Discussion paper

SJWEH Suppl 2009;(7):41–47

Occupational health epidemiology in the Nordic countries – status and trends

by Maria Albin, MD,[1, 2] Kristina Jakobsson, MD [1, 2]

Albin M, Jakobsson K. Occupational health epidemiology in the Nordic countries – status and trends. *SJWEH Suppl.* 2009;(7):41–47.

This overview aims to give an indication of the current status and trends in occupational health epidemiology in the Nordic countries. As indicated by recent biometric reviews, Nordic countries currently rank among the top five globally in terms of research output on the work environment. However, birth-cohort effects and rapid change in institutions and funding may seriously jeopardize this position. As a result, training a new generation of excellent researchers will be a major task for the next decade and require changes in funding structures. With respect to research topics, the ageing population in the Nordic countries will make preservation of work ability a major issue to explore from a multidisciplinary perspective. Moreover, the growing migration of labor, goods, and capital across borders is likely to increase the number of workers involved in dangerous work and unprotected by minimal occupational safety measures. Consequently, there is a need to research the efficiency of the present occupational safety structures under these new conditions. Research on occupational health services remains remarkably scant. The increase of mental ill-health, especially among young women, and the related interaction between structural societal change and the work environment are important challenges. New suggested disease mechanisms (eg, epigenetic change, oxidative stress, and intrauterine priming of sensitivity to postnatal exposure) are also important applied research areas for occupational epidemiology.

Key terms ageing population; bibliometry; cohort-effect; disease mechanism; funding; globalization.

Given that the proportion of the total amount of epidemiological research has declined and that its integrity is called into question due researchers' heavy reliance on non-public funding, Siemiatycki (1) has questioned the future of occupational epidemiology. Divergent perspectives on research challenges for the coming decades have recently been presented (2, 3). Moreover, an international evaluation has highlighted substantial strengths, but also considerable weaknesses and threats to Swedish work environment research (4). This paper aims to explore the current status and trends in occupational health epidemiology as a basis for a discussion on challenges and priorities.

Recent reviews

The Swedish Council for Working Life and Social Research appointed a group of international experts to make an inventory and evaluate Swedish occupational health research (4, 5). The 2007 report also provided an overview of the basic trends in and status of Danish, Finnish, and Norwegian research. In addition to analyzing this evaluation, we performed PubMed searches on occupational health research (Nordic: Finland, Denmark, Norway, Iceland), and considered presumptive trends in the work environment as well as challenges from scientific findings in other areas.

Publications

The main scientific domain of occupational health epidemiology is public health. A bibliometric analysis found that the average annual output in the period 1995–2004 was around 22 000 public health publications, with the Nordic countries providing a few percent, although in the top end in terms of publications per

1 Department of Occupational and Environmental Medicine, Lund University Hospital, Lund, Sweden.
2 Division of Occupational and Environmental Medicine, Department of Laboratory Medicine, Lund University, Lund, Sweden.

Correspondence to: Dr M Albin, Department of Occupational and Environmental Medicine, Lund University Hospital, SE 221 85 Lund, Sweden. [E-mail: maria.albin@med.lu.se]

million inhabitants (6). Within the field of occupational health, the Nordic share of the production is higher. A review of occupational health research from 1992–2001, in eight selected occupational medicine journals, found that the Scandinavian countries produced 17.9% of all articles in the field (7).

The evaluation of Swedish work environment research (4) similarly found that, between 2001–2005, Denmark, Finland, Norway, and Sweden contributed 18.5% of the publications in ten selected international journals on occupational health and ergonomics. This was 3% more than in 1986, due to an increase in the number of Danish and Norwegian publications. Among the Scandinavian countries, Sweden contributed the largest proportion of publications during 1986–2005 (8%), ranking third after the US (36%) and England (12%).

From 1986–2005, productivity (expressed as publications per year, per million inhabitants) was highest globally in Finland, followed by Sweden, Denmark, Norway, and the Netherlands (4). This is again similar to the findings for the sub-period 1992–2001, with Sweden as number one, followed by Finland, Denmark, Norway, Iceland, and the Netherlands (7).

