



# EPHOR

Exposome tools for a healthy working life

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## Summary

A wide range of 10 different exposures of main interest for work-related mortality and morbidity have been harmonised to feed into a first version of a comprehensive European Job-Exposure Matrix (EuroJEM1.0), coded into ISCO-88 (COM). The exposures are:

- Chemicals and particles, 1970-2020 (10-year intervals), exposure prevalence (3 categories), estimated average exposure level among the exposed, for:
  - Respirable crystalline silica
  - Nickel
  - Wood dust
  - Diesel engine exhaust
- Physical exposures, 1970-2020 (5-year intervals):
  - Occupational noise exposure (continuous scale)
- Psychosocial exposure, 1990-2015 (no subdivision), exposure prevalence, (4 categories)
  - Quantitative job demands
  - Decision authority
- Physical workload, 1997-2019 (no subdivision), exposure prevalence (5 categories)
  - Faster breathing due to heavy physical workload
  - Working in forward bent posture
  - Heavy lifting
  - Working in kneeling or squatting
  - Working with hands above shoulder level

The harmonised JEMs weigh heavily on data from the Nordic countries and Western Europe with a main gap for Eastern Europe calling for caution in applying them to this region.

Ongoing efforts include validation of the harmonised JEMs, as well as arrangements to ensure that EuroJEM will remain accessible and updated beyond EPHOR.

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## 1. Introduction

The objective of WP2 is to develop a dynamic EuroJEM, i.e. a set of job-exposure matrices for assessment of multiple occupational exposures (the external occupational exposome) in large populations across Europe. As a first step an inventory has been performed of existing JEMs (Solovieva et al 2022).

This report concerns the harmonisation of selected existing JEMs into a first version of the EuroJEM (EuroJEM1.0), serving as a basis for retrospective exposure assessment in the EPHOR mega cohort (WP5) and in the case studies (Working-life exposome, lung function, and obstructive lung disease among men and women, WP6, Exposome case studies on night shift work and health, WP7), and as part of the interactive toolbox (EPHOR Working-life Exposome Toolbox, WP9) for use by external researchers, professionals, and policymakers. In parallel to the harmonisation of existing JEMs, new JEMs are developed which will be included in EuroJEM1.0. These have been reported separately (Deliverable 2.4), as was a protocol to include new data in the EuroJEM to keep it dynamic, i.e. updated and relevant (Deliverable 2.3).

Priorities when selecting exposures for harmonisation have been set following discussions at meetings with the full consortium, but in especially close collaboration during further meetings with WP5, with subsequent assessment of feasibility within the relevant group of exposure assessment experts within WP2.

The work is conducted in panels (Chemicals and particles, Physical exposures, Ergonomic exposures, and Psychosocial exposure) formed around the groups of exposures described below, with regular follow-up at on-line or in-person meetings for all WP2 participants. Representatives of other WPs with special interest in the EuroJEM also participate in these meetings on a regular basis, e.g. WP5 and WP9. The work has been coordinated by KI, with participation of AU, FIOH, INSERM, SLL, STAMI and UU in the overall work. For some exposures we have been assisted also by external researchers, as described below.

In short, occupational codes have been harmonised between coding systems into the same coding system (ISCO-88 (COM) – the European version of ISCO-88). For the selected exposures described below, inconsistencies and gaps between different JEMs have been resolved by expert judgement, allowing between-country differences when factually motivated, and missing values have been covered by imputation when deemed appropriate. The work and resulting JEMs are described below for each main group of exposures.

## 2. Harmonisation of different exposures

### 2.1 Chemicals and particles

#### 2.1.1 Harmonisation strategy

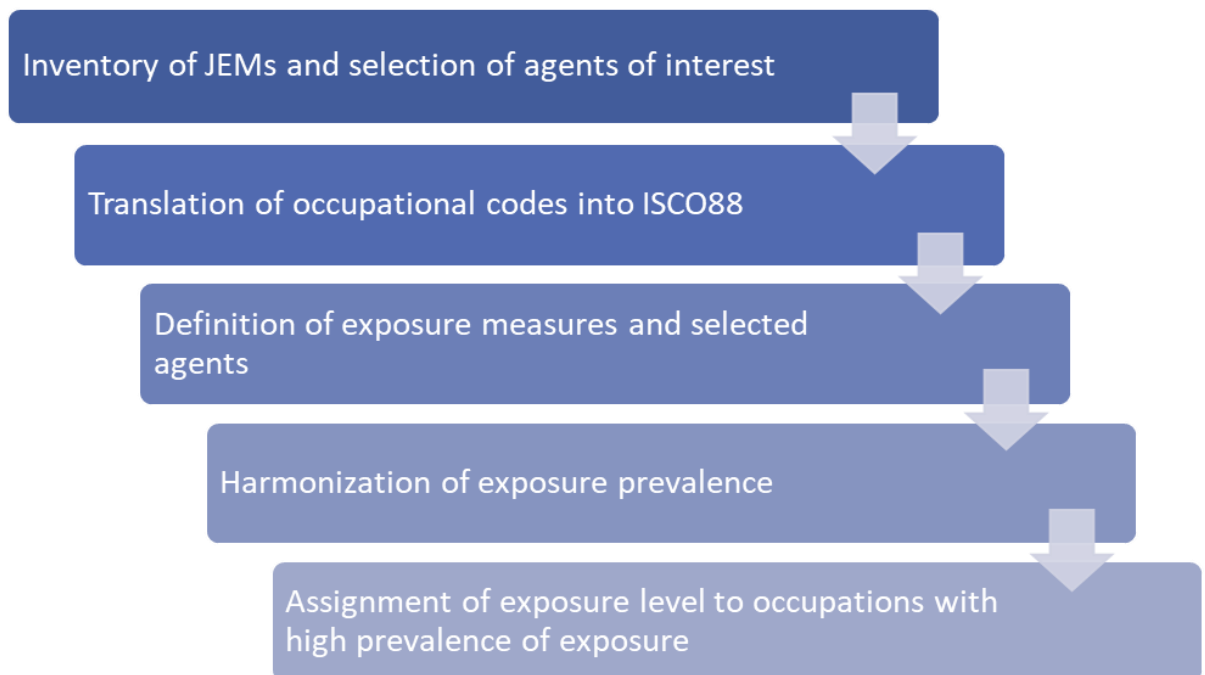
The group working with chemicals and particles in the EuroJEM consists of experts on job-exposure matrices and/or occupational exposures. The members come from several European countries to cover the differences in exposures that may exist in different regions, including partner (KI, FIOH, SLL, STAMI, AU, IS Global, UU, INSERM) and non-partner (University of Cantabria, Spain; University of Gothenburg, Sweden) institutions.

From the inventory of available JEMs developed by task 2.1 (Solovieva et al 2022), the group suggested agents to be included in the EuroJEM. In discussions with WP5 the possibility to produce a high-quality JEM for the agents was considered together with the epidemiological need. Data of interest were obtained from JEM-holders, and when necessary, occupational codes were translated into the International Standard Classification of Occupations, ISCO-88(COM). In the first version of the JEM (EuroJEM1.0) we have included four agents; respiratory Crystalline Silica Dust (RCS), Nickel, Wood dust and Diesel Engine Exhaust (measured as Elemental Carbon, EC).

In order to harmonise data from the high-quality JEMs we had chosen, the data from 3 to 5 JEMs were compiled for the agents of interest. In the first step the prevalence of exposed subjects in each occupation was assessed for a specific agent, and possible regional differences were evaluated.

In the second step occupations with a prevalence of exposed subjects above 25% was assigned with an exposure level from quantitative 'state of the art' JEMs available. The exposure level was expressed as the average air concentration of the agent during an 8-hour working day among the exposed workers in the occupation.

