

Work hazards and workers' mental health: an investigation based on the fifth European Working Conditions Survey

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KEY WORDS: Work hazards; risk assessment; job content; mental health

PAROLE CHIAVE: Rischi sul lavoro; valutazione dei rischi; mansioni; salute mentale

SUMMARY

Background: Workplace hazards are a significant source of health impairment for workers and of financial losses for firms. EU directives on workers' health and safety standards significantly contributed to reduce reported occupational injuries, yet the incidence and prevalence of work-related mental illness is still very high. **Objectives:** We investigated the association between work-related hazards and individuals' perceived mental health. We reviewed the existing evidence on the channels through which task-related factors, adverse agents and psychosocial factors are expected to affect workers' health, with specific regard to mental health. **Methods:** We used data from the fifth wave of the European Working Conditions Survey, covering over 40,000 face-to-face interviews with workers in 34 countries, which includes information on socio-demographic characteristics, firms and jobs attributes, employment status, as well as working conditions and health status. We carried out an empirical analysis with multivariate regression models in order to estimate the relationship between workers' mental health problems and workplace risk factors. **Results:** 21,020 interviews were used in the multivariate analysis. We found strong correlations between hazards and various indicators of mental health. Among hazardous agents, low temperatures ($\beta=0.0287$) and contact with infectious materials ($\beta=0.0394$) were positively associated with mental health outcomes. Among task/sequence-related factors, tiring or painful positions ($\beta=0.0713$), repetitive hand/arm movements ($\beta=0.0255$), working with VDUs ($\beta=0.0301$), repetitive tasks <10 min ($\beta=0.0859$) and working in evenings ($\beta=0.00754$) were positively associated with mental health. Various psychosocial risk factors related to both the content of the job (for example, frequent disruptive interruptions: $\beta=0.219$, working in free time: $\beta=0.0759$, poor work-life balance: $\beta=0.228$) as well as the job context (for example, bad employment prospects: $\beta=0.177$, low decisional autonomy: $\beta=0.245$, bad social relations: $\beta=0.186$, workplace violence: $\beta=0.411$) were positively associated with mental health. The main results of the decomposition show that an important contribution to workers' overall mental distress at work is associated with psycho-

Pervenuto il 27.8.2018 - Revisione pervenuta il 22.12.2018 - Accettato il 13.3.2019

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This work is part of a larger project on "Ageing and occupational hazards" sponsored by Università Cattolica (Project D.3.2.). A preliminary version of this paper was presented at the Workshop "Healthy ageing and the Labour market" held in December 2015 and in seminars at Bicocca University. Giuseppe Grasso provided excellent research assistance. The authors are grateful to E. Cottini, L. Cappellari, G. Turati and participants to the seminars for their comments. The data have been kindly made available by Eurofound. Usual disclaimers apply.

social risk factors (up to 60% for depression/anxiety symptoms and sleep disorders), while the contribution of somatic factors is on average lower (up to 20% for overall fatigue). **Conclusions:** We argue that action is needed to improve workers' mental well-being, and reduce the economic costs for both the national health system and employers. Regulations and traditional economic measures are unlikely to prove successful in providing adequate standards of primary and secondary preventive measures in the work place without an appropriate and reliable Risk Assessment Procedure.

RIASSUNTO

«**Rischi sul lavoro e salute mentale dei lavoratori: un'indagine basata sulla quinta European Working Conditions Survey**». **Introduzione:** I rischi sul lavoro sono una fonte significativa di danni alla salute dei lavoratori e di perdite finanziarie per le imprese. Le direttive comunitarie in materia di norme di salute e sicurezza dei lavoratori hanno contribuito a ridurre gli infortuni sul lavoro denunciati, ma l'incidenza e la prevalenza di disturbi mentali lavoro-correlati sono ancora elevate. **Obiettivi:** Viene analizzata l'associazione tra i rischi sul lavoro e la salute mentale dei lavoratori. La ricerca analizza e descrive i canali attraverso cui l'organizzazione del lavoro, le mansioni svolte, l'esposizione ad agenti pericolosi ed a fattori di rischio psicosociale sono associati alla salute dei lavoratori, con particolare riferimento alla salute mentale. **Metodi:** Lo studio fa riferimento ai dati della quinta Indagine europea sulle condizioni di lavoro, realizzata mediante l'effettuazione di oltre 40.000 interviste "faccia a faccia" con i lavoratori di 34 paesi diversi, che hanno permesso di raccogliere informazioni sulle caratteristiche socio-demografiche dei lavoratori, delle imprese e delle mansioni svolte, così come sulle condizioni di lavoro e sullo stato di salute dei lavoratori. L'analisi empirica condotta su questi dati utilizza modelli di regressione multivariata per stimare le associazioni tra fattori di rischio sul lavoro e la salute mentale dei lavoratori. **Risultati:** 21.020 interviste sono state utilizzate nella analisi multivariata. I risultati mostrano l'esistenza di forti correlazioni tra i rischi sul lavoro e vari indicatori di salute mentale. Tra i fattori di rischio, le basse temperature ($\beta=0,0287$) ed il contatto con materiale infetto ($\beta=0,0394$) hanno un'associazione positiva con gli outcomes di salute mentale. Tra i fattori legati ai compiti lavorativi, l'assunzione di posizioni stancanti o dolorose ($\beta=0,0713$), i movimenti ripetitivi della mano e/o del braccio ($\beta=0,0255$), il lavoro al videoterminale ($\beta=0,0301$), compiti lavorativi ripetitivi con frequenza di ripetizione <10 min ($\beta=0,0859$) ed il lavoro effettuato nelle ore serali ($\beta=0,0287$) hanno mostrato una associazione positiva con la salute mentale. Diversi fattori di rischio psicosociali inerenti il contenuto del lavoro (per esempio, le frequenti interruzioni disturbanti: $\beta=0,219$, il lavorare nel tempo libero: $\beta=0,0759$, l'equilibrio tra lavoro e vita extra lavorativa: $\beta=0,228$), ma anche il contesto lavorativo (per esempio le scarse possibilità di carriera: $\beta=0,177$, la scarsa autonomia decisionale: $\beta=0,245$, le insoddisfacenti relazioni sociali: $\beta=0,186$, la violenza sul posto di lavoro: $\beta=0,411$) sono associati positivamente con gli outcomes di salute mentale. I risultati mostrano che la salute mentale dei lavoratori è associata principalmente a fattori di rischio psicosociali (fino al 60% dei sintomi quali depressione/ansia e disturbi del sonno), mentre il contributo dei fattori di rischio somatici è mediamente inferiore (raggiunge il 20% se rapportato all'astenia). **Conclusioni:** Sembra indispensabile agire sia per migliorare il benessere mentale dei lavoratori sia per ridurre i costi economici a carico del Sistema Sanitario Nazionale e dei datori di lavoro. L'attuale regolamentazione per la tutela della salute occupazionale potrebbe rivelarsi, sotto questo profilo, carente ed inappropriata nell'attuazione delle necessarie misure di prevenzione primaria e secondaria sul posto di lavoro in assenza di una adeguata procedura di valutazione del rischio.