The mean number of citations (ie, impact) per publication during 1986–2005 was globally highest for the Netherlands, followed by Denmark, the US and Sweden (4). Some papers have an unusually high impact. A "citation classic" is a paper with at least 100 citations. In an analysis of publications in the five major occupational medicine journals from 1949 onwards, 85 citations classics were identified, 26 of which (33%) were from the US, followed by the UK and Sweden, both with 16 (19%) citation classics (8). In total, 25 (34%) citation classics were identified from the Nordic countries, and two papers were found in the top 20 [one paper on neck–shoulder disease (9) and another on workers in swine confinement buildings (10)].

Overall, the evaluation indicates that over the last 20–30 years, Nordic occupational health research has held a strong position worldwide, in terms of publications as well as citations. In relation to their respective populations, the Nordic countries are world class. Moreover, the occupational health share of the total public health publications seems to be higher in the Nordic countries than worldwide.

Breakthroughs in Scandinavian occupational health research include occupational solvent encephalopathy [by some dismissively called "the Scandinavian solvent syndrome" (11)] and further research on the effects of solvents on hearing and balance, including synergistic effects on hearing loss when combined with noise (12). This progress relied heavily on collaboration between toxicologists, clinical neuropsychologists, and epidemiologists. Moreover, the ongoing research was soon followed by preventive actions reducing exposure levels markedly (not the least due to awareness of the risk among labor unions) and the successful development of new products, such as water-soluble paints (13). However, even if the history of research on solvent exposure can be viewed as a success story, it should be pointed out that the long-term "No Observed Adverse Effect Level" (NOAEL) in humans for toxicity on the central nervous system remains to be established for several common neurotoxic solvents. This is a knowledge gap which has been given too little attention.

Other broad subject areas where Nordic research has been especially important are ergonomics, effects from psychosocial working conditions including shift work, effects of exposure to low-frequency noise, indoor climate research, and reproductive epidemiology – including fetal, maternal, and paternal exposures.

Researchers

Occupational health epidemiology expanded markedly during the 1970s and 1980s in the Nordic countries, introducing a birth-cohort effect with a substantial part of the senior researchers within occupational medicine and occupational hygiene now close to retirement age (4). The same problem is facing the occupational and environmental toxicologists. Training of a new generation of excellent researchers in these fields is thus a major task for the next decade.

Structures for funding should be adapted to this, providing support not only for doctoral and short periods of post-doctoral research, but also longer tenure. Sustainable strategies to counter the birth-cohort effect need to be put in place now. Unfortunately the consequences of failing to do so will not be visible until 5–10 years from now, so we all need to be very clear on this point whenever we have the possibility to put it forward.

Rapid changes in funding and downsizing/closing of national institutions threaten sustainability, unless substituted with other transparent long-term national strategies with high credibility. This was exemplified in Sweden by the change in infrastructure for funding of work life research, which took full effect in 2004, and the closing of the National Institute of Working life in 2007 which had one third of the total resources for research and development in this field (200 million SEK or 20 million). In 2007, we observed a low participation of young researchers in both the work environment and work psychology fields, while the age structure was more favorable in labor market research, an area less affected by the changes (14).

The new European Union (EU) Regulation on the Registration, Evaluation, Authorisation, and Restriction of Chemical substances (REACH), which entered into force in 2007, is set to drive major changes in the

global chemicals industry or, for that matter, any industry that uses or processes chemicals. Under REACH, manufacturers, importers and downstream users of high-volume chemicals are required to demonstrate that the production/import/use of a substance does not adversely affect human health and that risks are adequately controlled. However, the so-called evidence-based toxicology movement (www.ebtox.org), which was launched by the chemical industry, objects to restrictions in the absence of human evidence for adverse effect (15, 16). This indicates that there may be less common ground in the coming years between different stakeholders, and a greater need for unvested (independent) national toxicological competence than may have been previously foreseen.

Unique opportunities – unique obligations

Occupational epidemiology has unique opportunities in Nordic countries. Some of these opportunities are well recognized, such as the personal identification numbers which can be linked to good national registries of outcomes like deaths, cancers, and births. There are also twin-registries, whose potential in occupational epidemiology may still not be fully exploited.

