European Agency for Safety and Health at Work

Occupational cancer risk factors in Europe – Findings of the Workers' Exposure Survey for health and social care workers

Report

European Agency for Safety and Health at Work

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Acknowledgements: Marine Cavet, Xabier Irastorza, Elke Schneider (EU-OSHA), Prof. Lin Fritschi and Troy Sadkowsky, Data Scientists Pty Ltd – OccIDEAS (www.occideas.org).

PDF | ISBN 978-92-9402-379-7 | doi: 10.2802/0273680 | TE-01-25-003-EN-N

Table of Contents

List of figures and tables

- **List of Supplemental Figures**

List of Supplemental Tables

Abbreviations

AWES	Australian Work Exposures Study
EU-OSHA	European Agency for Safety and Health at Work
EU	European Union
HeSCare	Health and social care
NACE	Statistical classification of economic activities
OEL	Occupational exposure limit
OccIDEAS	Occupational Integrated Database Exposure Assessment System
UV	Ultraviolet
WES	Workers' Exposure Survey on cancer risk factors in Europe

Executive Summary

The European Agency for Safety and Health at Work (EU-OSHA) conducted the Workers' Exposure Survey on cancer risk factors in Europe (WES), which estimates exposure to cancer risk factors among European workers, including in the health and social care (HeSCare) sector, which is one of the largest employment sectors in the EU. The survey aims to increase knowledge on the current prevalence and circumstances of exposure to known cancer risk factors faced by workers, and on prevention strategies in place, overall and by sectors of activity.

WES included 24,402 telephone interviews conducted on workers aged 15 years or older from six EU Member States. Among those, 3,041 were affiliated with the HeSCare sector. For exposure assessment, WES uses the Occupational Integrated Database Exposure Assessment System (www.occideas.org), where probable exposure to selected cancer risk factors during the last working week was automatically estimated based on answers to a detailed questionnaire. The survey was finalised in 2023, covers 24 known cancer risk factors in almost all sectors of occupation, and is representative of the workforce in Germany, Ireland, Spain, France, Hungary and Finland.

Among the HeSCare sector survey respondents, the majority worked in the Healthcare sub-sector (n=2,478), 329 in residential care and 234 in social work. Almost two-thirds of HeSCare sector workers (65.3%) were females. Most respondents in the sector were born in the reporting country (87.1%) and were employed with a contract of unlimited duration (72.9%).

The most frequent job category in the HeSCare sector as defined by WES was health worker (91.3%). Work tasks commonly reported in the sector that may lead to exposure to cancer risk factors were sterilising equipment, particularly medical (18.8%) and driving or maintaining vehicles as part of their work (18.2%). Among the cancer risk factors considered, the most common exposures were to ionising radiation (7.4%), diesel engine exhaust emissions (6.2%), solar ultraviolet (UV) radiation (6.1%), formaldehyde (5.2%) and benzene (4.8%). The most frequent cancer risk factors with probable exposure at a high level were ethylene oxide (55.2% of workers exposed at a high level) and formaldehyde (43.7% of workers exposed at a high level).

An estimated 29.5% of HeSCare workers were exposed during the last working week to at least one of the 24 cancer risk factors assessed in the survey and 7.8% were exposed to two or more cancer risk factors. Males were more often exposed to at least one cancer risk factor during the last working week (34.3%) than females (24.3%) and were also more often exposed to two or more cancer risk factors (10.2%) than females (5.8%). Similarly to the overall WES findings (EU-OSHA, 2023a), the most frequent co-exposures assessed in HeSCare were diesel engine exhaust emissions and solar UV radiation.

The most common circumstance of exposure to ionising radiation in the sector was working with or near machines that used X-rays for purely diagnostic purposes. The use of radio-protective shields and radio-protective garments were commonly reported by workers in tasks linked to an exposure to ionising radiation. For diesel engine exhaust emissions, the most common circumstance of exposure was driving, maintaining or travelling in diesel-powered vehicles. Exposure to solar UV radiation occurred when working outside during the day (in a vehicle with the windows down at least one hour per day, or in the open) or when working with or near reflective surfaces. Commonly reported protection measures for solar UV radiation exposure included wearing clothing that covered most of the body, sunglasses, a hat or other head cover, which may have been influenced by the season in which interviews were conducted (September 2022 to February 2023).

WES results in the HeSCare sector provide valuable and up-to date sector-specific information about workers' exposures to known occupational cancer risk factors and the use of preventive/protective measures in the workplace. These findings inform targeted prevention such as the adoption of more task-specific measures, contribute to awareness raising and support EU policy initiatives.

Along with strengths of the survey, some limitations associated with the adopted approach include that exposure assessments were based on self-reports of tasks rather than on objective observations or workplace measurements, which may be prone to information bias. Also, frequency and duration of the tasks leading to exposure were not recorded, as only information about the last working week was captured. Detailed information about the frequency and duration of tasks leading to the exposures

studied in WES would have helped with more detailed exposure characterisation about these cancer risk factors. Finally, the appropriate use of protective measures such as respiratory equipment or the correct maintenance of ventilation systems are important elements not specifically evaluated with WES.

Furthermore, as a future prospect, the survey could potentially be expanded to other EU Member States covering more known or suspected occupational cancer risk factors and larger numbers of workers. A larger sample size and the inclusion of specific carcinogens that are of concern in HeSCare work would allow for a more granular and informative analysis at the sub-sector level and provide more insights to gender-specific issues.

1 Introduction

The European Agency for Safety and Health at Work (EU-OSHA) conducted a large worker exposure assessment survey on cancer risk factors that was finalised in 2023: the Workers' Exposure Survey on cancer risk factors in Europe (WES). The survey was implemented in six EU Member States: Germany, Ireland, Spain, France, Hungary and Finland. The survey provides estimates for workers' exposure during the last working week to 24 cancer risk factors including industrial chemicals, process-generated substances and mixtures, and physical risk factors in many occupations (EU-OSHA, 2023a, 2023b).

WES is the first survey of its kind conducted in the EU, and is based on an Australian concept, where detailed information about workers' current job and various demographic factors were collected via telephone interviews using a web-based application and used to estimate exposure to a number of pre-defined cancer risk factors. The Australian Work Exposures Study (AWES), conducted in 2011-2012, explored the prevalence of occupational exposure to known or probable carcinogens and focused on those most relevant to Australian working conditions at that time (Carey et al., 2014).

Although WES includes workers in all sectors of economic activity, this report focuses on findings from WES in the health and social care sector (HeSCare) sector, which was chosen for this first sectoral analysis of WES data, in the context of an ongoing multi-annual research activity that EU-OSHA is undertaking to generate up-to-date and evidence-based knowledge on the diverse occupational safety and health challenges faced by the sector and its workforce (see: https://osha.europa.eu/en/themes/health-and-social-care-sector-osh).

The HeSCare sector is classified by the Eurostat statistical classification of economic activities (NACE Rev. 2) under section Q (NACEQ: human health and social work activities). Further, NACEQ contains three divisions (also named sub-sectors in this report): healthcare activities (NACEQ-86, referred to as: Healthcare), residential care activities (NACEQ-87, referred to as: Residential care), and social work activities without accommodation (NACEQ-88, referred to as: Social work) (Eurostat, 2008). The sector provides jobs in formal care settings, that is, hospitals, nursing and care homes, or medical practices, and also includes workers who provide care to individuals in their own homes. More information on specific activities covered by each of these sub-sectors can be found in Table 1. Detailed information on the characteristics of HeSCare sector establishments in the EU with a specific focus on occupational safety and health has been published recently (EU-OSHA, 2024b).

The HeSCare sector is one of the largest in the EU, providing around 11% of all jobs (Eurostat, 2022). According to Eurostat Labour Force Survey statistics, over 21.5 million people were employed in the HeSCare sector (NACEQ) in 2022, mostly in Healthcare, with around 12.5 million workers. Employment levels in the HeSCare sector have been steadily increasing over the past 10 years in the EU, including across all of its sub-sectors (EU-OSHA, 2024b).

Workers in the HeSCare sector are exposed to a variety of work-related risks of different nature, including biological, psychosocial, musculoskeletal, physical and chemical exposures. Routine work-related manipulation of hazardous chemical substances can pose a risk of harmful exposures to many different workers in the HeSCare sector, including medical staff such as doctors, nurses, aides, emergency medical technicians and laboratory workers, but also administrative or cleaning personnel in hospital facilities or in home care settings (European Commission, 2023; Lindsley & Musu, 2022).

WES uses a cross-sectional study design and estimates the prevalence of exposure of workers (by a broad definition covering both employees and self-employed and excluding people working for private households) to pre-selected cancer risk factors, providing exposure probability and semi-quantitative information on exposure levels. Moreover, the survey offers detailed information on the circumstances of exposure and the availability and/or use of preventive and protective measures in the workplace as reported by the workers in the six EU Member States surveyed. First findings of WES were published in 2023 (EU-OSHA, 2023a).

Table 1: Health and social care activities sector, HeSCare (NACE Rev. 2)

Division	Class	Description
Q86 – Human health activities (Referred to as: Healthcare)	Q86.10	Hospital activities
	Q86.21	General medical practice activities
	Q86.22	Specialist medical practice activities
	Q86.23	Dental practice activities
	Q86.90	Other human health activities
Q87 – Residential care activities (Referred to as: Residential care)	Q87.10	Residential nursing care activities
	Q87.20	Residential care activities for mental retardation, mental health and substance abuse
	Q87.30	Residential care activities for the elderly and disabled
	Q87.90	Other residential care activities
Q88 – Social work activities without accommodation (Referred to as: Social work)	Q88.10	Social work activities without accommodation for the elderly and disabled
	Q88.91	Child day-care activities
	Q88.99	Other social work activities without accommodation not elsewhere classified

Source: Eurostat NACE Rev. 2 classification (Eurostat, 2008).

2 Methods

WES was conducted and coordinated by EU-OSHA between 2020 and 2023. A total of 24,402 valid interviews with workers from all sectors of occupation covering both employees and self-employed and excluding people working for private households were conducted. The respondents of the survey were individuals working in all sectors of economic activity,[1] aged 15 years or older, and whose residence and place of employment was in the territory of the countries where the survey took place. Only those workers who could understand and respond to the questions in the main national language of the country were included. Individuals were randomly sampled in each of the six included EU Member States and answered by telephone detailed questions tailored to each respondent about the tasks they had completed at work during the last working week (EU-OSHA, 2024a). Participants were also asked relevant demographic and job-related questions (e.g. contract type, number of weekly hours worked).

