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Research report

Who knows the risk? A multilevel study of systematic variations in work related safety knowledge in the European workforce

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Abstract

Objectives Health and safety instructions are important components of occupational prevention. Albeit instruction is mandatory in most countries, research suggests that safety knowledge varies among the workforce. We analysed a large European sample to explore if all subgroups of employees are equally reached. In a comparative perspective we also investigated if country-level determinants influence the variance of safety knowledge between countries.

Methods We used data on 24,534 employees from 27 countries who participated in the 2010 European Working Conditions Survey. Safety knowledge was measured as self-assessed quality of safety information. Country-level determinants were added from Eurostat databases (GDP) and the ESENER study (% companies with A: safety plan or B: a labour inspectorate visit). Associations between knowledge, socio-demographic, occupational characteristics, and macro-determinants were studied with hierarchical regression models.

Results In our sample 10.1% reported a low degree of health and safety knowledge. Across all countries, younger workers, lower educated workers, production workers, private sector employees, those with less job-experience, a temporary contract or who work in small-businesses were more likely to report low levels of information. Moreover, low information prevalence varied by country. Countries with a high proportion of companies with a safety plan and recent labour inspectorate on-site visits had higher proportions of informed workers.

Conclusions A vast majority reported to be well informed about safety risks but systematic inequalities in the degree of knowledge between subgroups were evident. Further efforts on the workplace, the organisational and the political level are needed to universally implement existing occupational safety regulations.

What this paper adds

- Basic information about health and injury risks at a workplace is a protective resource and legal obligations to provide proper instructions exist
- Previous studies suggest that particular subgroups of the workforce are less informed than others
- As no comprehensive overview of individual and country level variations in safety information exists, we conducted a comparative multilevel study with data from 27 European countries
- We found that self-reported low information was more common among employees with lower socio-economic or occupational position
- Country comparisons showed that the average level of information was higher in countries with frequent labour inspectorate visits and companies with a defined health and safety plan

Background

Basic knowledge about health and injury risks at the workplace can be regarded as one of the prerequisites to avoid specific dangers and to adopt generalized safety behavior [1–4]. Correspondingly, empirical studies find that safety knowledge is associated with psychological correlates of safety climate (e.g. safety motivation or initiative), safety behavior and outcomes like injuries or chronic disease [2, 5–10].

The importance of safety knowledge is valued in the occupational safety and health (OSH) laws of many countries. The European 1989 Laws Council directive (89/391/EEC), for instance, obliges employers to provide appropriate health and safety instructions to their employees (§6(2)). The directive is incorporated in the national OSH laws of all European Union member states. Thus, all employed should - at least from a legal point of view - be sufficiently instructed irrespective of their occupational position, qualification, gender, age or country. However, this premise has not to date been empirically tested – largely because population-based data about the compliance with this norm in everyday practice is largely missing. We argue that it is of importance to fill this evidence gap and in this paper we use data from the 2010 European Working Conditions Survey (EWCS) to do so.

First, systematic examination can provide an answer to the question if certain subpopulations of the workforce are less well informed about safety risks than the average of the employees. A previous data report from the European Working Conditions Survey (EWCS) 2005 suggested that blue-collar workers, employees in small-businesses and workers with temporary contracts were more often less well informed [11]. This raises the concern, that safety information may be insufficient especially in occupational groups with high exposure levels towards safety and health risks at the workplace. It is well documented that adverse working conditions, occupational injuries and work related diseases are not equally distributed across the workforce [12]. Examples are the pronounced differences in occupational injury rates by occupation groups [13, 14], higher injury rates in temporary employed [15] and higher exposure towards adverse physical or psychosocial working conditions in lower qualified workers [16–18]. In order to detect possible deficits in the diffusion of safety knowledge a comprehensive description, stratified for relevant subgroups like those mentioned before is needed.

Second, in a broader sense, systematic differences in safety knowledge may be a symptom of structural (country level) differences regarding OSH regulations, organization, commitment and inspection. The influence of macro-level factors on the distribution of health related working conditions at the individual level is the subject of a growing number of recent studies [19–26]. One important finding is that health related working conditions differ significantly between countries.