Another important advantage in the Nordic countries is that strategic sectors of our societies provide support for public health (including occupational health) research and trust that it will ultimately produce useful knowledge that will benefit wellbeing and societal prosperity. This enables access to workplaces and biological material to an internationally exceptional extent. However, this trust must continuously be nurtured. In the evaluation of Swedish work environment research, both trade unions and employers were critical and claimed that the research had too little impact on working life. Occupational health researchers (at least in Sweden) need to consider how they can assist in changing this perception. Implementation could also be a research topic in itself (17).

Country-specific opportunities are offered by the already available multigenerational registry (18) and the recently initiated LifeGene project (http://lifegene.ki.se/) in Sweden, the mother-child cohorts in Denmark (19) and Norway (20), the Age, Gene/Environment Susceptibility-Reykjavik Study (21), and the registry of prescribed drugs in Finland (22), among others. Also, some huge occupational cohorts are important assets, such as the Danish Work Environment Cohort Study (23) and the Swedish construction workers cohort (24), as well as population-based cohorts [ie, the Helsinki cohort (25)].

It may be argued that unique opportunities imply unique obligations within the international scientific community. Nordic researchers should consider if these opportunities are fully used and, if not, what the obstacles might be. Lack of funding is an obvious issue. Siemiatycki (1) has pointed out the threats to the integrity and credibility of the discipline from dependence on vested interests worldwide. This can easily create a vicious circle, as credibility has to be high among all stakeholders for occupational health research to have an impact on the societal level, and thus obtain special public funding. Recent developments in Sweden [ie, major cut-backs in funding and institutional structures (4)] are a drawback also on the Scandinavian level, since the contribution from one country is substantially weakened.

In parallel to developments at the national level, the possibility to strengthen occupational health epidemiology by the joint Nordic use of the unique opportunities should be considered in an effort to attract more international funding. Such initiatives have already been taken – a "small-scale" example is a Nordic cohort of dry cleaners (26), a larger-scale example is the study on the "changing work life and cancer risk in the Nordic countries" [or Nordic Occupational Cancer, NOCCA (27)] – but more could be done.

Changes in working life

An analysis of foreseen trends and coming priorities in occupational health epidemiology must be based on an understanding of what is happening to work itself (28).

New technologies are rapidly developed and marketed. It is likely that international institutions concerned with workers' safety will remain weaker than those dealing with consumers' safety – as is the case for instance within the EU. A good example is chemical safety in the hairdressing profession. The International Agency for Research on Cancer (IARC) has classified permanent hair dyes as probable human carcinogens (2A) (29), and many of them contain contact allergens. However, the work to eliminate hazardous substances in hair coloring products is, on an international level, largely driven by the EU hair dye strategy (2003) aimed at reducing the risk for consumers through the Scientific Committee on Consumer Products (30). The same seems to apply with regard to nano-materials, although 2 million workers worldwide are expected to be exposed in the next 15 years (31).

Another example of a marked gap – in knowledge as well as regulation of exposure levels – is exposure to small particles in the general population and occupational settings. Environmental exposure to small particles at low levels increases mortality and morbidity in the general population. Knowledge on how the risk

varies with particle and subject characteristics (such as age) is needed to evaluate the risk of such exposure in the work environment (32).

Demographics are changing in the Nordic countries due to the ageing population. Preservation of work ability will be a major issue to explore from a multidisciplinary perspective. Recent statistics from Sweden indicate that the expected remaining duration of working life, from age 35 and onwards, differs between occupations by up to 11 years for women and 8 years for men (33). We are also likely to see a shift towards research on determinants inside and outside working life for diseases which occur at an older age and cause long-lasting disability, such as cardiovascular and neurodegenerative diseases. Mental ill-health at younger ages is also a growing problem, especially among young women, where the interaction between structural societal change, individual vulnerability, and the work environment seems to be important (34, 35).

The occupational health research area is widening towards, on the one hand, a public health and a life-course perspective and, on the other hand, an in-depth understanding of underlying biological mechanisms. This applies to oxidative stress (36, 37), epigenetic change ["you are what your grandfather was exposed to" (38–40)], and intrauterine priming of sensitivity to postnatal exposure (41, 42).