Figure 1. Flow chart for the harmonisation process for development of the chemical EuroJEM.



### 2.1.2 Definitions, thresholds, and units of exposure

The definitions of exposure were inspired by FINJEM (Kauppinen et al 1998) and INTEROCC (van Tongeren et al 2013) and the thresholds for defining an occupation as exposed were set as follows (annual mean levels, exposure through inhalation):

- Respirable Crystalline Silica Dust (RCS): 0.02 mg/m<sup>3</sup> of exposure to respirable (aerodynamic diameter < 5 µm) quartz or crystalline silica containing dusts (eg, granite). Does not include amorphous silica dust. Respirable fraction.
- Nickel: 1 µg/m<sup>3</sup> exposure to nickel dust or fume from welding, smelting, grinding, or other processing of stainless steel and other materials containing nickel. Includes metallic nickel and all nickel compounds. Inhalable fraction.
- Wood dust: 0.1 mg/m<sup>3</sup> of exposure to wood dust (pine, spruce, birch, other softwoods and hardwoods, cane, wood bark etc). Inhalable fraction.
- Diesel Engine Exhaust: exposure levels in µg/m<sup>3</sup> EC (Elemental Carbon)
  - A continuous but low exposure to diesel engine emissions – for example diesel engine drivers or workers occupied outside in areas with high frequencies of diesel engine machines or vehicles.
  - On a regular basis (once a week or more) exposed to peaks of emissions from diesel engines longer than 15 minutes or daily exposure (once a day or more) exposed to peaks of emissions longer than 5 minutes.

### 2.1.3 Scales of exposure

Prevalence (P) of exposure within an occupation was categorised as:

- Non-exposed: P < 5 %
- Exposed: P = 5 - < 25 %, 25 - <75 % and 75 – 100 %

The level of occupational inhalatory chemical/particle exposure was assessed as a continuous variable, reflecting the estimated average level of exposure among exposed, i.e., exposure prevalence > 25 %, within an occupation.

### 2.1.4 Harmonised JEMs, occupational coding systems, time-periods, and regional applicability

Detailed information on the JEMs included in the harmonisation, occupational coding systems and translations (crosswalks), and data sources for the particle and chemicals' exposures is given in table 1.

The harmonised JEM covers five ten-year periods: 1970-79, 1980-89, 1990-99, 2000-09, and 2010-20. The average exposure of each period was assessed.

The underlying data used for the harmonisation come from the Nordic countries, Western and Southern Europe. When regional differences in exposure data was available it was used in the EuroJEM. The following regional data is available:

- Respirable Crystalline Silica Dust (RCS): Germany, The Netherlands, UK, France, Sweden, Italy/Spain, CEE countries (Central and Eastern Europe), Non-country specific
- Diesel Engine Exhaust: Non-country specific
- Wood dust: Denmark/Norway, Finland, The Netherlands, UK, France, Non-country specific

The expert group does not have sufficient information to assess to what extent the JEM is applicable also for Eastern Europe (except for RCS where data is available), and thus caution is recommended for such use.

Table 1. Description of Job-exposure matrices (JEMs) used in the harmonisation of occupational chemical/particle exposure agents for EuroJEM1.0.

Job Exposure Matrices	Agents used	Intensity	Time-resolved	Coding system and crosswalk	Comments	Citation, URL or PMID
<b>SYN-JEM</b>	RCS, Ni	quantitative	yes	ISCO-68	generic JEM, exposure data in ExpoSYN	<a href="https://www.ncbi.nlm.nih.gov/pubmed/27286764">https://www.ncbi.nlm.nih.gov/pubmed/27286764</a>
<b>FINJEM</b>	RCS, Ni, Wood, DEEX	quantitative	yes, 1945-2015	FINJEM occ classification, FINJEM version with ISCO88 national classification	generic JEM	Sanni Uuksulainen FIOH <a href="https://onlinelibrary.wiley.com/doi/abs/10.1002/%28SICI%291097-0274%28199804%2933%3A4%3C409%3A%3AAID-AJIM12%3E3.0.CO%3B2-2">https://onlinelibrary.wiley.com/doi/abs/10.1002/%28SICI%291097-0274%28199804%2933%3A4%3C409%3A%3AAID-AJIM12%3E3.0.CO%3B2-2</a> <a href="https://www.ncbi.nlm.nih.gov/pubmed/19225948">https://www.ncbi.nlm.nih.gov/pubmed/19225948</a>
<b>SWEJEM</b>	RCS, Ni, Wood, DEEX	quantitative (semi-quantitative)	yes	ISCO-based national classifications	generic JEM	contact Jenny Selander KI (Pernilla Wiebert et al: Scand J Work Environ Health 2013;39(3):295-301)
<b>MatEmEsp Spain</b>	RCS, Ni, Wood	quantitative	yes 1996–2005	Spanish Classification of Occupations (CNO94), based on ISCO-88	generic JEM	<a href="https://doi.org/10.1002/ajim.22213">https://doi.org/10.1002/ajim.22213</a>
<b>MATGENE – France</b>	RCS	quantitative	yes	national coding	generic JEM	<a href="http://expro.santepubliquefrance.fr/expro/accueil">http://expro.santepubliquefrance.fr/expro/accueil</a>



<b>DOM-JEM</b>	RCS, Ni	semi-quantitative	No	ISCO-68	generic JEM	<a href="https://doi.org/10.1136/oem.2010.055608">https://doi.org/10.1136/oem.2010.055608</a> . <a href="http://dx.doi.org/10.1136/oem.2010.055608">http://dx.doi.org/10.1136/oem.2010.055608</a>
<b>Swedish diesel JEM</b>	DEEX	quantitative	Yes 1950-2020	ISCO-88	generic JEM	<a href="http://www.ncbi.nlm.nih.gov/sites/entrez?db=PubMed&amp;cmd=search&amp;term=31368419">http://www.ncbi.nlm.nih.gov/sites/entrez?db=PubMed&amp;cmd=search&amp;term=31368419</a>
<b>DEEJEM</b>	DEEX, Elemental Carbon (EC)	Semi-quantitative	No	ISCO68 and ISCO88	Generic JEM	<a href="https://doi.org/10.1164/rccm.201911-2101OC">10.1164/rccm.201911-2101OC</a>

## 2.2 Physical exposures

### 2.2.1 Harmonisation strategy

The panel on physical exposures decided early on to focus on occupational noise exposure. This decision was made based on the needs for the analyses of the mega cohort (WP5) and availability. Discussions on WP5 needs of exposure assessment took place in 2020. The availability of JEMs for harmonisation was obtained from the inventory of JEMs reported in deliverable 2.1.

Following joint discussions during the first consortium meeting it was agreed that we should aim for quantitative JEMs as an end-product whenever possible. The inventory of available JEMs and additional literature searches resulted in a conclusion that only the Swedish SWEJEM and the Danish DOC\*X were eligible for inclusion in a quantitative noise JEM. It was decided to form a smaller work team (KI and AU), to merge the two data sources by expert judgements and measurement datasets.

A merge between the two existing expert assessments in Sweden (five categories: <70, 70-74, 75-79, 80-84, ≥85 dBA) and Denmark (three categories: <80, 80-84, ≥85 dBA) was made. All discrepancies were marked in yellow and the team of four assessors from KI and AU went through the differences manually at several work meetings (Figure 2). Decisions were made based on previous knowledge of the occupational settings and measurements of noise exposure for the occupation in question.

