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Letter to the editor

In a recent paper (Schlünssen et al., 2023) published in your journal the authors present global estimates of prevalences and levels of occupational exposure to respirable crystalline silica (RCS), asbestos and coal dust, by industrial sector. This is part of an attempt to increase the rigour and transparency of data to be used for the global estimates of work-related burden of disease and injury being undertaken jointly by the World Health Organization (WHO) and the International Labour Organization (ILO) (Pega et al. 2022). This is an important initiative and developing reliable estimates of the health burden of occupational exposures is essential to demonstrate the scale of the problem and influence occupational health policies to reduce this burden. We realise that developing accurate estimates for occupational exposure prevalence and intensity is difficult. However, we believe the method adopted by the authors is flawed.

Schlünssen et al. (2023) developed their estimates of exposure prevalence based on a systematic review and meta-analyses of reported occupational measurement results for the three agents, published between 1960 and 2018. The authors describe their approach as follows: "We included all study types with objective dust or fibre measurements, that **directly** or **indirectly** reported an estimate of the prevalence and/or level of occupational exposure to RCS, asbestos and/or coal dust." However, the authors actually reached their prevalence estimates using the analytical detectability of the contaminant: "where possible we used the analytical limit of detection (LOD) as the cut-off between exposed and unexposed". Based on their methodology, Schlünssen et al. (2023) report pooled estimates of the prevalence of exposure to RCS of 89% in the construction industry, 85% in the manufacturing industry and 75% in the mining industry (all with moderate quality evidence). For coal dust, the pooled prevalence estimate was 100% in the mining industry (moderate quality evidence). For asbestos, a pooled estimate of 77% was reported in the construction sector (low quality evidence). We believe that these prevalence estimates are not representative of the actual exposure prevalence for people at risk of occupational disease in these sectors and that the use of these estimates will lead to biased estimates of the burden of work-related disease from these exposures.

We have two main concerns about the methodology used by Schlünssen et al. (2023):

1) Using results from measurement studies that are not representative for all workers within the broad sectors of industry for which prevalence is estimated will result in upwardly biased estimates of prevalence
2) Defining prevalence of exposure based on the Limit of Detection will at the same time result in **inaccurate and often** downwardly biased estimates of the workforce at risk.

1) Unrepresentative measurement data.

There are very few, if any, exposure measurement datasets that are representative of the population of workers in industries from which they were obtained and none that are representative of broad industry sectors considered by the authors.

The Manufacturing, Construction and Mining sectors are very diverse. For example, the manufacturing sector includes companies producing food products, transport vehicles, chemicals, plastic and rubber products, electronic equipment, furniture, and other products. The diversity is less in the construction and mining sectors, but is still substantial. Within these broad industrial sectors there are many companies with no or negligible exposure to RCS, asbestos or coal dust. It is highly unlikely that RCS, asbestos or coal dust measurements are carried out in workplaces where these exposures do not occur. Even in companies where exposure to these agents does occur, it is still very rare that representative measurement strategies are used for the entire workforce, including white-collar workers. Researchers and occupational hygienists often target sampling effort in job groups where exposures are higher (worst-case sampling) or where more exposure variability is expected and will hardly or not at all measure white collar, office workers. Workers in these unexposed jobs and companies are not included in the denominator of the prevalence estimates, and hence these will produce overestimates of the prevalence.

2) Use of Limit of Detection to determine prevalence.

Even if measurement results from truly representative surveys were available, then the use of the limit of detection to determine prevalence would lead to inaccurate prevalence estimates to assess disease burden. The percentage of measurement results that are below the limit of detection will be highly dependent on the sampling and analytical method. For instance, for RCS different analytical techniques (X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy) have different analytical limits of detection for RCS. The used sampling pump (low-volume, versus hi-volume pumps) and measurement duration (full-shift vs partial-shift vs task-based measurements) will together with the analytical limit of detection define the actual limit of detection. Detection limits have generally decreased over time as equipment and methods have improved.

Furthermore, daily occupational exposures vary dramatically (up to multiple orders of magnitude, see for instance measurement results of the IMA-Dust Monitoring Programme (Zilaout et al., 2020; Zilaout et al., 2023). This has been known for more than half a century and has been quantified for up to three decades ago in multiple reviews for inhalation exposures, dermal exposure and biomarkers (Kromhout et al., 1995; Kromhout and Vermeulen, 2001; Symanski and Greeson, 2002; Symanski et al., 2006). So, a measurement on any given day on a specific worker might result in a concentration below the limit of detection, but