INTRODUCTION

Workplace hazards continue to represent a significant loss both for workers, in terms of health impairment, and for employers and governments, in terms of financial losses. Even though the introduction of EU directives setting standards for the protection of

workers' health and safety has contributed to a significant drop of the reported occupational injuries and illnesses in most European countries, still the degree of work-related health problems remains too high. Traditional economic analysis has put the emphasis on the need for employer to compensate workers for taking the hazards associated to their jobs. Indeed,

the literature and the major national and international organisms on Occupational Health have stressed the importance of appropriate primary prevention measures that should be taken to ensure the highest standards of occupational health and safety in every workplace (10, 17). In this paper, we use a very rich dataset, covering workers in 28 EU countries (11), with detailed information on working conditions, work-related hazards and presence of illnesses.

The objectives of our study are the individuation and the evaluation of the occupational risk factors, which could have a key role in the workers' mental health.

We argue that regulations and traditional economic measures are unlikely to prove successful in providing adequate standards of primary and secondary preventive measures in the work place, unless an appropriate and reliable Risk Assessment, i.e. a careful examination of what, in the workplace, could cause harm to workers. This requires a joint effort of Occupational Hygienists and Occupational Physicians, together with employers and worker participation, to foster better prevention and control management in the work environment. Our data support the hypothesis that better information and an adequate transposition and implementation of EU Directives concerning occupational health and safety issues, would be effective in reducing both frequency and severity of occupational Adverse Health Effects, i.e. discomfort, disturbances, disorders, diseases, etc., in the EU global workforce.

Literature review

This section reviews the main findings of the literature on mental health, workplace hazards and working conditions. We define mental health as commonly done in reference to mental illness. However, recent research has shown that even though mental health and mental illness are related, they represent different psychological states (5).

Mental health is "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community" (48). It is estimated that only about 17% of U.S adults are considered to

be in a state of optimal mental health (46). There is emerging evidence that positive mental health is associated with improved health outcomes.

Mental illness is defined as "collectively all diagnosable mental disorders" or "health conditions that are characterized by alterations in thinking, mood, or behavior (or some combination thereof), associated with distress and/or impaired functioning" (46). Depression is the most common type of mental illness, affecting more than 26% of the U.S. adult population (23). It has been estimated that by the year 2020, depression will be the second leading cause of disability throughout the world, trailing only ischemic heart disease (29).

Evidence has shown that mental disorders, especially depressive disorders, assume an important role in the etiology, course, and outcomes associated with many chronic diseases including diabetes, cancer, cardiovascular disease, asthma, and obesity (7) and many risk behaviors for chronic disease such as physical inactivity, smoking, excessive drinking and insufficient sleep.

Accurate measurement and improvement of the populations' mental health requires the recording of indicators that capture the full spectrum of disease severity. The use of multiple indicators provides a more comprehensive picture of mental health needs, than a single indicator alone. Multiple social, psychological, and biological factors determine the level of mental health of a person at any point in time. Poor mental health is also associated with rapid social change, stressful work conditions, gender discrimination, social exclusion, unhealthy lifestyle, risks of violence, physical ill health and human rights violations (48).

In the health care and public health arena, more emphasis and resources have been devoted to screening, diagnosis, treatment and prevention (9,18) of mental illness than mental health. Little has been done to protect the mental health of those free from mental illness. Researchers suggest that there are indicators of mental health, representing three domains, including the following (5):

Emotional well-being: such as perceived life satisfaction, happiness, cheerfulness, peacefulness.