ISCO 88	ISCO 88 code in text	Exp 197	Exp 19	Exp 1	Exp 15	Exp 15	Exp 19	Exp 20	Exp 2	Exp 2010-1	disco	1	<80 db	2	80-84 d	3	>=85 d	Totalsumma	Nytt värde 1,2,3	Kommentar	Number	
9	7111 Miners and quarry workers	5	5	5	5	5	5	5	5	5	5	5	7111					1	1	OKI	3	
10	7112 Stonemasons and blasters	5	5	5	5	5	5	5	5	5	5	7112	1					1	1	DIFF	>85	3
11	7113 Stone splitters, cutters and carvers	5	5	5	5	5	5	5	5	5	5	7113						1	1	OKI	3	
12	7123 Concrete placers, concrete finishers and related workers	5	5	5	5	5	5	5	5	5	5	7123		1				1	1	DIFF	>85	3
13	7124 Carpenters and joiners	5	5	5	5	5	5	5	5	5	5	7124						1	1	OKI	3	
14	7211 Metal moulders and coremakers	5	5	5	5	5	5	5	5	5	5	7211						1	1	OKI	3	
15	7212 Welders and flame cutters	5	5	5	5	5	5	5	5	5	5	7212						1	1	OKI	3	
16	7213 Sheet-metal workers	5	5	5	5	5	5	4	4	4	4	7213						1	1	DIFF	>85	3
17	7214 Structural-metal preparers and erectors	5	5	5	5	5	5	5	5	5	5	7214						1	1	OKI	3	
18	7221 Blacksmiths, hammer-smiths and forging-press workers	5	5	5	5	5	5	5	5	5	5	7221						1	1	OKI	3	
19	7222 Tool-makers and related workers	5	5	5	5	5	5	5	5	5	5	7222						1	1	OKI	3	
20	7223 Machine-tool setters and setter-operators	5	5	5	5	5	5	5	5	5	5	7223		1				1	1	DIFF	>85	3
21	7224 Metal wheel-grinders, polishers and tool sharpeners	5	5	5	5	5	5	5	5	5	5	7224						1	1	OKI	3	
22	7322 Glass-makers, cutters, grinders and finishers	4	4	4	4	4	4	4	4	4	4	7322						1	1	DIFF	>85	3
23	7411 Butchers, fishmongers and related food preparers	5	5	5	5	5	5	5	5	5	5	7411						1	1	OKI	3	
24	7422 Cabinetmakers and related workers	3	3	3	3	3	3	3	3	3	3	7422						1	1	DIFF	80-84	3
25	7423 Woodworking machine setters and setter-operators	5	5	5	5	5	5	5	5	5	5	7423						1	1	OKI	3	
26	7432 Weavers, knitters and related workers	5	5	5	5	5	5	5	5	5	5	7432		1				1	1	DIFF	>85	3
27	8111 Mining plant operators	4	4	4	4	4	4	4	4	3	3	8111						1	1	DIFF	>85	3
28	8112 Mineral-ore and stone-processing-plant operators	4	4	4	4	4	4	4	4	3	3	8112						1	1	DIFF	>85	3
29	8113 Well drillers and borers and related workers	5	5	5	5	5	5	5	5	5	5	8113						1	1	OKI	3	
30	8121 Ore and metal furnace operators	5	5	5	5	5	5	5	5	5	5	8121						1	1	OKI	3	
31	8122 Metal melters, casters and rolling-mill operators	5	5	5	5	5	5	5	5	5	5	8122						1	1	OKI	3	
32	8123 Metal heat-treating-plant operators	5	5	5	5	5	5	5	5	5	5	8123						1	1	OKI	3	
33	8124 Metal drawers and extruders	5	5	5	5	5	5	5	5	5	5	8124						1	1	OKI	3	
34	8131 Glass and ceramics kiln and related machine operators	4	4	4	4	4	3	3	3	3	3	8131						1	1	DIFF	>85	3
35	8139 Glass, ceramics and related plant operators not elsewhere classified	4	4	4	4	3	3	3	3	3	3	8139						1	1	DIFF	>85	3
36	8141 Wood-processing-plant operators	5	5	5	5	5	5	5	5	5	5	8141			1			1	1	DIFF	>85	3

Figure 2. Expert judgement Excel document (excerpt from the table), differences in noise level per occupation between Sweden and Denmark are marked in yellow.

An overview of the steps in the harmonisation procedure is given in Figure 3. An existing dataset of 1344 measurements in ISCO-88(COM) was already available to the Danish team. This was transferred to Sweden. The Swedish source data was only available in paper form and had to be digitalised. This was made manually by a project assistant. A template in Excel was first formed, all 4107 measurements were then entered manually. The next step was to manually translate all occupational codes from NYK83 to ISCO-88(COM). This was done at several work meetings internally at KI by three team members familiar with occupational coding systems.

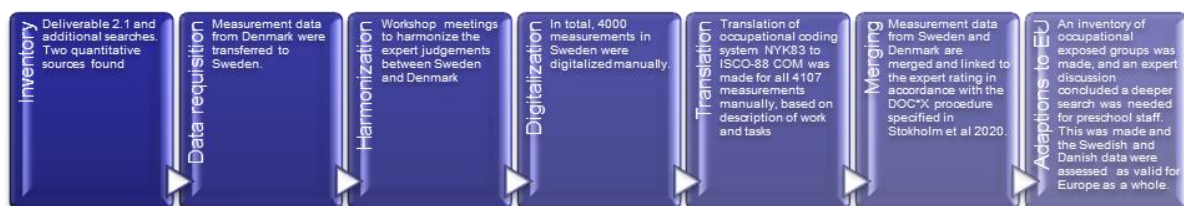


Figure 3. Overview of the harmonisation process.

The measurements and the expert assessments were merged using the statistical approach set up by DOC\*X (Stokholm et al 2020). In short, we assessed noise exposure levels for each of the 372 jobs described by DISCO 88. Jobs without measurements were assigned the weighted mean noise exposure level derived from the model for the corresponding category of the joint Swedish and Danish expert ratings. For jobs with exposure measurements

available, an average noise exposure estimate was calculated. Thus, an exposure level for all 372 jobs was estimated. Adaptations to the European level are described below.

### 2.2.2 Definition, unit and scale of exposure

The JEM provides 8h Laeq levels of occupational noise exposure on a 1-5 dB continuous scale.

### 2.2.3 Details on the harmonised JEMs

Detailed information on the two JEMs used in the harmonisation of occupational noise exposure for EuroJEM1.0 is given in Table 2.

The harmonised JEMs were used as a support when building a new quantitative JEM based on measurement data. This quantitative JEM will be included in EuroJEM1.0

### 2.2.4 Time periods and regions covered

The JEM covers the time period 1970 to 2020 in five to ten-year time slots.

A search for differences in occupational noise exposure across Europe was made and discussed. The only suspected difference identified was preschool teachers, due to differences in size of the groups of children. After reviewing a Eurostat report on preschools (European Commission 2019), Sweden and Denmark were considered as good averages with regard to the conditions in Europe. The JEM is therefore assessed as valid for Europe.

### 2.2.5 Plans for extensions

After discussions with other WPs it was decided to initiate the development of a new JEM on exposure to heat and cold (for short description see revised deliverable D2.4).

### 2.2.6 Translation of occupational codes

We used manual translations of occupational codes to convert the Swedish expert-based JEM and the Swedish measurement data from NYK83 and SSK-96 to ISCO-88-COM.

Table 2. Description of Job-exposure matrices (JEMs) used in the harmonisation of occupational noise exposure 1970-2020 for EuroJEM1.0.

