2020; Neumann et al., 2021).





**The new forms of work** in the digital economy rely on ubiquitous connectivity, data and new forms of mobile devices (mobile phones, tablets, etc.), allowing access to the internet always and everywhere and to dynamic websites (online platforms), creating digital public squares or marketplaces (EU-OSHA, 2017). Digital platforms facilitate or 'intermediate' online or on-location services provided by an individual to a client over a network (e.g. Facebook), allow access to on-demand physical services (e.g. Uber or Deliveroo), including commercial services (e.g. Amazon), and allow access to a virtual labour market in which workers can supply services (e.g. from online microtasks such as tagging pictures or reviewing content to professional services, such as coding, programming, architecture and design services). The platforms allow the matching of supply of and demand for such services. Big data permit the merging by internet platforms of colossal masses of directly exploitable commercial, personal and geographical data.

New business models based on online outsourcing (e.g. Upwork, Amazon Mechanical Turk, Freelancer) are growing thanks to high-speed networks. According to Huws (2020) about 2.9 % of the workers from the seven European countries<sup>1</sup> studied earned at least 50 % of their income from platform work in 2016-2017. In the United Kingdom — where trend data are available — the sector is growing fast, with a doubling in the past 3 years (2016-2019): 1 in 10 working adults now carry out platform work at least once a week (Huws, 2020).

Platform work is intricately linked to a broader trend towards precarious and informal work outside existing labour protection regulations (Huws et al., 2020). **New forms of work** employing new types of workers are emerging, such as **crowd working**, in which a myriad of workers (the 'crowd') can engage with work 24/7 almost everywhere (Degryse, 2017; Bérastégui, 2021). This trend also concerns traditional 'standard' forms of work, which are increasingly exposed to platformisation, leading to increasing fragmentation of the work tasks — which are allocated through digital platforms — and enhanced monitoring of their performance. Such evolution may be a two-faced process with more or less numerous winners and losers, involving the development of, on the one hand, **microwork** — poorly paid work (by the task) requiring few qualifications to perform small tasks — and, on the other hand, **online freelancing** — involving qualified self-employed workers (translators, accountants, etc.) looking for new customers and setting their own conditions and charges (Degryse, 2017). Archetypical examples are the Amazon Mechanical Turk platform for the former and the Upwork platform for the latter (Degryse, 2017). In contrast to workers assigned to a microwork platform, offering very little operational leeway or potential for professional development, online freelancers can adapt their working activities to their needs and non-work duties (Kotera and Correa Vione, 2020).

The digitalisation of work accelerates the long-term trends in ever-changing work organisation, which started 20 or 30 years ago, with increased **temporal flexibility** (variation in the numbers of hours worked and the timing of the work, e.g. flexitime) and **spatial flexibility** (allowing work tasks to be carried out almost everywhere, notably at home). Highly flexible organisations would require participative management practices to compensate for the lack of face-to-face interactions (Kotera and Correa Vione, 2020). However, the complexity can often be sorted out by various forms of 'digital Taylorism', which relies on very strict work prescription and tight digital monitoring of workers' performance. Such algorithmic management practices and digital surveillance reduce workers' operational leeway and involve new OSH risks. As with digitalisation, such **management practices** may, depending on the context of implementation, influence occupational health positively — by increasing workers' autonomy and professional development — or negatively — by increasing exposure to psychosocial stressors. According to the European Company Survey 2019 (Eurofound, 2020b), about half of establishments in the EU-27 and the United Kingdom used data analytics for process improvement (24 %), monitoring employees (5 %) or both (22 %).

The spread of the digital economy will reinforce the structural changes in the labour market segmentation by **age and gender categories** (McKinsey Global Institute, 2020). In many countries, the number of older workers using ICT is growing fast (Borle et al., 2021), while the extension of working lives due to insufficient pension entitlement, partial retirement schemes and multiple job-holding after retirement are promoted by the digital economy (Degryse, 2016). This may contribute to counterbalancing the ageing of the European workforce, exposing **older workers**, who are most at risk, to WRMSDs for longer periods (Roquelaure, 2018).

<sup>1</sup> Austria, Germany, Italy, the Netherlands, Sweden, Switzerland and the United Kingdom.

### 3. Effects of digitalisation and new forms of work on WRMSDs

#### 3.1. Relationships between biomechanical, organisational and psychosocial factors at work and WRMSDs

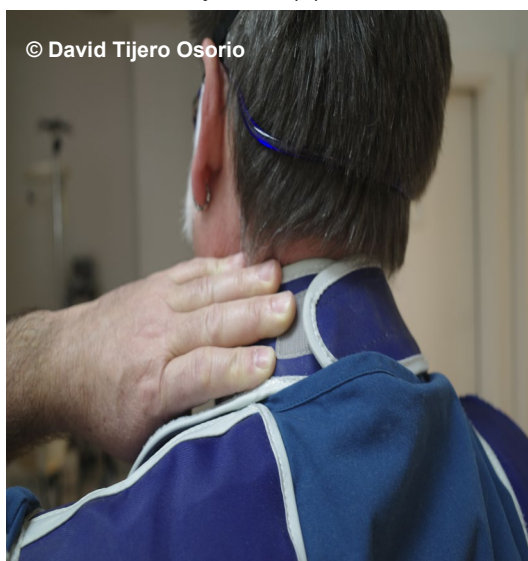
WRMSDs represent the main occupational health issue in Europe, together with work-related psychosocial issues, according to the periodic European Working Conditions Surveys (EWCSs) (EWCS, 2005, 2010, 2015) and the ESENER surveys (EU-OSHA, 2019e). MSDs are a major source of pain and discomfort in most sectors and occupations, leading to disability, long-term sick leave and job loss in the most severe chronic cases (some 5-10 % of all cases) (Roquelaure, 2018).

There is a consensus on the **multifactorial nature of WRMSDs** (EU-OSHA, 2020f) involving work-related biomechanical, organisational and psychosocial factors in addition to personal and medical factors. These factors are interrelated and may intervene both as (a) aetiological factors — influencing the onset of an episode of pain or significant functional impairment — and/or as (b) prognostic factors for chronicity or long-term disability (Roquelaure, 2018).

**The main work-related biomechanical risk factors for WRMSDs** are the physical work load, repetitiveness of movements, force intensity, uncomfortable postures, exposure to hand- and whole-body transmitted vibrations and localised pressure (da Costa and Vieira, 2010; Kozak et al., 2015; van der Molen et al., 2017; Roquelaure, 2018; EU-OSHA, 2019f, 2020e, 2020f). Schematically, two categories of work situation are at high risk of WRMSDs:

- a. **intensive dynamic motor tasks** requiring repetitive and/or forceful movements ('periarticular soft tissue overuse'), leading to muscular pain, tendinopathies and nerve entrapment, as frequently observed in European workers in the agriculture, industry and services sectors (EU-OSHA, 2020f);
- b. **prolonged low-intensity static work** ('periarticular soft tissue underuse'), resulting in increased occurrence and/or persistence of non-specific axial pain, as commonly reported by office workers performing visually and cognitively demanding tasks (Roquelaure, 2018; EU-OSHA, 2020f). In relation to point (b), prolonged constrained static postures during sedentary work, resulting in sustained activation of type I muscular motor units, can lead to motor unit dysfunction, nociceptive pathway activation and pain centralisation, which, in turn, trigger neck-shoulder, dorsal and lumbar pain (Johansson et al., 2003; Visser and van Dieën, 2006; Heneghan and Rushton, 2016).