WES provides exposure assessment for 24 known cancer risk factors, including both chemical agents (also process-generated) and physical agents (i.e. radiation), that were deemed relevant in the EU work-related context. The inclusion criteria and the list of the 24 cancer risk factors considered in WES have

[1] Except private households (NACE T), extraterritorial organisations (NACE U) and armed forces (ISCO sector 0).

been published earlier (EU-OSHA, 2023a). The main cancer risk factors present in the HeSCare sector (estimated in at least 30 respondents) are listed in Table 2.

Table 2: Cancer risk factors in the HeSCare sector, as estimated by WES (in alphabetical order)

Artificial UV radiation	Benzene	Diesel engine exhaust emissions	Ethylene oxide
Formaldehyde	Ionising radiation	Respirable crystalline silica	Solar UV radiation

Workers responded to detailed questions about their work during the previous working week, and specific questions were asked to each respondent based on the answers provided. In this way, workers were asked the minimum number of necessary questions to obtain the relevant information for exposure assessment. WES covered all types of occupations in Europe, and the survey questionnaire was operationally divided into 50 sets of job-related questions (job categories or modules) and 41 sets of task-related questions (task modules). The job-related questions were specific to the occupation or job (e.g. health workers, laboratory workers) the workers had, and the task-related questions were related to specific activities or processes (e.g. sterilising, laboratory work) performed by the workers. The same task could be done in different jobs and therefore asked to workers in different job categories (EU-OSHA, 2023a).

Probability and level of exposure to the cancer risk factors was automatically estimated using an innovative tool, the Occupational Integrated Database Exposure Assessment System (OccIDEAS) (Fristchi, 2019; Fritschi et al., 2009, 2020). OccIDEAS is a web-based application that uses specific predefined algorithms to assess workers' recent occupational exposure on an individual basis (at the respondent level). OccIDEAS has been previously used for exposure assessment in studies conducted in Australia and more recently in the New Zealand carcinogens survey (Carey et al., 2014; WorkSafe New Zealand, 2023), and it was slightly adapted to the EU context for WES.

The probability of exposure to any given cancer risk factor included in WES was further divided into three categories (levels) that were approximately related to EU occupational exposure limits (OELs)[2] at the time exposure assessment was conducted:

- probable exposure at a **high level** (exposure at or around the EU OEL);
- probable exposure at a **medium level** (exposure between 10% and 80% of the EU OEL);
- probable exposure at a **low level** (exposure less than 10% of the EU OEL, but higher than at community level).

The levels of exposure were based on the evidence from the published literature or existing national databases and on expert advice from occupational epidemiologists and hygienists from the six EU Member States where WES was conducted and took into account the information reported by the respondents regarding preventive measures at work (e.g. closed systems, ventilation, respiratory or other protection, cleaning measures).

When exposure for a worker to a given cancer risk factor occurred via different tasks, the worker was assigned the highest exposure level estimated, meaning that the worker may have been exposed to the same cancer risk factor at a lower level as well (EU-OSHA, 2024a). The full WES questionnaire and dataset are available online (EU-OSHA, 2025).

[2] More information about occupational exposure limits is available at: https://osha.europa.eu/en/legislation/directives/commission-directive-2009-161-eu-indicative-occupational-exposure-limit-values

3 Results

Among the total 24,402 respondents included in WES, 3,041 worked in the health and social care activities sector (HeSCare, NACEQ). The majority worked in Healthcare (n=2,478) (NACEQ-86), 329 in Residential care (NACEQ-87) and 234 in Social work (NACEQ-88).

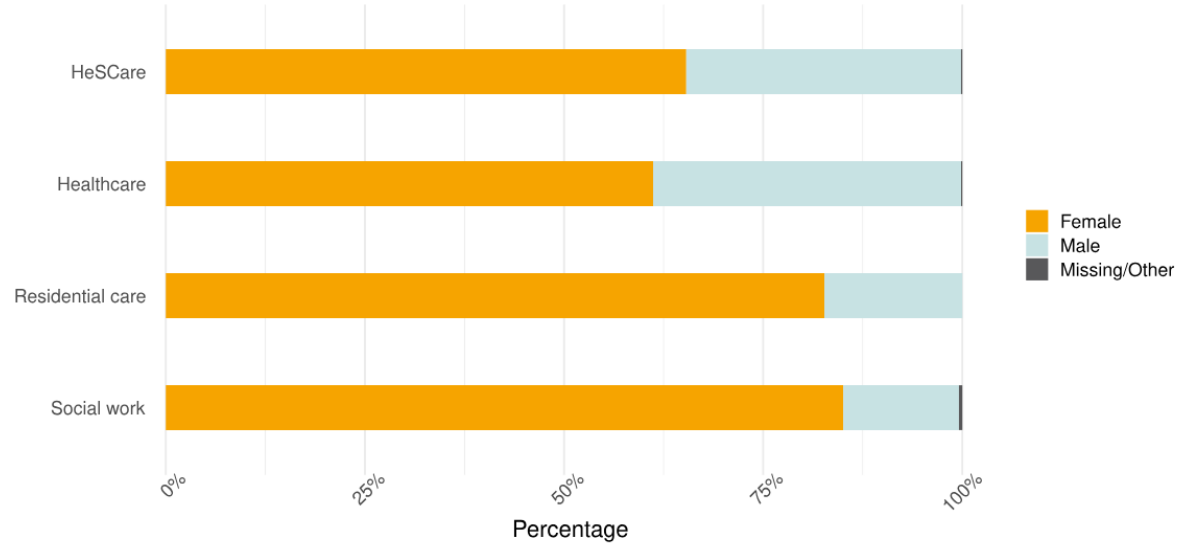
Due to the limited sample size by country for the HeSCare sector and sub-sectors, country-specific findings are not presented in this report. For the exposure assessment and the findings on circumstances of exposure and control measures, results are only reported when there are at least 30 workers per category.

3.1 Demographic variables

3.1.1 Gender

As expected from EU statistics (EU-OSHA, 2022; Eurofound, 2020), most respondents in the HeSCare sector were females (65.3%). In the Residential care and in the Social work sub-sectors, the percentage of female respondents was even larger (82.7% and 85.0%, respectively) (Figure 1).

Figure 1: Gender distribution of respondents in the WES overall sample, in the HeSCare sector and in its three sub-sectors (unweighted %)

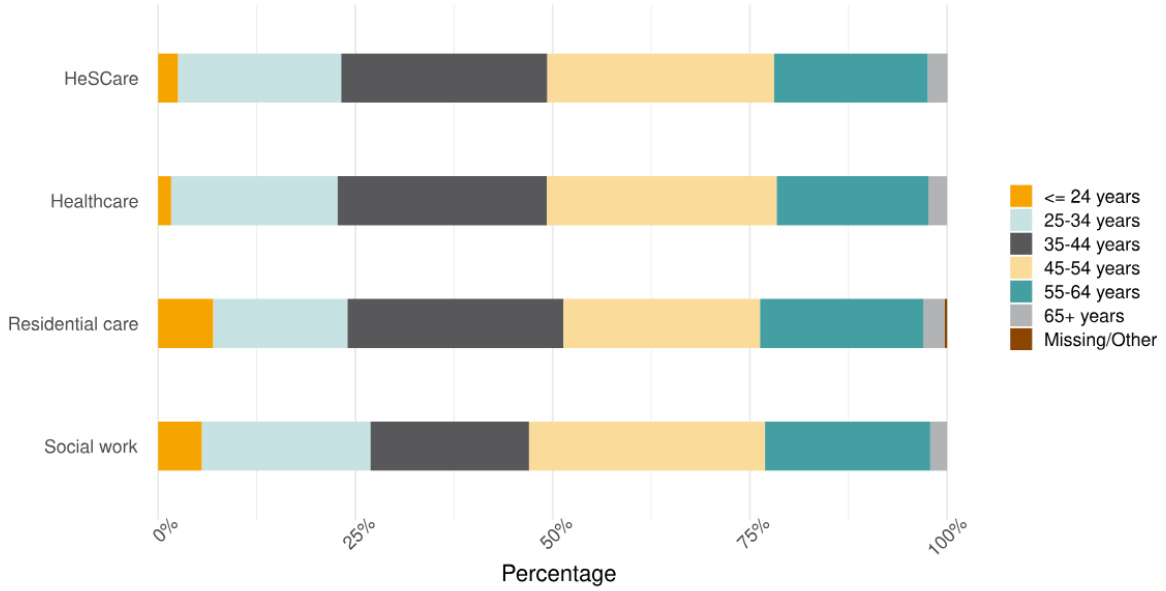


Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.

3.1.2 Age

The majority of respondents in the HeSCare sector ranged from 25-64 years (95.1%). Workers aged 24 years and below or 65 years and above represented the smallest age groups in the sector (2.5% and 2.4%, respectively), although a somewhat higher percentage of younger respondents aged ≤24 years was noted among Residential care and Social work, as compared to Healthcare (Figure 2). A generally similar distribution of respondents by age group was observed in the overall WES sample.

Figure 2: Age distribution of respondents in the HeSCare sector and in its three sub-sectors (unweighted %)

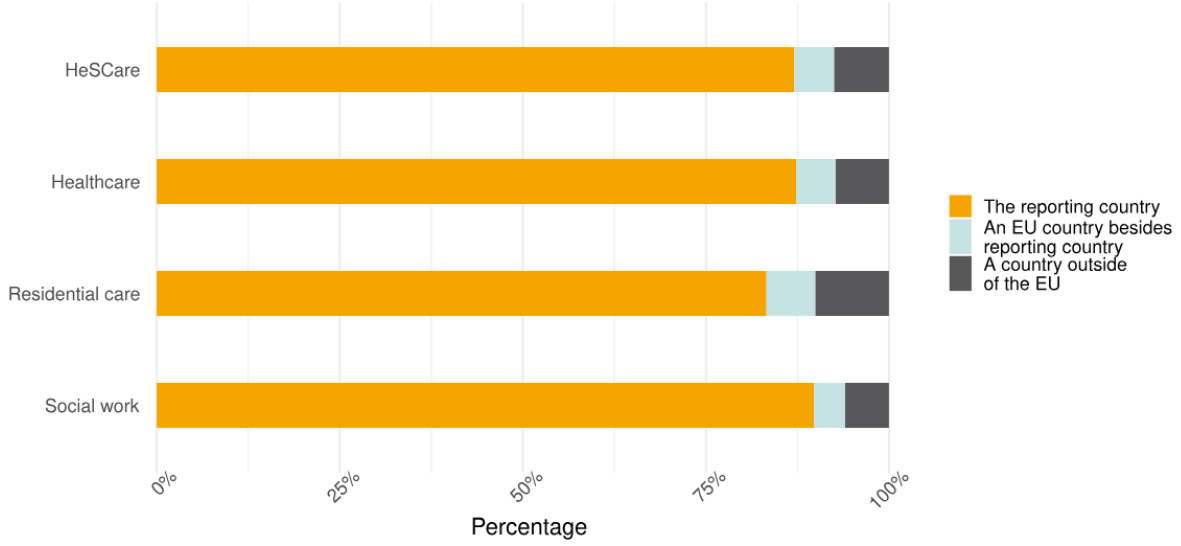


Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.

