International Journal of Hygiene and Environmental Health 220 (2017) 810–819

Contents lists available at ScienceDirect

International Journal of Hygiene and Environmental Health

journal homepage: www.elsevier.com/locate/ijheh

15 years of monitoring occupational exposure to respirable dust and quartz within the European industrial minerals sector

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ARTICLE INFO

Article history:
Received 6 December 2016
Received in revised form 24 March 2017
Accepted 25 March 2017

Keywords:
Occupational exposure
Respirable dust
Respirable quartz
Prospective monitoring
Exposure database
Industrial minerals

ABSTRACT

Introduction: In 2000, a prospective Dust Monitoring Program (DMP) was started in which measurements of worker's exposure to respirable dust and quartz are collected in member companies from the European Industrial Minerals Association (IMA-Europe). After 15 years, the resulting IMA-DMP database allows a detailed overview of exposure levels of respirable dust and quartz over time within this industrial sector. Our aim is to describe the IMA-DMP and the current state of the corresponding database which due to continuation of the IMA-DMP is still growing. The future use of the database will also be highlighted including its utility for the industrial minerals producing sector.

Methods: Exposure data are being obtained following a common protocol including a standardized sampling strategy, standardized sampling and analytical methods and a data management system. Following strict quality control procedures, exposure data are consequently added to a central database. The data comprises personal exposure measurements including auxiliary information on work and other conditions during sampling.

Results: Currently, the IMA-DMP database consists of almost 28,000 personal measurements which have been performed from 2000 until 2015 representing 29 half-yearly sampling campaigns. The exposure data have been collected from 160 different worksites owned by 35 industrial mineral companies and comes from 23 European countries and approximately 5000 workers.

Conclusion: The IMA-DMP database provides the European minerals sector with reliable data regarding worker personal exposures to respirable dust and quartz. The database can be used as a powerful tool to address outstanding scientific issues on long-term exposure trends and exposure variability, and importantly, as a surveillance tool to evaluate exposure control measures. The database will be valuable for future epidemiological studies on respiratory health effects and will allow for estimation of quantitative exposure response relationships.

1. Introduction

Occupational exposure databases are valuable instruments in the field of occupational hygiene (Kromhout et al., 1993; Kauppinen, 2000; Flanagan et al., 2006). Data derived from industry-wide occupational databases could in potential provide highly reliable and accurate information regarding workers' exposures and workplace exposure conditions. Numerous industry-specific exposure databases have been developed during the last two decades, for instance, PAPDEM for the paper and pulp industry (Kauppinen et al., 1997), AWE for the asphalt industry (Burstyn et al., 2000a,b) and EXASRUB for the rubber manufacturing industry (De Vocht et al., 2005).

Numerous mineral extraction and processing activities generate respirable dust in which crystalline silica dust is often an important constituent (Brown and Rushton, 2005). Silica occurs naturally in a crystalline or amorphous form and is one of the most common and abundant minerals largely present in the Earth's crust (Rees and Murray, 2007). Within a large variety of mineral industries exposure to respirable crystalline silica (RCS) can occur in almost all stages of the production processes (Kachuri et al., 2014). Epidemiological studies have found that occupational exposure to silica dust is significantly associated with adverse health effects as silicosis (Wilson et al., 2002), chronic obstructive pulmonary disease

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http://dx.doi.org/10.1016/j.ijheh.2017.03.010
1438-4639/

(COPD) (Rees and Murray, 2007) and lung cancer (Steenland et al., 2001).

In 1987, 1997 and 2011 the International Agency for Research on Cancer (IARC) reviewed the carcinogenicity of crystalline silica, inhaled in the form of quartz from occupational sources. In 1997 IARC changed its classification of crystalline silica from probably carcinogenic to humans (group 2A), mainly based on animal experiments, to carcinogenic to humans (group 1) mainly based on additional evidence from human observational studies. IARC upheld this classification in the most recent evaluation in 2011 (IARC, 1987; Wilbourn et al., 1997; Guha et al., 2011).

Minerals which are not chemically modified but occur naturally (e.g. crystalline silica) are excluded from REACH registration despite the unequivocally well-known occupational risks of RCS (Friede and Wyart-Remy, 2013).

In 2000, the European Industrial Minerals Association (IMA-Europe) representing the European producers of andalusite, bentonite, borates, calcium carbonate, cristobalite, diatomite, dolomite, feldspar, kaolin, kaolinitic clays, lime, mica, quartz, sepiolite, talc, vermiculite and wollastonite – i.e. around 500 mineral companies or groups operating more than 700 mines and quarries and 750 plants throughout Europe, recognized the vital need to monitor occupational respirable dust and quartz exposures and initiated a prospective Dust Monitoring Program (DMP). Since 2006, the resulting IMA-DMP database is hosted by the Institute for Risk Assessment Sciences (IRAS) of Utrecht University, The Netherlands, in collaboration with The Netherlands Expertise Center for Occupational Respiratory Disorders (NECORD).