Psychological well-being: such as self-acceptance, personal growth including openness to new experi-

ences, optimism, hopefulness, purpose in life, control of one's environment, spirituality, self-direction, and positive relationships.

Social well-being: social acceptance, belief in the potential of people and society as a whole, personal self-worth and usefulness to society, sense of community.

In our research, we have chosen to use as *Single mental health outcomes* three answers of the question Q69: Depression or anxiety, Overall fatigue and Sleep disorders. We have correlated these outcomes with the occupational risk factors reported by the workers in the same Master Questionnaire.

The choice of these outcomes is suggested by the aforementioned definitions and is supported by the content of the two most used questionnaires for the assessment of general mental health status, such as the General Health Questionnaire (GHQ-28) and the Structured Clinical Interview for DSM IV Axis I Disorders (28, 39).

Psychosocial work characteristics and common mental disorders

Mental disorders, and among them the two most common disorders i.e. depression and anxiety, are an important issue in occupational health because of the high costs and heavy impact on absenteeism, presenteeism (defined by the Center for Disease Control and Prevention as the measurable extent to which health symptoms, conditions, and diseases adversely affect the work productivity of individuals who choose to remain at work), and other work-related outcomes such as reduced work performance and turnover (3, 22).

Literature studies have widely demonstrated that the risk of mental health outcomes, especially depression or depressive symptoms, may increase with high psychological demands, low decision latitude (comprising low skill discretion and low decision authority), the combination of high demands and low latitude, and low social support (job strain model), and with the combination of high effort and low reward (effort-reward imbalance model) (4, 30, 31, 37, 40).

Since the publication of Karasek's paper (21), describing the job strain model and the effects of

job strain on well-being, the "psychosocial environment" at work, which is determined by an interaction between organizational environment on one hand, together with work content and employees' skills and needs on the other hand (20), has been investigated in depth, also considering the fact that there has been an increasing shift from "blue collar towards white collar", i.e. manual work towards non-manual work (12). Karasek postulated a "job-strain model" based on two key dimensions of the psychosocial work environment, psychological job demands and decision latitude. Two other dimensions may have a buffering effect on the job-strain model, the occupational social support (19) and the effort-reward imbalance (36).

Despite these early findings, the psychosocial model has been criticized, arguing that the association between work characteristics and health may be due to another confounder i.e. social class: consequently, poor work characteristics are merely a marker for low socioeconomic position (26).

Social disadvantage may partially confound the association between work and health, but even after adjustment for social position and, in occupational cohorts of homogeneous social status where this confounding factor would not be expected, work characteristics are still important determinants of psychological distress (8).

Moreover, the measurement of work characteristics based on self-report may be affected by the problem of response bias (27), speculating that preexisting personality traits or poor mental health could influence the reporting of work characteristics. Nevertheless, other studies demonstrated that adjustment of work characteristics by negative affectivity had little effect on the risk of psychological distress or on stressor-strain relationships, and also adjustment for personality measures, like hostility and low self-esteem, did not seem to explain the association between work characteristics and depressive symptoms (32, 38, 42).

A recent review has been carried out to clarify the association between psychosocial work stressors and occupational mental health (40). The review used longitudinal studies identified through a standardized search strategy and strict inclusion and quality criteria. A positive association was found in all pa-

pers exploring the effects of psychological demands on common mental disorders. The overall summary estimate of the risk of common mental disorders for those with the highest psychological demands was 1.39 and the summary risk was higher for men than for women. Fewer studies were identified that explored the effects of job strain on common mental disorders. The size of the summary point estimate for job strain was substantial, and it was among the two highest for the psychosocial work characteristics. Seven research groups were identified that explored aspects of interpersonal work relationships. Five out of the seven studies found a significant association between poor work relationships and mental illness. Two studies presented data in a way that could not be used in a meta-analysis. A modest increased risk was found in the meta-analysis of all studies for the effect of poor interpersonal relationships on common mental disorders. There were two longitudinal studies of effort–reward imbalance. The summary point estimate showed a substantial effect. There were also studies of job insecurity and common mental disorders. In three studies of job insecurity, the point estimate was 1.33.

In this meta-analysis, the strongest prospective associations were found for the combination of decision latitude and psychological demands (high job strain) and the combination of putting in high effort and receiving low reward (effort–reward imbalance) and common mental disorders, consistent with causal associations.

In addition to these findings, Bhui and colleagues (2) found that racial or ethnic discrimination has also been found to be associated with an increased risk of common mental disorders, while Shields in two studies, (34, 35), reported that long workhours (>35 hours per week) and shift work are associated with common mental disorders.

Non-Psychosocial work characteristics and common mental disorders

The majority of literature studies that have associated occupational risk factors to work-related mental illness were focused on psychosocial hazards. The studies investigating the link between physical, chemical and biological risk factors with mental

health in working settings are just a few of these and they neither report an adequate risk assessment, nor give due consideration to the well-known threshold limit values (TLVs) set by the American Conference of Governmental Industrial Hygienists.