Explanations for this phenomenon are complex and comprise many interrelated factors, e.g. welfare state arrangements, specific labor policies, different management cultures or the particular economic structure of a national economy (e.g. the mix of trades and industry) [27]. Here, we assume that the normative arrangement of OSH regulations as well as the execution and inspection of it in everyday practice may be part of the mentioned explanatory framework. Safety research has established the concept of safety climate as an organizational resource [28, 29]. This idea can be transferred to the higher level of whole countries because OSH regulations are codified in national laws and the compliance with the law is usually monitored by state agencies (e.g. labour inspectorates). This may also be related to the economic development of a country, with richer countries having more stringent health and safety laws and enforcement [30]. As country variations in safety knowledge have not been studied so far, we aim to assess between-country variations and explore whether indicators for the state of OSH regulation, OSH monitoring and economic growth are related to possible differences in national levels of safety knowledge.

Objectives

Thus, the first objective of our study is to systematically study the distribution of an indicator for safety knowledge in a large European population based sample.

The second objective is to describe country variations in safety knowledge and to explore if country-level structural variables influence possible variations.

Methods

Study population and inclusion criteria

We investigated the distribution of safety knowledge using data from the 2010 wave of the European Working Conditions Survey (EWCS). Samples from 27 countries were included. The EWCS is a periodical survey which is conducted every five years under responsibility of the European Foundation for the Improvement of Living and Working Conditions (EUROFUND). Details about the survey design and the sampling are reported elsewhere [11, 31, 32]. Briefly, random samples of the workforce of the participating countries were interviewed about their occupational situation, working conditions and health. In 2010 the overall response rate was 44% (ranging from 31% in Spain to 74% in Latvia) with a country specific sample size between 1000 to 4001 realised interviews.

We restricted the analytical sample for this investigation to a subgroup of 27,544 respondents who were between 16 and 60 years old, were working in full- or half-time employment with more than 15 working hours a week, and were not members of the armed-forces or self-employed. After

further exclusion of participants with missing data on any study variable (n=3010) the effective sample size of this analyses was 24,534 of which 12,964 were women.

Measures

Individual level variables were assessed using a standardized questionnaire. Our dependent variable was computed from the responses to a question asking participants about their perception of personal safety knowledge: "Regarding the health and safety risks related to performance of your job, how well informed would you say you are?". Answers were: "(1) very well informed, (2) well informed, (3) not very well informed, and (4) not at all well informed". We dichotomised the response-scale into a binary variable grouping answers 1, 2 and 3, 4 with the later indicating a self-reported lack of safety knowledge.

To study variations between groups of employees a number of individual level characteristics were included. First, we distinguished sex and age groups (see table 1 for categories). Type of occupation was measured by three variables: occupation (International Standard Classification of Occupations; ISCO), branches (standard industrial classification; NACE) and whether the individual worked in the private, public or another sector. School and vocational education was classified according to the ISCED-97 standard. Work experience was measured by a variable indicating the years at the current workplace. Finally, we included the type of contract and the size of the company.

To systematically explore possible macro-level drivers of country differences in safety knowledge macro-data on country level was retrieved. As no previous multilevel studies on the subject exist we used a small set of explorative indicators for which links with occupational safety and health on work unit or individual level could be hypothesised. First, the gross domestic product (GDP in purchasing power standard (pps) per capita) in the year of the survey was retrieved from Eurostat. Indicators directly related to occupational safety and health were computed from the dataset of the 'European Survey of Enterprises on New and Emerging Risks' (ESENER) [33]. ESENER is a Europe-wide survey which asked representatives from companies and organisations about a wide range of issues regarding attitudes, behaviours, structures and commitments to OSH regulations and implementation in 2009. Country specific proportions were calculated for two indicators: 1. documented policy, established management system or action plan on health and safety exists; 2. labour inspectorate visited workplace in last three years.