Participation in the IMA-DMP is open to all IMA-Europe member companies any time. In recent years, acknowledging the value of the IMA-DMP for the sector and their own company, several new members have started to participate in the project. At the time of the launch of the Program, a training workshop was organized to attract participants, and such meetings dedicated to the IMA-DMP have been organized every two years since and are open to all IMA member companies.

In 2006, 15 European industry sectors (the European Federations of producers of Glass Fibre, Precast Concrete, Foundry, Cement, Ceramics, Mortar, Mines, Natural Stones, Insulation Mineral Wool, Expanded Clay, Container Glass, Flat Glass, Calcium Silicate, Industrial Minerals (IMA-Europe) and Aggregates, and their European trade union (industriALL) with the notable exception of the construction industry) in which exposure to respirable silica is likely, signed a so-called tripartite Social Dialogue Agreement (SDA) with the aim of protecting their workers from health risks resulting from exposure to RCS. As part of this SDA they agreed on appropriate and credible measures for the improvement of working conditions, written down in a NEPSI good practice guide. NEPSI is the acronym for the resulting European Network for Silica formed by the employee and employer sectoral associations, which signed the Agreement on 25 April 2006 (NEPSI-EU, 2006). Besides providing information, instruction and training to the workforce, personal dust exposure monitoring is seen as one of the essential tools of the SDA.

The IMA-DMP aimed to collect representative occupational exposure data from a wide variety of workplaces to determine existing exposure levels and to monitor exposure trends over time. In addition, the DMP allows companies to check compliance with national occupational exposure limits, to have a complete picture of existing exposure levels at their sites, to identify situations requiring further investigation or implementation of additional control measures to reduce workers' exposure, and monitor effectiveness of implemented dust control measures. Moreover, this initiative is also intended to put the mineral industries in a better position to discuss with regulatory authorities on setting future occupational exposure limits.

The aim of this paper is 1) to describe the details of the IMA-DMP and the content of the resulting IMA-DMP database, 2) to illustrate the process of elaborating and maintaining such an industry-wide occupational exposure database, 3) to discuss its current state, its utility and the future of the IMA-DMP.

2. Methods

2.1. IMA-DMP protocol and sampling strategy

At the start of the IMA-DMP project in 2000 a standardized protocol was developed and submitted to each of the participating companies. This sampling protocol included all requirements related to how measurements should be performed in order to quantitatively determine exposure levels for standardized jobs present at the sites of participating companies. The protocol described strict criteria for the sampling strategy, the jobs classification and nomenclature, sampling procedure, number of measurements, duration of measurements, campaigns and which sampling equipment and analytical methods had to be used. Participating companies were supposed to follow this protocol with strict quality criteria (Lesley and Danielle, 1997) to yield representative and reliable information on respirable dust and quartz exposure levels of their workers. For inclusion in the resulting IMA-DMP database the measurements data had to fulfill the minimum requirements for the following items: 1) sampling of pre-defined exposure groups, 2) personal sampling, 3) availability of a unique worker code and 4) sampling duration.

Re (1): The IMA-DMP industry-specific standardized nomenclature for jobs was created based on an industry-specific generic job classification. The sampled population was selected according to the entire company workforce subdivided into standardized exposure groups corresponding to executed tasks and activities of the workers. Hence, standardized exposure groups were defined according to standardized jobs (Appendix, Supplementary data). The standardized job was used as a sampling unit and was defined as the set of activities carried out by a worker during his daily working time.

Re (2): The IMA-DMP database considered exclusively personal measurements which were representative of the exposure a worker received during a single shift. All sampling was undertaken during regular working conditions.

Re (3): Individual workers were coded with a unique worker code in order to distinguish between measurements performed on different individuals and by doing so allowing estimation of variability in exposure concentrations between workers and from day-to-day within workers. Most companies consisted of production facilities located at multiple sites, sometimes in more than one country. Complementary information concerning number of employed workers and type of minerals mined or used in their production processes was collected in the beginning and when new companies and sites entered the DMP.

Re (4): The IMA-DMP protocol requires personal samples to be collected during a full working shift which is defined as between 7 and 8 h. However, in the database measurements with a duration between 4 and 10 h were accepted as personal measurements representative for an 8-h shift. It should be noted that each 8-h TWA concentration of respirable dusts and respirable quartz in the IMA-DMP database, is estimated on the basis of the actual sampling duration during the measurement (as long as the sampling duration was within 4–10 h).

In addition, per campaign a minimum of six dust samples per standardized job per site is collected. All sampling equipment has been in conformity with the European standard EN 481 (NEN-EN 481, 1993) and the applied sampling devices were able to mea-