**Psychosocial factors at work** can influence the occurrence and/or persistence of WRMSDs either through increased biomechanical exposure or by triggering the stress mechanisms (Roquelaure, 2018; EU-OSHA, 2020f). Persistent exposure to psychosocial stressors results in dysregulation of the stress systems interacting with the musculoskeletal system through several pathways: (a) arousal of the central nervous system; (b) activation of the catecholaminergic pathway (vegetative nervous system)



increasing muscle tension, decreasing micropauses in muscle activity and altering tissues' repair capacities; (c) activation of the hypothalamus-pituitary gland-adrenal (HPA) cortex involved in the neurobiology of pain; and (d) secretion of pro-inflammatory cytokines (immune system) favouring centralisation of pain and microinflammation of the soft tissues (Eijkelhof et al., 2013; Taib et al., 2016). Work-related stress may affect muscle activity indirectly through behavioural changes affecting movements coordination and efficiency and 'work style' (e.g. increased work pace, high forces on the keyboard and mouse, fewer rest periods) (Roquelaure, 2018). The associations between psychosocial factors and WRMSDs work both ways: psychosocial factors can contribute to the causation of WRMSDs, but having a WRMSD can have negative consequences, including poor psychological health (EU-OSHA, 2021g).

Several psychosocial factors at work can produce — alone or in combination — synergistic effects with biomechanical exposure on the occurrence and/or persistence of WRMSDs (Vargas-Prada and Coggon, 2015; EU-OSHA, 2020f). The highest level of epidemiological evidence concerns factors related the job demands-control (JDC) model. This model assumes that high ‘job strain’ situations (i.e. jobs combining high job demand and low job control) increase the risk of WRMSDs, particularly when associated with low social support (‘iso-strain’) from managers and/or colleagues (Hauke et al., 2011; Lang et al., 2012; EU-OSHA, 2013; Kraatz et al., 2013; Vargas-Prada and Coggon, 2015; Prakash et al., 2017; van der Molen et al., 2017; Mansfield et al., 2018; Amiri and Behnezhad, 2020). Some psychosocial factors may have a moderating effect: for example, good support from co-workers or managers can offset the negative effects of high job demands (EU-OSHA, 2021g). Lower levels of evidence support the interrelationships between WRMSDs and other psychosocial factors at work, such as the effort/reward imbalance (Rugulies and Krause, 2008; Koch et al., 2014; Siegrist et al., 2019), role ambiguity, lack of fairness, ethical concerns, conflicts with work values and job satisfaction (Eatough et al., 2012; Davezies, 2013; Pekkarinen et al., 2013; Vargas-Prada and Coggon, 2015; Juvani et al., 2016; Buruck et al., 2019). To the best of our knowledge, no studies suggest a causal and direct relationship between psychosocial risk factors and WRMSDs in isolation, with physical risk factors invariably contributing. Indeed, where studies computed effect sizes (e.g. Roquelaure et al., 2020) physical factors generally played a larger role in the development of WRMSDs (although psychosocial factors were relevant) (EU-OSHA, 2021g).

**Work organisation characteristics, management practices and human resources strategies** generate domino effects on the conditions under which work is carried out and, consequently, exposure to work-related biomechanical and psychosocial factors (Westgaard and Winkel, 2011; Roquelaure, 2018). These cascading effects explain why the expected changes in work organisation and management practices following the digitalisation of the economy may have major consequences for the risk of WRMSDs.

According to conceptual models linking work organisation and psychosocial factors at work to WRMSDs (Roquelaure, 2018; EU-OSHA, 2019f), the pathway starts with (a) the economic, social and political environments (**macro level**), followed by (b) the organisation of production, work organisation and management practices at the company (or production unit) level (**meso level**), which, in turn, (c) influences the exposure to biomechanical and psychosocial risk factors at the individual (or team) work situation level (**micro level**). This chain of determinants elicits musculoskeletal and psychological strains and consecutive psychophysiological changes favouring the occurrence and/or persistence of WRMSDs. For example, management practices influence work-related biomechanical and psychosocial factors by determining the human resources allocated to the production activity and the quality of work relationships (Roquelaure, 2018).

Apart from work-related factors, several **personal** (e.g. age, gender, genetic predisposition) and **medical** characteristics (e.g. obesity, diabetes, inflammatory rheumatism) increase the risk of WRMSDs (EU-OSHA, 2019f). Certain individual psychosocial factors (e.g. anxiety, motivation), unappropriated cognitive processes (e.g. dysfunctional pain perception, fear of movement) and behaviours avoiding painful activities promote the chronicity of pain and disability (Hayden et al., 2019; Martinez-Calderon et al., 2019).

### 3.2. Impact of the new forms of work and employment on the exposure to risk factors for WRMSDs

The increasing trend towards digitalisation of the economy will reinforce the structural changes in the economy and, by increasing the services sector, as a result change the patterns of exposure to workplace hazards (EU-OSHA, 2020a). About 17 % of European employees performed telework or ICT-mobile work (TICTM) on a regular basis (and more occasionally) before the COVID-19 pandemic (Eurofound and ILO, 2017). In 2019 about 15 % of European establishments had introduced home-based telework according to the European Survey of Enterprises on New and Emerging Risks (ESENER) 2019 survey data (EU-OSHA, 2019e). Use of digital technologies was more common among professionals and managers, but was also significant among clerical support and sales workers. Despite variations in different sectors and socio-economic groups, ICT is becoming an integral part of nearly all sectors (EU-OSHA, 2019c). More than the technology itself, the changes in the way of working induced by ICTs give rise to challenges and opportunities for OSH (Degryse, 2016; EU-OSHA, 2018; Felknor et al., 2020; Hauke et al., 2020; Robelski and Sommer, 2020). According to the cascading risk model for



WRMSDs, the digitalisation of the economy and new forms of work may have an impact on the risk of incident and/or chronic WRMSDs in modifying exposure to biomechanical, organisational and psychosocial risk factors, and the resources to cope with these. In addition to these two main pathways, digitalisation may also increase the risk of WRMSDs in influencing to some extent modifiable personal and medical risk factors (Roquelaure, 2018; EU-OSHA, 2020f).