A continued growth in the migration of labor, goods, and capital across national boundaries is likely to increase: (i) the service sector in OECD (Organization for Economic Cooperation and Development) countries, (ii) the industrial sector in developing countries, and (iii) the informal sector globally. Also the proportion of working life characterized by job insecurity is increasing as shown in Finland (43). Consequences of this were investigated in the Danish Work Environment Cohort Study (23). The findings indicated that job insecurity is associated with a decline in health and that this effect is especially strong for those whose chances on the labor market are poor.

Overall, this seems to indicate that an increasing proportion of workers in dangerous trades will not be covered by minimal occupational safety measures, in neither the Nordic nor developing countries. This calls for reconsideration of the present occupational safety structures – which were developed mainly for work at big industrial plants – and a situation with a solid labor union counterpart. Can such structures be efficiently applied also to the service sector? What strategies should be tried in the informal sector?

Basic, but carefully performed, cross-sectional studies were crucial to change dangerous industrial processes and initiate regulations in the pioneering days of industrial medicine (44, 45). Such studies still have a potential, especially when exposure levels are unknown or suspected to be high. The available information about effect levels for many common exposures is surprisingly scant. The single aspect that would most increase the usefulness of these cross-sectional studies would be the inclusion of

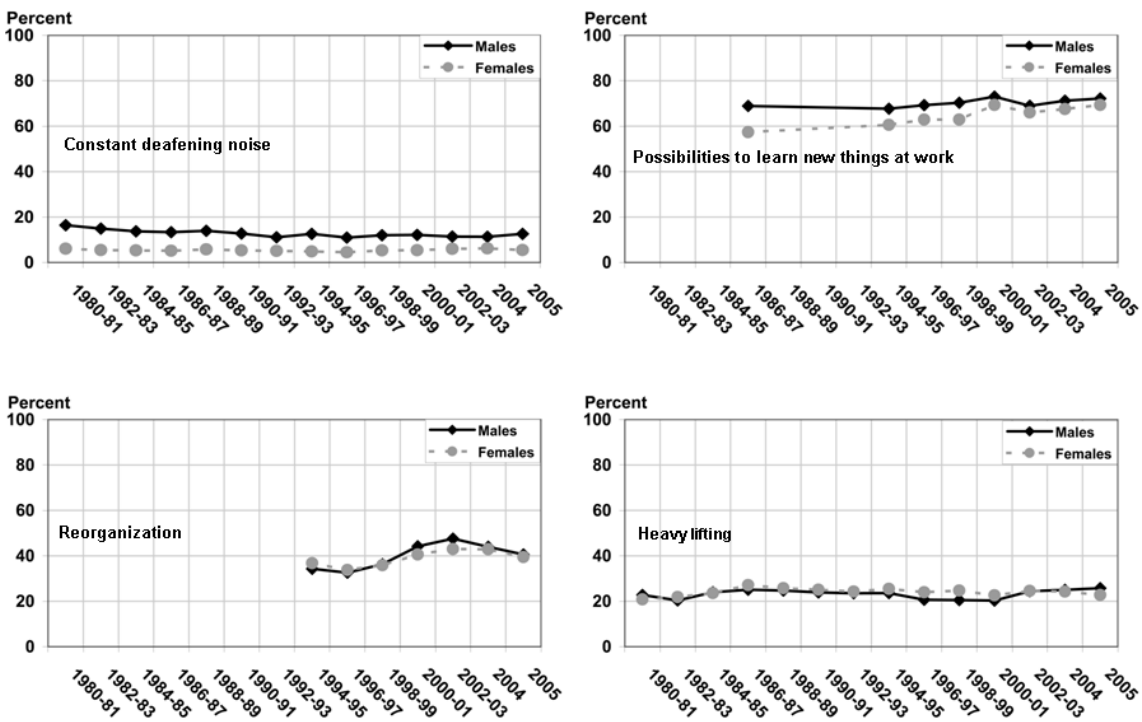

Figure 1. Changes in self-reported working conditions in Sweden 1980–2005 [(Source: Statistics Sweden (46)].

state-of-the-art occupational hygiene. Valid assessment of the exposures associated with a certain prevalence of disease is crucial as a basis for the setting of occupational standards and other regulatory measures.