Country	Period	Type of JEM	Information source	Measure	Metrics	Occupational codes
Sweden	5-year intervals 1970-2014	Generic	Actual noise measurements and expert judgement on occupation-specific noise level	Repeated measurements, both short-term and work-day. Both stationary and personal measurements	Noise levels: (1) <70 dB(A) (2) 70-74 dB(A) (3) 75-79 dB(A) (4) 80-84 dB(A) (5) ≥85 dB(A)	Nordic Occupational Coding System NYK 85/90 coding with 3-digit, comparable with ISCO-58 and coding system SSYK-96 comparable with ISCO-88 and SSYK-12 compatible with ISCO-08, both at a 4-digit level.
Denmark	2001-2003 2009-2010	Generic	Personal dosimeter measurements from 100 different jobs and expert-based ratings using 35 jobs as benchmarks	Repeated measurements during 2 subsequent work days. Only measurements during work were included  Expert judgement of noise level, using 35 jobs with ≥5 noise measurements as	Sex and age specific noise level in dB (statistically modelled)	DISCO-88, comparable with ISCO-88

benchmarks:

low level  
( $<80$   
dBA),

medium  
level (80–  
84 dBA),

high level  
( $\geq 85$  dBA)

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## 2.3 Psychosocial exposure

### 2.3.1 Harmonisation strategy

A "centralised" approach to harmonisation was not seen as possible for the psychosocial JEMs. The approach means that experts assess the level of exposure per occupation, which is not feasible for psychological job demands and decision authority at work. Only self-reported data are available for these work-environment factors, and there is thus a lack of objective data for experts to base their assessments on. In accordance with this, we do not find relevant examples of expert assessments of psychological job demands and decision authority at work in the research literature. The actual harmonisation strategy chosen was as follows. An existing, standardised occupational classification for the Nordic countries, was used so that psychosocial JEMs from Sweden, Finland and Norway could be compared. The occupations in each of the three countries were ranked from lowest to highest proportion of exposed workers (separately for psychological job demands and decision authority, as well as per men and women) and were divided into four exposure categories: (1) 0-24% exposed, (2) 25-49% exposed, (3) 50-74% exposed, and (4) 75-100% exposed. The exposure categories for the occupations was then compared between the countries, to see to what extent the occupations ended up in the same category across the countries (full agreement). Finally, each occupation was assigned one unified exposure level, based on the following rule: (a) if a particular occupation ended up in the same exposure category in at least two countries (full or partial agreement), the occupation was assigned this exposure level (1, 2, 3 or 4), and (b) in cases where a particular occupation ended up in different exposure categories in all three countries (no agreement), the most reasonable joint exposure level of the occupation was assigned after a discussion among the panel members.

### 2.3.2 Exposure definition (threshold)

No threshold value between exposed and unexposed was set for psychological job demands and decision authority at work. To our knowledge, there are no studies that show a threshold value for the risk of disease associated with psychological job demands and decision authority.

Instead, 'proportion exposed' were used, where in turn 'exposed' vs. unexposed was defined as mean response scores above and below the overall median score, respectively, in the surveys behind the country specific JEMs.

### 2.3.3 Unit of exposure

As mentioned above, we created four categories of exposure regarding psychological job demands and decision authority: (1) 0-24% exposed, (2) 25-49% exposed, (3) 50-74% exposed, and (4) 75-100% exposed.

### 2.3.4 Scales of exposure

We decided to categorise psychological job demands and decision authority into four groups reflecting proportion exposed in occupations across Finland, Sweden, and Norway (see the previous paragraph). As mentioned previously, this categorisation based on relative distributions of proportion exposed was judged to be the only feasible method. Some variation in items between the JEMs was also an obstacle to establishing any kind of absolute values.

### 2.3.5 Details on the harmonised JEMs

#### *Psychological job demands*

In the Finnish JEM, proportion exposed were calculated using mean scores based on a summation of scores from the following five items: "Work fast", "Work hard", "Excessive work", "Not enough time", and "Hectic job"; the five response categories range from (1) "Almost all the time" to (5) "Seldom or never". These items characterised quantitative demands.

In the Norwegian JEM, proportion exposed were calculated using mean scores based on "quantitative demands" and "role conflict". Quantitative demands are measured by the item "Do you sometimes have so much to do that you have to skip lunch, work longer than your normal working hours or take work home with you?" with five response categories, ranging from (1) every day, to (5) less often or not at all." Role conflict is measured by the three items "How often do you receive contradictory requests from two or more different people?", "How often are you given tasks without being given sufficient tools and resources to complete them?" and "How often do you have to do things that you think should be done in a different way?" with five response categories, ranging from (1) very seldom or never to (5) quite often or always.

In the Swedish JEM, proportion exposed were calculated using mean scores based on the summation of scores from the following three items: "So stressful not having time to talk or think about anything other than work", "Do you sometimes have so much to do that you have to pull in for lunches, work overtime or take work home?", and "Does the work require all your attention and concentration?"; response categories range from (1) "Almost all the time" to (5) "No, not at all" for the first and the last item and from (1) "Every day" to (5) "Seldom or never" for the second item.

#### *Decision authority, self-reported*

In the Finnish JEM, proportion exposed were calculated using mean scores based on a summation of scores from the following three items: "Allows own decisions", "Decision freedom", and "A lot of say on the job"; the response categories range from (1) "Almost all the time" to (5) "Seldom or never".

In the Norwegian JEM, proportion exposed were calculated using mean scores based on a summation of scores from the following three items: "Decide work pace", "Decide how to do the work", and "Influence decisions"; the response categories range from (1) "Very seldom or never" to (5) "Quite often or always" (reversed to harmonise with the other JEMs).

In the Swedish JEM, proportion exposed were calculated using mean scores based on a summation of scores from the following four items: "Decide work pace", "Decide when to take breaks", "Influence the planning of work", and "Decide when to do tasks"; response categories range from (1) "Almost all the time" to (5) "Seldom or never" for the first two items, and from (1) "Always" to (5) "Never" for the last two items.

### 2.3.6 Time periods covered

We consider the JEM representative of the period 1990-2015 at least, even though the underlying data are not from all these years. In Sweden, job demands seem to have increased to some extent during the period (Corin et al 2021) but, nevertheless, working conditions such as demands and decision authority at work show relatively small changes across medium-time periods.

### 2.3.7 Applicability regarding different regions in Europe

Psychosocial JEMs have mainly been developed in the Nordic countries. However, we aim to widen our discussion with holders of psychosocial JEMs where they exist or are under development outside Scandinavia; we have initiated discussions with those responsible for existing psychosocial JEMs in Italy, France, the Netherlands, and Spain. Provided that occupational crosswalks are successful, the applicability in other European regions could then be tested.

### 2.3.8 Plans for extension

The basis for this joint JEM is thus formed by three national JEMs from Nordic countries. A broadening of this basis could be considered, but before that the JEM should be tested against empirical data for validation purposes.

## 2.4 Physical workload

### 2.4.1 Harmonised JEMs and their basis

Existing European JEMs for physical workload were collected and scrutinised within task 2.1 in the EPHOR project. They were reviewed regarding whether they were based on self-reports, expert judgements, or technical measurements, and also the included exposures, exposure definitions, JEM metrics and if they were validated.

The availability of JEMs to harmonise was listed in EPHOR deliverable 2.1 (Solovieva et al 2022). From 14 identified ergonomic JEMs, six generic JEMs showed similarities in how the exposures were assessed, in the included exposures and in exposure definitions. They were based on self-reported exposures and came from the Nordic countries (Sweden, Norway and Finland), France and Spain. These JEMs were in a first step selected for further evaluation with regard to inclusion in the EuroJEM. They included data on the following exposures: heavy physical work, manual material handling/heavy lifting, working with hands above shoulder level, kneeling/squatting, working in forward bent posture, repetitive hand movements and forceful hand movements. At a later stage we split the exposure "heavy physical work" into two exposures: (1) "physically strenuous work" (involving heavy lifting and/or other physically demanding tasks) and (2) "faster breathing due to heavy physical workload" (work involves tasks leading to faster breathing).