Noise

Noise, or undesirable sound, is one of the most common environmental stressors and it can cause various health effects. Beyond the consequences of occupational noise exposure on the auditory system, extra-auditory effects, including annoyance, headache, sleep disturbance and impaired cognitive development in children, have been found (44).

Stansfeld (41, 43) suggested an association between environmental noise exposure and mental health, pointing out that controversies do exist as to whether noise exposure itself is related to mental illness, after controlling for environmental and socio-demographic variables (16, 24, 40).

A Korean study was carried out in order to examine the association between noise exposure and psychological symptoms, including depressive symptoms and suicidal ideation, in an active working population (50). In this study, the assessment of noise exposure and personal perceptions of its effects were obtained from self-report questionnaires. This cross-sectional study confirms that occupational noise annoyance and psychological symptoms, including depression and suicidal ideation, are linked. These associations were not attenuated by adjusting for individual characteristics, such as age, BMI, smoking habits and alcohol drinking, as well as socio-demographic characteristics, including education, occupation and household income, even with gender stratification.

Chemical substances

To our knowledge, there is only one study which investigated depressive symptoms and anxiety disorder in association with past occupational dust exposure (25). It was carried out in retired Chinese “factory workers”, without pneumoconiosis, after adjusting for multiple confounders. The results of this study showed a significant association between

past dust exposure (workers exposed to silica, cement, coal and asbestos where the mean duration of employment was 23.2) in the workplace, depressive symptoms and anxiety disorders, with dose-response relationships in older retired Chinese factory workers.

Heat stress

Exposure to extreme heat conditions has been found to be hazardous to health and linked, in many studies, to a range of illnesses and premature death (6).

A study on Thai workers (45) was conducted in order to identify the relationship between self-reported heat stress and psychological distress, and overall health status. Their principal finding was that heat stress was strongly and significantly associated with both poor overall health and psychological distress. These epidemiological associations remained substantial and highly statistically significant, when extensively adjusted for confounding (by age, sex, income, education, and job location) as well as when restricted to those who did not have other (non-thermal) work complaints (i.e. non-complainers).

Miscellaneous

Shattell and colleagues, with random sampling procedures, studied 316 male truckers, 21 years of age or older, from a large truck stop located within a 100-miles radius of Greensboro, North Carolina (33). Depressive symptoms were a significant finding in this study, since depression was reported by 26.9% of the participating truckers. Indeed, according to literature (1, 14, 15, 47), depression has been typically associated also with lower levels of education, low social support, high occupational stressors and job strain, financial strain and sleep problems in non-trucking samples of working men. Authors believe that these factors are particularly prevalent among long-haul truck drivers, who are often away from friends and family for several days to weeks at a time and who may experience the stressful trucking work environment for lengthy periods of time, even though HOS (Hours of Service Regulations) is applied.

METHODS

The data used in the empirical analysis is drawn from the 2010 European Working Conditions Surveys (EWCS) (49). The surveys offer a broad and multifaceted source of information on the quality of living and working conditions across the EU states. The 2010 EWCS surveyed random samples of workers through over 40,000 face-to-face interviews in EU27, Norway, Croatia, the former Yugoslav Republic of Macedonia, Turkey, Albania, Montenegro and Kosovo. The survey is based on a questionnaire that covers themes such as employment status, working duration, work organization, learning and training, physical and psychosocial risk factors, health and safety, work-life balance, worker participation, earnings and financial security, as well as work and health. The main questionnaire is composed of 77 questions and it can be considered as a semi-structured interview guide. The use of a standardized questionnaire administered in the original language in each country, allows cross-country comparisons minimizing measurement errors. The sampling process is designed as a multistage stratified sampling within each country, and weights are provided to ensure representativeness across all countries (see the Data Appendix for additional details).

The analysis was conducted focusing on several topics of the questionnaire, in particular on occupational mental health, considering that stress, depression and anxiety are second in the list of the work-related health problem, just after musculoskeletal related disorders. Indeed, they are quoted as the most serious among workers with a work-related health problem in the EU27 (12). The first step of the research was the construction of a set of indicators measuring risk factors present as work and health outcomes from the information available in the questionnaire. We also used the review of scientific literature to support the choice and measurement of the indicators. The mental health variable used to monitor the outcome in our research was created using the Question Q69 (The question Q69 literally says: "Over the last 12 months, did you suffer from any of the following health problems?"), recording self-reported symptoms as depression or anxiety, overall fatigue and insomnia or

general sleep difficulties experienced in the previous 12 months¹. Occupational risk indicators were constructed using several questions on workers' working conditions, which were then grouped into three main categories, defined as *somatic*, *task-related* and *psychosocial* risk factors. Each of these categories was then re-classified into subcategories detailing a specific domain of risk, as shown in Table 1.

