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Are occupational exposure limits becoming more alike within the European Union?

Linda Schenk,[1,2] Sven Ove Hansson,[2] Christina Rudén[2,1] and Michael Gilek[1]

[1] Södertörn University College, Huddinge, Sweden
[2] Royal Institute of Technology, Stockholm, Sweden

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ABSTRACT: The occupational exposure limits (OELs) established by seven different national regulatory agencies of EU member states are compared with those of the European Commission (EC). The comparison concerned: (1) what chemicals have been selected, (2) the average level of exposure limits for all chemicals, and (3) the similarity between the OELs of different EU member states and the OELs recommended by the European Commission. The average level of the exposure limits has declined during the past 10 years in four of the five countries in our study for which historical data were available to us. Poland has not changed its level noticeably and Germany has increased it. Since the first list of indicative OELs was established by the EC, a few of the EU exposure limits have been lowered. The similarity index indicates that the exposure limits of EU member states are converging towards the European Commission's recommended OELs. Still, the average level of OELs differs between organizations – the Estonian OELs are on average 35% higher than the Polish OELs. Copyright © 2008 John Wiley & Sons, Ltd.

KEY WORDS: occupational exposure limits; risk management; harmonization; European Union; chemicals regulation

Introduction

Occupational Exposure Limits

To protect the health of people exposed in their workplaces, authorities and organizations, among other precautions, set occupational exposure limits (OELs). How these exposure limits are determined and what they are supposed to protect against vary to some degree between different countries and organizations. OELs are set as limits to concentrations of harmful substances in the air, averaged over a period of time. Time-weighted averages (TWAs) are set for an 8 h day during a 40 h week. Short-term exposure limits (STELs) are set to help prevent effects that may occur following a short exposure. STELs usually refer to averages for a 15 min period.

Lists of OELs were introduced as risk management tools in the twentieth century. In 1938 the American Conference of Governmental Industrial Hygienists (ACGIH) was formed. It soon became one of the most influential organizations worldwide when it comes to occupational health regulations (Hansson, 1998a; Piney, 1998). In 1946 the first threshold limit values (TLVs), then called maximum allowable concentrations, were published, as a plain table listing exposure limits without further information about the intended protection (Piney, 1998). The ACGIH TLVs have been adopted by many regulatory agencies worldwide (Piney, 1998). This took place mainly in the 1950s and 1960s. After that the national agencies have increasingly developed their own OELs. The TLVs have repeatedly been criticized for lack of transparency and insufficient documentation (Castleman and Ziem, 1988; Roach and Rappaport, 1990; Rappaport, 1993; Hansson, 1998a, b; Rudén, 2003).

In 1978 the European Community announced its first Action Programme on health and safety at work, aimed at harmonizing provisions and measures regarding the protection of workers' health. Previous Community involvement in occupational health and safety had been scarce and with limited influence (Walters, 2002). The framework directive 80/1107/EEC was one of the most important outcomes of the 1978 Action Programme; it was the first directive to define a European legal framework for chemicals at the workplace and set out a number of preventive measures (Walters and Grodski, 2006). One of the measures prescribed was the setting of OELs [article 4(4)] (CEC, 1980). This framework directive has since been replaced by the 89/391/EEC, which is the framework now in effect. The directive 91/322/EEC was the first to define a number of indicative OELs. An informal advisory group of scientific experts assisted the EC in determining these indicative OELs. In 1995 this group received a formal status as the Scientific Committee on Occupational Exposure Limits (SCOEL). The SCOEL recommends health-based OELs to the EC. When they find it impossible on the basis of current knowledge to identify threshold doses below which