This adds up to an increased demand on the development of validated surveillance-systems for working conditions. Experienced occupational hygienists claim that we know less about current occupational exposure levels to hazardous substances in Sweden today than we did in the 1970s! We may believe that various exposure levels generally are lower nowadays, but self-reported exposures remain remarkably unchanged during the last two decades [figure 1 (46) see previous page], as do measurement data from some workplaces with regard to dust (47). The social and gender gradients for some exposures are profound, with little evidence of a decrease over a 12-year period [see table 1 below (48)]. New tools are currently developed to reduce the necessity for case-by-case exposure measurements (49), but need to be accessible and validated.

The research task is not only to identify and investigate possible occupational hazards but also to identify knowledge, work skills and work practices to minimize exposures and work more safely. Such a "salutogenic" research perspective is seldom seen. In this aspect, especially within the informal sector, much can be learned from researchers in developing countries, who have used participatory methods with promising results (50).

Also, research on occupational health services remains remarkably scant, especially since we consider it to be crucial for primary prevention and rehabilitation. The field of occupational health and safety does not have a long history of research on what works and does not work to prevent and control occupational diseases and injuries, despite a strong record in etiological research (51). Recent reviews of research priorities and challenges emphasize

Table 1. Reported working conditions in Sweden in percent in 2005–2007 and (1993–1995), respectively, by socioeconomic stratum and gender. Source Arbetsmiljön 2007 (48). Data are presented only for groups with 400 reports.

	Air pollution [a]		Wet work [b]		Hand/arm vibrations [c]		Repetitive work [d]		Noise [e]		Heavy lifting [f]		Lack of influence [g]		Overtime/ shorter lunch [h]		Threats and violence [i]	
	%	(%)	%	(%)	%	(%)	%	(%)	%	(%)	%	(%)	%	(%)	%	(%)	%	(%)
Unskilled workers																		
Men	37	(39)	18	(14)	14	(11)	62	(58)	38	(38)	33	(37)	46	(44)	26	(23)	13	(10)
Women	27	(25)	45	(50)	5	(2)	66	(58)	23	(17)	21	(26)	46	(40)	17	(15)	16	(17)
Skilled workers																		
Men	55	(53)	23	(24)	37	(29)	46	(42)	56	(52)	32	(34)	28	(30)	22	(20)	8	(4)
Women	26	(23)	72	(66)	3	(2)	53	(37)	21	(20)	28	(37)	31	(28)	24	(20)	36	(28)
Self-employed workers																		
Men	34	(37)	17	(17)	22	(20)	38	(40)	32	(30)	30	(35)	8	(7)	57	(57)	7	(6)
Women	–	(35)	–	–	–	(4)	–	(51)	–	(13)	–	(12)	–	(6)	–	(40)	–	–
White-collar workers																		
Low socioeconomic status																		
Men	14	(14)	5	(7)	3	(3)	40	(28)	15	(14)	12	(16)	25	(20)	37	(39)	13	(12)
Women	9	(11)	6	(8)	1	(1)	57	(51)	7	(6)	2	(3)	35	(36)	25	(23)	10	(8)
Medium socioeconomic status																		
Men	11	(14)	5	(5)	2	(2)	21	(18)	16	(15)	5	(5)	18	(12)	40	(44)	11	(10)
Women	11	(12)	24	(25)	1	(1)	31	(23)	19	(16)	6	(11)	23	(18)	43	(42)	21	(19)
High socioeconomic status																		
Men	6	(7)	4	(3)	1	(1)	14	(9)	6	(5)	1	(1)	11	(7)	54	(62)	8	(8)
Women	6	(8)	6	(7)	1	(2)	19	(17)	5	(7)	1	(1)	16	(14)	51	(53)	12	(15)
All workers																		
Men	28	(29)	13	(12)	14	(12)	38	(34)	29	(28)	20	(22)	25	(22)	37	(38)	10	(8)
Women	17	(18)	31	(32)	3	(2)	46	(42)	16	(13)	11	(16)	30	(28)	33	(28)	18	(16)