Statistical Analyses

Following a description of the study variables we examined associations between the individual level characteristics and self-assessed safety knowledge. Calculations were conducted using a pooled dataset containing all country samples. Regarding the hierarchical character of the data with individuals nested in countries, we applied hierarchical logistic regression modelling adjusting for country as the level 2 unit. Estimators for an association between independent and dependent variable (i.e. low safety knowledge) were calculated for each single indicator separately with adjustment for age and sex. Finally, all individual level variables were simultaneous entered into one regression model. In the respective table we report odds ratios (OR) and 95% confidence intervals (CI).

Country level variance in safety knowledge and its explanatory factors were also studied with hierarchical logistic regression models. We calculated the level 2 variance together with the median odds ratio (MOR) for an empty model. The MOR indicates variance between units (here: countries) in a multilevel model. It can be interpreted as the median increase or decrease in risk related to a movement from one country to another. It is calculated as the median odds ratio between all random pairs of units in the dataset [34, 35]. Values exceeding 1 indicate a between-country variation. Explanatory variables on country level were then introduced one by one into the empty regression model in order to assess their influence on the between-country variance. A reduction in variance is displayed as the proportional change in variance (PCV). No mutual adjustment was conducted due to the comparably small number of level 2 units. We also apply a likelihood ratio test (LR Test) of model fit.

All calculations were performed using STATA 13 statistical package (STATA, College Station, Texas).

Sensitivity analyses

This study relies on self-reported information from participants of a cross-sectional survey. Hence, we conducted a number of sensitivity analyses to explore the precision of our findings. First, all analyses were repeated with the 2005 wave of the EWCS to assess the temporal stability and control for sampling bias. To evaluate the validity of the outcome variable correlations between safety knowledge and different health related variables in the EWCS dataset were calculated (e.g. injuries in the past year, self-assessed health risks). Furthermore, participants were asked if they attended in any training activity provided by the employer in the past 12 month. We assessed the association between this variable and our outcome measure. To further assess the precision of the multilevel

analyses we removed all countries with a survey response rate below 40%.

Results

Socio-demographic and occupational characteristics of the 24,534 participants in the pooled dataset are summarized in table 1. The majority considers themselves as well informed about health and safety issues at their workplace. However, nearly 2,500 individuals feel to be not well informed, which is one out of 10 workers in the sample (10.1%).

<insert table 1>

Table 2 displays odds ratios of an association between the "not well informed"-status and individual level-characteristics. There is little difference between men and women but the odds ratio of being uninformed decreases significantly with age. A pronounced association is also seen for education: the lower the educational degree the higher the chance of reporting to be "not well informed". Comparable to education a lower occupational position tends to be associated with a higher proportion of uninformed individuals. The table further shows that uninformed employees are more common in the private sector, among those new at their workplace, among part-time workers, among temporary contract owners and in small-size companies. A mutual adjustment of all factors (model 2) results in small to medium change in the odds ratios derived from model 1. Although some confidence intervals cover 1 after mutual adjustment, the main trends remain still visible with the exception of age and economic sector. An additional adjustment for country-level determinants has no substantial effect on the level 1 estimator (not shown). Sensitivity analyses with the 2005 wave of the EWCS yielded comparable results (not shown).

<insert table 2>

Apart from the substantial variance of the outcome measure by individual characteristics we find pronounced differences between countries. Figure 1 relates the proportion of uninformed study participants in a country with the three macro-level indictors. Correlations are visualised by the crude regression line (dotted). There is a tendency for a lower prevalence of uninformed individuals in countries where a large proportion of companies have a documented health and safety policy or a high frequency of safety inspectorate on-site visits. The association between GDP and the proportion of uninformed workers is weak and mainly explained by a small number of outlying countries.

<insert figure 1>

Descriptive results are confirmed by the fixed effect estimators from the multivariate hierarchical regression analyses shown in table 3. The reduction of the between-country variance observed after introducing the macro-indicators into the crude model, however, is moderate. Largest reductions are present for the documented OSH policy and on-site visits. It is remarkable that an adjustment for individual level characteristics (i.e. the composition of the country samples) has no influence on the level 2 variance. Again, the result of the sensitivity analyses using the 2005 wave of the EWCS is quite similar.

