

The Changing Organization of Work and the Safety and Health of Working People: A Commentary

Paul A. Landsbergis, PhD, MPH

Recent trends in the organization of work may affect worker health through a variety of pathways—by increasing the risk of stress-related illnesses, such as cardiovascular disease, musculoskeletal disorders, and psychological disorders, by increasing exposure to hazardous substances and violence on the job, or by affecting occupational health services and training programs. Much remains to be learned about the nature of changes in work organization, and how they affect worker health and safety. While available evidence is limited, such evidence suggests that recent trends in work organization may be increasing the risk of occupational illnesses. In a groundbreaking publication, the National Institute for Occupational Safety and Health has provided a concise summary of available knowledge and a detailed agenda for research and development. (J Occup Environ Med. 2003;45:61–72)

Developed countries, including the United States, have been undergoing sweeping changes in the organization of work, however, these changes “have far outpaced our knowledge about the implications of these changes for the quality of working life and for safety and health on the job”¹, (p. v). These changes and their implications for occupational safety and health are detailed in an excellent new publication from the National Institute for Occupational Safety and Health (NIOSH), titled *The Changing Organization of Work and the Safety and Health of Working People* (Publication No. 2002-116, 1-800-356-4674 to order). The 32 page document was developed by the Organization of Work Task Force, one of the 21 Task Forces and priority areas developed under NIOSH’s National Occupational Research Agenda (NORA). It is the first government document in the United States to address this critical topic. This article summarizes the NIOSH document and adds additional commentary and reviews of the literature in a number of key areas. However, space limitations prevent those reviews from being either comprehensive or systematic.

NIOSH defines organization of work as the work process and the organizational practices that influence job design (see Fig. 1, reprinted from the NIOSH document). Also key are external factors such as the economic, political and legal environment that encourage or enable new organizational practices. The

From the Department of Community and Preventive Medicine, and Division of Cardiology, Department of Medicine, Mount Sinai School of Medicine, New York, NY.

Address correspondence to: Paul Landsbergis, Department of Community and Preventive Medicine, Mount Sinai School of Medicine, Box 1043, One Gustave L. Levy Place, New York, NY, 10029-6574; e-mail: paul.landsbergis@mssm.edu.

