



Consensus report

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Broadening the view of exposure assessment

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Broadening the view of exposure assessment

Exposure assessors from different disciplines met in Göteborg in June 2001.¹ Chemical, physical, biological, ergonomic, and psychosocial factors were addressed during the conference. Most aspects of exposure assessment were covered, and the conference highlighted some important strategies. This communication aims at addressing some important issues for improving science in the field of exposure assessment.

Performing adequate exposure assessments is an important component of the effort to improve health and the quality of life of working populations, both for finding causes and for evaluating preventive measures (1, 2).

The problem

Modern worklife is becoming increasingly complex, implying that it is necessary to assess a variety of physical, chemical, organizational, and social factors in order to describe the work situation fully. For each exposure, it is important to assess both the dimensions of intensity and time. For example, on the individual level, high-intensity, short-term exposures may not produce the same effects as low-intensity, long-term exposures. On the level of the industrial sector, there may be a trend towards lower chemical and physical exposures, while other exposures, such as psychosocial stressors, may be increasing. Thus the duration, frequency, and pattern of the occurrence of exposures over time can be related to important differences in health effects. In addition, the amount of time spent in leisure and other activities outside of work can modify the effects of workplace exposures. Because of the importance of the interrelationships among exposures, the context in which they appear, and their patterns over time, the assessment of a single exposure may not be sufficient to explain the occurrence of adverse health effects in a working population. For example, the assignment of worktasks usually determines exposure to specific factors (3, 4) and can be a major source of differences in health outcomes between different workers or worker groups. Often, the variability of a single exposure measure within a group is ignored as random noise, but further evaluation of this

variability may present a rich opportunity to explore the reasons for differences in exposure in the same work group.

“Exposure” is used here to refer to any feature of the environmental and organizational context of the work or nonwork situation that can be seen as external to the individual and might affect his or her health. However, the term appears less useful for psychosocial factors than for other types of agents, partly because it implies a passive role on the part of the individual and partly because it usually refers to a hazardous condition, whereas many psychosocial factors (eg, decision latitude, social support) can be health promoting. In addition, many exposure response relationships are J- or U-shaped, especially in the case of thermal, ergonomic and psychosocial factors. The optimal level for these factors is never zero. It is important that investigators define terms clearly and that terminology be standardized within each discipline.

A multilevel, multidisciplinary approach

A research question can arise at the following different levels: the individual (micro), the workplace (meso), or society as a whole (macro) (figure 1). For example, the investigator may seek to evaluate a health problem within a particular workplace or to assess the effects of a single chemical used throughout an industrial sector or to explain differences in sick leave rates across many industries. Regardless of the background of the primary investigator, the scientific review of the original research question should be broadened beyond one's own discipline. To do so, it is important to review the literature on similar health problems in other disciplines before defining the final research question. This would improve the ability to generalize conclusions, which is a major limitation in most epidemiologic studies. There are several approaches to examining the workplace in a multidisciplinary manner. Qualitative information on the broad context, including a description of all of the work conditions, permits us to locate the specific exposure profile in a multidimensional space (5). For example, if the study examines exposure to awkward wrist postures

¹ X2001 Exposure assessment in epidemiology and practice, a conference held in Goteborg, Sweden, on 10–13 June 2001.