### 3.2.1. Exposure to biomechanical stressors

Automation and digitalisation could influence biomechanical exposure in various proportions, depending on the technologies, jobs, sectors, forms of employment and strategies for implementing ICTs. In a general way, exposure to **strenuous physical work** and ergonomic hazards is expected to decrease with the digitalisation of the economy (EU-OSHA, 2021h).

**Robots and cobots** that allow weight compensation, inertia masking and strength amplification will reduce exposure to **high forces, repetitive movements and overhead work or awkward postures**. Lowering biomechanical exposure will be possible in various occupational situations at high risk of WRMSDs, namely material manual handling (MMH) and repetitive forceful shoulder movements, in the manufacturing, logistics, construction and agriculture sectors. Moreover, robots may replace the tasks at the highest risk of serious or fatal accidents at work, even in small companies.

**Passive or active body-worn assistive devices** (occupational exoskeletons) could reduce the mechanical load applied on the lower back (e.g. lumbar support robot) and shoulders (e.g. upper active exoskeleton) when automation is not available or possible (EU-OSHA, 2019d, 2020a). Such active/passive assistive devices can reduce the **physical workload** (on back or shoulder), but may have detrimental physiological (e.g. increased cardiovascular demand, local discomfort) and psychosocial (e.g. lack of social acceptability, stigmatisation) effects (Theurel et al., 2018).

**Digitalisation of the task and extensive use of digital devices** are expected to reduce the exposure to **heavy physical work and forceful movements** in the manufacturing industry and services sectors (EU-OSHA, 2018, 2019b, 2021b; Diebig, 2020; Neumann et al., 2021). However, the reduction in biomechanical hazards will probably be unequally applied across work situations, and biomechanical exposure may even increase in some categories of workers (Degryse, 2016). For example, several surveys showed that warehouses workers employed in large e-retail distribution centres — where orders are picked from storage, packed and then delivered under **time pressure and constant monitoring** (voice picking) — are at particularly high risk of WRMSDs (Degryse, 2016; EU-OSHA, 2020f; Huws et al., 2020; Bérastégui, 2021). The same applies for parcel delivery when workers cannot pay sufficient attention to the correct way to lift parcels to prevent MSDs because of the excessively fast pace of delivery controlled by algorithm-/AI-based monitoring systems. In AI-driven production lines, the reduction of the physical workload may be associated with increased **repetitiveness and lack of opportunities to take breaks** (very repetitive light work), reducing the gain in terms of risk of WRMSDs.

**Platform work** could have mixed effects on the risk of WRMSDs:

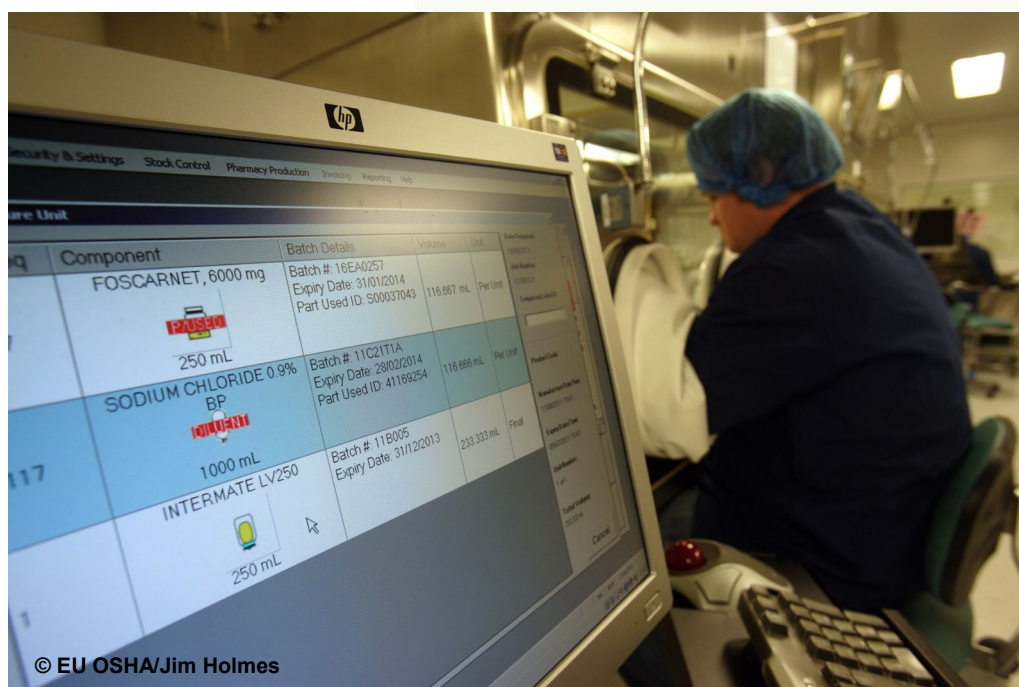
- reduction of biomechanical exposure for highly qualified freelancers teleworking on ‘online freelancing platforms’ and, to a lesser extent, crowd workers (‘crowd work platforms’) performing highly repetitive digital microtasks (e.g. cleaning or labelling datasets);
- increase in the physical workload and risk of accidents for the self-employed working on ‘on-demand physical services platforms’ and in charge of physically demanding jobs, such as food delivery (e.g. Deliveroo), cleaning (e.g. Helpline) or mechanical services (e.g. YourMechanic), under time pressure and permanent performance monitoring (Bérastégui, 2021).

**New forms of sedentary work**, such as ‘on-screen control and monitoring’ activities in the production sectors or online platforms, teleworking and working at home in the services sectors, are expected to increase the time spent in **sitting posture**, given that 25 % of men and 31 % of women were sitting all or most of the time in Europe in 2015 (Eurofound, 2016). Many home working spaces are not suitable for prolonged use or ergonomically compliant with the display screen equipment regulations, leading to chronic pain and MSDs. Performing predominantly visual tasks without breaks induces **sustained constrained static postures** of the trunk, neck and upper limbs, increasing the risk of chronic muscular pain (Visser and van Dieën, 2006; EU-OSHA, 2020b). Moreover, the trend towards sedentary work might reduce the level of daily exercise and energy expenditure, contributing, in association or not with

a lack of a balanced diet, to increased risk of **overweight, obesity and diabetes**, thereby also increasing the risk of WRMSDs (EU-OSHA, 2020b).

### 3.2.2. Exposure to psychosocial and organisational factors

The new forms of work and digitalisation will reinforce the current shifts in patterns of exposure to workplace hazards, increasing the number of European workers being exposed to psychosocial factors, cognitive overload and other forms of mental burden (Berg-Beckhoff et al., 2017; Diebig, 2020; EU-OSHA, 2020f; Kotera and Correa Vione, 2020; Bérastégui, 2021). The expected reduction in the physical workload may be counterbalanced in some work situations by an increase in task repetitiveness, cognitive workload and psychosocial demands induced by permanent monitoring of workers' performance (electronic monitoring and surveillance) and algorithmic human resources management. This will influence in various proportions the **main organisational and psychosocial risk factors for WRMSDs** (Berg-Beckhoff et al., 2017; Diebig, 2020; Borle et al., 2021).



