Metal working fluid exposure and diseases in Switzerland

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Background: Exposure to metal working fluids (MWF) is common in machining processes worldwide and may lead to diseases of the skin and the respiratory tract.

Objective: The aim of the study was to investigate exposure and diseases due to MWF in Switzerland between 2004 and 2013.

Methods: We performed descriptive statistics including determination of median and 90th percentile values of MWF concentrations listed in a database of Suva. Moreover, we clustered MWF-induced occupational diseases listed in a database from the Swiss Central Office for Statistics in Accident Insurance, and performed linear regression over time to investigate temporal course of the illnesses.

Results: The 90th percentile for MWF air concentration was 8.1 mg (aerosol + vapor)/m³ and 0.9 mg aerosol/m³ (inhalable fraction). One thousand two hundred and eighty skin diseases and 96 respiratory diseases were observed.

Conclusions: This is the first investigation describing exposure to and diseases due to MWF in Switzerland over a timeframe of 10 years. In general, working conditions in the companies of this investigation were acceptable. Most measured MWF concentrations were below both the Swiss and most international occupational exposure limits of 2014. The percentage of workers declared unfit for work was 17% compared to the average of other occupational diseases (12%).

Keywords: Metal working fluids, Occupational disease, Occupational exposure limit, Respiratory disease, Skin disease, Suva, Switzerland

Introduction

Metal working fluids (MWF) serve as coolants and lubricants in diverse types of machining processes like turning, grinding, cutting, or milling. Moreover, they help to remove fines or chips produced during the working process.^{1–3} Contamination occurs through contact with MWF and inhalation of aerosols or vapor of MWF. Exposed workers are often employed as machinists in metal industries including the production of machinery, engines, watches, micromechanics, automobiles, aircrafts, farm equipment, etc. The Swiss National Accident Insurance Fund (Suva) estimates that about 150,000 workers in Switzerland are currently occupationally exposed to MWF per year (unpublished).

MWF are heterogeneous, often consisting of oil (mineral, natural, or synthetic) and additives such as biocides, antifoaming agents, anticorrosive agents, etc.¹ During usage, secondary substances or microbes may appear in the MWF (e.g. nitrosamines, polycyclic aromatic hydrocarbons, metal particles, or organic solvents). Since the

risk of colonization with microbes is especially high in water-soluble MWF, which have largely replaced straight mineral oils,^{1,4} the use of biocides is indispensable. MWF are known to cause diseases mainly of the skin and to a much lesser extent the respiratory tract.^{5–7} The most common illness of the skin is irritant dermatitis, followed by allergic dermatitis, which occur mainly through contact with water-containing MWF.^{1,7–9} More rarely, oil acne, folliculitis and squamous cancer may result in individuals who have contact with straight oils.^{1,9} Respiratory conditions like cough, rhinitis, pharyngitis, bronchitis, and asthma are less common. Extrinsic allergic alveolitis (EAA, hypersensitivity pneumonitis) may occur with the use of modern water-containing MWF that can be colonized with microbes.¹⁰

We analyzed recent data on exposure to MWF and diseases caused by MWF in Switzerland. These data are available in the databases of Suva and the Central Office for Statistics in Accident Insurance (SSUV). Our analysis of these databases provides an estimation of exposure to MWF and the consequent occupational diseases. It is the first investigation of exposure to and occupational diseases due to MWF in Switzerland between 2004 and

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2013. Moreover, it is one of few published studies where both the MWF aerosol concentration and the MWF sum concentration (consisting of the sum of aerosol and vapor) is investigated.

Materials and methods

Measurement of MWF air concentration

Information on MWF air measurements is available in Suva's databases because Suva supervises the application of measures for the prevention of occupational diseases in all companies in Switzerland. In the case of plants using MWF, Suva may perform control measurements of MWF air concentration and order any required measures to lower the air concentration if necessary. Measurements are performed at all industries where exposure to MWF may occur. The laboratory performs reliable and consistent sampling and analysis and is certified according to SN EN ISO/IEC 17015:2005, STS 0136. The applied sampling method for MWF was described by the Institut für Arbeitsschutz,¹¹ in St. Augustin, Germany, and further developed by Suva. The method consists of two connected sampling steps. All inhalable airborne aerosols (particles and droplets) are collected according to SN/EN 481 (inhalable fraction) on glass fiber filters, followed by a Tenax adsorption tube for the volatile and semi-volatile components. Both the volatile and non-volatile components are captured with this sampling technique. The MWF components with a flashpoint >100 °C are then quantified by Infrared spectroscopy (methyl and methylene bands) by integrating the absorption peaks between wave numbers 3050 and 2750 cm⁻¹. The calibration is performed with the pure MWF used during sampling. Desorption is performed with perchloroethylene (C₂Cl₄). When solvents are found on the Tenax extract, an evaporation step is carried out before IR analysis to remove the solvents. The desorption of the filter (aerosols) and the Tenax-phase (vapors) were performed separately (up to 2010) or together (after 2010).