* Correspondence to: L. Schlenk, Södertörn University College, Huddinge, Sweden.
E-mail: linda.schenk@sh.se
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no harm to human health can be guaranteed, the SCOEL recommends a pragmatic OEL that is deemed to carry a sufficiently low risk. The feasibility of the OELs recommended by the SCOEL is evaluated by a separate committee, the Advisory Committee for Safety, Hygiene and Health at Work. It is an assembly of representatives from governments, employers' organizations and trade unions. Indicative OELs are established by the EC when it is concluded that there is a clear threshold dose below which there are no adverse effects on human health. The indicative exposure limits are to be taken into consideration by each member state, but the national OEL is allowed to be higher or lower than the EC indicative OEL. Binding OELs are, as the name implies, mandatory and each member state must either implement the limit set by the EC or a lower limit (Feron, 2003). Up to date decisions have been made on 105 substances resulting in 100 indicative OELs and five binding OELs. These are listed in 91/322/EEC (indicative OELs), 00/39/EC (indicative OELs), 98/24/EC (binding OEL for lead), 03/18/EC (binding OEL asbestos), 04/37/EC (binding OELs for wood dusts, vinyl chloride and benzene) and 06/15/EC (indicative OELs). The EU is not a pioneering agency concerning coverage of substances or the level of the OELs; rather, the Commission chooses to set exposure limits for substances already regulated by several European countries.

Several steps have already been taken towards a more harmonized methodology within the area of risk assessment of chemicals. The EU has proposed a number of 'principles for assessment of risks to man and the environment' in directive 93/67/EEC (EC, 1993) as well as in the Technical guidance documents in support of directive 96/67/EEC on risk assessment (EC, 2003b), to further common practices in risk assessment. A harmonization of national exposure limits can be expected, since the EU sets both binding and indicative OELs for each member state to consider in its national regulations. However as noted by Vincent (1998), a full international harmonization of OELs is unlikely and may not even be the most efficient means to improve the working environment. Vincent proposes an 'intermediate harmonization' with national lists of exposure limits based on national considerations but with common international criteria and methods.

Previous Research

Previous studies of occupational exposure limits have shown that there are large and unsystematic differences between decisions made for different chemicals with similar adverse health effects (Hansson and Rudén, 2006). Case studies concerning certain areas of occupation (Haber and Maier, 2002; Bigelow *et al*., 2004) or certain chemicals (Cunningham *et al*., 1998; Taylor *et al*., 2007) confirm that there are national differences in risk assessment and management of occupational chemical exposure.

A major argument for the harmonization of procedures and exposure limits is the aim to cut costs and minimize duplication of effort. A common minimal level of occupational protection will also reduce the risk of insufficient health protection being used as a means of competition to attract industry. As Vincent (1998) points out, harmonization will require changes in the regulatory practices, and regulatory authorities with older and larger bureaucracies may be the ones most resistant to change. A similar conclusion is drawn by Grabbe (2001), who studied the influence of the EU on governance in post-communist countries in Central and Eastern Europe. The potential influence of the EU was very large since EU membership was a high priority for these countries. According to Grabbe (2001), a lack of stable form of governance could mean less institutional resistance. An anticipated EU membership has also been identified as a driving force for administrative reform by Lippert *et al*. (2001). The Commission's review of the implementation of the framework directive 89/391/EEC in the EU member states did in fact conclude that the impact of the directive was greater in member states either with less developed legislation in the field or legislation not already based on preventive principles, as the EU directives are intended to be (EC, 2004b).

Another aspect of OELs is that they tend to decrease gradually over time as they are revised. This has been shown in several studies, e.g. Hansson (1998a), which includes a review of the Swedish OELs from 1969 to 1992. Greenberg (2004) made a review of the documentation of British asbestos exposure limits from 1898 to 2000 and Markowitz and Rosner (1995) reviewed the TLV for silica from 1935 to 1990. Both these studies show that the OELs are lowered as more information on adverse effects becomes available and the protection of workers' health is given higher priority.