**Intensity of work:** The digital economy is expected to further increase the work intensification observed in Europe in recent decades across most sectors and occupations (EU-OSHA, 2018). The spread of AI, ICT, intelligent manufacturing, advanced automation and management practices relying on algorithms is expected to improve productivity. However, optimising workers' tasks assignment and maximising the cognitive and physical workloads could lead to work intensification and physical and cognitive overload (EU-OSHA, 2019b).

The proportion of workers experiencing cognitive overload, digital fatigue, mental exhaustion and various forms of **'technostress'** (i.e. negative cognitive, affective and behavioural psychosocial reactions to ICT use) should increase (Berg-Beckhoff et al., 2017). In 2015, about 9 % of the European workers used ICT outside the employer's premises, 2 % teleworked mainly from home and 7 % were exclusively ICT-mobile workers. ICT-mobile workers and teleworkers experienced greater work intensity and, as a result, higher levels of stress (41 % vs 25 %) (Eurofound, 2016). Digitally induced work intensification seems to mediate the negative mental effect of ICT use rather than the use of ICT per se (Borle et al., 2021).

The digitalisation is creating highly mentally demanding creative 'high-tech jobs' ('top digital jobs') while offering a large autonomy to highly qualified workers. Because of the work intensification induced, such workers may be exposed to prolonged low-intensity static work, resulting in an increased occurrence and/or persistence of non-specific axial pain. At the other end of the occupational spectrum, the number of workers undertaking repetitive and/or forceful movements, putting them at high risk of WRMSDs, will increase with the spread of 'digital galley slaves' performing physically and mentally demanding repetitive jobs devoid of operational leeway (e.g. parcel delivery, e-retail warehouse workers,

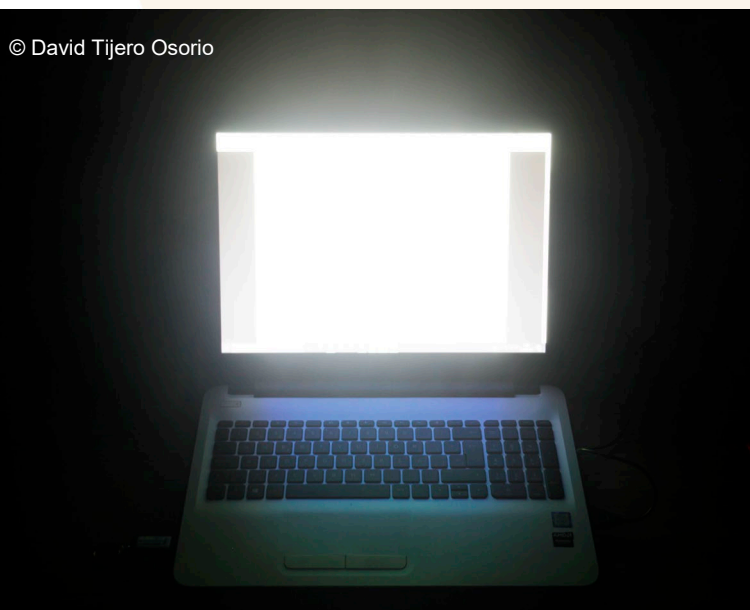
'Mechanical Turks' working on digital platforms) (Degryse, 2016; EU-OSHA, 2018; McKinsey Global Institute, 2020).

As already observed in platform workers, algorithmic management exposes numerous workers to both quantitative overload due to hectic work rates and qualitative underload due to the tasks being broken down into a myriad of simple microtasks with **poor job content** performed by crowd workers in the service and industry sectors (Bérestégui, 2021). Too **high psychological demand** (e.g. cognitive overload, emotional pressure) — a major dimension of the JDC model — will therefore affect an increasing number of European workers, even in manual and low-skilled occupations. Sufficient decisional latitude and training will probably counterbalance the detrimental effects of the psychosocial workload in highly qualified workers. Conversely, the excessive **psychological demand** combined with low job control will expose less qualified workers to a **job strain situation**, producing occupational stress and thereafter having synergistic effects with biomechanical stressors to increase the risk of WRMSDs (Roquelaure, 2018; EU-OSHA, 2020f). In microwork platforms or on-screen monitoring activities — and more generally in low-skilled jobs, job strain may be reinforced by the qualitative underload linked to **job monotony**, boredom and job dissatisfaction leading to psychological distress that may increase the incidence/chronicity of WRMSDs (Vargas-Prada and Coggon, 2015; Diebig, 2020).

**Autonomy and job control:** In traditional forms of employment, Taylorian rigid work organisations, such as assembly line work and lean manufacturing, provide workers with little operational leeway and decision-making latitude to cope with the inherent variability of their work situations (Roquelaure, 2018). As shown by the 2015 EWCS, ICT-mobile workers and teleworkers experienced greater autonomy at work and working time autonomy (Eurofound, 2016). However, the digitalisation of the manufacturing and service industries may either reinforce or diminish workers' autonomy and operation leeway, depending on the ergonomic design and implementation strategies of not only the automation (human-robot interaction), AI and ICTs but also the management practices.

The autonomy provided by digital devices, such as laptops, tablets and smartphones, smart watches and data glasses, allowing people to work almost anywhere/any time may be paradoxical, since the greater independence might be associated with the feeling of being obliged to work everywhere or all the time (Borle et al., 2021). Although self-employed workers may have chosen platform work to gain autonomy, those engaged in on-location platform-determined work actually have limited autonomy to decide on their tasks, working time, workplace and work organisation, even when self-employed (De Groen et al., 2018). Similarly, workers' sense of autonomy could be paradoxical because of the systems' need for permanent control, role ambiguity and lack of involvement in decision-making directly affecting their activities or utilisation of their skills (Bérestégui, 2021; EU-OSHA, 2021b).

A lack of autonomy may also occur in the context of digitalisation: workers are progressively less in control of their work in numerous manufacturing and service sectors where AI systems and robots allocate tasks and dictate the pace of work, and where algorithmic management monitors performance and sends instant feedback when performance is not in line with expected targets. In the manufacturing industry, the spread of collaborative robots with automated or semi-automated decision-making influencing assembly line workers might be a disguised way to reintroduce old Taylorian management principles ('digital Taylorism'), reducing operational leeway, such as micromanagement, hidden behind the mirror of new technologies. For example, the Taylorian assembly line model has not totally disappeared in agile manufacturing methods such as lot size manufacturing. Thanks to AI-enhanced automation and virtual reality environments, this means that assembly line workers can carry out on-





the-spot new tasks that are learned instantly and carried out only for the time required to manufacture specific orders as they come in. Such work situations, combining very low decision latitude with high psychosocial demands under time pressure, may be worse than similar tasks in traditional assembly line work. A high level of job strain is expected in such agile manufacturing, with increased risks of WRMSDs, regardless of the level of biomechanical stress (EU-OSHA, 2020f). Moreover, some forms of ‘digital Taylorism’ are being extended to sectors and types of jobs in the service industry and many office-like jobs that were not under Taylorian management in the past, following the spread of algorithmic management and digital surveillance.