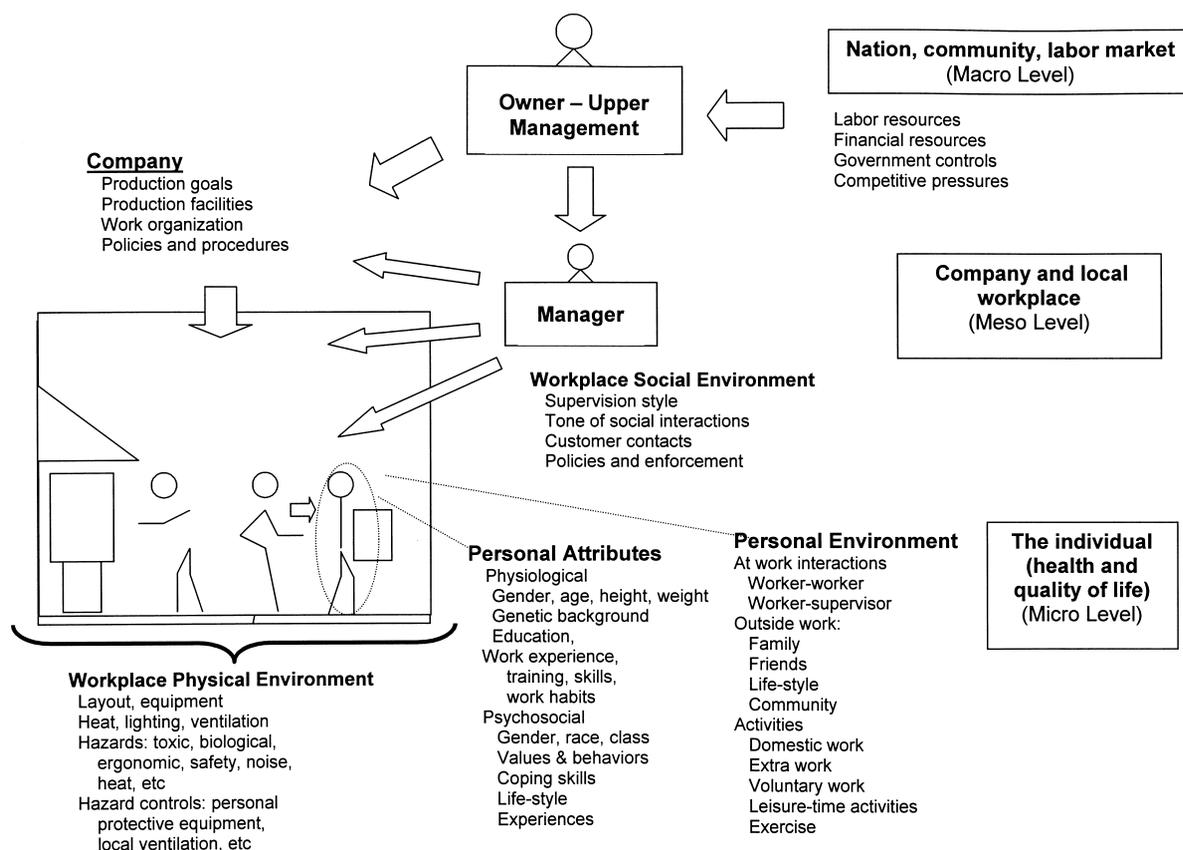


Figure 1. The physical and social context for workplace hazards. The arrows indicate the direction and magnitude of control. In a given exposure situation, only some of these factors are important determinants of stress.

on a machine-paced assembly line, the health effects may differ, if a similar physical load were experienced in a more flexible work setting. In addition, the exposures may have different effects in the presence of a chemical exposure, and documentation of the chemical environment is therefore important even if detailed industrial hygiene measurements are not part of the study protocol. Similarly, the effect of an airborne chemical may be greater in a job in which heavy physical work leads to a faster respiratory rate and higher tidal volume.

There are three levels at which exposures are determined, and they should be considered in assessments. The macro level is mainly determined by societal system and politics. The meso level is the organizational level in companies and organizations. The micro level is represented by the individual.

The next strategy is to broaden the context within which the initial problem is framed. It does not necessarily require a detailed analysis by the investigator, but could be done by reviewing available statistics and talking to representatives from the field or industry in open-ended discussion. The discussion could be summarized in notes that are later used to write about the problem.

A broad view of the structural context in which a problem exists should be identified, including the multiple levels of the workplace and social organization in which the problem is embedded. For example, at the company level, the economic position of the company in the industrial sector should be recognized. Conditions such as whether the industrial sector is in decline or in a period of very rapid expansion and whether the company is in a different economic position relative to the rest of the sector may affect the specific exposures experienced by workers at the shop-floor level (6, 7).

It is also desirable to investigate the characteristics of the workforce of interest, such as whether the workers' job contract is temporary or full-time and whether there is a union, and demographic characteristics such as the educational level, gender, ethnicity and age of the workforce, whether many workers hold more than one job, and what the nonoccupational activities of the workers are (such as domestic work, family responsibilities, and hobbies) (8–10). For example, exposure-response relationships sometimes differ between women and men — whether because of different occupational exposures or their “background” disease rates (ie, other risk

factors) are often not known (11, 12). Another example is that groups with short-term exposure to chemical agents sometimes have higher risks than those with long-term exposures. In the interpretation of such findings, it is important to consider past occupational exposures, especially among low-wage workers who move among temporary jobs and may also experience adverse "life-style" factors (13).

The next step in broadening the context is to describe the full range of workplace factors that may be related directly or indirectly to the initial problem (14).

A more formal approach involves the statistical examination of the patterns of co-occurrence of exposures. For example, Härenstam et al (15) used a cluster analysis to construct groups not on the basis of a single type of exposure, but instead on the combination of general work conditions and physical and chemical exposures in the workplace. This approach expands the chemical exposure assessment definition of a "similar exposure group," which traditionally includes only a single exposure, so that it is defined as a group with a similar combination of exposures from multiple levels of the workplace organization. Cohidon and his colleagues (16) used a hierarchical classification method to subdivide economic sectors and occupational titles into groups that had low within-group variance and high between-group variance with regard to the combination of psychosocial, physical and chemical factors simultaneously.

An alternative method for incorporating multidimensional information would be to define several levels of data collection, including the analysis of the exposure(s) of primary concern at the level of the individual and other characteristics at the level of the group (eg, average income within the occupation or personnel policies or market position of the firm) (17). Multilevel analytic techniques can then be used to take account of both group and individual characteristics in the examination of predictors of health risks.