<insert table 3>

Finally, a number of sensitivity analyses were performed to empirically assess the validity of the outcome variable used in the analyses described above. They revealed a strong correlation between the outcome measure and the participation in an on-the job training program during the past 12 month. Moreover, a low degree of information was associated with a higher rate of injuries previous to the study and a worse self-rated health.

Discussion

The first objective of this study was to describe variations in the degree of safety knowledge across the workforce of 27 European countries. We found that self-reported low information was more common among certain subgroups of the population. Those were mainly groups with a lower socio-economic or occupational position, and also amongst women and the young or less experienced. The distribution with regard to individual socio-economic or occupational characteristics was quite comparable across all countries suggesting a systematic pattern in the information practice in the European region. The second objective was to examine the variation in the degree of safety knowledge between countries. Results show that the average level of knowledge varies between countries and that this variation was partly explained by the frequency of labour inspectorate visits and by the proportion of companies with a defined health and safety plan.

An interpretation of the results has to take the methodological characteristics (strength and limitations) of this study into account. A key issue is the measurement of the dependent variable. Safety knowledge was operationalized as the answer to a single question asking for a self-assessment of the quality of the personal information about OSH risks. The notion on individual

perception makes it difficult to draw conclusions about the objective availability and the content of safety instructions. Nor does the belief of being well informed mean that a person actually is. It is, for instance, possible that an employee feels to be well informed just because he or she was not instructed and therefore not aware of any risk. A certain degree of misclassification is therefore likely.

The self-assessed measure is nonetheless a relevant indicator. Research on the etiology of occupational injury has convincingly shown that 'subjective' factors like knowledge, risk perception, skills and motivation are important determinants of 'objective' safety performance [2, 3]. As such they are intermediate factors between the more distal safety climate of an organization and the actual safety behavior of the individual worker [4, 7]. Safety climate is an established concept in safety research and denotes safety resources, cultures and action on the level of workgroups or whole organization [29, 36]. A positive safety climate may be enforced by the existence of a safety policy, the organizations commitment to safety, training or the behavior of the direct supervisor. However, the individual perception of those aspects is still important for translating climate into a desired role behavior [29, 37].

In conclusion, we assume that the main outcome measure is an appropriate indictor for the investigation of health and safety issues although its limitations (i.e. subjective, only one aspect of safety culture, no objective behavior) must clearly be named. This assumption is also supported by the results of the sensitivity analyses performed.

The finding of a variation in the knowledge measure by socio-demographic and occupational characteristics in 27 European countries is considerable. We observed a systematic pattern of lower OSH knowledge in the more disadvantaged occupational groups like lower educated individuals in blue collar jobs and with temporary contracts. Importantly, it is well known that especially those groups have a higher exposure to health adverse working conditions as well as comparably higher general rates of manifest disease and injuries [12, 25, 38]. It can therefore be argued that the aim of the legal obligation to instruct employees is not fully achieved in high risk groups and that this misinformation may further aggravate already existing health inequalities. It is not possible to disentangle association in more detail in this study and it remains unclear if instructions were not at all provided, provided in an incomplete way or were presented in a format inappropriate for this particular target group. Further exploration is needed in order to identify ways to improve knowledge diffusion at the level of workplaces, e.g. by designing training programs especially for persons with a low basic education.

Moreover, certain interventions on the organizational and the political level may play a role in reducing inequalities in safety knowledge. This is suggested by the analyses of country differences

in this study. Although the obligation for an appropriate health and safety instruction is incorporated in the European legal framework we found a variance in the prevalence of uninformed workers by country. Variations were insignificantly related with GDP while the proportion of companies with a documented safety plan and with a visit by the labor inspectorate explained parts of the between-country variance. The later variables were operationalized as country means from the ESENER sample of organizations. We hypothesize that countries with a better ranking on those variables have a stronger emphasis on the implementation and control of health and safety regulations and create a more favorable safety climate at the organizational level. The better performance on safety indicators at the individual level in this study may then be the result of policies both on a state level and on the level of organizations. Again, methodological flaws must be considered. The macro-level empirical information was aggregated from a survey (ESENER). Response rates differed between countries and there is a certain danger of biased data if responders were not representative for all businesses.