Walters and Grodzki (2006, p. 126) conclude that there are strong similarities between EU member states in their systems for setting OELs. They refer to the influence of the ACGIH and also, to a lesser extent, to the Nordic countries, Germany and the EU. Taylor *et al*. (2007) compared how the European OEL for lead on the protection of workers' health has been implemented in 14 EU member states. Their results show that the OELs for lead set nationally were mostly the same as the EU binding OEL; in five cases the exposure limits were lower. The biological limit values (allowable concentrations of lead in the blood of employees) for lead exhibited a larger variation between countries.

Aims of this Study

The level of the OELs depends on the outcomes of the risk assessment and risk management processes for the regulated substances. The OELs are exact numerical values which simplifies quantitative comparisons and statistical analyses. Comparisons of the final OELs can help uncover instances where risk assessment led to discordant results

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or principles of risk management differ. This study compares the OELs of seven EU member states. Questions asked were: What discernible differences are there in the coverage of substances that are regulated with occupational exposure limits and in the levels of these exposure limits? How have recent developments concerning occupational health and safety regulations within the European Union affected the OELs of the member states? Has any harmonization of OELs taken place within the European Union?

It is important to distinguish between the setting for a regulation and its implementation. Clearly, the differences in the implementation of regulation are also important. They are not investigated in the present study.

Method

Our Database

This study is based on the standard-setting documents collected in published form or via the websites of, and e-mail communication with the authorities and organizations in question. Seven regulatory agencies of different countries and the European Union, issuing both mandatory and indicative exposure limits, became available to us through these channels. The seven countries are: Estonia, Finland, France, Germany, Poland, Sweden and the UK. The ACGIH TLVs have been very influential worldwide and thus we include them in some comparisons, even though the ACGIH is a private organization seated in the USA. For five countries and the EU, our database also includes lists of OELs from preceding regulations. They are used for further analysis of the development during the past 10 years. Table 1 displays the list of OELs collected for this study.

The database used for the analyses contains only substances specified with a CAS number on the included lists. The CAS (Chemical Abstracts Service) numbers ensure an unequivocal identification of chemical substances since the chemical naming systems are not concordant and the same chemical can have several different accepted names. The CAS designations are therefore used to minimize confusion. The exclusion of substances for which no CAS number was given is a simplification that unfortunately excludes some substances and mixtures from the analyses, but the selection is still deemed as representative for the regulations of the different organizations. The final database used for all analyses in this study contains 1097 substances with CAS identification numbers.

Coverage of Substances

First, we compared the coverage of substances on the different lists. The number of substances regulated by each country was compared. Then the number of substances added and/or subtracted from each version of a list to the next was counted. To investigate whether the EU has had any influence on the coverage of substances in the member states, we registered the number of substances added nationally at least one year after those substances were included in an EU directive.

Table 1. The lists of OELs collected for this study

Agency	Year	Reference
ACGIH	2005	ACGIH 2005
Estonia	2001	Estonian Ministry of Social Affairs 2001
EU	1991	EC 1991
	1996	EC 1996
	2000	EC 2000
	2003	EC 2003a
	2004	EC 2004a
	2006	EC 2006
Finland	1993	Arbetsministeriet 1993
	2002	Social- och hälsovårdsministeriet 2002
	2005	Social- och hälsovårdsministeriet 2005
France	2005	INRS 2005
Germany	1995	DFG 2005
	2000	DFG 2000
	2005	DFG 1995
Poland	1998	The Minister of Labour and Social Policy 1998
	2002	The Minister of Labour and Social Policy 2002
	2005	The Minister of Labour and Social Policy 2005
Sweden	1996	AFS 1996
	2000	AFS 2000
	2005	AFS 2005
UK	1995	HSE 1995
	2000	HSE 2000
	2005	HSE 2005

The Geometric Means Method

A comparison of the general levels of two lists of exposure limits should refer to all substances that have exposure limits on both lists. For each substance, the quotient between its values on the two lists is the best indicator of the difference. This results in a number of ratios as an indicator of the difference between the lists. To extract a single numerical value representing the overall levels of the two lists, the geometric mean of these ratios has been calculated. This method was applied to OELs in Hansson (1998a) and will be referred to as the geometric means method in this paper. An important reason for the choice of geometric means over median or arithmetic means is that for any two lists, say A and B, the geometric mean of the A/B ratios is above 1 if and only if that of the B/A ratios is below 1 (the product of the two values is always 1). Using arithmetic means will not be satisfactory since which list is perceived as having a higher level can depend on which list is used as the denominator. For further elaboration on why this method was chosen see Hansson (1998a, appendix A).