**Poor social relations at work:** Automation and algorithmic management in various occupations and jobs will increase the number of people working remotely, often individually without contact with colleagues or even in competition with them. Full-time teleworking may lead to **physical and social isolation** (Oakman et al., 2020) and, despite the hyperconnectivity, reduce social interactions at work, especially informal interactions, with either colleagues or managers (EU-OSHA, 2021c). A lack of management countermeasures and isolated work with restricted access to informal information-sharing, notably mandatory home-based telework, can be detrimental in terms of informal learning, instrumental support, organisational commitment, social and emotional integration, and organisational trust between colleagues and managers. Psychosocial situations exposing workers to **weak social support** (iso-) — together with high psychological demands and low job control (job strain) — will increase the ‘job iso-strain’ situations at highest risk of occupational stress and WRMSDs (Hauke et al., 2011). However, as for platform work, we still lack data on the size of the phenomenon and the extent to which digital workers lack different types of support (such as career mentoring, coaching and collegial task support) and from different sources (supervisors, co-workers, organisation) (Bérastégui, 2021).

**Ethical concerns, lack of reward and organisational justice:** The spread of digital human resources (HR) management, such as ‘people analytics’, questions the value placed on employees’ well-being. Moving from traditional manager-worker relationships to remote and algorithmic management — with permanent digital surveillance of performance (e.g. keystroke logging and monitoring emails, telephone calls and internet usage) and behaviours (e.g. tracking location and movements using a global positioning system (GPS), radio-frequency identification (RFID), closed-circuit television (CCTV), sensors, webcams, wearable devices), as well as rating using a platform interface — encourages asymmetric power relationships. Such intrusive digital monitoring can generate tensions and undermine employment relations, including for those working in traditionally mobile occupations who are accustomed to more autonomy and discretion (Eurofound, 2020b). For example, delivery workers or maintenance technicians, who previously had considerable degree of organisational autonomy, are now trackable via their GPS with continuous assessment of their routes, stops and detours (Degryse, 2016). Moreover, permanent real-time monitoring may also introduce game-like dynamics and add pressures on workers to meet performance targets (Eurofound, 2020b).

The lack of information on the decision-making process in task assignments and work appraisal procedures can lead to feelings of a lack of fairness (De Groen et al., 2018; Eurofound, 2020b; Bérastégui, 2021). This can affect workers’ confidence in the organisation (**organisational trust**) and the sentiments of **organisational justice**, and this may contribute to the occurrence of WRMSDs (Pekkarinen et al., 2013; Juvani et al., 2016; Buruck et al., 2019).

**Ethical concerns** with psychological conflicts of values may occur as a result of an imbalance between what is demanded at work and employees’ professional, social or personal values. Although not new, the spread of unfair pay and procedural inconsistencies in the digital economy may reinforce the feeling of **effort/reward imbalance** (i.e. wages, recognition, job security and career opportunities) (Siegrist et al., 2019). Such lack of ‘social reciprocity’ has been identified as risk factors for WRMSDs (Koch et al., 2014). Moreover, crowd workers may suffer from a **fragile professional identity** as a result of a lack of meaningfulness at work and good role models, rendering them more likely to experience occupational stress (Bérastégui, 2021).

**Job insecurity:** Although standard employment (permanent, full-time employment based on labour law) remains dominant (Eurofound, 2020d), recurrent European surveys show an increasing **diversity and precariousness of employment forms** (part-time work, temporary work and other forms of precarious employment, such as ‘zero hour’ contracts) in response to the increased flexibility in the labour market. Ever-changing working environments — following companies’ restructuring, subcontracting and outsourcing practices — lead to persistent uncertainty on the future of one’s job and feelings of not being able to cope with changes. Those are major sources of psychosocial stress for most workers, especially those in weaker occupational categories. This will be aggravated in the digital economy by the new forms of employment and **‘boundaryless careers’** offering several positions in

multiple organisations and transient work with a lack of training and opportunities for skills development allowing for career development (McKinsey Global Institute, 2020).

Statistics on digital workers are sparse, but recent data suggest that between 0.5 % and 3 % of adults have earned income through online intermediaries in the United Kingdom and Germany, and their number is currently probably growing fast (Eurofound and ILO, 2017). However, platform work often remains occasional, and most platform workers performed their supplementary activities in their field of competency (e.g. cleaning, childcare, delivery, taxi services, household maintenance services) providing a minor salary top-up. Although the minority of professional platform workers performing only platform work (about 10 %) is growing fast, it remains difficult to isolate platform workers as a special type of worker (Huws et al., 2020).

According to the gig economy model, jobs can be broken down into separate tasks (or 'gigs') and outsourced to individuals with specialist skills working as freelancers. Most assignments are over short periods, exposing gig workers, even those highly qualified, to persistent feelings of job insecurity and psychosocial stress (Bérestégui, 2021). Indeed, such jobs differ from standard employment conditions in not only the formal employer-employee (or client-self-employed) relationship (e.g. employee sharing, job sharing, voucher-based work, portfolio work, collaborative employment), but also the work patterns (e.g. interim management, casual work) (Degryse, 2016; OECD, 2018; Eurofound, 2020d). Most gig workers are treated as self-employed, but this may become **bogus self-employment** when workers are subject to subordination and dependent relationships with the requester and/or platform (Bérestégui, 2021).

**Emotional demands at work:** Of the employees in the EU, 41 %, mainly women, work in direct face-to-face contact with the public (customers, users, patients) (Eurofound, 2020a). Such jobs involving constant customer care and public relations are known to be emotionally demanding (Eurofound and ILO, 2019). Another major component of emotional labour is the permanent surveillance and public evaluation. This is observed in many 'standard jobs' where a rating system attached to awards/penalties has been introduced, but such permanent public evaluation is consubstantial to platform work (e.g. ride-hailing platforms). **Hiding feelings**, 'always keeping full self-control in all circumstances, and having a permanent positive attitude' is crucial to maintaining a good ('five stars') rating and safeguard future employability. In the same way as traditional public service and care workers, new on-demand physical services workers (e.g. those working for Uber or Deliveroo) are often exposed to unfair and conflictual relationships with customers and requesters (Bérestégui, 2021). Such **adverse social behaviours**, and in a worse situation **violence and bullying**, may be linked to WRMSDs, probably partly through the mediating effect of psychological distress (EU-OSHA, 2020f).