The description of the psychosocial risk indicators subcategories deserves a special note, namely job context and job content. The first set of indicators refer to the work environment (understood as

“environmental characteristics of the workplace and the associated workers task sequence”) and the interface between co-workers and supervisors (job instability, decisional autonomy, interpersonal support and social environment), while the second set of indicators relates to tasks performed by the worker (workload, work intensity and flexibility of working times). These indicators are then used as explanatory variables in the empirical analysis, to explain mental health outcomes in European workplaces. After dropping all observations with missing values in any of our variables of interest, we are left with

Table 1 - Occupational risk factors

Somatic	Hazardous agents	Chemical	Breathing fumes/powders; vapours; contact with chemicals; passive tobacco smoke.
		Physical	Vibration from tools; loud noise; extreme temperatures.
		Biological	Contact with infectious materials; dealing directly with people; visiting customers/patients.
	Task/sequence-related factors	Manual handling of loads/patients	Lifting/moving people; carrying/moving heavy loads.
		Biomechanical overload of the MSS	Tiring/painful positions; standing; repetitive hand/arm movements; computer work; short repetitive tasks (<1 or 10 min).
		Shift work/Unsociable hours	Working on shifts; at night; in evening; on Saturdays; on Sundays.
Psychosocial	Job content	High work intensity	Facing frequent disruptive interruptions; working intensely (at high speed/on tight deadlines).
		Low time flexibility	Working long hours (>40 h p.w. or >10 h p.d. more than once a month); during free time; having a poor work-life balance; not having time to accomplish tasks.
	Job context	Job instability	Job insecurity; bad employment prospects.
		Low decisional autonomy	Low authority over work processes; low autonomy over job schedule.
		Low interpersonal support	Low colleague/manager support
Adverse social environment	Bad social relations; discrimination; workplace violence.		

¹ Notice that while the reliability of self-reported data is often criticized due to random errors and subjective biases, several studies have documented their high correlation with more objective measures (Eurofound 2012). In particular, we used information available in question 69 (letters from K to M).

Table 2 - Summary statistics on mental health outcomes and occupational risk factors

Variable	Mean	(Std. Dev.)	Min.	Max.	N
Mental health	0.489	(0.500)	0	1	33,407
<i>Single mental health outcomes</i>					
Depression or anxiety	0.114	(0.318)	0	1	33,314
Overall fatigue	0.417	(0.493)	0	1	33,314
Sleep disorders	0.210	(0.407)	0	1	33,332
<i>Somatic risk factors indicators</i>					
Hazardous agents					
<i>Chemical hazards</i>					
Breathing in fumes/powders	1.724	(1.502)	1	7	33,349
Breathing in vapours	1.474	(1.147)	1	7	33,309
Contact with chemical substances	1.625	(1.342)	1	7	33,312
Tobacco smoke from others	1.572	(1.268)	1	7	33,306
<i>Physical hazards</i>					
Vibrations from tools	1.948	(1.725)	1	7	33,355
Loud noise	2.251	(1.787)	1	7	33,375
High temperatures	1.933	(1.505)	1	7	33,317
Low temperatures	1.895	(1.433)	1	7	33,302
<i>Biological hazards</i>					
Contact with infectious materials	1.558	(1.349)	1	7	33,276
Dealing directly with people	4.294	(2.449)	1	7	33,334
Visiting patients/clients	0.246	(0.431)	0	1	33,267
Task/sequence-related factors					
<i>Manual handling of loads</i>					
Lifting or moving people	1.440	(1.204)	1	7	33,346
Carrying or moving heavy loads	2.281	(1.723)	1	7	33,360
<i>Biomechanical overload of the MSS</i>					
Tiring or painful positions	3.025	(2.001)	1	7	33,313
Standing	4.222	(2.276)	1	7	33,364
Repetitive hand/arm movements	3.995	(2.278)	1	7	33,303
Working with computers	3.453	(2.452)	1	7	33,310
Repetitive tasks < 1 min	0.260	(0.439)	0	1	32,731
Repetitive tasks < 10 min	0.400	(0.490)	0	1	32,701
<i>Shift work/Unsociable hours</i>					
Working at night	1.255	(3.700)	0	30	33,034
Working in evenings	3.273	(5.795)	0	31	32,835
Working on Sundays	0.602	(1.137)	0	5	32,983
Working on Saturdays	1.208	(1.523)	0	5	32,921
Shift work	0.207	(0.406)	0	1	33,187
<i>Psychosocial risk factors indicators</i>					
Job content					
<i>High work intensity</i>					
Frequent disruptive interruptions	0.155	(0.362)	0	1	33,280
Work intensity	0.588	(0.492)	0	1	33,321

(continued)

Table 2 (continued) - Summary statistics on mental health outcomes and occupational risk factors