To compare several lists against each other, one standard comparison list should be used to which all lists in the study are compared. Then the exposure limits of the individual OEL list should be divided with the exposure limits of the comparison list. This should be done for each substance that exists on both lists, resulting in a list of ratios. The geometric mean of these ratios can be used as a measure of the overall level of the list in question. It would perhaps be natural to assume that such a standard, or comparison list, has to be toxicologically reasonable, in other words that it should contain medically sound OELs. Since our knowledge of dose–response relationships is only fragmentary for many substances, such a standard would be very difficult to come by. Fortunately, due to our choice of geometric means for aggregation, the relationships between different lists (i.e. the ratios between the overall values) will be the same irrespective of the values on the comparison list. Hence, the values assigned to substances on the comparison list are not important. What *is* important, however, is the choice of substances to be included. The comparison list should contain mainly substances that can be found on most lists of OELs. For studies of harmonization with the EU lists, the obvious choice is to use the European list of OELs as a comparison list. More precisely, we used the consolidated list of OELs up to 2006, henceforth called the EU list. It comprises 102 of the EU binding and indicative OELs for substances specified with CAS numbers and limit values measured in ppm or mg m^{-3}. The largest addition of substances to this list was made in 2006. Without those, the comparison list would have been too small in comparison to the national list to give a good indication of the overall level of the member state OELs. Thus, when describing the development of the overall level for the different member states during the 10 past years we have used the present EU list as a comparison list.

The comparison list of 102 EU regulated substances also contains short-term exposure limits (STELs). In the cases where 8 h TWAs have not been defined, the STELs have been used for the derivation of a ratio. Where TWA ratios have been available, STEL ratios have been disregarded. When individual lists have only specified STELs and the comparison list only TWAs, the TWA has been adjusted with the factors recommended by the ACGIH (as first defined by the ACGIH 1963, specified in Hansson, 1998a; see Table 2).

For many substances, OELs are given in both ppm and mg m^{-3}. When recalculating from ppm to mg m^{-3} the values have usually been rounded off. In some cases this leads to considerable differences in the ratios depending on whether OELs in ppm or mg m^{-3} are used. In such cases, preference is given to ppm values. In this way the anomaly caused by the rounding off of OELs will be minimized. When lists have defined the OEL in different units, conversion of mg m^{-3} to ppm has been performed in the following manner:

Table 2. Multiplicative factor to recalculate the 8 h time weighted average exposure limit of the comparison list to a corresponding short-term exposure limit

TWA (ppm or mg m^{-3})	*C* factor[a]
$X \le 1$	3
$1 < X \le 10$	2
$10 < X \le 100$	1.5
$100 < X \le 1000$	1.25
$1000 < X$	1

[a] This conversion factor was first suggested by the ACGIH in 1963, see Hansson 1998a.

Concentration in ppm = [concentration in mg m^{-3} × 24.1 (l/mol)]/mol weight (g mol^{-1}), 24.1 being the molar volume of air at 20 °C and 101.3 kPa (AFS, 2005).