**Working time/blurring boundaries work/personal life:** Digital work, mobile work and telework trigger contradictory effects on health and well-being, since the same workers may report both positive and negative ergonomic and health consequences. According to the 2015 EWCS, ICT users, especially ICT-mobile workers or home-based teleworkers, work more often for **long hours** (more than 48 hours per week) than other workers (28 % vs 14 %). As a whole, they more often complain (26 % vs 18 %) of a **poor work-life balance** (Eurofound, 2016) (

Such long working hours — and, even more so, '24/7' availability — generate overlapping of paid and non-paid work, and work-home interference, resulting in work intensification with blurred boundaries between work and non-work spaces and times (Eurofound and ILO, 2017). Atypical work schedules and alteration of the work-life balance due to digital technologies pressurising workers to work at any time and anywhere can lead to increased psychosocial stress levels. Regular home-based telework or occasional digital work have fewer negative consequences than high mobile digital work. Long working hours, as well as work in non-working time and a work-life conflict, are likely to increase WRMSDs (EU-OSHA, 2020f). Regarding the positive effects of ICT use and telework, workers, notably those in professional jobs and at higher levels of seniority having chosen these forms of work, report greater **autonomy** to organise working time based on individual workers' needs and preferences. However, this depends on whether it is voluntary and the degree of informal agreement between the employee and the manager, which is shaped by management's attitudes towards telework. Moreover, telework reduces **commuting time** between home and the workplace, and exposure to stressful traffic congestion (Eurofound and ILO, 2017).



**From a gender perspective**, the 2015 EWCS shows that there is a higher share of men performing TICTM (54 % of men vs 46 % of women) (Eurofound and ILO, 2017). Within the different types of TICTM arrangements, men were more prevalent as highly mobile TICTM employees and self-employed TICTM



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than women, and women were more prevalent in regular home-based telework than men, while both sexes were almost equally distributed in occasional TICTM (Eurofound and ILO, 2017). Women tend to use the possibilities of new technologies and more flexible ways of working to combine work and family obligations more often than men, mainly by teleworking from home. When teleworking, women tend to work shorter hours than men and seem to achieve a slightly better work-life balance (Eurofound and ILO, 2017).

**Gender inequalities** remain a reality in the digital economy: women represent about one out of three platform workers and their hourly

wages average about two thirds of men's rates (Bérestégui, 2021). An ILO survey conducted in 2015 and 2017 shows that many women combine crowd work with care responsibilities and prefer to work during the evenings and at night (ILO, 2020).

Whether digitalisation will close or widen gender gaps in the labour market will, to a large extent, depend on the public and companies' policies. The specialisation and division of labour — with increasing importance of services, sub-contracting and labour flexibility — can decrease the job quality, leading to higher proportions of women performing low-skilled repetitive digital microtasks (e.g. crowd call centres) and physically demanding tasks in the service industry (e.g. cleaning). However, 'new' job opportunities in STEM-related occupations (i.e. science, technology, engineering and mathematics, e.g. software developers, data analysts, medical imaging specialists) may be created in sectors that are traditionally female dominated, such as business services, health, education and social services (OECD, 2017).

**In summary**, if the digitalisation of the economy will influence exposure to the main risk factors for WRSDs, **the resulting risks of WRMSDs** are difficult to predict, as it will depend on the economic sectors, occupations, socioeconomic positions and specific management context, i.e. the degree of autonomy given to the workers (Berg-Beckhoff et al., 2017; Diebig, 2020; Borle et al., 2021).

### 3.3. Impact of the COVID-19 pandemic

The COVID-19 pandemic has had an impact of exceptional magnitude and scope, affecting the socioeconomic situation and health of millions of people in the EU (by September 2020, over 2.2 million EU inhabitants had contracted the virus).

The COVID-19 crisis has strongly affected Europe's labour markets, and it may take years for employment to return to its pre-crisis levels (McKinsey Global Institute, 2020). The 2020 economic downturn threatened the **job security** and the **career prospects** of millions of furloughed or laid-off employees across different industries (e.g. hospitality and food services, manufacturing, retail, travel and trade). According to the 'living, working and COVID-19' e-survey conducted in May 2020, 8 % of those working for an employer and 13 % of those self-employed became unemployed (Eurofound, 2020c). The COVID-19 crisis has increased inequalities in employment and working conditions, with greater negative consequences for young workers, women, low- and medium-skilled workers and the self-employed (ILO, 2021). COVID-19 has exacerbated an already fragile situation for platform workers (e.g. work stoppages due to self-isolation, lack of sick leave payment) (ETUI and ETUC, 2020). The workers most likely to be affected by automation in the long term are those also most at risk in the COVID-19 pandemic, and the crisis could accelerate some of the displacement in several key sectors (e.g. wholesale and retail) (McKinsey Global Institute, 2020). Apart from career and financial impacts, the economic downturn may lead to **social isolation**, **emotional distress** (e.g. uncertainty about one's

future career options and opportunities) and **psychological disorders** (e.g. increased anxiety) (Giorgi et al., 2020; Kramer and Kramer, 2020; Nimrod, 2020).

The COVID-19 pandemic has had, and will continue to have, far-reaching influence on work organisation, work culture and **working conditions** across Europe. The pandemic accelerated the trends that were already under way involving the migration of work to online or virtual environments (EU-OSHA, 2021f).

Recommendations for social distancing have boosted emergent changes in work practices, such as working from home, virtual teamwork, virtual leadership and management; the proportion of Europeans **teleworking** suddenly increased to 40 % in April 2020 (JRC, 2020). Since then, sedentary working from home has become the norm for millions of workers in the EU. This new experience of **working from home** may change occupational perspectives on remote and virtual work. Indeed, telework involved only a minority of workers (5 %) in 2019 — mainly in ICT- and knowledge-intensive sectors and highly qualified occupations — before the crisis (JRC, 2020). In many EU countries, more than half of the workers who have started working from home since the pandemic had no prior experience of teleworking. Strikingly, working from home was mandatory for most employees according to the imperatives of social distancing, which is in contrast to teleworkers who were already voluntarily teleworking, making it difficult to generalise earlier findings on the impact of telework (Kniffin et al., 2021). COVID-19 has accelerated the expansion of synchronous, or not, **e-communications**, video chats and e-meetings (e.g. Zoom videoconferencing) between geographically dispersed team members, as well as **working in virtual teams**. Virtual team workers may lack the communication richness, creative sharing of ideas and social support available to face-to-face teams. Home-based telework and virtual team work are likely to expose workers to higher levels of **psychosocial distress** and **presenteeism** (Steidelmüller et al., 2020; Kniffin et al., 2021).