Variable	Mean	(Std. Dev.)	Min.	Max.	N
<i>Low time flexibility</i>					
Long hours	0.347	(0.476)	0	1	33,297
Working in free time	1.928	(1.159)	1	5	32,786
Poor work-life balance	0.186	(0.389)	0	1	33,263
Not enough time to accomplish tasks	2.059	(1.012)	1	5	33,228
Job context					
<i>Job instability</i>					
Job insecurity	0.204	(0.403)	0	1	31,353
Bad employment prospects	0.461	(0.498)	0	1	32,485
<i>Low decision authority</i>					
Low authority over work processes	0.723	(0.447)	0	1	33,406
Low autonomy over job schedule	0.201	(0.401)	0	1	33,259
<i>Low interpersonal support</i>					
Low support from colleagues	0.082	(0.274)	0	1	31,851
Low support from managers	0.161	(0.368)	0	1	32,061
<i>Adverse social environment</i>					
Bad social relations	0.184	(0.388)	0	1	33,311
Discrimination	0.068	(0.252)	0	1	33,425
Workplace violence	0.153	(0.360)	0	1	33,438
Socio-demographic variables					
Female	0.517	(0.500)	0	1	33,454
None to lower secondary education	0.231	(0.422)	0	1	33,368
Secondary education	0.455	(0.498)	0	1	33,368
Tertiary education	0.314	(0.464)	0	1	33,368
Age <25	0.086	(0.281)	0	1	33,454
Age 25-35	0.270	(0.444)	0	1	33,454
Age 36-55	0.530	(0.499)	0	1	33,454
Age >55	0.114	(0.318)	0	1	33,454
Married	0.766	(0.423)	0	1	28,952
Has child	0.604	(0.489)	0	1	28,952
Firm/Job characteristics					
Firm size 1-9	0.332	(0.471)	0	1	32,384
Firm size 10-49	0.333	(0.471)	0	1	32,384
Firm size 50-99	0.118	(0.323)	0	1	32,384
Firm size 100+	0.217	(0.412)	0	1	32,384
Permanent contract	0.772	(0.420)	0	1	33,269
Public sector	0.312	(0.463)	0	1	33,224
Tenure	9.418	(9.403)	0	47	32,951

Note: Higher values indicate worse outcomes/risk, for any variable.

final sample of approximately 30,000 observations. Summary statistics on mental health outcomes and occupational risk indicators used in the empirical analysis are reported in table 2.

Statistical analysis was performed estimating a set of multivariate regression models specified as,

$$MH_{ic} = \alpha + JS'_{ic}\beta + JPS'_{ic}\gamma + X'_{ic}\delta + \theta_c + \varepsilon_{ic} \quad [1]$$

where subscript i and c indicate respectively individuals and countries. MH_{ic} is our binary indicator of mental health defined either as overall mental health problem (any symptom), or as specific

symptoms (depression/anxiety, overall fatigue and sleep disorders). $J\text{Sic}$ is a vector of risk indicators for somatic attributes of the job (hazardous agents and task related factors), $J\text{PSic}$ is a vector of psychosocial risk indicators accounting for the work environment (i.e. the job context) and work organisation attributes (i.e. the job content). Finally, $X\text{ic}$ is a set of controls for demographic characteristics of the workers, firm and job attributes, while c is country fixed-effect to account for heterogeneity in legal and cultural norms across countries. Model [1] above is estimated as a linear probability model on the pooled by country sample, using the appropriate cross-country weights².

RESULTS

Most findings in the empirical analysis accord with the evidence available from previous country

level studies, though in this study we can extend the analysis to a larger set of countries. In Figure 1, we use the Fields' decomposition method to evaluate the main contributions to the variance of mental health distress in our sample of European workers, according to somatic risk factor, psychosocial risk factors, workers' demographic characteristics, job and firm attributes and, finally, country specific factors (13).

The main results of the decomposition show that an important contribution to workers' overall mental distress at work is associated with psychosocial risk factors (up to 60% for depression/anxiety symptoms and sleep disorders), while the contribution of somatic factors is on average lower (up to 20% for overall fatigue). Notice that in the most encompassing regression specifications, which include up to 40 regressors of interest and 50 additional controls for demographic characteristics, industry, occupation