Geometric Similarity

To investigate whether there is a process of harmonization within the EU or not, we developed a method that we will refer to as the *geometric similarity* method. Its purpose was to determine how similar the different national lists of exposure limits were to those of the EU list. The geometric similarity is a geometric mean of the distance of the national OELs from the EU OELs. In assessing a particular list we used the ratio for each substance, between its value on the list in question and the EU list. Ratios above 1 were inverted while ratios below 1 were kept, resulting in a new list of *similarity ratios*. The geometric mean of the similarity ratios was then calculated. It could only assume positive values below or equal to 1. A geometric mean of 1 corresponded to complete similarity and as the geometric mean decreased so did the similarity of the exposure limits to the EU OELs.

The difference between the geometric means method and the geometric similarity method can be exemplified with the hypothetical lists A and B. Both lists contain only two substances, substances I and II. On list A the OEL for substance I is 0.5 ppm and for substance II 8 ppm, while on list B it is 80 ppm for substance I and 0.05 ppm for substance II. The comparison list has an OEL of 1 ppm for both substances. The geometric mean for both lists A and B is thus 2; the overall levels of these lists are the same. However, the geometric similarity for list A is 0.25 ($\sqrt{0.5 \times 8^{-1}}$) and for list B it is 0.025 ($\sqrt{80^{-1} \times 0.05}$). Hence, list A is more similar to the comparison list than list B.

Results

Coverage of Substances

Table 3 displays, for the most recent version of each list, the number of individual exposure limits and the number

Table 3. The number of regulated substances on each list and the number of regulated substances with a CAS identification number

Country/organization	Total no. of OELs	Number of CAS-designated[a]
Estonia	436	352
EU	105	102
Finland	760	742
France	556	514
Germany	325	313
Poland	541	490
Sweden	436	385
UK	414	358

[a] Number of different CAS designations in each list.

Table 5. The geometric mean of ratios and the geometric similarity of the most recent national lists, using the EU list as a comparison list

Country/organization	No.[a]	Geometric mean	Geometric similarity
ACGIH[b] (2005)	95	1.158	0.650
Estonia (2001)	82	1.095	0.860
Finland[c] (2005)	101	0.816	0.805
France (2005)	97	0.948	0.728
Germany (2005)	70	0.964	0.746
Poland (2005)	100	0.809	0.665
Sweden (2005)	91	0.959	0.604
UK (2005)	81	1.058	0.769

[a] Number of substances both on the individual list and the comparison list. [b] American Conference of Governmental Industrial Hygienists. [c] The Finnish OELs are said to be harmful concentrations, i.e. not health-protecting, safe concentrations as is the intention of the other countries' OELs.

of substances with CAS designations. Finland has the highest number of exposure limits (760) and Germany the lowest number (325). The average number of substances on the national lists is about 500. Table 4 shows how many substances have been added to or subtracted from national lists during approximately the preceding 10 years. Three of the five countries have implemented major changes in the composition of their national OEL lists. The number of OELs on the Polish list has been substantially increased while the number of OELs on the German and UK lists has decreased. The Hazardous Substances Committee of Germany has undertaken a review of its OELs, leading to the withdrawal of a great number of exposure limits, suspected not to be truly health based, up to 2005 (Castleman, 2006). In the UK the Occupational Exposure Standards and Maximum Exposure Limits were replaced in 2005 by Workplace Exposure Limits and 'principles of good practice'. The Occupational Exposure Standards and Maximum Exposure Limits were transferred to the new Workplace Exposure Limit system, but those exposure limits for which there was insufficient evidence that they protect human health were withdrawn (Walters and Grodzki, 2006, pp. 119–169). The number of substances on the current national lists of OELs that are also on the EU list is displayed in Table 5.

Levels of Exposure Limits

Table 5 lists the geometric means of ratios of the most recent national regulations of the seven member states. In Fig. 1 the geometric means for each member state's most recent list of OELs are ranked in ascending order. Figure 2 shows the development over time of these variables. Estonia and the UK have geometric means of ratios above 1; their overall level of exposure limits is thus higher than that of the EU OELs. The Polish list has the lowest level; its overall level of OELs is 19% lower than the that of EU list. It can be seen in Fig. 2 that the overall level of exposure limits has decreased in three of these countries during the past 10 years. Germany is the most obvious exception as the overall level of the exposure limits increased from 2000 to 2005. Poland's OELs have not changed noticeably from 1998 to 2005 (from 0.815 to 0.811). The level in 2002 was lower though (0.777), which could mean that substances added from 2002 to 2005 obtained values that deviated downwards from the EU list less than previous OELs.