The COVID-19 pandemic has changed some industries or supply chains fundamentally, accelerated trends that were already under way in some sectors and opened up opportunities for novel industries to emerge. For example, the pandemic has enhanced the market for software and webcams used to monitor the computer-based activities and take webcam shots of employees working remotely at regular intervals to monitor their availability and presence in front of their computer (JRC, 2020). Overall, COVID-19 is likely to exacerbate **work intensity** between sectors, reinforcing the general trends produced by the digitalisation of the economy. In addition to reduced working hours in some sectors and occupations, many workers have had to cope with increased workload and psychosocial stress. This concerned first and foremost the 'essential' or 'life-sustaining' workers, notably women (e.g. emergency room medical personnel and supermarket staff), but also higher-skilled service workers (e.g. education, information and communication, and financial and insurance activities) (Eurofound, 2020c; ILO, 2021). In that sense, the COVID-19 pandemic has provided a 'stress test' for OSH in the EU, revealing several structural deficiencies in the regulatory system, with many workers themselves exposed to SARS-CoV-2 (the cause of COVID-19) and its related psychosocial risks (ETUI and ETUC, 2020).

## 4. Implications in terms of risk assessment, surveillance, preventive approaches and intervention

Digitalisation will bring new and emerging OSH challenges and also opportunities depending on how the technology is implemented, managed and regulated. One of the key challenges for the surveillance and prevention of WRMSDs is keeping pace with the rapid technological and organisational advances resulting in new and emerging risks.

### 4.1. Risk assessment and surveillance

**Epidemiological surveillance** relies on up-to-date data on the extent of new forms of work and digitalisation and the impact on workers' health and well-being, according to industry sectors, occupations, occupational categories and groups at risk (e.g. elderly and disabled workers) (EU-OSHA, 2020d). Epidemiological surveillance should use both quantitative and qualitative methods to be adapted to the variety of risk factors in more diverse, dispersed and continuously evolving working populations (Bérastégui, 2021).

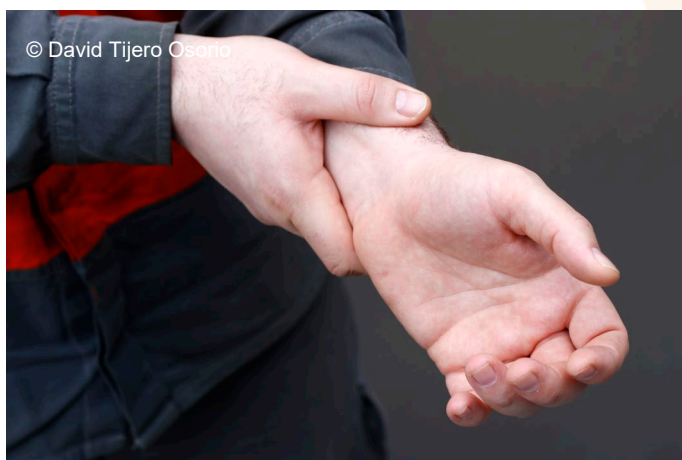


**The risk assessment of work situations** is a major step in preventive intervention. However, it is a means to an end — not an end in itself — and requires the implementation of preventive and corrective measures. According to the scientific literature, WRMSDs arise from multiple risk factors, including biomechanical risk factors and psychosocial and organisational factors (EU-OSHA, 2020e, 2020f). The multifactorial dimension of WRMSDs suggests that there should be an integrated and multilevel approach to risk assessment, covering both physical and psychosocial risks, and this not only at the individual's work situation level (micro level), but also at the production (or office) unit's (meso) and company's (macro) levels. Risk assessment should actively involve the workforce to ensure that actual work activities are assessed (Roquelaure, 2016; EU-OSHA, 2020e; 2021d).

There is a need for the development of suitable tools or procedural approaches to monitor all specific risks related to digitalisation (virtual work, telework, flexible working patterns, etc.) and their impact on exposure to biomechanical and psychosocial factors for WRMSDs. Assessing risks for teleworkers or remote workers is particularly challenging (e.g. getting into the worker's home or assessing risks away from the employer's premises). This requires sensible and innovative approaches (EU-OSHA, 2019b, 2021b) involving the worker, for example by developing digital technologies (e.g. an app) to be used by the worker to carry out the assessment or videocalls to show the workstation. A smart surveillance system using mobile miniaturised monitoring devices, embedded or not in personal protective equipment (PPE), might allow real-time monitoring of ergonomic hazards and musculoskeletal health at the individual level. Using big data and a job exposure matrix, individual data may be merged to provide a risk assessment at the meso or macro levels (Madsen et al., 2018; EU-OSHA, 2020c). However, as for the use of these data in HR, digital monitoring raises queries regarding ethical issues in collecting and using such data on workers and their representatives involvement and regarding practical implementation strategies (EU-OSHA, 2021b).

## 4.2. Prevention and management of WRMSDs

To date, most interventions aimed at addressing WRMSDs have addressed physical risk factors (EU-OSHA, 2020e). Single intervention programmes (specific implementation of technical, organisational or training measures) often failed to prevent WRMSDs, **while multicomponent interventions** (covering



physical and psychological demands, and addressing ergonomic and organisational aspects of work) seem to be the most effective (Driessen et al., 2010; Kennedy et al., 2010; Roquelaure, 2018; Stock et al., 2018; EU-OSHA, 2021d). This will probably be the case in the specific context of digitalisation, although improving the ergonomic properties of digital devices will be always useful. Interventions should therefore not only focus on digital technologies per se but also consider their utilisation in real working practices, as well as the interactions between the different contextual factors of the work situation. The prevention plan should consider that

organisational and psychosocial factors can, as well as possibly contributing to the problem, provide part of the solution (EU-OSHA, 2021g). For example, positive support from co-workers and managers can help offset the adverse effect of other factors (such as periods of high demand). Furthermore, some factors can work on both physical and psychosocial risks. For example, enabling greater individual freedom over scheduling work breaks (when possible) can act directly to reduce physical strain but can also provide a greater sense of personal control (EU-OSHA, 2021g).

**Participatory interventions**, involving the workforce in (a) understanding the situation (e.g. how digital technologies are used in the particular work situation and how they can result in high demands) and (b) the development of solutions seems to be the most effective intervention design when embedded in a strong prevention-oriented corporate culture (EU-OSHA, 2021d, 2021e). Conducting such an intervention requires high-level skills in ergonomics and sufficient time and stability of the work organisation to implement efficient intervention. Moreover, certain precautions must be taken to adequately assess psychosocial risk factors (e.g. organisational justice). This requires openness and honesty on the part of the workforce, and appropriate measures should be in place to safeguard and protect individual confidentiality (EU-OSHA, 2021g).

**Implementation strategy** is a key issue in the context of digitalisation, as preventive intervention is difficult to implement in an ever-changing economic and organisational environment. Risk assessment should be followed by (a) a strategic analysis of the possibilities for transforming the work situation and (b) the mobilisation of sufficient human and economic resources at the company level to ensure that changes to work and work systems are really introduced and maintained. Communication and collaboration/involvement is another key issue to ensure that change is explained and cascaded down within the workforce. Practical experience suggests that change introduced or enforced without such involvement could be counterproductive and lead to resentment and a lack of commitment and cooperation (EU-OSHA, 2021g).