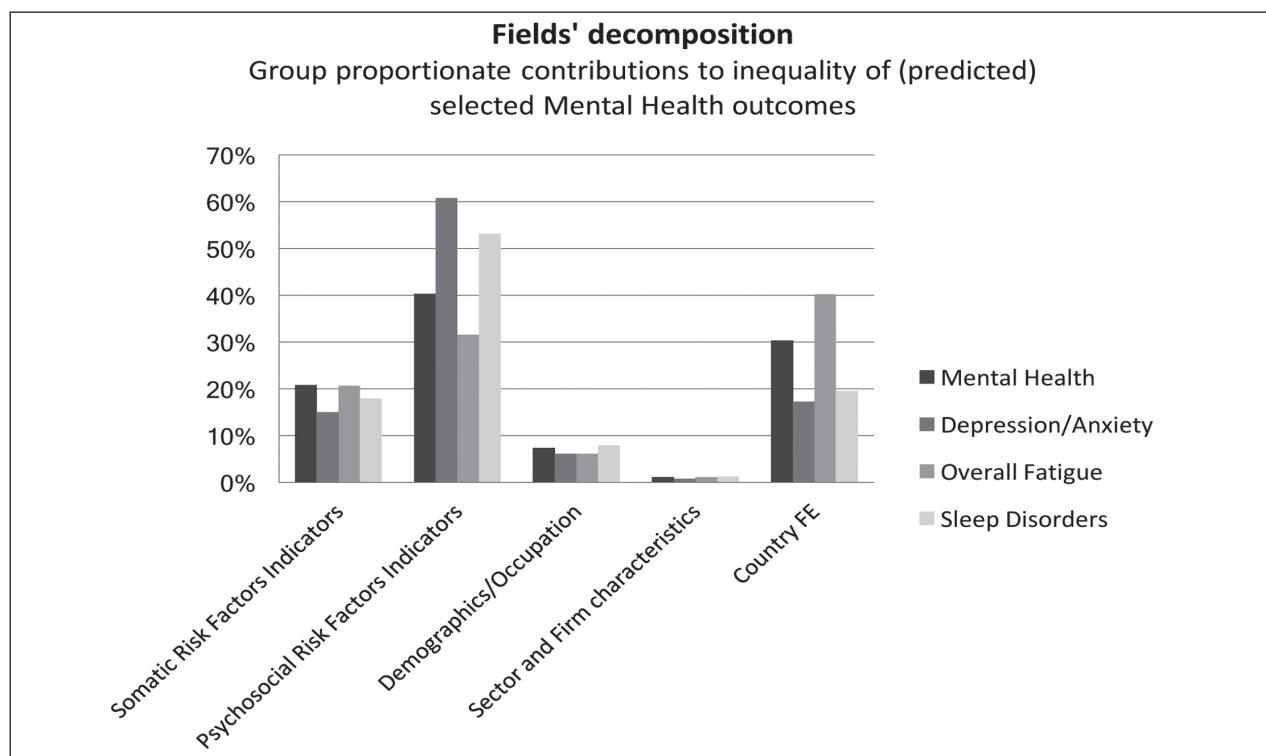


Figure 1 - Fields' decomposition on selected mental health outcomes

²We also estimated the model using a non-linear probit model to account for the discrete nature of the dependent variables. Results are unchanged. For easy of interpretation we only report the linear probability estimates, other results are available upon request with the authors.

and country attributes, the total number of observations after deleting missing values drops to 21,000. While this may be a reason for concern, we evaluated the sensitivity of the results to the potential non-randomness of the sample reduction and found no strong evidence of selection on the sample representativeness.

Somatic occupational risk factors indicators

Somatic occupational risk factors include both adverse agents (chemical, physical and biological hazards), as well as risk factors related to work tasks (dynamic or static biomechanical overload of the musculoskeletal system and shift work). The main set of results is summarized in Table 3 (the full set of results can be obtained upon request to the authors).

Among adverse agents, chemicals show no statistically significant association with job tasks involving inhaling of particulate and airborne substances, passive tobacco smoke and other situations dealing with chemical substances. Loud intensity noise and low temperatures are the physical hazards that result positively associated with mental health outcomes, while vibrations from tools and high temperatures

show no statistically significant association. Biological hazards involving workers' contact with infectious materials are strongly associated with mental health outcomes, while dealing directly with people or visiting patients/clients does not appear to interfere with workers' mental health.

Among task/sequence-related factors, we considered risk factors that involve an overload of the MSS (Muscular-Skeletal System): either dynamic (i.e. in case of manual lifting, handling or carrying objects), or static (i.e. when tasks require long standing, as for shop assistants, or extended periods of time on a sitting posture, as for call centers operators). The manual handling of loads shows no association with mental health outcomes, while all other risk indicators concerning the biomechanical overload of the MSS exhibit a positive correlation with impaired mental health outcome and are statistically significant (with the only exception of standing and repetitive tasks for less than 1 min). In contrast to the existing literature, the rich specification adopted here shows that, conditional on a large set of covariates, shift work is not statistically correlated with perceived mental well-being, except for work at night or in evenings.

Table 3 - Multivariate regression between work-related risk factors (Somatic Risk Factors, Job Content and Job Context) and mental health: regression coefficients and robust standard errors

	Coefficient	Standard error	p-value
PANEL (A): Somatic Risk Factors Indicators			
Hazardous agents			
<i>Chemical hazards</i>			
Breathing in fumes/powders	0.0176	(0.0139)	0.205
Breathing in vapours	-0.0188	(0.0184)	0.307
Contact with chemical substances	-0.00744	(0.0153)	0.629
Tobacco smoke from others	0.0115	(0.0142)	0.418
<i>Physical hazards</i>			
Vibrations from tools	-0.0197	(0.0126)	0.118
Loud noise	0.0231	(0.0121)	0.056
High temperatures	0.0167	(0.0127)	0.188
Low temperatures	0.0287	(0.0131)	0.028
<i>Biological hazards</i>			
Contact with infectious materials	0.0394	(0.0147)	0.007
Dealing directly with people	0.0123	(0.00782)	0.115
Visiting patients/clients	0.0393	(0.0403)	0.329

(continued)

Table 3 (continued) - Multivariate regression between work-related risk factors (Somatic Risk Factors, Job Content and Job Context) and mental health: regression coefficients and robust standard errors