From the collected range of OELs two hypothetical lists were assembled, one consisting of the highest OEL in the range for each substance and one including all the lowest

Table 4. Changes in the coverage of substances on national lists

Country	No. of removed substances the preceding 10 years[a]	No. of these removed substances that now are on the EU list	No. of added substances the preceding 10 years[a]	No. of these added substances that were on the EU list the previous year
Finland	3	0	89	11
Germany	98	14	53	5
Poland	14	0	154	27
Sweden	8	0	83	10
UK	138	7	39	2

[a] Finland 1993–2005, Germany 1995–2005, Poland 1998–2005, Sweden 1996–2005, UK 1995–2005.

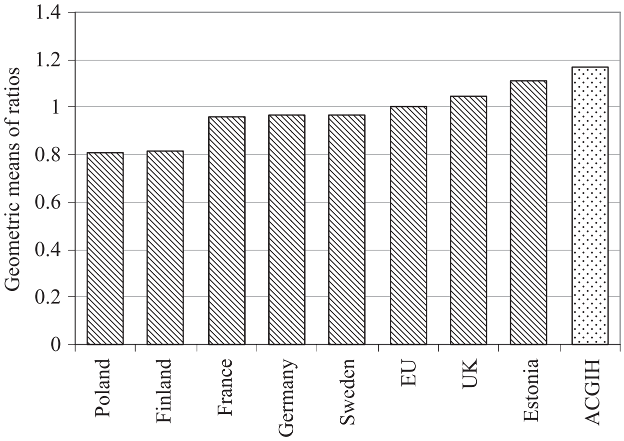

Figure 1. The geometric means of ratios in ascending order. The lower the geometric mean, the lower is the overall level of the exposure limits of that list. Among the included countries, Poland and Finland have the lowest overall levels of exposure limits, whereas Estonia has the highest overall level. The non-European organization ACGIH was included because of its worldwide influence. The level of the ACGIH TLVs is higher than that of the European lists under study

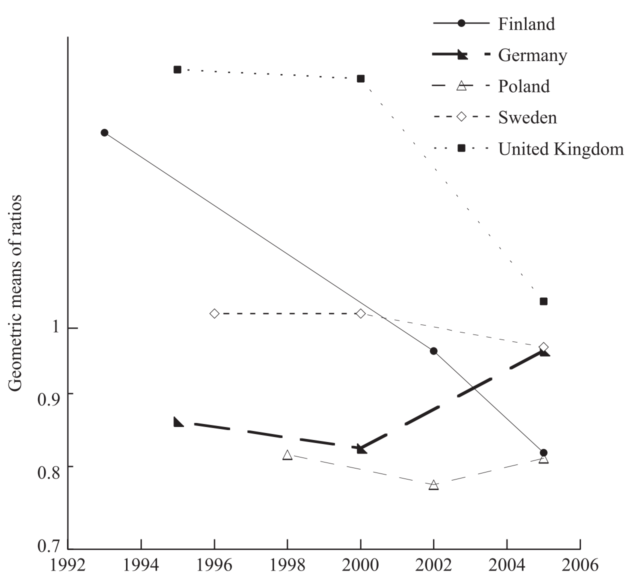

Figure 2. Geometric means of ratios, plotted against time

OELs in the range for each substance. Only substances regulated by at least five EU member states as well as the EU were included, resulting in 95 OELs. The geometric means of these two lists were 1.454 and 0.508, respectively. For seven of these 95 substances all OELs listed had the same value as the indicative OEL set by the EU. The remaining 88 substances were used to compile Table 6. The table confirms the general picture of the differences in OELs between countries that was shown in Table 5.