In a second step only three JEMs that have used ISCO-88 comparable occupation classification systems were selected. We started the harmonisation work into the first version of the EuroJEM (EuroJEM version 1) with a Finnish (Solovieva et al 2012), a Norwegian (Hanvold et al 2019) and a



Swedish (Badarin et al 2021) JEM for physical workload. These JEMs are all based on self-reported exposures from national surveys and include gender-specific exposure assessments. The Nordic JEMs were selected because of an existing crosswalk between these countries' coding systems and ISCO-88(COM) developed earlier in a Nordic project (Solovieva et al. 2022). We decided to start with three exposures: faster breathing due to heavy physical workload, working in forward bent posture, and heavy lifting (Nordic JEM -EuroJEM version 1)

In a third step we developed a second version (EuroJEM version 2) adding a French JEM for physical workload; the gender-specific JEM CONSTANCES<sup>1</sup> (Wuytack et al 2023). This JEM is based on self-reported exposures from questionnaires in a large population-based cohort; the CONSTANCES cohort and include sex-specific exposure assessments. The gender-specific JEM CONSTANCES is a modified version of earlier developed JEM CONSTANCES (Evanoff et al. 2019) and more comparable with the Swedish, Norwegian and Finnish JEMs. A Nordic-French crosswalks was developed to recode occupational codes of the JEM CONSTANCES into ISCO-88 (COM). In this third step we also expanded the EuroJEM (version 1) by adding two more exposures: working in kneeling or squatting and working with hands above shoulder level. Four exposures: faster breathing due to heavy physical workload, working in forward bent posture, heavy lifting and working in kneeling or squatting, were harmonized between the three Nordic JEMs (Nordic JEM- EuroJEM version 1) and the JEM CONSTANCES. The fifth exposure; working with hand above shoulder level, was harmonized between the four JEMs directly, i.e. no Nordic JEM was created for this exposure.

#### 2.4.2 Definition of exposure, unit of exposure, and scale of exposure

##### *Faster breathing due to heavy physical workload*

The EuroJEM exposure "faster breathing due to heavy physical workload" (here shortened to "faster breathing") is based on three national JEMs; the Swedish, Norwegian and French (Table 3). The Finnish JEM does not include this exposure. The questions in the Swedish and Norwegian JEMs are similar; the only difference is that in the Swedish one the proportion of time is asked for, while it is the proportion of the workday in the Norwegian one. The JEM CONSTANCES JEM does not include such a question. Instead, we used the overall intensity of physical workload during a typical day of work that has been assessed with the Borg Rating of Perceived Exertion (RPE) Scale. The scale ranges from 6 (No effort at all. Sitting and doing nothing) to 20 (Absolute maximal effort (highest possible) Exhaustion). Based on the testing of different cut-offs, it was judged that ratings of  $\geq 14$  (at least Strong effort needed) was the most equivalent exposure level to exposed to faster breathing  $\frac{1}{4}$  of the time or more, the exposure used from the two Nordic JEMs.

We decided to define exposure as being exposed to heavy breathing  $\frac{1}{4}$  of the time or more. The EuroJEM metric was decided to be the proportion of exposed workers within an occupation, with five categories: 0-5 %, 6-24 %, 25-49 %, 50-74 % and 75-100 %.

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<sup>1</sup> This JEM was still under development at the time when the harmonization of the first three exposures was performed and was not among identified existing JEMs listed in the D2.1.



Table 3. Exposure definitions of faster breathing due to heavy physical workload, exposure metric and occupational codes in the Swedish, Norwegian and French JEMs and in EuroJEM version 1 (“Nordic JEM”) and 2.

	Swedish JEM	Norwegian JEM	EuroJEM v.1	CONSTANCES JEM (French)	EuroJEM v. 2
Definition	Faster breathing due to heavy physical workload: 1. almost all the time 2. about ¾ of the time 3. half of the time 4. about ¼ of the time 5. about 1/10 of the time not at all	Faster breathing due to heavy physical workload: 1. almost all the time 2. ¾ of the workday 3. ½ of the workday 4. ¼ of the workday 5. very little of the workday	Faster breathing due to heavy physical workload	Borg Rating of Perceived Exertion (RPE) Scale from 6 (No effort at all. Sitting and doing nothing) to 20 (Absolute maximal effort (highest possible). Exhaustion)	Faster breathing due to heavy physical workload
Exposed	¾ of the time or more	¾ of the workday or more	¾ of the time or more	Borg RPE Scale ≥ 14 (at least Strong effort needed)	¾ of the time or more
Metric	proportion of exposed	proportion of exposed	0 = 0-5% 1= 6-24% 2= 25-49% 3= 50-74% 4= 75-100%	proportion of exposed	0 = 0-5% 1= 6-24% 2= 25-49% 3= 50-74% 4= 75-100%
Occupational codes	SSYK96	STYRK98	ISCO-88 (COM)	PCS	ISCO-88 (COM)
Mainly used crosswalks	SSYK96 -> ISCO-88 (COM)	STYRK98-> ISCO-88 (COM)		PCS-> ISCO-88 (COM)	
Additional crosswalks	SSYK96 -> Nordic -> ISCO-88 (COM)	STYRK98-> Nordic -> ISCO-88 (COM)		PCS-> Nordic -> ISCO-88 (COM)	

### *Working in forward bent posture*

The EuroJEM exposure “working in forward bent posture” (here shortened to “forward bent posture”) is based on four national JEMs; the Swedish, Norwegian, Finnish and French (Table 4). The questions in these JEMs differ somewhat. It is asked about the proportion of the time in the Swedish JEM, but for the proportion of the workday in the Norwegian one. In the Finnish JEM, it is asked about exposure for at least one hour per day (yes/no). In the French it is asked about whether a typical day of work involves leaning forward or sideways regularly or for a prolonged period, and if so, the number of hours exposed. Also to be noted, the Swedish and Norwegian questions specify forward bent posture as without support from hands or arms, while the questions in the other two JEMs do not.

We decided to define exposure as being exposed to forward bent posture ¾ of the time or more. The EuroJEM metric was decided to be the proportion of exposed workers within an occupation, with five categories: 0-5 %, 6-24 %, 25-49 %, 50-74 % and 75-100 %.

Table 4. Exposure definitions of working in forward bent posture, exposure metric and occupational codes in the Swedish, Norwegian, Finnish and French JEMs and in EuroJEM version 1 (“Nordic JEM”) and 2.