To conclude, albeit individual and country variances are present it should nonetheless be noted, that the vast majority of the participants in all countries reported to be well or very well informed. This can be seen as a proof that legal interventions like the obligation to provide health and safety instructions are effective and could help to improve occupational health and safety. Benchmarking between countries and subgroups may then help to level out differences and to ensure best practice.

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Competing Interests

The authors declare no competing interests.

Contributorship statement

ND designed the work and drafted the manuscript. ND, TL, TAE, CB conceptionalised the theoretical background. TL, ND, KvdW conducted the statistical analyses. ND, TL, TAE, CB, MTM, KvdW interpreted the data. All authors critically revised the draft. All authors approved the manuscript.

Tables and Figures

Table 1 Description of the analytical sample and distribution of main study variables (N=24,534; EWCS 2010)

		Number	(%)
Sex	Male	11570	(47.16)
	Female	12964	(52.84)
Age	16-29	4439	(18.09)
	30-39	6615	(26.96)
	40-49	7216	(29.41)
	50-60	6264	(25.53)
Education (ISCED-97)	No/Primary	886	(3.61)
	Secondary	14477	(59.01)
	Post secondary	1370	(5.58)
	Tertiary	7801	(31.80)
Sector of economy (NACE)	Agriculture, forestry, fishing	531	(2.16)
	Industry	6064	(24.72)
	Services	9078	(37.00)
	Public Administration and defence	1784	(7.27)
	Other services	7077	(28.85)
Occupation (ISCO)	Legislators, senior officials and managers	1440	(5.87)
	Professionals	3765	(15.35)
	Technicians and associate professionals	4135	(16.85)
	Clerks	2960	(12.06)
	Service workers and shop and market sales workers	4460	(18.18)
	Skilled agricultural and fishery workers	228	(0.93)
	Craft and related trades workers	2953	(12.04)
	Plant and machine operators and assemblers	2251	(9.18)
	Elementary occupations	2342	(9.55)
Ownership	Private	15426	(62.88)
	Public	7464	(30.42)
	Other	1644	(6.70)
Time at workplace	Less than one year	2169	(8.84)
	1-4 years	7582	(30.90)
	5 and more years	14783	(60.26)
Working hours	Part-time job	4347	(17.79)
	Full-time job	20094	(82.21)
Contract	Permanent	20507	(83.59)
	Temporary	4027	(16.41)
Company size	Small (1-9 pers.)	7347	(29.95)
	Medium (10-99 pers.)	11202	(45.66)
	Large (100-499 pers.)	3895	(15.88)
	Very large ($\geq$500 pers.)	2090	(8.52)
Safety knowledge	Well informed	22049	(89.87)
	Not well informed	2485	(10.13)

Table 2 Associations between individual level variables and information about health and safety risks across 27 countries (OR and 95 % CI from hierarchical regression modelling with country as level 2 unit; N=24,534; EWCS 2010)