	Coefficient	Standard error	p-value
Task/sequence-related factors			
<i>Manual handling of loads</i>			
Lifting or moving people	-0.0179	(0.0160)	0.263
Carrying or moving heavy loads	0.00541	(0.0119)	0.649
<i>Biomechanical overload of the MSS</i>			
Tiring or painful positions	0.0713	(0.0101)	0.000
Standing	0.00477	(0.00930)	0.608
Repetitive hand/arm movements	0.0255	(0.00820)	0.001
Working with computers	0.0301	(0.00901)	0.000
Repetitive tasks <1 min	-0.0544	(0.0392)	0.165
Repetitive tasks <10 min	0.0859	(0.0366)	0.018
<i>Shift work/Unsociable hours</i>			
Working at night	0.00365	(0.00499)	0.464
Working in evenings	0.00754	(0.00307)	0.013
Working on Sundays	0.00341	(0.0175)	0.846
Working on Saturdays	-0.0187	(0.0133)	0.159
Shift work	-0.0519	(0.0446)	0.246
PANEL (B): Psychosocial Risk Factors Indicators			
Job Content			
<i>High Work Intensity</i>			
Frequent disruptive interruptions	0.219	(0.0463)	0.000
Work intensity	0.0578	(0.0352)	0.100
<i>Low time flexibility</i>			
Long hours	0.127	(0.0381)	0.000
Working in free time	0.0759	(0.0156)	0.000
Poor work-life balance	0.228	(0.0428)	0.000
Not enough time to accomplish tasks	0.0434	(0.0165)	0.000
Job Context			
<i>Job instability</i>			
Job insecurity	0.00378	(0.0416)	0.928
Bad employment prospects	0.177	(0.0338)	0.000
<i>Low decision authority</i>			
Low authority over work processes	0.103	(0.0375)	0.006
Low autonomy over job schedule	0.245	(0.0448)	0.000
<i>Low interpersonal support</i>			
Low support from colleagues	0.0578	(0.0586)	0.327
Low support from managers	0.0647	(0.0454)	0.156
<i>Adverse social environment</i>			
Bad social relations	0.186	(0.0424)	0.000
Discrimination	0.250	(0.0699)	0.000
Workplace violence	0.411	(0.0486)	0.000
<i>N</i>		21,020	
Pseudo R ²		0.149	

Psychosocial Risk Factors Indicators

Psychosocial Risk Factors are related to both the content of the job (work intensity and working time flexibility), as well as the job context, such as the perceived stability of the job, the low decisional autonomy and workplace interpersonal relations/social environment. Psychosocial risk factors, both jointly and individually, show a strong positive and statistical significant association with workers' perceived mental well-being.

In terms of Job Content indicators, frequent and disruptive interruptions at work, along with long hours and poor work-life balance, prove to be harmful for workers' mental health. Among Job Context indicators, perceptions of bad employment prospects seem to matter more than overall job insecurity for workers' psychological well-being. Equally harmful is low latitude of decision, both in terms of authority over work processes and autonomy in the job schedule. Finally, psychological / organizational climate is shown to matter a lot: bad social relations, episodes of discrimination, as well as workplace violence, significantly contribute to harm workers' mental health. Conversely, the lack of interpersonal support from colleagues is not a source of psychological distress.

DISCUSSION

Although empirical analyses based on large survey data provide considerable information on workers' demographic characteristics, nevertheless, several shortcomings regarding both workplace environment and job-tasks features should be considered. These are mainly related to "the way the question is asked and its content" in the questionnaire. The first fault is that the health problems workers complained of, only refer to the last twelve months. Therefore, some workers' complaints could be present at the time questionnaires were administered (for instance depression symptoms), even though the problem originated from previous jobs. Moreover, some questions about mental health disorders consider neither the duration nor the onset of the symptoms, which makes cause-effects relationships particularly hard to evaluate.

The second shortage, in view of the comparison with the data available in the literature, is that the symptoms listed are sometimes not sufficiently specific, both in terms of frequency and in terms of severity. For example, regarding the question "sleep disorders", it could be the case of an employee who complained of sleeping problems only a few times during the previous year (which could only be episodically related to work), or the case of a worker affected by chronic insomnia with periodical disturbances, whose connection with work could be high. Finally, another limitation of survey data is that the exposure to occupational risk factors (hazard) is based on Likert-type indicators and entirely self-assessed by workers, thus introducing relevant elements of subjectivity difficult to control in empirical analyses, particularly in absence of any objective Hazard Recognition or Risk Assessment practice to refer to.

Nevertheless, the possibility of processing a large set of data across different countries increases the "external validity" of the results in different working contexts and institutional settings, thus at least partially overcoming the lack of representativeness of single country-specific case study.

CONCLUSIONS

Our research proposes a new path for understanding the possible effect of the relationships between occupational hazards and mental health highlighting a new evidence in an area of considerable interest for the well-being of workers, as well as for the economic repercussions on the national health system and employers. We argue that action is needed to improve workers' mental well-being and reduce the economic costs for both the national health system and employers. Regulations and traditional economic measures are unlikely to prove successful in providing adequate standards of primary and secondary preventive measures in the work place, unless an appropriate and reliable Risk Assessment program is employed. In order to better understand the pathophysiological association between uncommon risk factors (for instance low temperatures) and workers' mental health evidenced by our study, our findings need to be supported by objective on-site evaluations, which, by the way, are commonly carried out by Occupational Hy-

gienists in most of workplaces all over Europe. The results of this investigation, if properly associated to this kind of survey, could bring a significant positive contribution to the data analysis and interpretation. Moreover, future research should consider a more detailed classification of workers and their occupation, such as 3-digit International Standard Classification of Occupations. This would allow a better association of the occupational risk factors workers are exposed to with the possible outcomes for their health. In addition, we believe that the evidence resulting from the very common and frequent risk assessment procedures, which on daily basis are carried out in most European countries, should be considered, even though this approach will require a new specifically designed survey.

NO POTENTIAL CONFLICT OF INTEREST RELEVANT TO THIS ARTICLE WAS REPORTED BY THE AUTHORS

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