Analysis of air concentration measurements

Suva's occupational hygienists examine the companies' measures for preventing occupational diseases such as adherence to the official exposure limits by measuring air concentrations of potentially harmful substances or correct use of personal protective equipment. Air concentration measurements are listed in an internal Suva database. Between 2004 and 2010, both the aerosol and vapor concentrations had been measured (487 single measurements in 49 companies). Since 2010, only the sum concentration (i.e. the sum of the aerosol and vapor concentrations) was recorded (185 single measurements in 16 companies).

In this investigation, we determined median and 90th percentile values both of the aerosol concentration and the sum concentration of aerosol + vapor. The results were compared with the Swiss threshold values for MWF at that

time, which were 0.2 mg/m³ (inhalable fraction) for the MWF aerosol concentration and 20 mg/m³ for the MWF sum concentration. We also performed a linear regression through the annual median sum concentrations to determine the change of the MWF sum concentration over time.

Analysis of occupational diseases

Occupational physicians employed by private insurance companies or Suva review suspected cases of occupational diseases. Since Suva has not defined rules for conducting diagnostic investigations, each individual physician is tasked with choosing the most appropriate diagnostic tools for individual cases. The acknowledged cases of all insurance companies are encoded and registered in a database of the Central Office for Statistics in Accident Insurance (SSUV). We grouped the MWF-induced diseases between 2004 and 2013 into skin diseases (with subgroup "contact dermatitis" and subgroup "other skin diseases"), respiratory diseases (with subgroups "upper airways diseases," "lower airways diseases," "asthma," "exogenous allergic alveolitis," "other respiratory diseases") and other diseases. We then distinguished between allergic and non-allergic skin and respiratory diseases. We moreover determined the total number of respiratory and skin diseases per year and performed a linear regression over time. In some cases, the occupational physician encoded a secondary diagnosis. Therefore, we also determined the number of secondary skin and respiratory diagnoses.

The suspected causative MWF can be encoded either as mineral oil, synthetic fluid, or MWF additive. Because it is not always possible to determine a single MWF or additive as the causative agent of the disease with certainty, we did not differentiate between these three possible codes but treated them as one code. Where several compounds are, or might be, involved in the disease, more than one substance code can be recorded. The substance codes are ranked in the order of probability to cause the disease. For this study, we took into account all cases where MWF occurred, even if they were not ranked first in the list. In our analysis, we grouped the diagnoses into skin diseases, respiratory diseases, and other diseases. Further subgrouping is explained in the results section. The relevant time point for analysis was the date of acknowledgment of the illness as an occupational disease.

Suva issues declarations of unfitness (NEV, German: "Nichteignungsverfügung") for workers whose health could be greatly harmed if he or she were to continue working. We calculated the percentage of workers declared unfit for work due to MWF-related occupational diseases in relation to all MWF-induced occupational diseases between 2008 and 2013 because the declarations have been recorded in a Suva database only since 2008. This percentage was compared with the percentage of all workers declared unfit for work due to an occupational disease between 2008 and 2013.

Table 1 Medians and 90th percentiles for the MWF sum concentrations (between 2004 and 2013) and the aerosol concentrations (between 2004 and 2010)

	Sum concentration (<i>n</i> = 672) (mg/m ³)	Aerosol concentration ^a (<i>n</i> = 487) (mg/m ³)
Median	1.8 (IQR 0.7–3.7)	0.2 (IQR 0.1–0.4)
90th percentile	8.1	0.9

^aInhalable fraction.

Statistical analysis

Measurements were treated as independent data, although there were several measurements per visit. However, plant measurements are typically taken in different rooms or in different places and the number of measurements per visit varies. Therefore, the treatment of each measurement independently and with no distinction between personal and stationary measurement is justified to produce a rough estimation of the situation in the production sites. This methodology has been used previously.¹² When the air concentrations were below the detection limit, we took the detection limit as lowest value. We report the median and the 90th percentile values of the air concentrations. We used linear regression to determine trends over time.