		Prevalence Not well informed %	Model 1		Model 2	
Sex	Male	10.03	1.00	#	1.00	
	Female	10.22	1.05	(0.97-1.15)	1.08	(0.98-1.19)
Age	16-29	12.55	1.00	$	1.00	
	30-39	10.84	0.85	(0.75-0.95)	1.06	(0.93-1.20)
	40-49	9.41	0.73	(0.65-0.82)	0.96	(0.84-1.10)
	50-60	8.49	0.68	(0.60-0.78)	0.91	(0.79-1.05)
Education (ISCED-97)	Tertiary	8.78	1.00		1.00	
	Post secondary	7.01	1.08	(0.86-1.36)	0.93	(0.73-1.18)
	Secondary	10.67	1.34	(1.22-1.48)	1.05	(0.93-1.18)
	No/Primary	18.06	2.50	(2.02-3.08)	1.72	(1.36-2.17)
Sector of economy (NACE)	Agriculture, forestry, fishing	11.30	1.00		1.00	
	Industry	9.32	0.74	(0.56-0.99)	0.86	(0.61-1.20)
	Services	11.56	0.83	(0.63-1.10)	1.00	(0.72-1.39)
	Public Administration and defence	9.59	0.74	(0.54-1.01)	1.10	(0.76-1.58)
	Other services	9.04	0.64	(0.48-0.85)	0.87	(0.62-1.22)
Occupation (ISCO)	Legislators, senior officials, managers	6.67	1.00		1.00	
	Professionals	7.68	1.10	(0.86-1.40)	1.21	(0.94-1.56)
	Technicians and associate professionals	8.17	1.13	(0.89-1.44)	1.13	(0.89-1.44)
	Clerks	11.72	1.61	(1.27-2.05)	1.51	(1.18-1.93)
	Service workers and shop and market sales workers	11.57	1.63	(1.29-2.06)	1.40	(1.10-1.79)
	Skilled agricultural and fishery workers	13.16	1.96	(1.26-3.07)	1.50	(0.91-2.49)
	Craft and related trades workers	10.94	1.72	(1.34-2.19)	1.62	(1.25-2.10)
	Plant and machine operators and assemblers	9.28	1.54	(1.20-2.00)	1.48	(1.13-1.94)
	Elementary occupations	14.39	2.27	(1.78-2.89)	1.86	(1.44-2.40)
Ownership	Private	11.20	1.00		1.00	
	Public	8.25	0.77	(0.70-0.85)	0.86	(0.76-0.98)
	Other	8.58	0.78	(0.65-0.94)	0.86	(0.71-1.04)
Time at workplace	Less than one year	15.91	1.00		1.00	
	1-4 years	11.53	0.74	(0.64-0.85)	0.88	(0.76-1.02)
	5 and more years	8.56	0.50	(0.44-0.58)	0.68	(0.58-0.79)
Working hours	Part-time job	11.53	1.00		1.00	
	Full-time job	9.83	0.89	(0.79-0.99)	0.96	(0.86-1.08)
Contract	Permanent	9.21	1.00		1.00	
	Temporary	14.80	1.73	(1.56-1.92)	1.41	(1.26-1.59)
Company size	Small (1-9 pers.)	12.11	1.00		1.00	
	Medium (10-99 pers.)	9.72	0.84	(0.76-0.92)	0.93	(0.84-1.03)
	Large (100-499 pers.)	8.73	0.73	(0.63-0.83)	0.85	(0.74-0.98)
	Very large (≥500 pers.)	7.94	0.64	(0.54-0.77)	0.80	(0.67-0.96)

Note. In model 1 all covariates are adjusted for sex and age. In model 2 all covariates are mutually adjusted.
age adjusted only $ sex adjusted only

<see file>

Figure 1 Correlation between macro indicators and information about health and safety risks (N=24,534; EWCS 2010)

Table 3 Reduction in the between country differences in information about health and safety risks: Results of hierarchical logistic regression models (N=24,534; EWCS 2010)

	Model 1 Empty model	Model 2 +individual variables	Model3 Empty model + documented policy	Model 4 Empty model + inspectorate	Model 5 Empty model + GDP
Fixed effects					
Macroindicator (OR and 95% CI)			0.99 (0.976-0.998)	0.99 (0.972-0.999)	1.00 (0.999-1.000)
Random effects					
Country level					
Between country variance (95 % CI)	0.237 (0.133-0.423)	0.241 (0.135-0.430)	0.198 (0.111-0.355)	0.202 (0.112-0.364)	0.210 (0.117-0.375)
MOR	1.59	1.60	1.53	1.54	1.55
PCV (%)		-2%	16.5%	14.8%	11.4%
Statistics					
Log-likelihood	-7800.65	-7631.68	-7798.34	-7798.72	-7799.10
Likelihood Ratio Test		P=0.0000	p=0.0313	p=0.0494	p= 0.0780
AIC	15605.31	15323.35	15602.67	15603.45	15604.20
BIC	15621.52	15566.59	15627.00	15627.77	15628.53

Note. MOR = median odds ratio; PCV = proportional change in variance; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion

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