3.1.3 Country of birth

In the HeSCare sector, most of the respondents (87.1%) were born in the reporting country, 5.5% in an EU Member State other than the reporting country, and 7.5% in a country outside of the EU. The distribution of participants by country of birth was generally similar between the three sub-sectors, as well as in the overall WES sample (Figure 3).

Figure 3: Country of birth of respondents in the HeSCare sector and in its three sub-sectors (unweighted %)



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.

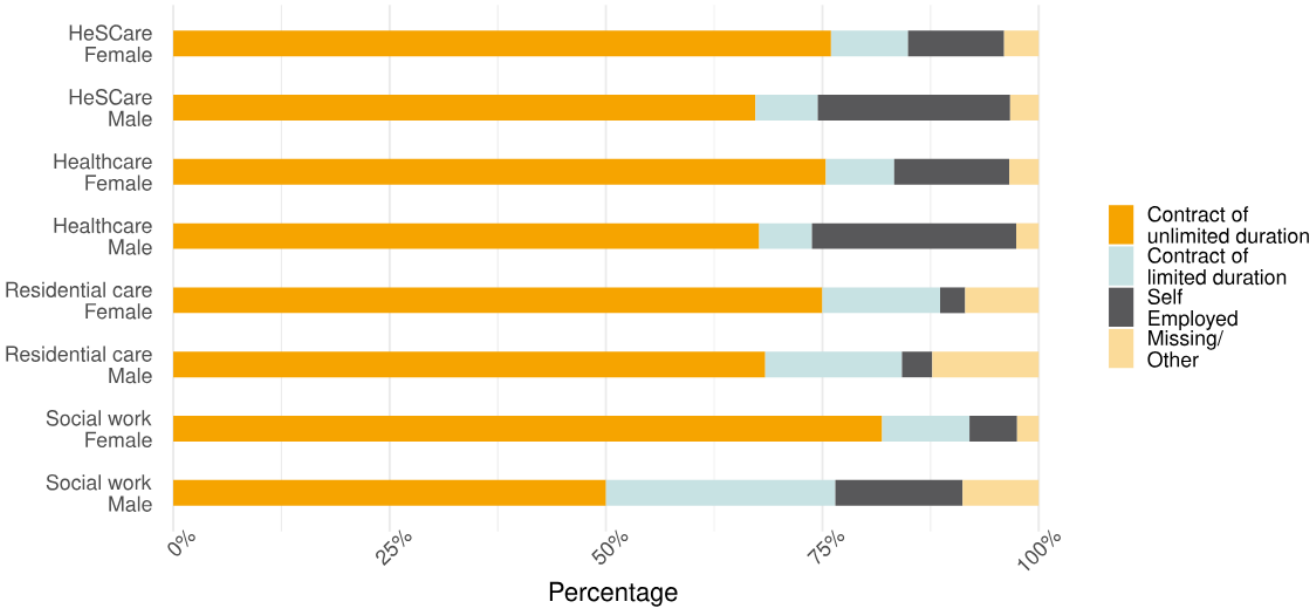
3.2 Job-related variables

3.2.1 Employment status and contract type by gender

In the HeSCare sector overall, females (76.0%) tended to be working as employees with a contract of unlimited duration more often than males (67.2%), whereas almost twice the percentage of male respondents (22.2%) were self-employed compared to females (11.1%).

In the Residential care and Social work sub-sectors, the proportion of respondents with contracts of limited duration was somewhat greater than in the Healthcare sub-sector, and differences in self-employed respondents by gender persisted (Figure 4).

Figure 4: Employment status and contract type by gender of respondents in the HeSCare sector and its three sub-sectors (unweighted %)



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.

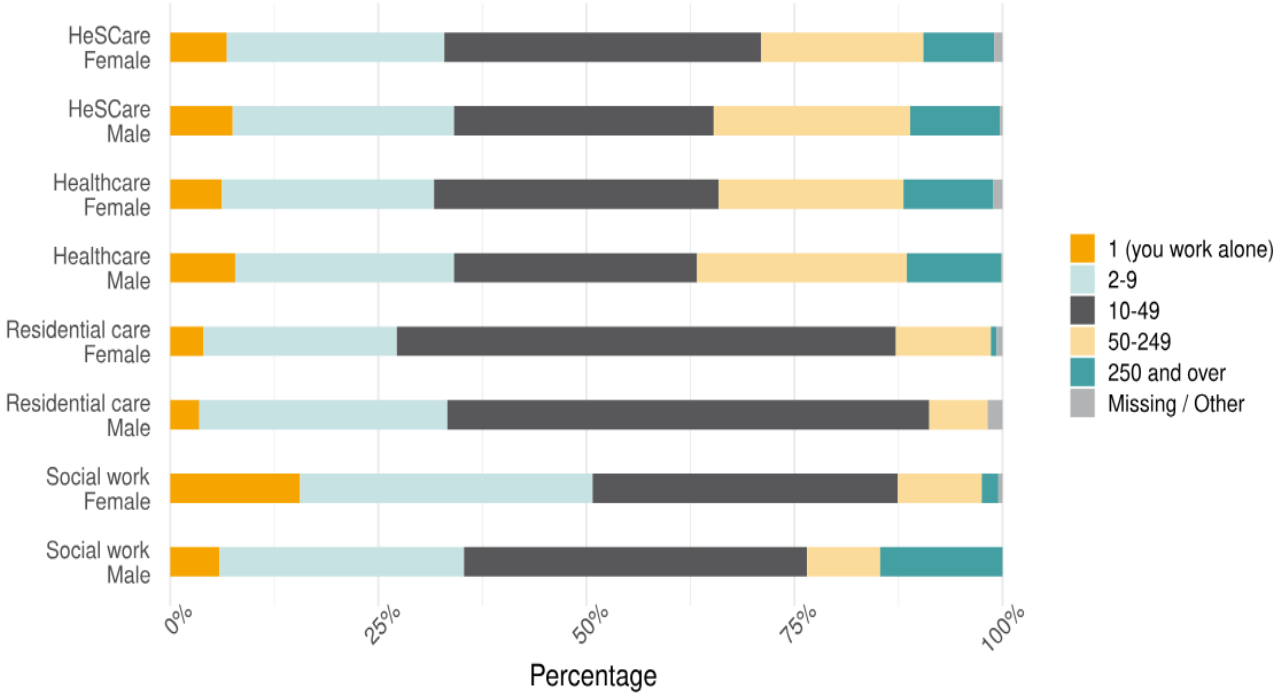
When looking at specific occupations as coded by the International Standard Classification of Occupations (ISCO-08)[3] in relation to employment status by gender, the most common ISCO codes (three-digit level) among self-employed females in the HeSCare sector were medical doctors (ISCO 221, 41.8%), followed by other health professionals (ISCO 226, 28.2%), social and religious professionals (ISCO 263, 9.1%), other health associate professionals (ISCO 325, 5.5%), nursing and midwifery associate professionals (ISCO 322, 4.5%), and personal care workers in health services (ISCO 532, 3.6%). The distribution of the most common ISCO codes in self-employed males in the overall HeSCare sector were also medical doctors but with a higher percentage than in the females (ISCO 221, 55.8%), followed by other health professionals (ISCO 226, 25.3%), social and religious professionals (ISCO 263, 5.6%), other health associate professionals (ISCO 325, 3.9%), and traditional and complementary medicine professionals (ISCO 223, 2.1%).

[3]See International Standard Classification of Occupations: ISCO-08, 2012, International Labour Office: https://www.ilo.org/global/publications/ilo-bookstore/order-online/books/WCMS_172572/lang--en/index.htm

3.2.2 Company size

Most respondents in the HeSCare sector, both male (81.4%) and female (83.6%), worked in companies ranging in size from two to 249 workers, similar to what was observed in the overall WES sample (86.2% and 85.9%, respectively) (Figure 5). The majority worked in companies with 10 to 49 workers (31.2% and 38.0%, respectively). A total of 6.8% of female respondents and 7.5% of male respondents in HeSCare reported to be the sole worker at their workplace, similar to 6.9% and 6.6% in the overall WES. In residential care, the majority of female (59.9%) and male (57.9%) respondents worked in companies of 10 to 49 workers. Among social workers, females tended to be working alone (15.6%) more frequently than males (5.9%), although the sample size is small in this group.

Figure 5: Company size and gender of respondents in the HeSCare sector and its three sub-sectors (unweighted %)

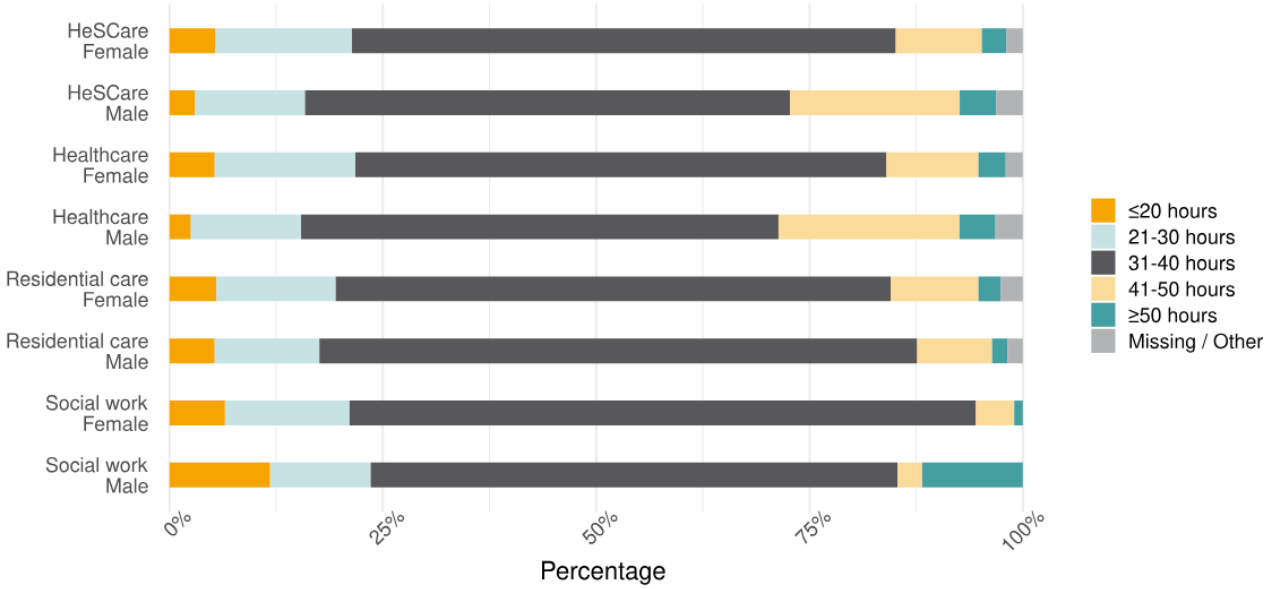


Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.