Results

Exposure data

A total of 672 measurements during 65 plant visits were recorded between 2004 and 2013 (Table 1). The median sum concentration was 1.8 mg/m³ (IQR 0.7–3.7) and the 90th percentile for the sum concentrations was 8.1 mg/m³ (the mean sum concentration would be 3.0 mg/m³). The distribution of the measured sum concentration was log-normal in good approximation. Linear regression indicated that the log-transformed concentrations were significantly dependent on time ($P < 0.001$), the annual decrease in concentration was 7.3% of the concentration of the preceding year (Fig. 1).

Data on separate aerosol concentrations are available up to the year 2010; after 2010, the aerosols on the filter and the vapor on the resin were desorbed together and only the sum concentrations were determined. We identified 49 plant visits between 2004 and 2010 for which the measurements of aerosol concentrations could be used for this study (487 measurements). The median aerosol concentration and its 90th percentile were 0.2 mg aerosol/m³ (inhalable fraction; IQR 0.1–0.4) and 0.9 mg aerosol/m³ (inhalable fraction) respectively (the mean would be 0.5 mg aerosol/m³) (Table 1). The vapor rates per plant were between 26% and 100% (mean vapor concentration / mean sum concentration). The median over all measurements was 92% (IQR 77–98%). Figure 2 shows the rates in relation to the time between measurement in the plant and analysis in the laboratory. There was no clear decrease over time (linear regression with $R = 0.11$).

Occupational diseases

Between 2004 and 2013, 1,280 (92%) skin diseases, 96 (7%) respiratory diseases, and nine other diseases (five eye conditions, two headaches, one ear condition, one other disease) were acknowledged as occupational illnesses caused by MWF (Table 2). The diagnosis was contact dermatitis in 99% of the skin diseases. The number of skin diseases diminished over time, from 157 in 2004 to 97 in 2013 (maximum in 2008 with 185 skin diseases, minimum in 2009 with 95 diseases), the average decrease was seven illnesses per year (linear regression of $R = 0.67$; Fig. 3);

Figure 1 MWF sum concentrations per plant visit.

Figure 2 Vapour rates (mean vapour concentration / mean sum concentration) of each visit as a function of the time between measurement in the plant and analysis in the laboratory.

Table 2 Occupational diseases between 2004 and 2013

	Total
All diseases	1385 (100%)
Skin	1280 (92%)
Contact dermatitis	1261
Other skin diseases	19
Airways	96 (7%)
Upper airways	34
Lower airways	15
Asthma	31
EAA	4
Other respiratory diseases	12
Other diseases	9 (0.7%)

Notes: Diseases of the upper airways are rhinitis and pharyngitis. Diseases of the lower airways are laryngitis, tracheitis, bronchitis, and bronchiolitis. EAA, extrinsic allergic alveolitis.

respiratory diseases remained more or less constant with an average of nine cases per year (linear regression of $R = 0.09$). 64% (= 825/1280) and 85% (= 82/96) of all skin and respiratory diseases, respectively, were encoded as non-allergic, although this finding should be interpreted with caution (see discussion section).

Secondary diagnoses were recorded for 221 (16%) cases. For 192 cases with a skin disease, additional diagnoses were encoded (15%). Of these, 158 were skin conditions and 12 were airway diseases. Comorbidities were encoded for 29 cases with a respiratory disease (31%). 18 of these were respiratory diseases and six were skin diseases. Crosswise comorbidities between skin and respiratory illnesses were seen in 1% of the skin disease cases and in 6% of the respiratory disease cases.

We also analyzed the NEVs for the last six years, i.e. from 2008 to 2013 (before 2008 the data were not available in the database). During this time period there were 1891 NEVs in total, with a median of 312 NEVs per year (IQR 310–327). This corresponds to 12% of all occupational diseases during this period ($n = 16075$). One hundred and

thirty workers were issued with an NEV due to MWF during this period, corresponding to 17% of all 775 MWF-induced occupational diseases between 2008 and 2013. One hundred and thirteen of these NEVs were due to skin diseases, 15 due to respiratory diseases, three due to skin diseases and respiratory diseases, one due to eye disease, and one due to ear disease. The database does not distinguish between allergic and non-allergic diseases. Two-and-a-half workers per year (median; IQR 2–4.5) were issued with an NEV due to respiratory diseases related to MWF. The median number of occupational respiratory diseases in general was 393 per year during this period (IQR 371–414). The relative risk of being issued with an NEV when suffering from an MWF-induced respiratory disease was 29%, nearly twice as high as when suffering from an MWF-induced skin disease (16%).