	Swedish JEM	Norwegian JEM	Finnish JEM	EuroJEM v.1	CONSTANCES (French)	EuroJEM v.2
Definition	Forward bent posture (while not using support from hands or arms) 1. almost all the time 2. about ¾ of the time 3. half of the time 4. about ¼ of the time 5. about 1/10 of the time 6. not at all	Forward bent posture (without supporting on hands or arms) 1. almost all the time 2. ¾ of the workday 3. ½ of the workday 4. ¼ of the workday 5. very little of the workday	Forward bent posture (while standing or kneeling) for at least one hour a day (yes/no)	Working in forward bent posture	Leaning forward or sideways regularly or for prolonged periods during typical working days 1. Never or nearly never 2. <2 hours per day 3. 2-4 hours per day 4. > 4 hours per day	Working in forward bent posture
Exposed	¾ of the time or more	¾ of the workday or more	one hour a day or more	¾ of the time or more alternatively one hour or more	2-4 h or more/day	¾ of the time or more
Metric	proportion of exposed	proportion of exposed	proportion of exposed	0 = 0-5 % 1 = 6-24 % 2 = 25-49 % 3 = 50-74 % 4 = 75-100 %	proportion of exposed	0 = 0-5% 1= 6-24% 2= 25-49% 3= 50-74% 4= 75-100%
Occupational codes	SSYK96	STYRK98	Code comparable with ISCO-88(COM)	ISCO-88(COM)	PCS	ISCO-88 (COM)
Mainly used crosswalks	SSYK96 -> ISCO-88(COM)	STYRK98-> ISCO-88(COM)			PCS-> ISCO-88 (COM)	
Additional crosswalks	SSYK96 -> Nordic -> ISCO-88(COM)	STYRK98-> Nordic -> ISCO-88(COM)			PCS-> Nordic -> ISCO-88 (COM)	

### Heavy lifting

The EuroJEM exposure “heavy lifting” is based on four national JEMs; the Swedish, Norwegian, Finnish and French (Table 5). The questions in these JEMs differ regarding size of loads and frequency/duration per day (Table 5). As both the Norwegian and the Finnish JEMs define heavy lifting as lifting > 20 kg, this size of loads was suggested to be selected as the definition in the EuroJEM. We decided to define exposure as being exposed to daily lifting > 20 kg several times per day. This was judged to correspond to “lifting > 15 kg several times per day and every day” in the Swedish JEM, “lifting > 20 kg 5-19 times/day and every day” in the Norwegian JEM, “lifting > 20 kg at least 10 times per day and every day” in the Finnish JEM and “carrying loads 10-25 kg or >25 kg at least 2-4 hours per day” in the French JEM. To be noted, the definition of the exposure in the JEM CONSTANCES is “porter” in French, i.e. carrying or manipulating objects, which is a broader exposure concept compared to lifting in the other three JEMs.

The EuroJEM metric was decided to be the proportion of exposed workers within an occupation, with five categories: 0-5 %, 6-24 %, 25-49 %, 50-74 % and 75-100 %.

Table 5. Exposure definitions of heavy lifting, exposure metric and occupational codes in the Swedish, Norwegian, Finnish and French JEMs and in EuroJEM version 1 (“Nordic JEM”) and 2.

	Swedish JEM	Norwegian JEM	Finnish JEM	EuroJEM v.1	CONSTANCES	EuroJEM v.2
Definition	Lifting > 15 kg several times per day 1. every day 2. a couple of days/week 3. one day/week 4. a couple of days/month 5. not at all/rarely	Lifting > 20 kg 1. 20 times/ day 2. 5-19 times/day 3. 1-4 times/day 4. not at all	Lifting > 20 kg at least 10 times per day, every day (yes/no)	Daily lifting >20 kg	How much time do you spend doing the following tasks or activities: <u>Carrying a load that weighs 10 to 25 kg</u> 1. Never or nearly never 2. <2 hours per day 3. 2-4 hours per day 4. > 4 hours per day <u>Carrying a load that weighs 25 kg or more</u> 1. Never or nearly never 2. <2 hours per day 3. 2-4 hours per day 4. > 4 hours per day	Daily lifting >20 kg
Exposed	several times every day	5-19 times/day every day	at least 10 times per day, every day	several times per day, every day	at least 2-4 hours per day	several times per day, every day
Metric	proportion of exposed	proportion of exposed	proportion of exposed	0 = 0-5% 1= 6-24% 2= 25-49% 3= 50-74% 4= 75-100%	proportion of exposed	0 = 0-5% 1= 6-24% 2= 25-49% 3= 50-74% 4= 75-100%
Occupational codes	SSYK96	STYRK98	FISCO01	ISCO-88 (COM)	PCS	ISCO-88 (COM)
Mainly used crosswalks	SSYK96 -> ISCO-88 (OM)	STYRK98-> ISCO-88 (COM)	FISCO01-> ISCO-88 (COM)		PCS-> ISCO-88 (COM)	
Additional crosswalks	SSYK96 -> Nordic -> ISCO-88 (COM)	STYRK98-> Nordic -> ISCO-88 (COM)	FISCO01-> Nordic -> ISCO-88 (COM)		PCS-> Nordic -> ISCO-88 (COM)	

### *Working in kneeling or squatting*

The EuroJEM exposure "working in kneeling or squatting" (shortened to "kneeling or squatting") is based on three national JEMs; the Finnish, Norwegian and French (Table 6). The Swedish JEM does not include this exposure. The questions in these JEMs differ somewhat regarding duration per day. We therefor decided to define exposure as being exposed to daily kneeling or squatting. This was judged to correspond to "kneeling or squatting for at least one hour a day" in the Finnish JEM, "daily kneeling or squatting => ¼ of the workday" in the Norwegian JEM and daily kneeling or squatting =>"2-4 hours per day" in the French JEM.

The EuroJEM metric was decided to be the proportion of exposed workers within an occupation, with five categories: 0-5 %, 6-24 %, 25-49 %, 50-74 % and 75-100 %.

Table 6. Exposure definitions of working in kneeling or squatting, exposure metric and occupational codes in the Finnish, Norwegian and French JEMs and in EuroJEM version 1 (“Nordic JEM”) and 2.

	Finnish JEM	Norwegian JEM	EuroJEM v.1	CONSTANCES (French)	EuroJEM v. 2
Definition	Kneeling or squatting for at least one hour a day (yes/no)	Daily kneeling or squatting: 1. almost all the time 2. ¾ of the workday 3. ½ of the workday 4. ¼ of the workday 5. very little of the workday	Daily kneeling or squatting	During a typical workday do you kneel or squat: 1. Never or nearly never 2. <2 hours per day 3. 2-4 hours per day 4. > 4 hours per day	Daily kneeling or squatting
Exposed	¼ of the time or more	¼ of the workday or more	¼ of the time or more	2-4 h or more/day	¼ of the time or more
Metric	proportion of exposed	proportion of exposed	0 = 0-5% 1 = 6-24% 2 = 25-49% 3 = 50-74% 4 = 75-100%	proportion of exposed	0 = 0-5% 1 = 6-24% 2 = 25-49% 3 = 50-74% 4 = 75-100%
Occupational codes	FISCO01	STYRK98	ISCO-88 (COM)	PCS	ISCO-88 (COM)
Mainly used crosswalks	FISCO01-> ISCO-88 (COM)	STYRK98-> ISCO-88 (COM)		PCS-> ISCO-88 (COM)	
Additional crosswalks	FISCO01-> Nordic -> ISCO-88 (COM)	STYRK98-> Nordic -> ISCO-88 (COM)		PCS-> Nordic -> ISCO-88 (COM)	

### *Working with hands above shoulder level*

The EuroJEM exposure “working with hands above shoulder level” (shortened to “hands above shoulder level”) is based on four national JEMs; the Swedish, Norwegian, Finnish and French (Table 7). The questions in these JEMs differ somewhat. It is asked about the proportion of the time in the Swedish JEM, but for the proportion of the workday in the Norwegian one. In the Finnish JEM, it is asked about exposure for at least one hour per day (yes/no). In the French it is asked about whether a typical day of work involves working with one or two hands above the shoulders regularly or for a prolonged period, and if so, the number of hours exposed.

We decided to define exposure as being exposed to working with hands above shoulder level ¼ of the time or more. The EuroJEM metric was decided to be the proportion of exposed workers within an occupation, with five categories: 0-5 %, 6-24 %, 25-49 %, 50-74 % and 75-100 %.