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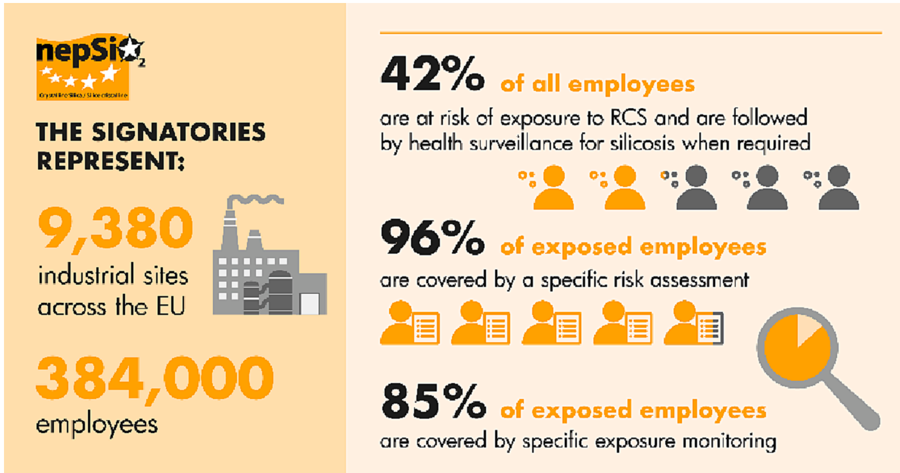

Fig. 1. 2022 Key Performance Indicators for the signatories of the European Network for Silica (NEPSI), the European multi-sectoral social dialogue agreement aimed to minimise worker exposure to RCS. (https://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=10405&furtherNews=yes).

could be above the occupational exposure limit the next day, hence potentially underestimating the prevalence.

When using prevalence data to estimate disease burden, for example as Rushton et al. (2010) did for occupational cancer burden in Britain, it is important that prevalence data are relevant to the estimate of relative risk for the group. This requires that the assessment of prevalence should be based on the long-term average exposure over many years rather than from daily measurement data and that the relative risk estimate chosen for the burden calculations is consistent with the prevalence data.

Alternative approaches

Alternative approaches to estimate prevalence data have been around for decades. For example, at the end of the previous century Kauppinen et al. (2000) developed the database CAREX (Carcinogen Exposure) that provided estimates of prevalence of exposure to carcinogens for workers in Europe based on a Finnish registry of workers exposed to carcinogens (ASA) (Kauppinen et al., 1990) and workplace surveys in the US (Seta et al., 1989, Sieber 1990, Pedersen and Sieber 1990) in combination with labour force data. Similar databases are available for Canada and Latin America.

Another more recent approach concerning prevalence figures for RCS exposure comes from 19 industrial sectors in Europe within the European Network for Silica (NEPSI), a European multi-sectoral social dialogue agreement aimed to minimise worker exposure to RCS signed by employer and employee organisations. In their most recent biennial report (2022) on key performance indicators (see Fig. 1) compiled by bottom-up reporting by individual companies, it is shown that of 384,000 employees at 9,380 sites 42% are exposed to RCS, a prevalence estimate much lower than reported by Schlünssen et al. (2023).

We realise that the NEPSI initiative is relatively unique, and similar data may not be readily available for other sectors and in other parts of the world. However, other approaches are available. For example, EU-OSHA has recently carried out a large survey in several countries in the EU to estimate the prevalence of exposure to carcinogens, using a method developed for the Australian Work Exposures Study (AWES) by Carey et al. (2014). Results of the European survey are expected to be reported in 2023 or 2024. (https://osha.europa.eu/en/facts-and-figures/workers-exposure-survey-cancer-risk-factors-europe). Prevalence data from such surveys will not be perfect as they are based on self-report by workers and self-employed and because they are only relevant for the current situation in the industry. However, we consider such information likely to be more informative for exposure prevalence estimates for health burden estimation, than that from the published literature based on the percentage of measurements > LoD.

Also, quantitative job exposure matrices are available with historical estimates of exposure (e.g. Peters et al. 2016), which can be linked to national census or survey data (e.g. the EU labour force survey) to obtain prevalence and intensity estimates. Cherrie et al. (2017) successfully used a combination of such tools, linked with census and survey data, as well as data collected directly from trade associations, to obtain EU-wide estimates of prevalence of exposure in their evaluation of proposed changes to the EU Carcinogens and Mutagens Directive. These alternative approaches are likely more representative of long-term average exposure.

Interestingly, we note that for the paper by Teixeira et al. (2021), which has a very similar purpose to the Schlünssen et al. paper, but focussing on exposure to noise, the authors decided to use data obtained from representative surveys in Europe (European Working Conditions Survey) and the U.S. (National Health and Nutrition Examination Survey – NHANES and the National Health Interview Survey – NHIS). The estimated prevalence of exposure to noise (>85 dB(A)) of 17% for the general working population appears to be much more realistic than the exposure prevalence data presented in the paper by Schlünssen et al. (2023) for RCS, asbestos and coal dust.

In conclusion, in our opinion, the use of the exposure prevalence data reported by Schlünssen et al. (2023) based on measurement data and the use of the limit of detection to determine prevalence will result in inaccurate estimates of the burden of disease. In order to arrive at more accurate and convincing estimates of the burden of work-related ill-health, approaches like CAREX, AWES, EU carcinogens survey, SYNJEM or the ILO/WHO approach for noise are required to provide valid estimates of prevalence and intensity of exposures.

Declaration of Competing Interest

HK participated in 2019-2021 in a project commissioned by NEPSI and financed by the European Union to develop a NEPSI standardized RCS measurement methodology, which would enable the NEPSI partners to collect RCS exposure data in a harmonised way.

Data availability

No data was used for the research described in the article.

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