3.2.3 Hours worked per week

In the HeSCare sector, and similarly in the overall WES, respondents largely reported weekly working hours spanning from up to 20 hours per week (lower range) to up to more than 50 hours per week, with the majority working between 31 and 40 hours per week (reported by 63.8% of female and 56.9% of male respondents in the sector) (Figure 6). In the HeSCare sector, male respondents tended more often to work 40 hours or more per week than females (24.2% vs 13.0%, respectively).

Figure 6: Hours worked per week and gender of respondents in the HeSCare sector and its three sub-sectors (unweighted %)



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.

3.3 Job categories and tasks in the HeSCare sector

The most frequent job categories as defined in WES that were present in the HeSCare sector with at least 30 respondents each included: health workers (which considers health professionals and includes nurses, dentists, dental assistants, nurses in home care, doctors, surgeons, etc., 91.3%), laboratory workers/chemists in all type of scientific laboratories (2.3%), food workers including all food-related jobs such as chefs/cooks, bakers, butchers, food processing plants or food retail outlet (1.6%), office or administration workers (1.5%), and cleaners including domestic, industrial and commercial cleaners (1.1%) (Table 3). Similarly, the most common tasks (among those included in WES) that were present in the sector were sterilising equipment (mostly medical) (18.8%), driving/maintenance of vehicles as part of the work (18.2%), cleaning hands with chemicals (14.2%), working outside during the day (10.8%), and the use of medical radiation (e.g. X-rays, CT scans) (8.1%).

In Healthcare (NACEQ-86), most of the respondents replied to the health workers job category (93.1%). Regarding tasks, most of the respondents replied to the task categories of sterilisation (20.7%), cleaning hands (15.7%), driving/maintenance (14.6%), medical radiation (9.9%) and solar UV radiation (7.3%). In Residential care (NACEQ-87), the job category most represented was also health worker (87.5%). The tasks gathering most of the respondents were driving/maintenance (22.2%), working outside during the day (18.8%), sterilising (12.8%) and cleaning hands (10.0%). In Social work (NACEQ-88), the health worker job module was completed by 77.4% of respondents, while the most frequent tasks were driving/maintenance (50.9%) and working outside during the day (35.9%).

Table 3: Job categories and tasks in the HeSCare sector and in its three sub-sectors (unweighted %)

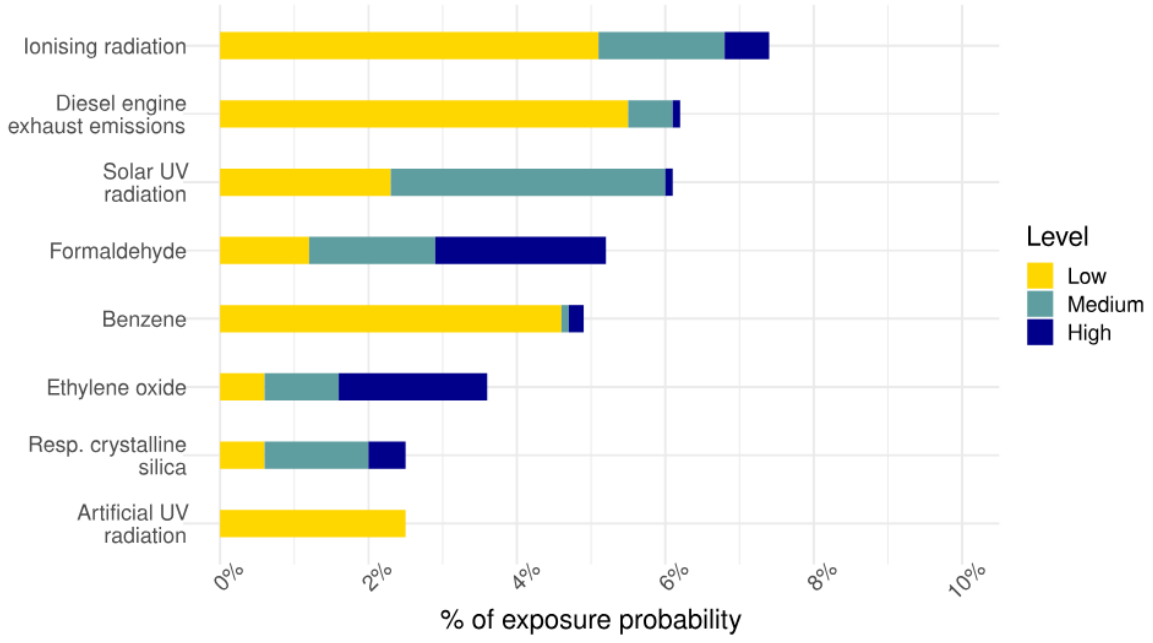
		HeSCare (%) n=3,041	Healthcare (%) n=2,478	Residential care (%) n=329	Social work (%) n=234
Job categories	Health worker	91.3	93.1	87.5	77.4
	Laboratory worker/chemist	2.3	2.8	0.0	0.0
	Food worker	1.6	-	-	-
	Office worker	1.5	-	-	-
	Cleaner	1.1	-	-	-
Tasks	Sterilising	18.8	20.7	12.8	-
	Driving/ maintenance	18.2	14.6	22.2	50.9
	Cleaning hands	14.2	15.7	10.0	-
	Working outside during the day	10.8	7.3	18.8	35.9
	Medical radiation	8.1	9.9	-	0.0
	Pathology laboratory	2.4	2.9	-	0.0
	Gross anatomy laboratory	1.6	1.9	0.0	0.0

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: all respondents working in the HeSCare sector in Germany, Ireland, Spain, France, Hungary and Finland.
Note: Only findings with at least 30 respondents per cell are considered.

3.4 Exposure to cancer risk factors in the HeSCare sector

The most frequently estimated cancer risk factors present in the HeSCare sector at any level of exposure (ranked from highest to lowest prevalence) were ionising radiation (7.4%), diesel engine exhaust emissions (6.2%), solar UV radiation (6.1%), formaldehyde (5.2%), benzene (4.8%), ethylene oxide (3.6%), respirable crystalline silica (2.5%) and artificial UV radiation (2.5%) (Figure 7). The exposures estimated to occur most frequently at a high level in the sector were ethylene oxide (55.2% of exposed at a high level) and formaldehyde (43.7% of exposed at a high level), and those occurring at a medium level were solar UV radiation (59.7% of exposed at a medium level), respirable crystalline silica (56.7% of exposed at a medium level) and formaldehyde (32.9% of exposed at a medium level).

Figure 7: Proportion of HeSCare sector workers probably exposed to cancer risk factors included in WES, by level of exposure (% of all workers in the sector)

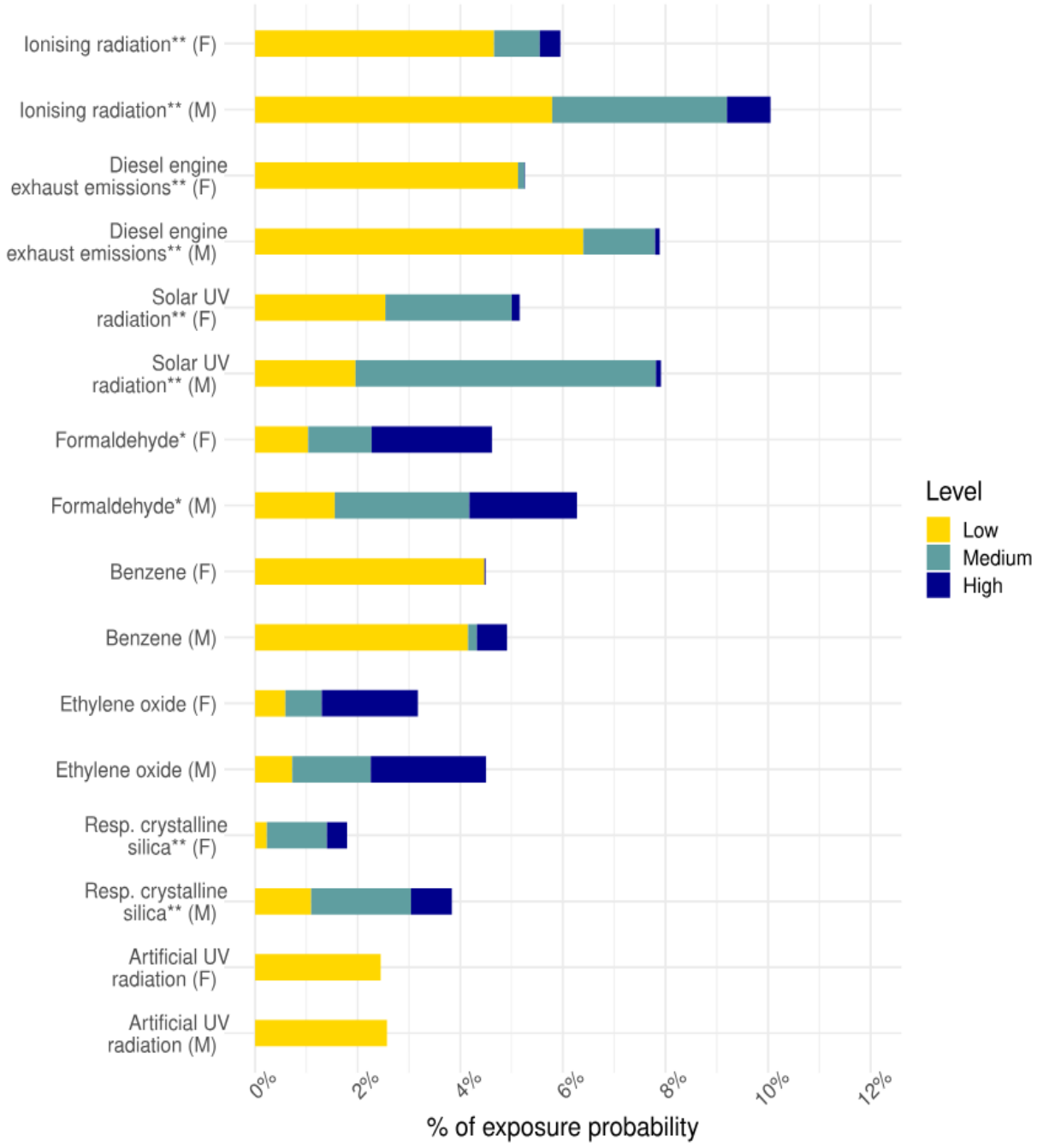


Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland.