Copyright © by American College of Occupational and Environmental Medicine

DOI: 10.1097/01.jom.0000048175.88600.18

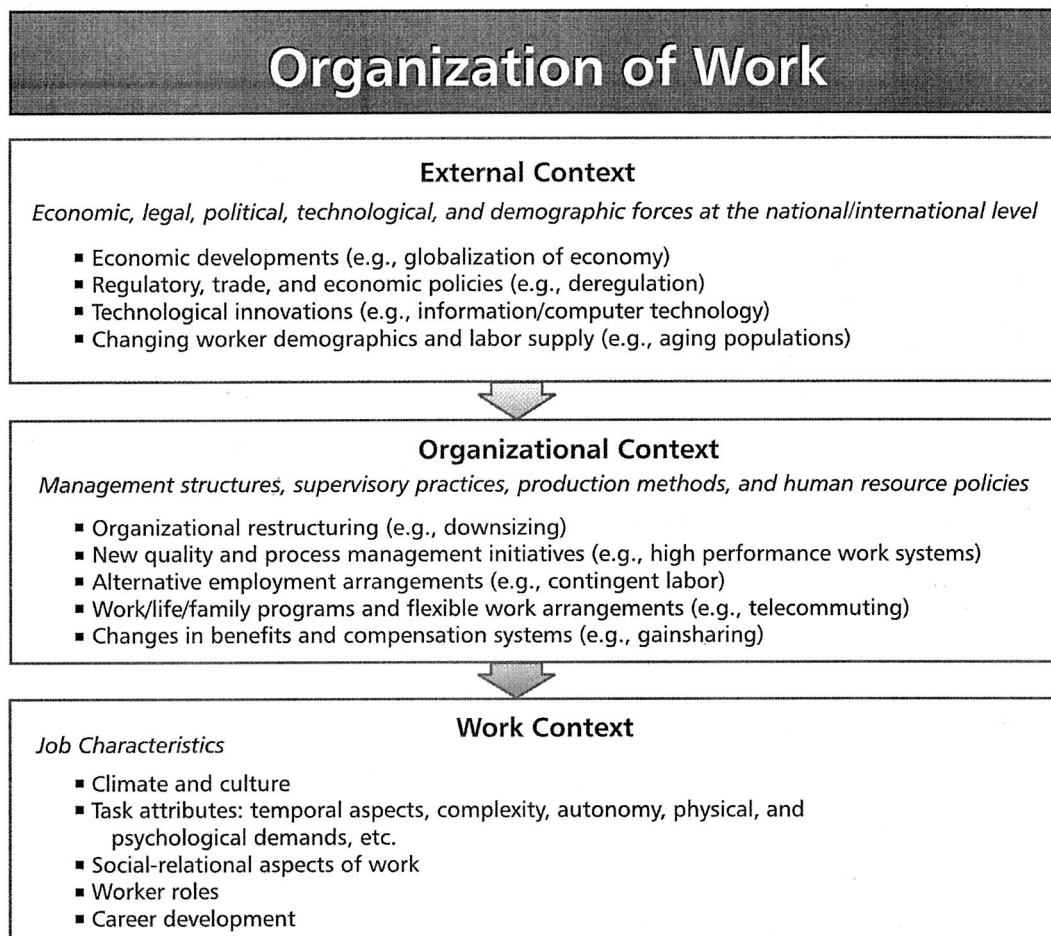


Fig. 1. Organization of work model in NIOSH document.

NIOSH document describes a range of new organizational practices that employers have implemented to compete more effectively in the global economy, primarily:

1. Organizational restructuring, such as downsizing and outsourcing.
2. Flexible and quality management initiatives (also called new systems of work organization), such as total quality management (TQM), lean production, modular manufacturing, and high performance work systems.
3. The use of temporary and contingent (contract) labor.

Some have argued that new systems of work organization offer increased flexibility, responsibility and learning opportunities.² Others have focused on the health risks posed by these trends, for example, the Tokyo

Declaration, a consensus document produced by occupational health experts from the European Union, Japan and the United States, at a 1998 meeting at Tokyo Medical University:³

“organization restructuring, mergers, acquisitions and downsizing, the frantic pace of work and life, the erosion of leisure time, and/or the blending of work and home time. Most of these developments are driven by economic and technological changes aiming at short-term productivity and profit gain. . . . Production practices are increasingly ‘leaner.’ New employment practices such as use of contingent workers are increasingly adopted. Concurrently, job stability and tenure is decreasing. . . . New management models are introduced with more teamwork, just-in-time, and TQM (Total Quality Management). . . . This rapid change, combined with both over- and under-employment, is likely to be highly stress provoking. Occupational stress-related mental and psychosomatic complaints are very common in all 15 EU member states”³, (p. 3–4).

An Agenda for Research and Development

To improve our knowledge of the health effects of these trends, NIOSH Organization of Work Task Force members, in their groundbreaking publication, detail four essential features of an agenda for research and development:

1. The need for data collection efforts to better understand the prevalence of work organization risk factors (such as high job demands, low job control, job insecurity and extended work hours) and how they may be changing. NIOSH recommends that periodic national surveys need to be conducted, modeled on the national Quality of Employment Surveys, conducted by the U.S. Department of Labor between 1969 to

1977. The European Union has undertaken cross-national surveys of working conditions at 5-year intervals since 1990. Also lacking is systematic data collection to monitor new systems of work organization and their associated human resource practices, which are spreading throughout the economy. Health surveillance efforts, such as the National Health Interview Survey, usually lack sufficient job data to make the link between job characteristics and health effects.