Discussion

We analyzed MWF exposure and occupational diseases caused by MWF in Switzerland over a 10-year period using the databases of Suva and SSUV. The results for the measured MWF sum concentrations (i.e. sum of aerosol and vapor concentrations) were compared with the Swiss occupational exposure limits (OELs). At the time of this study, there were two threshold values in Switzerland: one OEL related to pure mineral oils without additives: 0.2 mg/m³ (inhalable fraction); the other OEL related to MWF (not further specified) including additives: 20 mg/m³ for the MWF sum concentration.¹³ As mineral oils without any additives are rarely utilized in metal processing in Switzerland, the OEL for pure mineral oils is rarely used in this context.

Analysis of exposure situation

Between 2004 and 2013, 672 measurements were recorded. The majority of measured MWF air concentrations were

Figure 3 Occupational skin and respiratory diseases caused by MWF over time.

Notes: Skin diseases are shown in continuous lines and respiratory diseases in dotted lines.

far below the OEL of the sum concentration: the median was 1.8 mg/m^3 and the 90th percentile was 8.1 mg/m^3 . It is difficult to compare these values internationally because nearly all other countries' OELs relate to the MWF aerosol concentration, whereas in Switzerland the MWF sum concentration was used (Table 3). The Swiss threshold value for the sum concentration was based on a former technical reference concentration ("Technische Richtkonzentration," TRK) in Germany.¹⁴ One of the few studies where also the sum concentrations were determined is a German investigation with nearly 7000 measurements in 1534 plants between 2000 and 2005.¹² The median sum concentration in this study was 4.7 mg/m^3 and the 90th percentile was 17.1 mg/m^3 (the median of the aerosol concentrations was 0.25 mg/m^3 and the 90th percentile was 1.7 mg/m^3). This means that most German sum (and aerosol) concentrations of that study were about twice as high as the Swiss levels determined some years later in the investigation published here.

The reason for determining the sum concentration instead of the aerosol concentration lies in the measurement technique. When measuring MWF, a filter traps the aerosols in the ambient air. Because a measurement normally lasts one to two hours (or longer), parts of the aerosols evaporate from the filter.^{2,15–17} To trap the evaporated vapor, a cartridge with a resin has to be placed after the filter. In our study, we found that 92% (median) of an MWF was in vapor form. An internal evaluation by Suva has shown that the storage time after desorption does not influence the results and that there is no clear correlation between the vapor rate and the time between the measurement in the plant and the analysis in the laboratory (Fig. 2).

To compare the situation of MWF exposure in Switzerland with other countries, we analyzed the aerosol concentrations of the measurements in addition to the sum concentrations. However the aerosol concentrations were only determined separately up to 2010, after which the filter with aerosols and the resin with vapor

were desorbed together and therefore no separate data are available. We identified 49 plant visits where the aerosol concentration had been measured separately. The median and the 90th percentile concentrations were 0.2 mg/m^3 (inhalable fraction) and 0.9 mg/m^3 (inhalable fraction), respectively. There are several international OELs relating to the inhalable fraction of mineral oil (Table 3) – but these OELs cannot be used for comparison with our data as pure mineral oils were not used in metal processing in Switzerland during the period reviewed. By contrast, only a few countries, such as Austria or Sweden, list OELs relating to MWF in general (Table 3). The National Institute for Occupational Safety and Health (NIOSH) has suggested $0.4 \text{ mg aerosol/m}^3$ (thoracic fraction) as a recommended exposure limit (REL) in the U.S.A, corresponding to about $0.5 \text{ mg aerosol/m}^3$ (total fraction). Concentrations measured as thoracic, total or inhalable fractions are difficult to compare with each other because the correlation between different fractions depends on particle size. This is why different factors have been suggested to convert one fraction into another one.^{1,3,4,18–21} By applying the factors proposed by the Dutch Expert Committee on Occupational Safety (DECOS) for converting the suggested REL of NIOSH for the thoracic and total fractions into the inhalable fraction, we obtain threshold values between 0.6 and 1 mg aerosol/m^3 (inhalable fraction) (Table 3). These values are in the range of the 90th percentile of our study and the corresponding OELs of Austria and Sweden.