In the Healthcare sub-sector, workers' most frequently estimated exposures were ionising radiation (8.3%), formaldehyde (6.0%), diesel engine exhaust emissions (4.8%), ethylene oxide (4.2%), solar UV radiation (4.0%), benzene (3.7%), respirable crystalline silica (2.9%) and artificial UV (2.8%) (Appendix, Figure A1). The most frequent exposures estimated to occur at a high level in healthcare workers were ethylene oxide (54.0% of exposed at a high level) and formaldehyde (41.3% of exposed at a high level). Among workers in the Residential care sub-sector, the most frequent exposures were solar UV radiation (14.7%) and diesel engine exhaust emissions (9.1%). In social workers, these were solar UV radiation (19.5%), benzene (19.3%) and diesel engine exhaust emissions (18.0%). For both residential and social workers in the sector, exposures were generally estimated to be probably at low or medium levels.

When looking at estimated exposure to cancer risk factors by gender in the HeSCare sector, males typically presented a greater estimated prevalence of exposure compared to females (Figure 8). Differences were statistically significant for exposure to ionising radiation (10.0% among male vs 6.0% among female workers), diesel engine exhaust emissions (7.9% among male and 5.3% among female workers), solar UV radiation (7.9% among male and 5.2% among female workers), formaldehyde (6.3% among male and 4.6% among female workers), and respirable crystalline silica (3.8% among male and 1.8% among female workers).

Figure 8: Proportion of HeSCare workers probably exposed to cancer risk factors included in WES, by level of exposure and gender (% of all workers in the sector)



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland.
*Note: F = Female, M = Male. **p-value<0.01, *p-value<0.05.*

The ranking of exposures ordered by estimated frequency (considering any exposure level) was similar between the genders, except for respirable crystalline silica which ranked higher than artificial UV radiation exposure in males (Table 4).

Table 4: Prevalence of exposure (%) to cancer risk factors in the HeSCare sector by gender

Cancer risk factor	Male	Cancer risk factor	Female
1. Ionising radiation	10.0	1. Ionising radiation	6.0
2. Diesel engine exhaust emissions	7.9	2. Diesel engine exhaust emissions	5.3
3. Solar UV radiation	7.9	3. Solar UV radiation	5.2
4. Formaldehyde	6.3	4. Formaldehyde	4.6
5. Benzene	4.9	5. Benzene	4.5
6. Ethylene oxide	4.5	6. Ethylene oxide	3.2
7. **Respirable crystalline silica**	3.8	7. Artificial UV radiation	2.4
8. Artificial UV radiation	2.6	8. **Respirable crystalline silica**	1.8

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland.

In the Healthcare sub-sector, males also typically presented greater estimated prevalence of exposure to any cancer risk factor considered in WES than females (Appendix, Figure A2). The most frequent exposures differed somewhat by gender in this sub-sector, with the top-ranking exposures for men being ionising radiation (9.3%), diesel engine exhaust emissions (7.5%), solar UV radiation (6.6%) and formaldehyde (6.6%), and among females ionising radiation (7.6%), followed by formaldehyde (5.6%), ethylene oxide (3.8%) and benzene (3.2%).

3.5 Multiple exposures

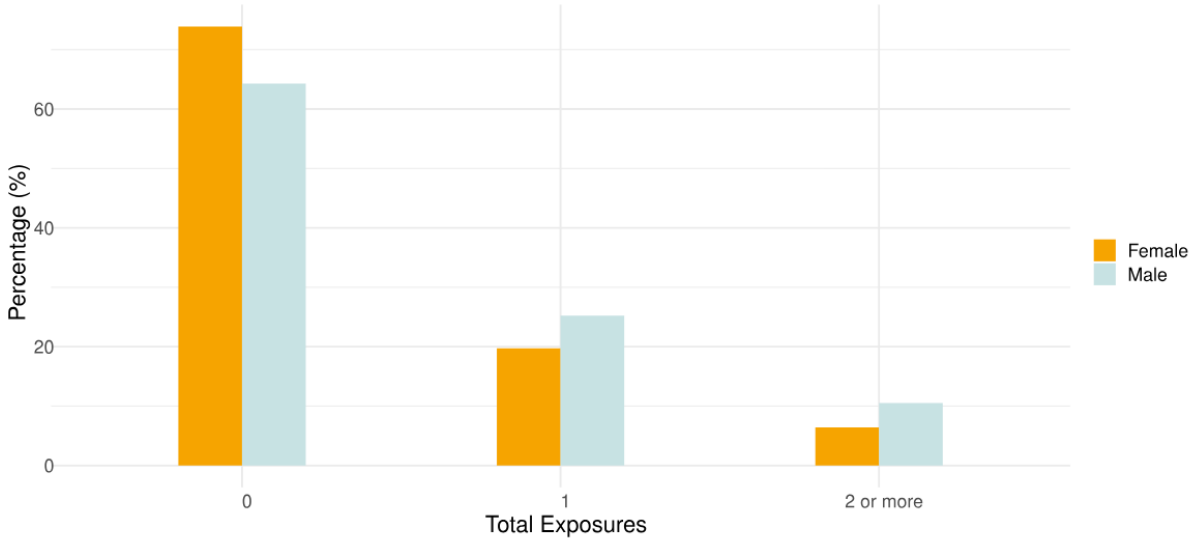

Photo by Denniz Futalan

WES also provides information on workers' probable exposure to more than one cancer risk factor during the same working week (reference interview period). Workers probably exposed to at least two cancer risk factors were considered as having multiple exposures, although exposures may not necessarily have occurred at the same time or through the same work process, and the combinations of multiple exposures vary.

In the HeSCare sector, 29.5% of respondents were exposed to at least one cancer risk factor during the last working week. Males were more often exposed to at least one cancer risk factor (34.3%) than females (24.3%). Regarding multiple exposures, 7.8% of workers in the sector were probably exposed to two or more cancer risk factors, with persistent gender differences (10.2% in males vs 5.8% in females) (Figure 9). On the contrary, a higher share of females in the HeSCare sector was assessed as unexposed to the cancer risk factors considered by WES when compared to males (75.7% vs 65.7%) (significant statistical *p-value<0.001*).

The most common combination of exposures occurring during the same working week in the HeSCare sector were diesel engine exhaust emissions and solar UV radiation, ethylene oxide and formaldehyde, and ionising radiation and artificial UV radiation. Diesel engine exhaust emissions and solar UV radiation was the most common combination of exposures among both males and females. Findings for the multiple exposures in the Healthcare sub-sector are available in Appendix, Figure A3.

Figure 9: Number of exposures to cancer risk factors included in WES in males and females in the HeSCare sector estimated in the same working week



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland.

3.6 Exposure circumstances to cancer risk factors and the use of control (prevention) measures at work

WES provides detailed information on the specific work circumstances by which workers likely became exposed to the cancer risk factors evaluated. When relevant, workers also replied to questions about whether they worked in closed or partially closed systems, the presence and type of ventilation in the workplace, or the use of personal protective equipment including respiratory equipment while working, among others. Questions were tailored to the job categories and specific work tasks, providing relevant information at the workplace level.

This section presents information on the underlying work-related exposure circumstances and the reported use of controls for the eight cancer risk factors assessed by WES in the HeSCare sector. Findings on levels of exposure (low, medium or high) or information on use of workplace controls (prevention measures) are only reported when there are at least 30 respondents per category.

3.6.1 Ionising radiation

Overall, a total of 7.4% of workers in the HeSCare sector were estimated to be exposed to ionising radiation, which is the most common exposure in WES in this sector.

Table 5 shows exposure circumstances to ionising radiation, ordered by estimated frequency of exposure at any level. Note that the same worker exposed to ionising radiation may have been involved in more than one of the tasks listed during the same working week. Table 5 further shows among those

exposed to ionising radiation the probable levels of exposure for each circumstance, as low, medium or high, as estimated with the OccIDEAS tool.

The two most prevalent circumstances of exposure to ionising radiation in the sector included working with or near machines that used X-rays for purely diagnostic purposes (55.9% of the workers exposed to that cancer risk factor) and working with radioisotopes or caring for patients who received radioisotopes (37.1% of the workers exposed to ionising radiation). In both cases, more than 60% of the exposed workers were estimated to have been exposed at a low level (75.4% and 62.6%, for each work circumstance, respectively). Estimated exposure to ionising radiation at a high level was found more often when administering radiotherapy (12.1%) and working with radioisotopes or caring for patients who received radioisotopes (10.1%). Circumstances of exposure to ionising radiation were similar for males and females (not shown).

Table 5: Circumstances of exposure to ionising radiation in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Working with or near machines that used X-rays for purely diagnostic purposes	55.9	75.4	21.5	3.1
Working with radioisotopes or caring for patients who received radioisotopes	37.1	62.6	27.3	10.1
Working with or near machines that used X-rays for interventional radiography	26.3	61.9	34.5	3.6
Administering radiotherapy, such as brachytherapy	17.5	50.4	37.5	12.1
Working with or near radiation-producing machines	8.7	-	-	-
Using X-rays for sterilisation	8.5	-	-	-

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to ionising radiation in Germany, Ireland, Spain, France, Hungary and Finland.
** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).*
Note: Examples of working with or near machines that used X-rays for purely diagnostic purposes include plain X-rays, mammography, general CT; working with or near machines that used X-rays for interventional radiography includes fluoroscopy, angioplasty; and working with or near radiation-producing machines includes X-ray machines and X-ray analysis apparatus.

For four of the circumstances of exposure to ionising radiation listed above, questions on the use of radio-protective shields or garments and the distance from the radiation source were asked to the workers (Table 6). The use of radio-protective shields was commonly reported among all these circumstances, ranging from 77.9% to 85.0%, as was the use of radio-protective garments, ranging from 67.0% to 87.4%. About 7.6% of respondents working with or near machines that used X-rays for purely diagnostic purposes reported standing at two metres or more from the radiation source when operating them, and this information was not asked in the other circumstances of exposure. The percentage of participants who reported wearing an individual dosimetry badge ranged from 31.4% for those working with or near machines that used X-rays for purely diagnostic purposes to 67.1% for those administering radiotherapy, such as brachytherapy.