2. The need to understand the health and safety effects of prominent trends in organizational practices, such as restructuring, lean production and flexible staffing. Research in this area needs to consider the changing workforce. For example, women are disproportionately represented in jobs with reduced flexibility, pay and benefits and account for almost all the growth in working hours, and African-American women are twice as likely to be employed in temporary jobs than in traditional work arrangements. NIOSH suggests that these new organizational practices may also pose special risks for the growing number of older workers.¹
3. The need for more intervention research, targeting workplace practices, such as job redesign, that may protect worker safety and health. In addition, the effects of legislation and public policy that influence work organization need to be evaluated, as well as “interventions” designed by management to improve productivity and quality, such as “lean production.”
4. The need to formalize and promote organization of work as a distinctive field of study within occupational safety and health, and to develop the multidisciplinary training essential for research and intervention efforts in this area. Such training “would combine methods and content

from the fields of occupational health, epidemiology, psychology, management, industrial relations, and other relevant disciplines”¹, (p. 25). To facilitate this development, NIOSH has funded graduate training programs in Occupational Health Psychology.⁴ (See, eg, <http://www.cdc.gov/niosh/ohp.html#training>, <http://www.workhealth.org/UCLA%20HP%20class%202002/hp%20UCLA%20OHP%202002.html>.)

The following sections provide brief reviews by the author of trends in work organization and impacts on health and safety. Ideas and suggestions from the NIOSH document are clearly specified.

Trends in Work Hours

According to the International Labor Office, total hours worked per person have been declining in Japan and in a number of European countries, however, they have been increasing in others, including the United States. United States workers’ average weekly work hours are now the longest in the developed world, 1966 hours in 1997.⁵ Prime-age working couples are contributing nearly four additional months of annual work time since the 1970s.^{6,7} One important research need is to better quantify the increasing trend, not necessarily reflected in official statistics, of unpaid overtime worked by salaried workers “to deal with excessive workloads.”⁸

Trends in Job Characteristics

Very limited data on trends in job characteristics are available in the United States. In Europe, a series of surveys conducted between 1977 to 1996 reveal dramatic increases in “time constraints” (ie, time pressures or workload demands).⁹ In the United States, only one national survey of job characteristics, comparable to the 1969 to 1977 Quality of Employment Surveys, has been conducted—by the Work and Families Institute in 1997. This survey also

indicates increases between 1977 and 1997 in job demands—from 55% to 68% for “working very fast” and from 40% to 60% for “never enough time to get everything done on my job.”¹⁰

Somewhat increased job decision latitude or job control was also reported in these surveys. In Europe, the proportion of workers reporting a measure of autonomy over their pace of work increased from 64% in 1991 to 72% in 1996.¹¹ In the United States surveys, “freedom to decide what I do on my job” increased from 56% in 1977 to 74% in 1997 and “my job lets me use my skills and abilities” increased from 77% in 1977 to 92% in 1997.¹⁰

However, several methodological limitations of the 1997 United States survey limit our ability to identify the extent of changes. First, the 1997 survey excluded anyone without a telephone, and the response rate was much lower than the 1977 survey (53% versus 73%). Second, the 1977 to 1997 comparison file included only wage and salary workers and excluded self-employed, contract, or contingent workers.¹⁰ The self-employed contingent group was larger in 1997 than 1977 and is more likely to have lower job control. In addition, today, there are more undocumented workers in the United States performing hazardous, stressful and low control work—a group not likely to have participated in the survey.

Job strain, also called “high strain” work, and defined as the combination of high job demands and low job control, is an important risk factor for hypertension and cardiovascular disease (CVD).¹² Because job control appears to buffer (moderate) the effects of job demands on risk of stress-related illness, increases in job control reported in the European and United States surveys might compensate for the increases in job demands. (On the other hand, there may be a limit to the buffering effects of job control in cases of extreme job demands.) Job strain was

not analyzed in the United States surveys. However, in Europe, increases in autonomy were not sufficient to compensate for increased work intensity. The proportion of “high strain” jobs in Europe increased from about 25% in 1991 to about 30% in 1996.⁹

European surveys in the year 2000 show continuing increases in work intensity and job demands, however, increases in job control or autonomy in the earlier period have leveled off or are declining slightly.^{13,14} The trends of increasing demands and stable control between 1995 to 2000 suggests that the prevalence of job strain has continued to increase in Europe, an alarming trend with a potentially dramatic impact on future risk of hypertension and CVD.