To calculate the median and the 90th percentile concentrations, we took all measurements independently from individual factories. As different numbers of measurements were recorded for a given factory, it was assumed that plants with a lot of measurements were overrepresented. However, measurements were recorded in different parts of a plant with differing MWF air concentrations. Moreover, the measurements were not recorded in randomly selected plants but in those that were of interest to Suva. This means that companies with suspected bad

Table 3 Overview of OELs of various countries and committees for mineral oils and MWF (2015)

Country	Committee/authority	Concentration (mg/m ³)	A/V	Type of MWF
Switzerland (before 2016)	SUVA	20	A + V	MWF (with additives)
		0.2 i	A	MO (pure, heavy)
Germany	AGS	(formerly 10)	A + V	MWF (water-soluble and insoluble)
	DFG	(formerly 5 i)	A	MO
Austria	BMASK	20	A + V	MWF (with or without additives)
		5 i	A	MO (without additives)
		1 i	A	MWF (with additives)
The Netherlands	SER	5 i	A	MO
	DECOS	1.6 i	A	MO (highly refined, not recycled)
		0.1 i	A	MWF (with contaminants, mineral oil-based and maybe synthetic oil-based)
Sweden	SWEA	1	A	MO (mist and fume)
EU	SCOEL	5 i	A	MWF (non-aqueous part)
		–	–	MO (severely refined without additives)
				MO (unrefined or mildly refined)
U.S.A.	NIOSH	5 t (~10 i)	A	MO
		0.4 th/0.5 t (~0.6–1 i)	A	MWF, all types
	OSHA	5 t (~10 i)	A	MO
		15 t	A	PNOR
		5 r	A	PNOR
		0.5 t (~0.6–1 i)	A	MWF (recommended by advisory committee)
	ACGIH	5 i	A	MO (pure, severely refined; excl. MWF)
		–	–	MO (poorly and mildly refined)
Other countries in the GESTIS database		0.2–5	A	MO

Notes: A, aerosol; ACGIH, American Conference of Governmental Industrial Hygienists; AGS, Ausschuss für Gefahrstoffe; BMASK, Bundesministerium für Arbeit, Soziales und Konsumentenschutz; DECOS, Dutch Expert Committee on Occupational Standards; DFG, Deutsche Forschungsgemeinschaft; GESTIS, Gefahrstoffinformationssystem der Deutschen Gesetzlichen Unfallversicherung; i, inhalable fraction; MO, Mineral oil; NIOSH, National Institute for Occupational Safety and Health; OSHA, Occupational Safety and Health Administration; PNOR, particulate not otherwise regulated; r, respirable fraction; SCOEL, Scientific Committee on Occupational Exposure Limit Values; SER, Social and Economic Council of the Netherlands; SUVA, Schweizerische Unfallversicherungsanstalt; SWEA, Swedish Work Environment Authority; t, total fraction; th, thoracic fraction; V, vapour.

Only long-term values are given. NIOSH and OSHA relate their values to the thoracic and total aerosol fractions to obtain an estimation of the corresponding inhalation fraction we used the conversion factors suggested by DECOS¹ and wrote the recalculation in parentheses. The recommended PEL of the OSHA advisory committee has not been officially adopted by OSHA.

exposure situations may be overrepresented. In fact, the average air concentrations might be lower than the ones in our publication. In summary, the results of our investigation should just be taken as a rough estimation of the situation in Switzerland.

Analysis of occupational diseases

We also analyzed the number of acknowledged occupational diseases due to work with MWF. It is well-known that MWFs mainly affect the skin and to a lesser extent the respiratory tract.^{5,7} This is reflected in our study. We found 1280 skin diseases (99% involved contact dermatitis) compared to only 96 diseases of the respiratory tract as the main diagnosis. Only 221 secondary diagnoses were encoded. Most of these comorbidities concerned the same organ system as the main diagnosis (82% in case of the skin and 62% in case of the lungs).

The number of skin diseases diminished over time (average decrease of seven per year; Fig. 3). This is in

line with the general trend for occupational skin diseases in Switzerland: between 2004 and 2013 there was a decrease from 741 to 581 occupational skin diseases per year. This phenomenon may be a reflection of the intensive efforts to ameliorate skin protection during recent years and the probable reduction in the number of workplaces where skin exposure occurs. There was a temporary increase in 2008 ($P < 0.05$) – the reason for this phenomenon is unknown to us; there were no changes in statistical methods and there were no campaigns for skin protection that might explain the peak.