Table 6: Protection measures reported regarding exposure circumstances to ionising radiation in the HeSCare sector (%)

Exposure circumstances	Use of radio-protective shields	Use of radio-protective garments	Working at two metres or more from the radiation source	None of the protection measures asked
Working with or near machines that used X-rays for purely diagnostic purposes	85.0	67.0	7.6	3.0
Working with radioisotopes or caring for patients who received radioisotopes	83.6	86.5	not asked	5.8
Working with or near machines that used X-rays for interventional radiography	84.6	87.4	not asked	1.5
Administering radiotherapy, such as brachytherapy	77.9	85.5	not asked	12.1

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to ionising radiation in Germany, Ireland, Spain, France, Hungary and Finland, and working in one or more of the circumstances listed.
Note: Examples of working with or near machines that used X-rays for purely diagnostic purposes include plain X-rays, mammography, general CT; working with or near machines that used X-rays for interventional radiography includes fluoroscopy, angioplasty; and working with or near radiation-producing machines includes X-ray machines and X-ray analysis apparatus. Examples of use of protective shields include lead or plexiglass shields, structural shields, shielding; and use of radio-protective garments includes lead aprons, gloves and thyroid guards.

3.6.2 Diesel engine exhaust emissions

A total of 6.2% of workers in the HeSCare sector were assessed as probably exposed to diesel engine exhaust emissions in their last working week. The primary exposure circumstance included driving, maintaining or travelling in diesel-powered vehicles (99.9%), mostly estimated at a low level of exposure (89.7%) (Table 7) and similar findings were observed for males and females (not shown). Performing any maintenance work on diesel-powered vehicles or driving a diesel-powered vehicle inside a building (as part of work) accounted for a small proportion of the exposed workers to diesel engine exhaust emissions in the sector (2.7% and 0.5%, respectively).

Table 7: Circumstances of exposure to diesel engine exhaust emissions in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Driving, maintaining or travelling in diesel-powered vehicles	99.9	89.7	9.0	1.3

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to diesel engine exhaust emissions in Germany, Ireland, Spain, France, Hungary and Finland.
** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).*

Information on the use of controls was not collected in WES for tasks associated with probable exposure to diesel engine exhaust emissions relevant in the sector.

3.6.3 Solar UV radiation

A total of 6.1% of workers in the HeSCare sector were probably exposed to solar UV radiation, considering any level of exposure. Ocular exposure to solar UV radiation was included in the exposure assessment.

The main circumstances for workers having a probable exposure to solar UV radiation (Table 8) were:

- working outside during the day in a vehicle with the windows down at least one hour per day;
- working outside during the day in the open;
- working with or near reflective surfaces; and
- working outside during the day under partial shade at least one hour per day.

Circumstances were similar for males and females (not shown). The most common circumstance of probable exposure to solar UV radiation at a high level (and also frequent at medium level) was working with or near UV reflective surfaces such as sand, glass, roofing iron or water, estimated in 6.1% of the exposed workers in the sector (Table 8). Working outside during the day, either under partial shade or in a vehicle with the windows down at least one hour per day, was frequently linked to low or medium exposure levels, depending on the reported use of protective measures (Table 9).

Table 8: Circumstances of exposure to solar UV radiation in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Working outside during the day in a vehicle with the windows down at least 1 hour/day	42.2	42.4	57.6	0.0
Working outside during the day in the open	39.4	6.7	88.4	4.9
Working with or near reflective surfaces	36.5	26.1	67.8	6.1
Working outside during the day under partial shade at least 1 hour/day	23.4	51.7	47.9	0.4

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to solar UV radiation in Germany, Ireland, Spain, France, Hungary and Finland.

** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).*

Note: Examples of working with or near reflective surfaces include sand, glass, roofing iron, water, concrete or cement, plastic and snow.

Among protection measures reported by the workers, wearing clothing that covered most of the body was reported by the majority of respondents, from 81.5% for those working under partial shade to 99.7% for those working outside in the open (Table 9). Wearing sunglasses was also common, particularly among those working outside during the day in a vehicle with open windows (48.3%) or those near reflective surfaces (41.4%). Wearing a hat or other head cover was reported by a moderate proportion of respondents working outside during the day under partial shade (32.5%) or in the open (25.4%). The use of sunscreen was less common, ranging from only 9.9% to 12.5% among those working outside, but the survey was conducted during the fall and winter months, which may have affected workers' frequency of use of sun protective measures.

Table 9: Protection measures reported regarding exposure circumstances to solar UV radiation in the HeSCare sector (%)

Exposure circumstances	Protection measures				
	Wearing sunglasses	Wearing clothing that covered most of your body	Wearing sunscreen	Wearing a hat or other sun protection head cover	None of the protection measures asked
Working outside during the day under partial shade at least 1 hour/day	24.6	81.5	12.5	32.5	8.4
Working outside during the day in the open	14.9	99.7	9.9	25.4	0.2
Working with or near reflective surfaces	41.4	not asked	not asked	not asked	58.6
Working outside during the day in a vehicle with the windows down at least 1 hour/day	48.3	93.5	12.5	not asked	6.2

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to solar UV radiation in Germany, Ireland, Spain, France, Hungary and Finland, and working in one or more of the circumstances listed.

Note: Examples of working with or near reflective surfaces include sand, glass, roofing iron, water, concrete or cement, plastic and snow. Example of wearing clothing that covered most of your body includes trousers and shirts or t-shirts with sleeves.

3.6.4 Formaldehyde

Overall, 5.2% of workers in the HeSCare sector were probably exposed to formaldehyde during the previous working week. The most common tasks included working in a gross anatomy laboratory (37.9%) and using formald ehyde or formalin for sterilisation (36.7%) (Table 10). The task with the greatest percentage of workers exposed at a high level was using formaldehyde or formalin for sterilisation (79.3%). In all these cases, estimated exposure at a high level was likely related to poor ventilation or little reported use of protective equipment by the workers during the performance of the tasks (Table 11).

Table 10: Circumstances of exposure to formaldehyde in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Working in a gross anatomy laboratory	37.9	34.3	53.7	12.0
Using formaldehyde or formalin for sterilisation	36.7	1.8	18.9	79.3
Handling formaldehyde, specimens preserved in formaldehyde solution (formalin) or waste containing formaldehyde	29.3	15.9	41.3	42.8
Using or coming in contact with formaldehyde during laboratory work tasks	9.9	-	-	-

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to formaldehyde in Germany, Ireland, Spain, France, Hungary and Finland.

** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).*

Note: Examples of working in a gross anatomy lab include doing dissections, washing biological tissues, filling containers with formalin in open workspaces and carrying out autopsies.

The presence of a general ventilation system and the use of a laboratory fume hood were commonly reported across different exposure circumstances to formaldehyde. The presence of local exhaust ventilation or on-tool extraction or the use of respiratory protective equipment was less frequently reported.

Table 11: Protection measures reported regarding exposure circumstances to formaldehyde in the HeSCare sector (%)

Exposure circumstances	Protection measures						
	Use of local exhaust ventilation or on-tool extraction	Use of a lab fume hood, a fume cupboard, a multiple slot hood, or a ventilated bench	Use of general ventilation system	Use of rubber face mask fitted with a particle/vapour filter or cartridge	Use of a powered air-purifying respirator (PAPR)	Use of an air-supplied respirator or self-contained breathing apparatus (SCBA)	None of the protection measures asked
Working in a gross anatomy lab	34.4	not asked	65.4	2.7	8.0	2.4	13.7
Using formaldehyde or formalin for sterilisation	19.7	not asked	65.0	3.1	13.2	0.0	18.8
Handling formaldehyde, specimens preserved in formaldehyde solution (formalin) or waste containing formaldehyde	not asked	63.0	not asked	5.5	5.2	18.2	27.3

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to formaldehyde in Germany, Ireland, Spain, France, Hungary and Finland, and working in one or more of the circumstances listed.
Note: Examples of working in a gross anatomy lab include doing dissections, washing biological tissues, filling containers with formalin in open workspaces and carrying out autopsies.

3.6.5 Benzene

Overall, 4.8% of HeSCare sector workers were assessed to be recently exposed to benzene, although occupational exposure was largely estimated to occur at a low level. The main work circumstance for the workers probably exposed to benzene was fuelling a vehicle with petrol (89.1%), followed by performing any maintenance work on petrol-fuelled vehicles, and using or coming in contact with benzene during laboratory work tasks (Table 12).

Table 12: Circumstances of exposure to benzene in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Fuelling a vehicle with petrol	89.1	98.0	0.0	2.0
Performing any maintenance work on petrol-fuelled vehicles	6.3	-	-	-
Using or coming in contact with benzene during laboratory work tasks	6.2	-	-	-
Driving a petrol-fuelled vehicle inside a building (as part of work)	1.9	-	-	-

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to benzene in Germany, Ireland, Spain, France, Hungary and Finland.
* Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).
Note: Performing any maintenance work on petrol-fuelled vehicles includes tune-ups, exhaust pipe work, or engine overhauls on petrol-fuelled vehicles, and/or draining fuel tanks or changing fuel filters on petrol-fuelled vehicles.

In WES, workplace preventive/protective measures in relation to benzene were asked for other circumstances than those present in the HeSCare sector (e.g. degreasing or fuel/petrol tank cleaning tasks).

3.6.6 Ethylene oxide

Altogether, 3.6% of HeSCare professionals were probably exposed to ethylene oxide during the last working week. Exposure circumstances to ethylene oxide were using ethylene oxide gas for sterilisation (66.6%), of which 82.9% were exposed at a high level, as well as handling or coming in contact with ethylene oxide during laboratory work tasks (16.9%) (Table 13).