These trends may also vary by socioeconomic status (SES), although very little data is available to test such a hypothesis. The combination of hectic and monotonous work, as a proxy measure for job strain, shows little change in Swedish national surveys between 1992–2000 for all workers. (During 1992, the Swedish economy was impacted by a major recession.) However, between 1992–2000, among low income workers as well as blue-collar workers, prevalence of hectic/monotonous work increased from about 12 to 20%.¹⁵

The limited United States data available underscore the need for periodic comprehensive surveys of all constituents of the United States workforce, and the evaluation of risk factors such as job strain and SES.

Impact of New Systems of Work Organization on Job Characteristics

Manufacturing

The NIOSH NORA report points out that new work systems, such as lean production and TQM, in contrast to the traditional assembly-line approach to job design, have often sought “to capitalize on the ingenuity, creativity and problem-solving

ability of workers to make the production process more efficient”¹, (p. 9). Lean production is designed to reduce impediments to the smooth flow of production through continuous improvement (“kaizen”) in productivity and quality, “just-in-time” (JIT) inventory systems (“kanban”), and elimination of “wasted” time and motion (“muda”).¹⁶ Small teams of hourly workers (quality circles) meet to solve quality and productivity problems.

Early proponents of lean production argued that, by rotating jobs and sharing responsibilities, “multi-skilled” workers can solve quality problems at their source and boost productivity. The “freedom to control one’s work” replaces the “mind numbing stress” of mass production. Workers in a lean plant have the opportunity “to think actively, indeed proactively,” to solve workplace problems. This “creative tension” makes work “humanly fulfilling”², (pp. 13 14, 99, 102). However, these early studies of auto manufacturing did not measure job characteristics, work hours, or occupational injuries and illnesses,² rather, they relied mainly on interviews with managers.¹⁷

More recent studies (reviewed in¹⁸) also point out that lean production provides for more job enlargement, cross-training and problem-solving opportunities than traditional manufacturing job design. However, quality circles are not empowered to make managerial decisions, as are the autonomous workgroups typical of Scandinavian Socio-Technical Systems design. Lean production leaves the traditional hierarchy and assembly-line essentially unchanged.^{16,19,20} Cycle-time typically remains very short (often 1 minute or less in auto assembly) and following highly standardized steps at narrowly defined tasks is mandatory.^{17,21} Reliance is placed on industrial engineering, time studies and predetermined standards to ensure maximum workloads.²² JIT inventory systems remove the stock between operations

which act as buffers in the system, and “removes any ‘free time’ the worker may have previously enjoyed while the machine ran through its cycle”²³ (p. 66).

In Canadian and United States studies of lean production in auto manufacturing, job demands were often reported to be elevated.^{24–26} However, British manufacturing employees reported significantly fewer “problem-solving” demands after introduction of a moving assembly line²⁷ and British auto parts employees reported slightly less workload if they participated in the implementation of a lean system—but a significant increase in workload if they did not participate.²⁸

Low or decreasing decision authority was also reported in many cases, including a decline in participation in decision-making, and “influence over the job” over time as new systems were implemented.²⁹ British employees reported significantly less job control after the moving assembly-line and elements of lean production were introduced.²⁷ The promise of producing highly trained “multiskilled” workers was also challenged by Canadian and United States survey data.^{19,29} British truck manufacturing employees reported a decrease in skill variety and use.²⁷

Another new system has been called “high performance work organizations,” often implemented as part of labor-management negotiations. For example, at an auto plant in Wayne, MI, 71% of workers report having benefited from the “team concept.”³⁰ Workers had input into the design of the new system before it was put in place, team leaders were elected, teams could schedule personal and vacation time, the union monitored overtime and seniority rights, and the new system was written into contract language and ratified overwhelmingly.³⁰ In one area, workers had more control and discretion and were able to stockpile their product (contrary to JIT principles). Of course, labels such as “lean,”

“team concept,” and “high performance work organizations” are used to describe a wide range of experiments in work organization. We need to evaluate these experiments for their actual effects on job characteristics such as job demands, control and support, rather than rely on the label used in a particular workplace.