Table 6. The number of exposure limits that are equal to either the highest or the lowest OEL in the range. Only substances on at least five national lists and the EU list are included. Substances with the same value on all lists have been excluded

Country/organization	No. of min[a]	No. of max[b]
Estonia	7	51
EU	19	47
Finland	27	33
France	20	47
Germany	19	23
Poland	40	12
Sweden	14	42
UK	13	46

[a] Number of national/EU OELs that equal the lowest OEL in the range. [b] Number of national/EU OELs that equal the highest OEL in the range.

Similarity between the Lists

In Table 5 the geometric similarity for the current lists of OELs is displayed, while Fig. 3 shows its development over time. The geometric similarity can only range between 0 and 1. The closer the national exposure limits are to EU exposure limits, the higher is the geometric similarity. As can be seen in Table 5, Estonian exposure limits are the ones most similar to the EU OELs, even if the high overall level of OELs might imply otherwise. Least similar to the EU OELs are the Swedish exposure limits. The geometric similarity of the national OELs tends to increase over time. This means that the national exposure limits are approaching the EU level. The data summarized in Table 7 confirm this; the substances that have been added

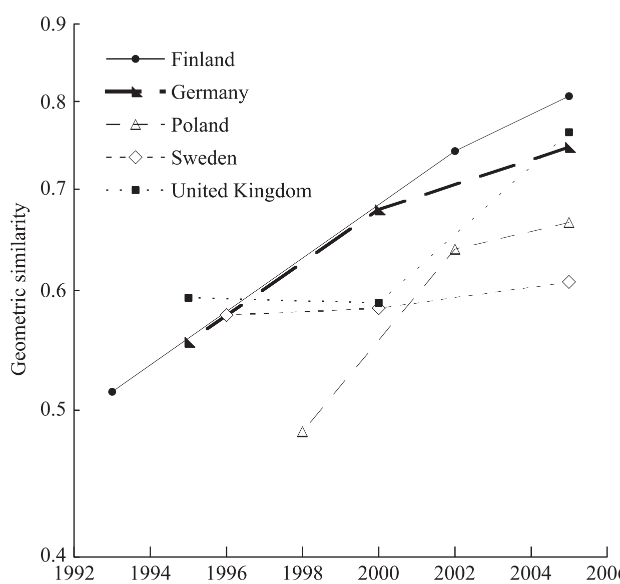

Figure 3. Geometric similarity of individual list to the EU list plotted against time

Table 7. Number of substances added nationally after being included in an EU regulation. Also a comparison of the geometric mean of ratios and the geometric similarity of the substances added after EU added them, compared with the same variables of the entire national list

Country	No. of substances added after EU regulation[a]	Geometric mean of ratios of these added substances	Geometric mean of total list	Geometric similarity of these added substances	Geometric similarity of total list
Finland	11	1	0.816	1	0.805
Germany	5	0.871	0.964	0.660	0.746
Poland	27	0.799	0.809	0.799	0.665
Sweden	10	0.725	0.959	0.725	0.604
UK	2	1	1.058	1	0.769

[a] Added in national lists the year after, or later the same substances have been regulated by an EU directive.

nationally after being included in an EU directive have a higher degree of similarity to the EU OELs than other substances.

The Polish list shows the highest level of assimilation of added substances on OEL lists. Twenty-seven of the 154 substances (18%) added in the Polish regulation have been added after the same substances have been regulated in an EU directive (Table 4). These substances have a generally lower level that the other congruent EU substances while the similarity measure shows that the new substances, for all countries except Germany, actually are closer to the EU levels than previously set exposure limits (Table 7). The high number of substances added in the recent years, the large proportion of them also being recently added by the EU, and the fact that the geometric similarity is increasing, support our hypothesis that Poland is indeed in a process of harmonizing with the EU OELs.