Table 13: Circumstances of exposure to ethylene oxide in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Using ethylene oxide gas for sterilisation**	66.6	3.6	13.5	82.9
Handling or coming in contact with ethylene oxide during lab work tasks	16.9	-	-	-

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to ethylene oxide in Germany, Ireland, Spain, France, Hungary and Finland.
** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level).*
*** Using ethylene oxide gas for sterilisation in a solution or in an autoclave/sterilisation unit..*

The presence of a general ventilation system was reported by almost two-thirds of the HeSCare workers exposed to ethylene oxide when using ethylene oxide gas for sterilisation (63.1%) (Table 14). Local exhaust ventilation or on-tool extraction was less common when using ethylene oxide gas for sterilisation (31.6%), and the least common protection measure applied was respiratory protection. A total of 35.5% of exposed workers to ethylene oxide in the HeSCare sector reported not using any of the protection measures considered in the survey

Table 14: Protection measures reported regarding exposure circumstances to ethylene oxide in the HeSCare sector (%)

Exposure circumstances	Protection measures						
	Use of local exhaust ventilation or on-tool extraction	Use of general ventilation system	Use of rubber face mask fitted with a particle/vapour filter or cartridge	Use of a powered air-purifying respirator (PAPR)	Use of an air-supplied respirator or self-contained breathing apparatus (SCBA)	Specimens or waste in sealed containers when not in use	None of the protection measures asked
Using ethylene oxide gas for sterilisation	31.6	63.1	4.0	9.5	6.5	15.2	35.5

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to ethylene oxide in Germany, Ireland, Spain, France, Hungary and Finland, and working in one or more of the circumstances listed.

3.6.7 Respirable crystalline silica

A total of 2.5% of the workers in the HeSCare sector were probably exposed to respirable crystalline silica in the last working week. More than 75% of them were manufacturing crowns, false teeth or bridges in dentistry-related activities, with exposure reaching medium or high level in virtually all cases (Table 15).

Table 15: Circumstances of exposure to respirable crystalline silica in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Manufacturing crowns, false teeth or bridges	75.1	0.2	72.1	27.7
Driving in a construction site, a mine or a quarry	3.6	-	-	-

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to respirable crystalline silica in Germany, Ireland, Spain, France, Hungary and Finland.
** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).*

The availability or use of protection measures was only asked to those workers manufacturing crowns, false teeth or bridges, and included (following the hierarchy of control measures) working in an enclosed box or system (72.0%), the use of local exhaust ventilation or on-tool extraction (83.8%), and the use of a rubber face mask fitted with a particle/vapour filter or cartridge (2.8%) (Table 16). Only 4.1% of the workers involved in these highly technical tasks reported having used none of the protection measures asked in the survey.

Table 16: Protection measures reported regarding exposure circumstances to respirable crystalline silica in the HeSCare sector (%)

Exposure circumstance	Protection measures			
	Enclosed box or system	Use of local exhaust ventilation or on-tool extraction	Use of rubber face mask fitted with a particle/vapour filter or cartridge	None of the protection measures asked
Manufacturing crowns, false teeth or bridges	72.0	83.8	2.8	4.1

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to respirable crystalline silica in Germany, Ireland, Spain, France, Hungary and Finland, and working in one or more of the circumstances listed.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3.6.8 Artificial UV radiation

A total of 2.5% of the workers in the HeSCare sector were estimated to be exposed to artificial UV radiation in the last working week. The exposure circumstances to artificial UV included using UV light for sterilisation (62.8%) and administering UV treatment for skin or other conditions (31.7%) (Table 17).

Table 17: Circumstances of exposure to artificial UV radiation in the HeSCare sector (%)

Exposure circumstances	Share of exposed workers doing the task, at any level (%)	Low level* (%)	Medium level* (%)	High level* (%)
Using UV light for sterilisation	62.8	100	0.0	0.0
Administering UV treatment for skin or other conditions	31.7	-	-	-

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers exposed to artificial UV radiation in Germany, Ireland, Spain, France, Hungary and Finland.
** Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level for a given circumstance).*

Regarding protection measures for exposure to artificial UV radiation, questions were asked in WES only in relation to administration of UV radiation for medical treatments. These included whether UV radiation units were fully enclosed or contained behind glass and plexiglass screens and the use of safety goggles, glasses or another eye-protective garment. However, due to the limited number of respondents per category (fewer than 30), results are not presented.

4 Summary of findings and discussion

Among the 24,402 respondents from six EU Member States included in WES, 3,041 were working in the HeSCare sector (NACEQ), one of the largest economic activities in Europe. Two-thirds of HeSCare respondents were female (65.3%), and the majority were workers in the Healthcare sub-sector (or ISCO division NACEQ-86).

Overall, **29.5% of HeSCare workers** (including employees and self-employed) were assessed by WES as probably exposed to at least one cancer risk factor during the last working week, with exposures being more common among male workers, as previously observed for the entire WES sample (EU-OSHA, 2023a) and also in the earlier AWES and New Zealand carcinogens survey studies where male workers had higher prevalence and levels of exposure to all cancer risk factors included (Carey et al., 2014; WorkSafe New Zealand, 2023).

Further, 7.8% of workers in the HeSCare sector were exposed to two or more of the cancer risk factors evaluated in WES. The most prevalent cancer risk factors were ionising radiation (7.4%), diesel engine exhaust emissions (6.2%), solar UV radiation (6.1%), formaldehyde (5.2%) and benzene (4.8%), and the most common co-occurring exposures during the last working week were diesel engine exhaust emissions and solar UV radiation. Workers probably exposed to at least two cancer risk factors were considered as having multiple exposures, although exposures may not necessarily have occurred at the same time or through the same work tasks. According to our survey results, males typically presented a greater estimated prevalence of exposure to the cancer risk factors studied compared to females. This difference could be attributed to gender differences in specific occupations and tasks, as well as in the specific circumstances of exposure and control measures reported.

When looking at the results in the Healthcare sub-sector (the largest group within HeSCare), similar findings were observed: 7.4% of workers were exposed to two or more of the cancer risk factors and the most frequently assessed cancer risk factors were ionising radiation, formaldehyde, diesel engine exhaust emissions, ethylene oxide and solar UV radiation, and the most common co-occurring exposures during the last working week were diesel engine exhaust emissions and solar UV radiation.

These findings show that approximately one-third of workers in the HeSCare sector were probably exposed to one or several of the cancer risk factors studied in WES during the last working week. The overall number of exposed workers is lower in this sector than in the entire WES, covering almost all sectors of occupation (EU-OSHA, 2023a). This could well be explained by the selection of occupational cancer risk factors in WES, which may be more frequent in some sectors than others. Exposure assessment to cancer risk factors in the HeSCare sector needs to be interpreted in light of these predefined cancer risk factors, and it may well have led to an underestimation of the real cancer risks faced by workers in this sector. There are many other known carcinogens not covered by WES that are common to occupational settings in different jobs and tasks (Loomis et al., 2018). HeSCare workers in particular may be exposed to a range of hazardous medicinal products at work, many of which are known human carcinogens (Lindsley & Musu, 2022; NIOSH, 2024) and for which best practices for safe management in the workplace may often not be in place (European Commission, 2023).

WES uses the OccIDEAS tool to determine the workers' probable exposure to cancer risk factors (EU-OSHA, 2023b). A specific task-based approach is used by OccIDEAS, which integrates information reported by the respondents on the presence and use of control measures at work. The tool has been successfully applied in previous studies, and some adaptations to exposure assessment were introduced relevant to the EU work context and its legislative framework on chemicals.

However, there are also certain limitations to the approach. Firstly, exposure assessments were based on self-reports of tasks that could be affected by social desirability constraints (e.g. underreporting or overreporting some tasks or behaviours, for example, in relation to the use of protective measures), which may further lead to information bias. Also, the survey is cross-sectional (the last working week) and information regarding frequency and duration of tasks during that period was not captured, neither was information on the respondent's duration of the current job available, which would have allowed to further characterise exposure patterns to these cancer risk factors and estimate future occupational cancer burden. Finally, estimated exposure levels and the reported use of protection measures at work may have potentially been influenced by the season of the year in which the survey was conducted (in particular for some of the cancer risk factors studied, such as solar UV radiation). The appropriate use

of respiratory equipment or the correct maintenance of ventilation systems are key aspects of exposure control that have not been evaluated in WES.

The HeSCare sector is large and heterogeneous, and it includes an array of professionals ranging from nursing, caring roles like doctors, aides and emergency medical technicians in hospitals and alike, pharmacists, dentists, physiotherapists and laboratory workers to office/administration staff, managers, cleaners and others delivering essential services to society. Although in total more than 3,000 WES respondents were classified as HeSCare workers, there are sample size limitations to further investigate prevalence and levels of exposure to cancer risk factors at the sub-sector level (particularly in the Residential care and Social work sub-sectors) or at the level of the distinct occupations in the sector or by country.

The findings of WES contribute to raising awareness on the persistence of exposure to cancer-causing agents in the workplace, as identified in this report focusing on the HeSCare sector. Additionally, these results show that exposures may often occur in combination and indicate differences in exposure by gender. By providing information on current work practices in the sector and identifying the specific circumstances by which workers may have become exposed to the cancer risk factors, the results of this survey can inform the adoption of more task-specific preventive measures and policies.