The incidence rates of respiratory diseases were low (approximately nine cases per year) and showed no trend. Modern MWFs often contain water, which leads to an increased risk of the growth of microbes and the development of EAA¹⁰; however, the number of EAA was very low (4 cases in 10 years). Possible explanations for this finding are the good storage conditions of MWFs or under-diagnosis of EAA. Generally, occupational respiratory

diseases appeared to increase slowly by 8 cases per year from 346 cases in 2004 to 460 cases in 2013 in Switzerland (linear regression with $R = 0.47$).

We did not compare our numbers with those of other countries because the systems for acknowledging occupational diseases and recording the statistics for occupational diseases are different and the diagnostic procedures are different or not defined (especially in the case of observational studies). As mentioned above, our investigation provides an estimation of the situation.

Most illnesses were encoded as non-allergic (64% of the skin diseases and 85% of the respiratory illnesses). The number of allergic diagnoses is probably higher because testing for allergy (e.g. epicutaneous testing, patch testing, and/or antibody determination) was not standardized and was not always performed.

Contact dermatitis mainly occurs through direct contact of the skin with MWF. Hands and forearms are the most frequently affected body parts. Other body areas, e.g. the face, are affected more rarely and MWF aerosols and vapors in the air appear to be less important for induction of skin diseases. 16% of workers with MWF-induced skin diseases left their workplace due to a declaration of unfitness by Suva. This is somewhat higher than the percentage of NEVs for occupational diseases in general during the same period (12%).

In contrast to skin diseases, respiratory illnesses are triggered by airborne MWF. Hence, most international OELs are based on non-allergic effects of the respiratory tract. These aerosol-based OELs do not necessarily prevent the occurrence of skin diseases. The incidence rate of non-allergic respiratory diseases in our study remained low, approximately nine cases per year during this period (or even less when taking into account the abovementioned diagnostic uncertainty associated with an allergic condition). This corresponds to no more than approximately 0.006% of all 150,000 workers exposed to MWFs in Switzerland (estimation of Suva), or to 2% (median = 393) of all occupational respiratory diseases per year. Fewer than three workers per year were issued with a declaration of unfitness due to MWF-induced respiratory illnesses between 2008 and 2013 (the database does not distinguish between allergic and non-allergic cases), compared to a total of 312 declarations per year released by Suva (median value for this period). Other authors also report low levels of respiratory diseases due to MWF.^{10,22,23} The relative risk of being issued with a declaration of unfitness in the case of respiratory diseases was 29%, which is nearly twice as high as for skin diseases (16%). The possibility of underreporting cannot be ruled out: on the one hand, certain sicknesses show a long latency time, leading to misinterpretations, on the other, mild complaints might be considered as not severe enough to warrant reporting to the insurance company.

Summary

Exposure to MWF is a common phenomenon because cutting fluids are widely used in metal processing. Suva estimates that about 150,000 workers are exposed to MWFs in Switzerland. This study gives an estimation of the MWF air concentrations in Swiss plants and the number of occupational diseases due to MWF exposure between 2004 and 2013. During this period, the 90th percentiles for the MWF air concentration were 8.1 mg (aerosol + vapor)/m³ and 0.9 mg aerosol/m³ (inhalable fraction), respectively, which was below the official Swiss and most other international official OELs during that period. The main occupational diseases caused by MWF were – as expected from other studies – skin illnesses, representing about 92% of all MWF-induced diseases ($n = 1385$ in total). The other illnesses concerned the respiratory tract (7%) or other organs (1%). The skin diseases decreased steadily over time (in accordance with occupational skin diseases in general in Switzerland), whereas the incidence rate for respiratory illnesses remained stable at a low level of about nine new cases per year (in contrast with occupational respiratory diseases in general, which seem to increase slowly). 17% of the affected workers had to leave their workplace due to a declaration of unfitness by Suva (in addition to those who quit the job without a declaration), which is slightly higher than the percentage of the declarations for all occupational diseases in the same period (12%). For the determination of an OEL, only the non-allergic respiratory effects are of interest; therefore the vast majority of MWF-induced diseases – i.e. skin diseases – cannot be prevented by such an aerosol-based OEL. Taking into consideration our observations, the results of other studies and the comments of international OEL committees, the Swiss threshold values have been changed as of 2016. The new Swiss OELs for MWF are 10 mg/m³ for the sum of aerosol + vapor concentration, 1 mg/m³ for the aerosol concentration (inhalable fraction) and 5 mg/m³ for pure, highly refined mineral oils (inhalable fraction).

Disclosure statement

No potential conflict of interest was reported by the authors.

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