[a] Exposed at least ¼ of the time to air pollution (inorganic dust, organic dust or chemicals that you can see or feel).
[b] Exposed at least ¼ of the time to skin contact with water.
[c] Exposed at least ¼ of the time to vibration from hand-held tools.
[d] Must at least ½ of the times repeat the same task many times/hour.
[e] Exposed at least ¼ of the time to noise.
[f] Daily conditions: lifting several times per day at least 15 kg.
[g] Can usually not/never be involved in decisions about how to perform own work.
[h] Have to shorten lunch or work extra hours or bring work home every week.
[i] Subject to violence or threats of violence during the last 12 months.

the need to (i) consider why the existing knowledge has had so little impact, (ii) better evaluate research, and (iii) conduct an economic analysis of the costs and benefits of workplace interventions (2, 52).

Concluding remarks

Occupational health epidemiology now delivers the harvest of the funds contributed to the field especially during the 1980s. The investments have resulted in a number of highly qualified research groups equipped with an astonishingly wide spectrum of research tools, covering an equally wide spectrum of health outcomes.

As indicated by a recent bibliometric review, the output from the Nordic countries is globally ranked among the top five, using different quality indices. However, birth-cohort effects among researchers and rapid change in institutions and funding may seriously jeopardize these assets during the coming ten years. Consensus between workers, employers, and government was the basis for the Nordic success story. This needs to be restated (at least in Sweden) if it is to prosper in the future. Given adequate infrastructure, Nordic occupational epidemiology is well equipped to respond to both challenges from ongoing and forthcoming changes in the work environment, and advances in other scientific disciplines.

References

1. Siemiatycki J. Keynote on: Future of occupational epidemiology. Occup Environ Med. 2007;64:e46.
2. Albin M, Broberg K, Jakobsson K. Research challenges in occupational and environmental medicine until 2030. Occup Environ Med. 2009;66:3–5.
3. Erren TC. Identifying research challenges for occupational and environmental medicine until 2030: an initiative. Occup Environ Med. 2009;66:5–6.
4. Wegman DH, Burdorf A, Oldershaw P, Schulte-Fortkamp B, Viikari-Juntura E. International evaluation of Swedish work environment research. Scand J Work Environ Health. 2007;33 suppl 1:32–45.
5. Swedish Council for working Life and Social Research (FAS). International evaluation of Swedish work environment research. Stockholm: FAS; 2006 [cited 23 October 2009]. Available at: http://www.fas.se/upload/dokument/evaluations/Evaenvironment.pdf.
6. Clarke A, Gatineau M, Grimaud O, Royer-Devaux S, Wyn-Roberts N, Le Bis I, et al. A bibliometric overview of public health research in Europe. Eur J Public Health. 2007;17 suppl 1:43–9.
7. Navarro A, Martín M. Scientific production and international collaboration in occupational health, 1992–2001. Scand J Work Environ Health. 2004;30(3):223–33.
8. Gehanno J-F, Takahashi K, Darmoni S, Weber J. Citation classics in occupational medicine journals. Scand J Work Environ Health. 2007;33(4):245–51.
9. Hagberg M, Wegman DH. Prevalence rates and odds ratios of shoulder-neck diseases in different occupational groups. Br J Ind Med. 1987;44:602–10.
10. Donham K, Haglind P, Peterson Y, Rylander R, Belin L. Environmental and health studies of farm workers in Swedish swine confinement buildings. Br J Ind Med. 1989;46:31–7.
11. Hogstedt C. Has the Scandinavian solvent syndrome controversy been solved? Scand J Work Environ Health. 1994;20 special issue:59–64.
12. Hodgkinson L, Parsher D. Effects of industrial solvents on hearing and balance: a review. Noise Health. 2006;8:114–33.
13. Hollander E. "Varför var det så segt? – om lågriskkemi, miljödriven innovation och kravformning" [The enigmatic time pattern of environmental innovation][dissertation]. Stockholm: Department of Industrial Economics and management, Royal Institute of Technology; 1995.
14. Albin M, Johansson G, Järvholm B, Wadensjö E. Att säkra arbetslivsforskning av hög relevans och kvalitet [Ensuring work life research of high relevance and quality]. Arbetsmarknad Arbetsliv. 2009;15(2):55–68.
15. Guzelian PS, Victoroff MS, Halmes NC, James RC, Guzelian CP. Evidence-based toxicology: a comprehensive framework for causation. Hum Exp Toxicol. 2005;24:161–201.
16. Rudén C, Hansson SO. Evidence-based toxicology – 'sound science' in new disguise. Int J Occup Environ Health. 2008;14:299–306.
17. Kristensen P, Nordhagen R, Wergeland E, Bjerkedal T. Job adjustment and absence from work in mid-pregnancy in the Norwegian Mother and Child Cohort Study (MoBa). Occup Environ Med. 2008;65:560–6.
18. Andersson A, Enblad G, Tavelin B, Björkholm M, Linderoth J, Lagerlöf I, et al. Family history of cancer as a risk factor for second malignancies after Hodgkin's lymphoma. Br J Cancer. 2008;11:1001–5.
19. Juhl M, Andersen PK, Olsen J, Andersen AM. Psychosocial and physical work environment, and risk of pelvic pain in pregnancy: a study within the Danish national birth cohort. J Epidemiol Community Health. 2005;59:580–5.
20. Magnus P, Irgens LM, Haug K, Nystad W, Skjaerven R, Stoltenberg C, et al. Cohort profile: the Norwegian Mother and Child Cohort Study (MoBa). Int J Epidemiol. 2006;35:1146–50.
21. Harris TB, Launer LJ, Eiriksdottir G, Kjartansson O, Jonsson PV, Sigurdsson G, et al. Age, Gene/Environment Susceptibility-Reykjavik Study: multidisciplinary applied phenomics. Am J Epidemiol. 2007;165:1076–87.
22. Virtanen M, Pentti J, Vahtera J, Ferrie JE, Stansfeld SA, Helenius H, et al. Overcrowding in hospital wards as a predictor of antidepressant treatment among hospital staff. Am J Psychiatry. 2008;165:1482–6.
23. Rugulies R, Aust B, Burr H, Bültmann U. Job insecurity, chances on the labour market and decline in self-rated health in