Investigations of work conditions sometimes pay insufficient attention to obtaining adequate contrast for the exposure(s) under study. Given that many health effects have multiple causes, the investigator should decide a priori whether to attempt to isolate the effect of a single exposure or whether to examine the joint effects of multiple exposures. If the goal is the former, then other potentially relevant exposures must be as similar as possible among the study groups, and knowledge of the full range of these exposures is essential to avoid possible confounding. If the goal is the latter, then the study groups should be selected with attention to contrasts in each of the exposures, both separately and jointly, so again information on exposure profiles should capture the broad variety of potential risk factors including non-occupational factors for an efficient study design.

Concluding remarks

The broadening of exposure assessment to include a multidisciplinary, multilevel approach would enhance scientific methods by developing new conceptual models and analytic techniques. It would also provide opportunities for a better understanding of the complex relationships among environmental factors, health, and the quality of life. We need more arenas in which different disciplines can meet to develop interdisciplinary work that evaluates the complex nature of exposures. We see many opportunities for synergy between different disciplines in exposure assessment. We would like to promote a dialogue about how exposure assessment researchers could engage in more multidisciplinary work and to invite suggestions about how obstacles to multidisciplinary work among exposure assessors can be overcome.

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References

1. Härenstam A, Bodin L, Karlqvist L, Nise G, Schéele P, MOA Research Group. The modern work-style — assessing exposures in future jobs. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:3–5. *Arbete och Hälsa* 2001:10.
2. Quinn MM, Exposure assessment for epidemiology and practice: mind the gap! In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:423–5. *Arbete och Hälsa* 2001:10.
3. Carayon p, Sae-Ngow A, Newman L, Schmitz W. Assessment of psychosocial work factors among computer users — tools developed at the University of Wisconsin-Madison. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice.

- Stockholm: Arbetslivsinstitutet, 2001:83–9. Arbete och Hälsa 2001:10.
4. Park J-S, Punnett L, Wegman DH. Levels of job routinization and implications for exposure assessment. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001: 33–5. Arbete och Hälsa 2001:10.
 5. Loomis D, McDonald MA, Lipscomb H, Dement J. Integrating qualitative and quantitative methods to assess occupational exposures. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001: 282–3. Arbete och Hälsa 2001:10.
 6. Härenstam A, Bodin L, Karlqvist L, Nise G, Schéele P, the MOA Research Group. The moderns work-style — assessing exposures in future jobs. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001: 3–5. Arbete och Hälsa 2001:10.
 7. Warren ND. Company economic position: associations with employee-reported MSD risk factors and indicators. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:42–44. Arbete och Hälsa 2001:10.
 8. Bergqvist U. Exposure to radiofrequency fields and mobile telephony. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:499–507. Arbete och Hälsa 2001:10.
 9. Heederik D. High molecular weight sensitizers: how much more progress do we need? In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:426. Arbete och Hälsa 2001:10.
 10. Starck J, Toppila E, Pykkö I. The role of free time and military exposure in total life noise exposure. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001: 100–2. Arbete och Hälsa 2001:10.
 11. Karlqvist L, Leijon O, Härenstam A, Scheele P, the MOA research group. Are the physical demands in work life too high? In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:414–6. Arbete och Hälsa 2001:10.
 12. Smith KF, Flowers L. Exposure modeling using static and dynamic definitions of physical workload and regional musculoskeletal symptoms in women and men In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:141–3. Arbete och Hälsa 2001:10.
 13. Rice C, Rosenman K. Can exposure be assessed? Guidance to evaluating feasibility from a multi-country cancer mortality study. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:272–4. Arbete och Hälsa 2001:10.
 14. Dosemeci M, Coble J, Stewart PA, Bowman JD, Yost MG, Kaune WT, Mantiply E, Linet M, Inskip P. Quantification of exposure to electromagnetic fields (EMF) in a case control study of brain tumor in adults in the U.S. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:457–9. Arbete och Hälsa 2001:10.
 15. Härenstam A, Bodin L, Karlqvist L, Nise G, Scheele P, the MOA research group. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:3–5. Arbete och Hälsa 2001:10.
 16. Cohidon C, Niedhammer I, Chouaniere D, Guéguen A, Bonenfant S. Exposure to job stress factors in a national survey in France: construction of a job-exposure matrix (JEM). In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001: 304–6. Arbete och Hälsa 2001:10.
 17. Warren ND, Company economic position: associations with employee-reported MSD risk factors and indicators. In: Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 Exposure assessment in epidemiology and practice. Stockholm: Arbetslivsinstitutet, 2001:42–4. Arbete och Hälsa 2001:10.
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- [A copy of the extended abstracts written for the meeting [Hagberg M, Knave B, Lillienberg L, Westberg H, editors. X2001 exposure assessment in epidemiology and practice (Arbete och Hälsa, 2001;10)] is currently available on the Internet at www.niwl.se/ah/2001-10.html or can be obtained from the National Institute for Working Life in Stockholm, Sweden.]