Discussion

There are definitely reasons to expect an effect of the EU regulations on the coverage of substances on national lists, considering that a national risk assessment and management process is mandatory for the substances that are assigned an indicative OEL. However, most substances given indicative OELs had national exposure limits already before the directive in question. The actual effect of the EU on the coverage is thus not clear, but it is possible that countries that develop new occupational health and safety regulations are more influenced by the EU standards than countries with already institutionalized practices.

There is no demand on the individual countries to implement the exact value of the EU indicative OELs, and the level of exposure limits still varies between the member states. The overall level of exposure limits is approximately 35% higher for Estonia than Poland. The levels of the exposure limits have been decreasing for most lists as time has passed. There are several driving forces for this development, among them increasing knowledge of dangers, better technology available and lowered acceptance of occupational health risks.

The geometric similarity measure shows that the national exposure limits have become more similar to the EU OELs over time. We cannot determine whether this is an effect of harmonization without further scrutiny of the each country's motives for the individual OELs. One has to bear in mind that the national response to a harmonizing incentive, like an EU directive, depends on the current national circumstances. Harmonization is usually conceived as a conscious process. As can be seen in Figure 2, the overall level of the OELs varied more among countries only 10 years ago than it does today. Also one can note that the clustering seems to be towards the upper level of the spectrum (Table 6). Thus we conclude that the process in progress during the past 10 years could well be a result of an aspired harmonization.

The currently high level of the EU OELs compared to the studied European countries was somewhat surprising. A general harmonization process could be expected to lead to exposure limits at intermediate level. Instead, harmonization seems to take the form of adjustment upwards that may reverse the previous trend of OELs becoming lower over time. This development could be cause for concern if it leads to a lower margin of safety being accepted. To estimate the size and nature of a possible such effect, further study of toxicological documentation for each individual substance is needed.

It is generally accepted that risk decision processes should be transparent. However, how will the transparency of the decision-making process for occupational health and safety be affected by an increasing centralization of decision-making to the EU? Of course many benefits come from harmonization, as it joins several perspectives into one process. Among those benefits are reduced costs for each participant and that low demands on occupational health will not become a means of competition to attract industries, at least not within the EU.

The effect of harmonization is expected to be more pronounced in nations having experienced a recent constitutional change. In our study the most obvious

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examples are Estonia and Poland, due to changes in the political system of both countries in 1989. However, the nature of the influence differs between the two countries. In the case of Estonia the main influence of the EU on the national OELs seems to be on the level of the exposure limits, rather than the coverage of the lists. The similarity index shows that the Estonian OELs are the ones in our selection that are the most similar to the EU OELs. Currently 82 out of 102 possible substances have OELs on both the EU list and the Estonian list; this is less than the average in Table 5. For Poland the influence of the EU list is not very discernible concerning the overall level or similarity, although the latter has increased since the list of 1998. On the other hand, Poland has the list where most substances have been added nationally after being included in an EU directive (Table 7); Poland is also the country that has added the largest number of substances during the time interval of our study (Table 4). The largest influence of the EU on the Polish list seems thus to be on the coverage rather than the level of exposure limits.

Since most European countries have an overall level of exposure limits that is lower than that of the EU, harmonization could lead to regulations offering less protection for human health. That is, if the indicative OELs of the EU are simply assimilated without adjustment, it would lead to an increase in the overall level since a majority of the previously set national exposure limits seem to have resulted in lower exposure limits than the present EU indicative OELs.

Harmonization can also have another negative effect. Important changes in OELs are often introduced by pioneering agencies suggesting advancements of safety demands and methodology. One not very desirable effect of harmonization could be that these front-runners will become scarce in the future.

The prevalence of chemical health risks on workplaces depends not only on the chosen levels of OELs but also on other factors, including how stringently these OELs are implemented and enforced. Therefore it is important not to draw any conclusions on the quality of actual working conditions from the material presented here.

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