Table 7. Exposure definitions of working with hands above shoulder level, exposure metric and occupational codes in the Swedish, Norwegian, Finnish and French JEMs and in EuroJEM version 1 (“Nordic JEM”) and 2.

	Swedish JEM	Norwegian JEM	Finnish JEM	CONSTANCES (French)	EuroJEM v. 2
Definition	Sometimes working with hands at or above shoulder level: 1. almost all the time 2. about ¾ of the time 3. half of the time 4. about ¼ of the time 5. about 1/10 of the time 6. not at all	Working with hands at or above shoulder level: (daily): 1. almost all the time 2. ¾ of the workday 3. ½ of the workday 4. ¼ of the workday 5. very little of the workday	Working with hands above shoulder level for at least one hour a day (yes/no)	Daily working with one or two arms above the shoulders regularly or for a prolonged period: 1. Never or nearly never 2. <2 hours per day 3. 2-4 hours per day 4. > 4 hours per day	Working with hands above shoulder level
Exposed	¼ of the time or more	¼ of the workday or more	at least 1 h a day	2-4 h or more/day	¼ of the time or more
Metric	proportion of exposed	proportion of exposed	proportion of exposed	proportion of exposed	0 = 0-5% 1 = 6-24% 2 = 25-49% 3 = 50-74% 4 = 75-100%
Occupational codes	SSYK96	STYRK98	FISCO01	PCS	ISCO-88 (COM)
Mainly used crosswalks	SSYK96 -> ISCO-88 (COM)	STYRK98-> ISCO-88 (COM)	FISCO01-> ISCO-88 (COM)	PCS-> ISCO-88 (COM)	
Additional crosswalks	SSYK96 -> Nordic -> ISCO-88 (COM)	STYRK98-> Nordic -> ISCO-88 (COM)	FISCO01-> Nordic -> ISCO-88 (COM)	PCS-> Nordic -> ISCO-88 (COM)	

### 2.4.3 Harmonisation strategy

#### *EuroJEM version 1 (Nordic JEM)*

As described above we started the harmonisation process between the three most comparable JEMs from Sweden, Norway and Finland and developed the EuroJEM version 1 (Nordic JEM) with three selected exposures; faster breathing, forward bent posture and heavy lifting. Faster breathing was available only in two JEMs: the Norwegian and Swedish. For the other two exposures, all three JEMs could be used.

An expert panel was formed consisting of two occupational medicine researchers and work environment experts from each Nordic country (Finland, Norway and Sweden) to solve disagreements between the national JEMs by a consensus procedure.

From each national JEM, the values of proportion of exposed workers within an occupation were rounded and categorised into five exposure groups: 0-5 %, 6-24 %, 25-49 %, 50-74 % and 75-100 %. The harmonisation was then conducted by the following steps for each exposure separately depending on the availability of an exposure estimate in the three JEMs.

#### *Occupations with ISCO-88(COM) codes and with estimates from both (faster breathing) or all three JEMs available*

1. The occupations were checked for the agreement regarding exposure category between the JEMs.
2. When there was full agreement between JEMs for an occupation, this category value was assigned to the EuroJEM.
3. For occupations with disagreements, the expert panel discussed until a consensus was reached, and then assigned exposure categories to the EuroJEM. The following considerations were used in the consensus discussions:
  - a. Tasks and activities within the occupation were discussed and used to resolve disagreements. Correspondence between the descriptions of the occupation under ISCO-88(COM) code and for matched national codes were also looked at. Discussions were held about whether the exposure categories of the different JEMs were reasonable according to what was known by the panel experts regarding work tasks and activities.
  - b. Characteristics of the national JEMs:
    - i. The size of the occupational group, i.e. the number respondents from the particular occupation in the survey on which the exposure estimate in the national JEM was calculated. The following categories for the size of occupations were used: >199, 50-199, 10-49 and < 10. JEMs where the estimate was based on the smaller sizes were considered less reliable. Estimates from JEMs with larger sizes had higher weights for the consensus agreements.
    - ii. Whether there was a genuine estimate (based on survey responses for the specific occupation and gender) or whether the estimate was based on merged occupations or

genders. JEMs with genuine estimates were considered more reliable.

- iii. For the exposure heavy lifting, the size of loads is assessed differently in the Nordic JEMs (as described above). As heavy lifting is defined as lifting > 20 kg in both the Norwegian and Finnish JEMs, this size of load was used for the EuroJEM. However, in the Swedish JEM, heavy lifting is defined with a lower cut-off load: > 15 kg. We found that for several occupations, the proportion exposed to heavy lifting was higher in the Swedish than in the Norwegian or Finnish JEMs. In such cases it was assumed that the exposure value was high due to the lower load size in the Swedish JEM. However, for some occupations, the proportion of workers exposed to heavy lifting in the Swedish JEMs was lower than in either Norwegian or Finnish JEM. In such cases, if the size of occupation in the Swedish JEM was large, the estimates of the Swedish JEM had a higher weight in resolving disagreement.
- c. If disagreements were considered to reflect true differences between the countries regarding the work content in an occupation, and all values to be trustworthy with regard to i - iii. above, a mean value of the exposure categories was assigned. If one national value was close to the border of the exposure group, and close to the other JEM values, this was also taken into consideration.

#### *Occupations with missing information on exposure estimates from at least one national JEM*

The following scenarios were found:

- The national codes were matched to ISCO-88(COM) codes in all JEMs, but the exposure estimate was missing from one (faster breathing) or two of the JEMs.
  - The national codes were not matched to ISCO-88(COM) codes in all JEMs (but in at least one of them).
  - No matching between the national codes and ISCO-88(COM) codes was found for any of the JEMs, i.e. no exposure estimate was available based on national JEMs.
4. For these scenarios the expert panel discussed until reaching a consensus and assigned exposure categories to these occupations. The same considerations described above (bullet 3) was used, with the addition of the following solutions when relevant:
    - a. For occupations with agreement in exposure rates based on two JEMs and missing in the third JEM, the exposure category from the two JEMs was assigned.
    - b. When exposure estimates were available from at least one national JEM, the exposure category from a JEM with a relatively large occupation size was assigned.
    - c. If an exposure estimate was available for only one gender, it was considered to assign the same exposure category for both genders (a similar strategy was applied during the construction of the national JEMs)

- d. The Nordic crosswalk (described in the section Crosswalks or translation of occupational codes below) was used in the panel discussion to assign exposure category based on the group of occupations (a similar strategy was applied during construction of the national JEMs for occupations with less than 10 survey respondents).

### *EuroJEM version 2*

As described above, we continued the harmonization work and developed a EuroJEM version 2 adding a French JEM; the JEM CONSTANCES, also adding two more exposures: kneeling or squatting, and hands above shoulder level.

Four exposures: faster breathing, forward bent posture, heavy lifting and kneeling or squatting, were first harmonized between the Nordic JEMs, and later harmonized between the “Nordic JEM” (EuroJEM 1.0) and the JEM CONSTANCES. The fifth exposure hand above shoulder level was harmonized between four JEMs directly, i.e. no “Nordic” JEM was created for this exposure.

A similar harmonization strategy as described above for EuroJEM version 1 was used for EuroJEM version 2. The expert panel was extended with two occupational medicine researchers and work environment experts from France.

#### 2.4.4 Time periods covered

The data material for the currently harmonised variables for the EuroJEM has been collected between 1997 and 2019. The Swedish JEM covers the time period 1997-2013, the Norwegian JEM 2006 and 2009, the Finnish JEM 2001 and the French 2012-2019. The average exposure in these time periods was calculated for each JEM.