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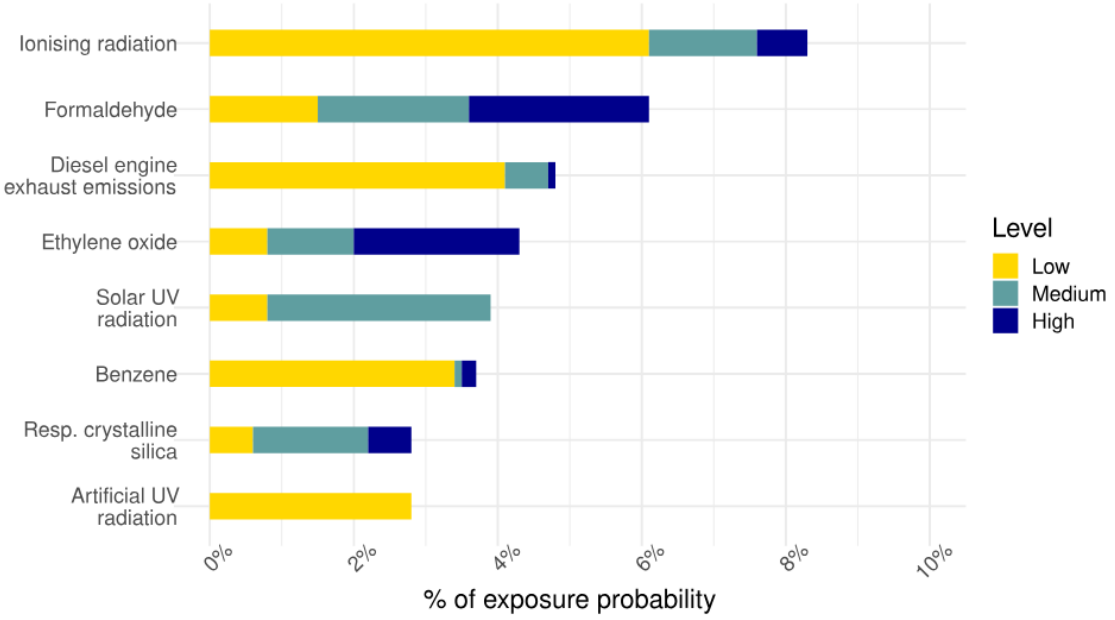
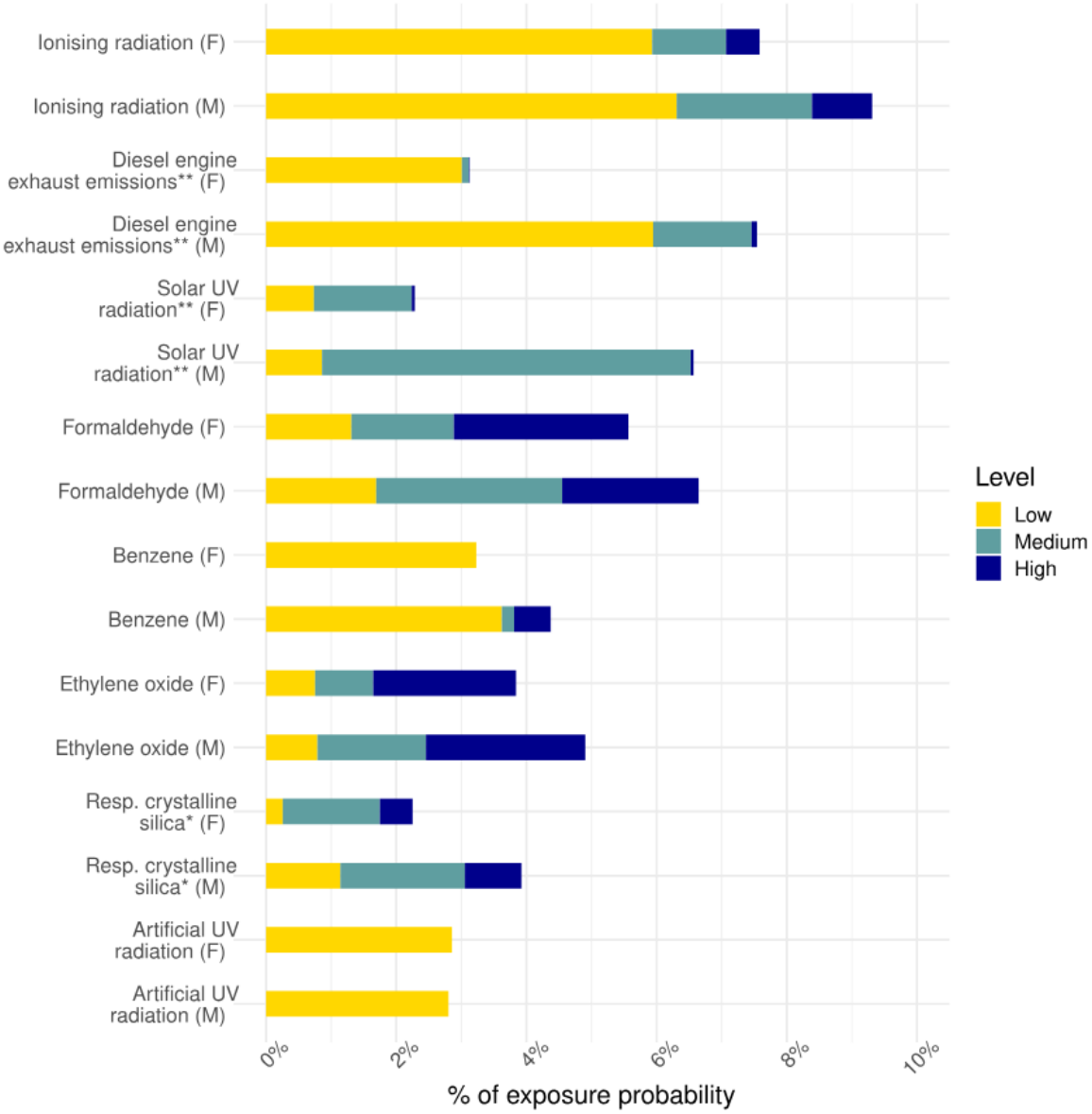
Appendix — Supplemental Figures and Tables

Figure A1: Proportion of exposed workers overall, and by exposure level in the Healthcare sub-sector



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: Healthcare workers in Germany, Ireland, Spain, France, Hungary and Finland

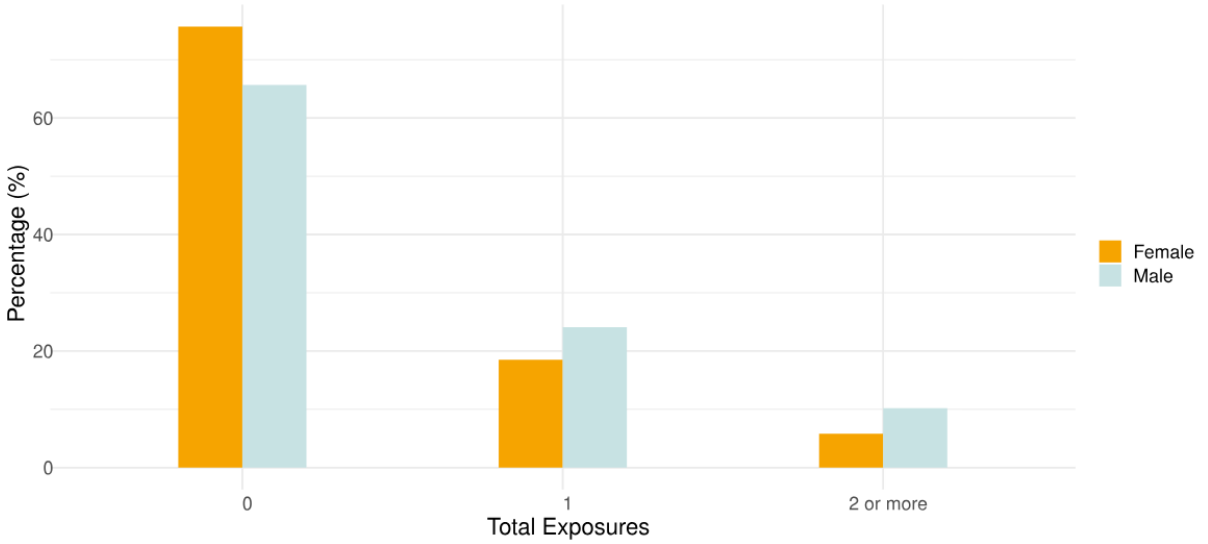
Figure A2: Proportion of exposed workers overall and by gender, by exposure level in the Healthcare sub-sector



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: Healthcare workers in Germany, Ireland, Spain, France, Hungary and Finland.

*Note: F = Female, M = Male. **p-value<0.01, *p-value<0.05.*

Figure A3: Estimated number of exposures to cancer risk factors in males and females in the Healthcare sub-sector



Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: Healthcare workers in Germany, Ireland, Spain, France, Hungary and Finland.

Table A1: Ranking of exposures to cancer risk factors by estimated frequency of exposure (at any level) in the HeSCare sector and in its sub-sectors

Cancer risk factor	HeSCare	Healthcare	Residential care	Social work
Ionising radiation	1	1		
Diesel engine exhaust emissions	2	3	2	3
Solar UV radiation	3	5	1	1
Formaldehyde	4	2		
Benzene	5	6		2
Ethylene oxide	6	4		
Respirable crystalline silica	7	7		
Artificial UV radiation	8	8		

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland.

Table A2: Proportion of exposed workers overall, and by exposure probability level, HeSCare sector and in its sub-sectors (%)

Cancer risk factor	Exposure at any level (%)	Low level# (%)	Medium level# (%)	High level# (%)
HeSCare sector				
Ionising radiation	7.4	69.0	23.6	7.5
Diesel engine exhaust emissions	6.2	89.7	9.0	1.3
Solar UV radiation	6.1	38.1	59.7	2.2
Formaldehyde	5.2	23.4	32.9	43.7
Benzene	4.8	94.4	1.2	4.4
Ethylene oxide	3.6	17.6	27.2	55.2
Respirable crystalline silica	2.5	22.4	56.7	21.0
Artificial UV radiation	2.5	100	0.0	0.0
Healthcare				
Ionising radiation	8.3	74.0	18.0	8.0
Formaldehyde	6.0	24.3	34.4	41.3
Diesel engine exhaust emissions	4.8	85.0	13.1	1.9
Ethylene oxide	4.2	18.1	27.9	54.0
Solar UV radiation	4.0	19.7	79.1	1.2
Benzene	3.7	92.4	1.9	5.7
Respirable crystalline silica	2.9	21.9	56.3	21.8
Artificial UV radiation	2.8	100	0.0	0.0
Residential care				
Solar UV radiation	14.7	63.5	34.4	2.1
Diesel engine exhaust emissions	9.1	99.6	0.4	0.0
Solar UV radiation	19.5	54.3	40.8	4.9

Cancer risk factor	Exposure at any level (%)	Low level# (%)	Medium level# (%)	High level# (%)
Benzene	19.3	97.1	0.0	2.9
Diesel engine exhaust emissions	18.0	97.2	2.4	0.4

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland.
Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level).

Table A3: Proportion of HeSCare workers probably exposed to the cancer risk factors included in WES by gender (% of all workers in the sector)

Cancer risk factor	Gender	Exposure at any level (%)	Low level# (%)	Medium level# (%)	High level# (%)
Ionising radiation**	Male	10.0	57.6	33.9	8.4
	Female	6.0	78.3	15.0	6.8
Diesel engine exhaust emissions**	Male	7.9	81.1	17.7	1.1
	Female	5.3	97.3	2.5	0.1
Solar UV radiation**	Male	7.9	24.7	74.0	1.2
	Female	5.2	49.2	47.8	3.0
Formaldehyde*	Male	6.3	24.7	41.8	33.4
	Female	4.6	22.4	26.8	50.8
Benzene	Male	4.9	84.5	3.5	12.0
	Female	4.5	99.5	0.0	0.5
Ethylene oxide	Male	4.5	16.1	34.0	49.9
	Female	3.2	18.6	22.4	59.0
Respirable crystalline silica**	Male	3.8	28.5	50.7	20.8
	Female	1.8	12.8	65.3	21.9
Artificial UV radiation	Male	2.6	100	0.0	0.0
	Female	2.4	100	0.0	0.0

Source: authors' own elaboration, based on WES 2023, EU-OSHA; reference population: HeSCare workers in Germany, Ireland, Spain, France, Hungary and Finland. # Levels of exposure (low, medium and high) add up to 100% (the total of workers exposed at any level). ***p-value*<0.01, **p-value*<0.05.

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