**Digital technologies and new forms of work** create new OSH risks but may also offer opportunities to improve the prevention of WRMSDs in various ways:

- reduction in physically demanding (e.g. exoskeleton) and repetitive or routine (e.g. robots and cobots) tasks;
- ability to provide (in some cases) higher levels of autonomy and flexibility;
- reduction in commuting time thanks to teleworking;
- better access to the labour market for ageing workers, disabled workers and those workers with care responsibilities at home (Degryse, 2016).

Smart surveillance systems and PPE may be used for **advanced digital interventions**. Such ICTs can provide real-time information on the level of psychophysiological and behavioural parameters, such as physical workload (e.g. during strenuous voice picking tasks) and the level of fatigue and stress (e.g. during prolonged telework). Thanks to AI-tailored preventive interventions, advice may be delivered in real time to influence worker behaviour and prevent potential OSH problems (EU-OSHA, 2020c). However, the feasibility and effectiveness of such digital interventions need to be evaluated.

**OSH training** is a key issue to prevent WRMSDs and promote occupational health and well-being. Digitalisation may also offer opportunities for more effective **OSH training** of practitioners and workers to update their skills accordingly to the spread of digital work and virtual environments (EU-OSHA, 2021b, 2021h). However, while useful, 'training' for the 'new digital economy' and investment in skills and qualifications will probably not be sufficient (by itself) to prevent WRMSDs (Degryse, 2016).

### 4.3. Regulation and public policies

**Digital technologies and new forms of work**, as well as the online platform economy, create new challenges for labour protection and OSH management. However, the digitalisation of the economy may be an opportunity to improve OSH if properly regulated. A major challenge will be to update the existing **OSH regulations and policies** at European or national level to adapt them to a more dispersed and diverse workforce (employment forms, work location, flexible working time, etc.) to ensure ubiquitous and efficient OSH surveillance and prevention. Considering the complex and evolving landscape of digital work, traditional regulations and public policies may lag behind changes in practice following new and emerging working conditions. In addition to the necessary adaptation of the EU OSH regulations, some forms of policy, such as standards and voluntary social partner agreements, can be useful, as shown by the recent framework agreement on digitalisation (European Social Partners, 2020).

With business hierarchies changing and many workers either managing themselves or being managed remotely or by AI, there is likely to be a loss of clarity about who is responsible for OSH and how it should be overseen and regulated. Flexible working environments and mobile digital technologies present a significant challenge for OSH, as many such environments are not ergonomically suitable, but employers have little control over them. A key consideration is the responsibility of employers and workers, and social protection, given the rise of the independent worker. In most Member States, the application of OSH legislation depends on having an employment relationship, which is more difficult to establish for online platforms workers (EU-OSHA, 2019a). In practice, many gig and on-call workers are presently not covered by standard labour regulations and institutions (including minimum wages, safety and health, and working time regulations), and this may have negative consequences on job quality and inequality (OECD, 2018). As underlined by trade unions, the digital economy may promote an **insidious deregulation and failure to respect labour law** (the employment relationship, employment contracts, collective agreements, wages, etc.) not only for the new forms of jobs, but also for 'standard' jobs (Degryse, 2017).



**Concerning telework**, the EU Framework Agreement on Telework (July 2002) stipulates that employers have the same OSH responsibilities for home-based teleworkers as for any other workers, including identifying and managing the occupational risks (see EU-OSHA, 2021c for details). The spread of working from home or from outside the employer's premises raises concerns regarding the invasion of privacy and employees' right to disconnect. Although teleworkers may have to connect to be able to work, this should not imply that they assent to continuing surveillance or monitoring outside working hours (Eurofound, 2020b).

The review of the **OSH directives**, namely the directives on the minimum safety and health requirements for the workplace (89/654/EEC) and for work with display screen equipment (90/270/EEC), may open up opportunities to enlarge their scope to improve OSH protection and the prevention of WRMSDs for all workers using new digital devices (e.g. laptops, smartphone, tablets), regardless of the location of work (e.g. employer's premises, mobile teleworking at home) and type of work organisation (e.g. standard jobs, online platforms).

**Compensation for WRMSDs:** WRMSDs of the upper limbs are one of the main causes of claims for compensation in the EU, with large variations in the rates of recognition between Member States. In most countries, the compensation criteria refer only to specific disorders, such as rotator cuff tendinopathy or carpal tunnel syndrome, and to biomechanical risk factors in a context of 'periarticular soft tissue overuse'. In general, the cases of non-specific WRMSDs, such as shoulder pain or neck pain, commonly observed in workers performing prolonged low-intensity static work during visually and cognitively demanding tasks, do not fulfil the compensation criteria. A growing number of non-specific WRMSDs is expected to emerge in the context of digitalisation of work, and this opens up avenues for a revision of the compensation criteria for WRMSDs in most Member States.

## 5. Conclusion

**The world of work changes fast**, which requires innovative strategies and appropriate regulation to accompany changes in technology, work organisation and forms of employment and limit their impacts on OSH. The digitalisation and robotisation of the economy have been reinforced by the COVID-19 pandemic, and this has accelerated the spread of new forms of work, intensification of work and the fragmentation of the workforce in many occupations and industry sectors. The classic workplaces have also evolved as a result of the potential to work at any time and anywhere using digital and virtual devices while developing new skills.

**Digital technologies and new forms of work** represent opportunities and challenges for policy-makers, companies and workers. Indeed, while digital technologies and new forms of work organisation create an opportunity for highly qualified and adaptable workers, they are challenging and potentially sources of WRMSDs, psychosocial stress and poor well-being for less qualified workers or those less inclined to change. Nevertheless, the risk of WRMSDs, psychosocial stress and poor well-being should not be neglected, even for highly qualified workers, as their high degree of autonomy may in some cases be an incentive to 'choose' to spend long hours teleworking without proper breaks. Consequently, if putting special focus on low-skilled workers is useful, company's OSH management should involve all workers, and should monitor and adjust, if necessary, their working conditions and provide proper training in order to protect the safety and health of all workers.

**Prevention and management of WRMSDs** needs to be continuously adapted to the evolution of digital technologies and organisational changes. Innovative intervention designs should be promoted to adapt them to the diverse, dispersed and evolving populations working in ever-changing environments. This particularly concerns integrated prevention to reduce the incidence of WRMSDs and also their consequences in terms of persistence, recurrence and resulting disability. Management of WRMSDs (including rehabilitation programmes) should be adapted to the digital economy and new forms of work while benefiting from digital technologies to facilitate their implementation. Moreover, companies and OSH practitioners will have to develop and implement innovative and tailored strategies to train workers, promote their health and well-being — including older workers and workers in precarious employment — and sustain the employability of new generations of workers in the new digital world of work.

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