#### 2.4.5 Applicability with regard to different regions in Europe

The underlying data used for the EuroJEM comes from Sweden, Norway, Finland and France. As the labour market and working conditions show great similarities in Northern Europe and Scandinavia, we assume that this version is applicable in large parts of Northern Europe. As French data has been added in the second step, we believe that the latest version is also applicable in Western Europe. However, we cannot judge whether this version is valid also for Southern and Eastern Europe.

#### 2.4.6 Crosswalks or translation of occupational codes

Translation of SSYK96, STYRK98 and FISCO01 national occupational codes to ISCO-88(COM) was made based on crosswalks developed earlier in a Nordic project Solovieva et al. 2022 For occupational codes with no direct correspondence to the ISCO-88(COM), the Nordic code was assigned. This Nordic code was used for the imputation of missing exposures when needed. For translation of ISCO88(COM) to ISCO-88, an available crosswalk was used. Translation of French national occupational codes (PCS2008) to ISCO-88 was made based on the crosswalk developed by two external experts (Université d’Angers, France and Washington University, St. Louis, USA).



## 3 Further use of the EuroJEM1.0

### 3.1 Analyses of the EPHOR mega cohort

#### 3.1.1 Exploring knowledge gaps

WP5 has formed subgroups identifying key knowledge gaps for each high priority disease category which has, in an iterative process, guided the work with the EuroJEM1.0. EuroJEM1.0 will be used for both targeted hypotheses testing in the EPHOR mega cohort (e.g., evaluating multiple exposures in relation to a health outcome or the potential of vulnerable periods in which exposure has a stronger effect), but also in broad exploratory (agnostic) analyses (e.g. identifying new risk factors for a disease, and additional diseases associated with a known risk factor). In addition, EuroJEM will be used to describe the exposome in Europe: e.g. descriptives, correlations between exposures and possibly geographical locations.

#### 3.1.2 Validation of the EuroJEM1.0

Suggested first steps in the validation is to explore if already known key associations are identified by the EuroJEM1.0. A second validation approach would be to explore the availability of individual exposure information combined with occupational codes over a range of exposure levels and agents of exposure within individual cohorts in the mega cohort. This could allow comparison of the exposure assessment derived from using EuroJEM1.0 with the estimate based on individual exposure information. In addition, it may contribute to estimations of effects of misclassification on the risk estimates, which is of relevance for the health impact assessment (Impact assessment, WP8)

### 3.2 Interactive EuroJEM V1 – toolbox

The selected harmonised existing JEMs covered by this report (D2.2) combined into a first version of the EuroJEM (EuroJEM1.0), will together with the new JEMs (D2.4) be part of the interactive EuroJEM V1 tool in the We-Expose toolbox. Thus, exposures in EuroJEM1.0 which include chemical & particle exposures, psychosocial exposures, ergonomic exposures, and physical exposures, will be complemented with new JEMs assessing exposures to solar ultraviolet radiation and precarious work.

Preliminary discussions have led to the following functionalities for the interactive EuroJEM1.0 tool:

- Description of the EuroJEM: exposures included, how exposure estimates may be used, and contact information.
- A landing page for making the JEMs available for scientists, containing a description of the JEMs and contact information to request access. *Primary stakeholder: Researchers.*
- The possibility to select e.g. an exposure or an occupation. Based on the user input, an interactive treemap is populated with a) prevalence of different exposures based on occupation selected, or b) prevalence of different exposed occupations based on exposure selected. When prevalence information is not available, an alternative visualisation (e.g. simple list) will be generated. *Primary stakeholder: Policy makers, OSH professionals.*
- Based on a selection of one or more boxes on the treemap:
  - A line graph is populated with the selected combination of job and exposure level over time. If multiple boxes are selected, the lines will allow comparison to be made for up to n selections. If temporal information is unavailable, box plots may be used for exposure level comparison. *Primary stakeholder: OSH professionals, researchers.*
  - A heatmap pivot table is populated with the selected combination of job and exposure over time. The user will also be presented with a menu here to include additional fields



such as country, additional jobs, additional exposures, time period, etc. If desired, we could allow for tables to be downloaded to a spreadsheet/text format. *Primary stakeholder: OSH professionals, researchers.*

The functionalities of the Interactive EuroJEM1.0 tool, as described above, are based on the assumption that required data is available (including quantitative exposure estimates, time trends and country specific estimates). Realistically, this may differ per exposure. Consequently, in the development of the tool, we start with data-rich exposures and ultimately find functional solutions/alternatives for other exposures with less data support and coverage. A first version of the tool will become available at in mid 2024 via the toolbox ([Working Life Exposome Toolbox — We Expose \(we-expose.eu\)](https://www.we-expose.eu)).

### 3.3 Exposure assessment in the case-studies

The case-study on lung function and obstructive lung disease (WP6) will use information from the EuroJEM and link it to life-time job-information from the cohorts. In addition, information on current exposures obtained from work-place measurements in the case-studies (WP6 and WP7) will inform further developments of the EuroJEM.

### 3.4 Developments of a dynamic EuroJEM

A protocol for updating EuroJEM1.0 has been described in deliverable (D2.3).

### 3.5 EuroJEM beyond EPHOR

While development, quality assurance and access to EuroJEM during the project period of EPHOR is taken care of through the overarching procedures for consultation and decision-making within the project, there is a need to arrange for these processes and structures beyond EPHOR. A discussion on this has started, currently based on the following assumptions:

- Ensuring easy and transparent access for external researchers
- Governance by a board consisting of partners with an interest in keeping the EuroJEM accessible, updated and to ensure quality of the data
- Hosting by a partner with resources to administrate the EuroJEM

A preliminary version of an external web-page will be tested during the second half of 2024.

## 4 Discussion and conclusion

The work with the EuroJEM has in some aspects been more demanding than originally anticipated. The decision to classify exposure at a four-digit level in ISCO88(COM) has required expert judgement when constructing crosswalks for numerous occupational codes, i.e. in instances when occupational groups in the original coding system are split or merged in ISCO-88(COM).

Another challenge has been that, in contrast to JEMs for e.g. noise or chemicals, which are based on measurements, the JEMs for psychosocial and ergonomic exposures are based on self-reports from surveys, and exposure definitions are less uniform. Thorough analyses have been necessary to assess the comparability between the slightly varying survey questions between countries.

The different JEMs within the EuroJEM have applied different approaches to characterising who is “exposed”. For the chemicals and particles, many occupational groups are characterised as “unexposed”, usually meaning that their exposure is not different from that in the general population. However, for some highly prevalent occupational exposures, e.g. noise, physical strain,

job control, all occupational groups have been characterised with regard to prevalence or degree of exposure.

It is a limitation that the harmonisation so far has relied mainly on JEMs from the Nordic countries and Western Europe, as most existing JEMs were generated to assess exposure in these countries. As described in our previous deliverable on existing JEMs (D2.1), apart from exposure to chemicals/particles, there are rather few existing non-Nordic JEMs. Sometimes country-specific coding systems put additional barriers to harmonisation. We have attempted to reduce these limitations by extensive work with crosswalks from country-specific codes when indicated, and expert judgement on the applicability of JEMs created for one region to other regions. These assessments were performed separately for each exposure. The assessment of the applicability of each JEM regarding the different European regions should be seen as a guidance.

Currently, most gaps are seen for Eastern Europe. At the same time there are few occupational cohorts from Eastern Europe. This means that within EPHOR we will not be able to test the applicability of the EuroJEM1.0 for Eastern Europe. This gap can be seen as a reflection of the state of occupational research in the region. However, based on country- and agent-specific expertise, it may be possible to conclude if there is a wider applicability.

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