a representative sample of the Danish workforce. J Epidemiol Community Health. 2008;62:245–50.

24. Järvholm B, From C, Lewold S, Malchau H, Vingård E. Incidence of surgically treated osteoarthritis in the hip and knee in male construction workers. Occup Environ Med. 2008;65:275–8.

25. Rahkonen O, Laaksonen M, Martikainen P, Roos E, Lahelma E. Job control, job demands, or social class?: the impact of working conditions on the relation between social class and health. J Epidemiol Community Health. 2006;60:50–4.

26. Lynge E, Andersen A, Rylander L, Tinnerberg H, Lindbohm ML, Pukkala E, et al. Cancer in persons working in dry cleaning in the Nordic countries. Environ Health Perspect. 2006;114:213–9.

27. Finnish Cancer Registry. Work and cancer in the Nordic countries (NOCCA) [Internet]. Helsinki: Finnish Cancer Registry [cited 23 October 2009]. Available from: http://www.cancerregistry.fi/eng/research/AID159.html

28. Gochfeld M. Occupational medicine practice in the United States since the industrial revolution. J Occup Environ Med. 2005;47:115–31.

29. Baan R, Straif K, Grosse Y, Secretan B, El Ghissassi F, Bouvard V, et al. Carcinogenicity of some aromatic amines, organic dyes, and related exposures [news]. Lancet Oncol. 2008;9:322–3.

30. Europa. Commission bans 22 hair dye substances to increase consumer safety [press release]. Brussels: Europa; 2006 [cited 23 October 2009]. Available from: http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1047&format=HTML&aged=0&language=EN&guiLanguage=en

31. Schulte P, Geraci C, Zumwalde R, Hoover M, Kuempel E. Occupational risk management of engineered nanoparticles. J Occup Environ Hyg. 2008;5:239–49.

32. Sjögren B. Occupational exposure to air pollutants, inflammation and ischemic heart disease [editorial]. Scand J Work Environ Health. 2004;30(6):421–3.

33. Wikman A. Arbetslivslängd [Length of working life]. In: Kadefors R, editor. Behov av och möjligheter till ett utsträckt arbetsliv för den äldre arbetskraften [The need for and opportunities in extending working life for the older members of the labour force]. Gothenburg (Sweden): Arbetslivsinstitutet; 2007.

34. Stansfeld S, Head J, Fuhrer R, Wardle J, Cattell V. Social inequalities in depressive symptoms and physical functioning in the Whitehall II study: exploring a common cause explanation. J Epidemiol Community Health. 2003;57:361–7.

35. Wege N, Dragano N, Erbel R, Jockel KH, Moebus S, Stang A, et al. When does work stress hurt?: testing the interaction with socioeconomic position in the Heinz Nixdorf Recall Study. J Epidemiol Community Health. 2008;62(4):338–41.

36. Suntres ZE. Role of antioxidants in paraquat toxicity. Toxicology. 2002;180:65–77.

37. Valko M, Morris H, Cronin MT. Metals, toxicity and oxidative stress. Curr Med Chem. 2005;12:1161–208.

38. Jirtle RL, Skinner MK. Environmental epigenomics and disease susceptibility. Nat Rev Genet. 2007;8:253–62.

39. Miller RL, Ho SM. Environmental epigenetics and asthma: current concepts and call for studies. Am J Crit Care Med. 2008;177:567–73.

40. Salnikow K, Zhitkovich A. Genetic and epigenetic mechanisms in metal carcinogenesis and cocarcinogenesis: nickel, arsenic, and chromium. Chem Res Toxicol. 2008;21(1):28–44.

41. Viberg H, Fredriksson A, Eriksson P. Changes in spontaneous behaviour and altered response to nicotine in the adult rat, after neonatal exposure to the brominated flame retardant, decabrominated diphenyl ether (PBDE 209). Neurotoxicology. 2007;28:136–42.

42. Prins GS, Tang WY, Belmonte J, Ho SM. Perinatal exposure to oestradiol and bisphenol A alters the prostate epigenome and increases susceptibility to carcinogenesis. Basic Clin Pharmacol Toxicol. 2008;102:134–8.

43. Nurminen M. Worklife expectancies of fixed-term Finnish employees 1997–2006. Scand J work Environ Health. 2008;34(2):83–95.

44. Hamilton A. Exploring the dangerous trades: the autobiography of Alice Hamilton, M.d. Boston (MA): Little, Brown and company; 1943 [available in reprint].

45. Merewether ER, Price CW. Report on effects of asbestos dust on the lungs and dust suppression in the asbestos industry. London: Her Majesty's Stationery Office; 1930.

46. Statistics Sweden (Statistiska Centralbyrån, SCB). Undersökningar av levnadsförhållanden [Living Conditions Survey, ULF]. Stockolm: Statistics Sweden [cited 27 August 2008] Available from: http://www.scb.se/Pages/Product____12199.aspx

47. Institute for Risk Assessment Sciences (IRAS). Improved Exposure Assessment for Prospective Cohort Studies and Exposure Control in the Rubber Manufacturing Industry (ExAsRub.) [Final report]. Utrecht (the Netherlands): IRAS; 2004.

48. Arbetsmiljöverket. Arbetsmiljön 2007 [The work environment 2007]. Stockholm: Arbetsmiljöstatistik; 2008. Rapport 4.

49. Tielemans E, Warren N, Schneider T, Tischer M, Ritchie P, Goede H, et al. Tools for regulatory assessment of occupational exposure: development and challenges. J Expo Sci Environ Epidemiol. 2007;17 suppl 1:S72–80.

50. Loría Bolaños R, Partanen T, Berrocal M, Alvárez, Córdoba L. Determinants of health in seasonal migrants: coffee harvesters in Los Santos, Costa Rica. Int J Occup Environ Health. 2008;14:129–37.

51. Hulshof C, Hoenen J. Evidence-based practice guidelines in OHS: are they agreeable? Ind Health. 2007;45:26–31.

52. Iavicoli S, Rondinone B, Marinaccio A, Fingerhut M. Research priorities in occupational safety and health: a review. Ind Health. 2006;44:169–78.

Received for publication: 13 February 2009