Lean work and other team-based methods have spread beyond auto manufacturing to other manufacturing industries. For example, the traditional production process in the United States garment industry is the “bundle” system.^{31,32} Operators perform one task on each piece in the bundle of cut garment parts, which often takes only a few seconds.^{31,33} The fragmented, repetitive work combined with piece-rate leads to high rates of work-related musculoskeletal disorders (WRMDs).^{34,35} In a new system, “modular manufacturing,” teams of multiskilled operators assemble an entire garment, with reduced supervision, and are involved in quality control, machine maintenance, and sometimes in setting and meeting group goals.³¹ Piece-rate wages are replaced by an hourly wage with a group bonus.³² Modular garment workers reported greater skill use, but also increased perceived stress and no difference in job satisfaction compared to “bundle” workers.^{32,33} Similar new work systems have also been implemented outside of manufacturing, in industries such as telecommunications and health care.

Telecommunications

There was little impact of self-managed teams on unionized customer service work. However, unionized installation and repair workers reported significantly more job satisfaction, autonomy, coworker support, days of training, and advancement opportunities relative to workers in traditionally managed (but highly skilled) craft jobs. Their job satisfaction was significantly associated with “on-line” participation (eg, greater autonomy) but not with

“off-line” participation (eg, quality of work life, TQM, problem-solving teams).³³

Health Care

In the United States health care industry, two forms of work restructuring introduced in the 1990s have been studied. First, “patient-focused care,” based on TQM, uses cross-trained multiskilled teams, with fewer individual job categories, decentralized ancillary services, and computers to reduce case recording time. Registered nurses (RNs) manage teams, but fewer RNs are needed since lower paid unlicensed generic health care workers undertake some direct care.^{36,37} Second, “operations improvement” seeks rapid cost savings by reducing the number of RNs and replacing them with nurses’ aides.³⁸ These new approaches are replacing an earlier system developed in 1970s known as “primary nursing,”³⁹ “professional nurse practice models” or “magnet hospitals,” which featured RN autonomy and control over clinical practice and decentralized decision-making.^{40–42} Cost containment efforts have led to longer hours of work and increased stress among nurses, and have contributed to a nursing shortage.⁴³ Expansion of the “magnet hospital” approach, to help attract and retain staff, could provide a valuable antidote to the current shortage.

While “considerable attention has focused on the adverse effects of . . . widespread and abrupt changes in work practices on patient care. . . .” NIOSH points out that little research has been conducted on the effects of these changes on job characteristics or on employee health and safety¹, (p. 18). Case studies of patient-focused care experiments or downsizing in the health care industry have relied primarily on measuring job satisfaction and not job characteristics such as demands or control.¹⁸

Summary

The limited research available provides little evidence that manufacturing workers are “empowered” under lean production.¹⁸ Rather, the studies suggest that lean production in auto manufacturing creates intensified work paces and demands. Increases in decision authority and skill are very modest and/or temporary, and decision latitude remains low.

Thus, such new systems of work organization may be increasing “job strain” and risk of hypertension and CVD. The NIOSH NORA team describes the concern that “. . . various worker participation or involvement strategies may often be more ceremonial than substantive, having little meaningful influence on worker empowerment—or perhaps even eroding workers’ means to influence job conditions through more traditional labor-management mechanisms such as collective bargaining”¹, (pp. 15–16).

Many research issues remain, including: comparisons between types of new work systems, eg, lean production, “high performance work organizations,” and Scandinavian systems; forms of worker participation; forms of skills training and development; impacts on coworker support and solidarity, for example, to what extent is peer pressure used to increase work pace; and the nature of new work systems in nonunion settings, since existing studies are primarily from unionized workplaces.¹⁸

Impact of Trends in Work Organization on Worker Health and Safety

The organization of work can have an important impact on stress-related health outcomes such as cardiovascular disease, musculoskeletal disorders and psychological disorders (described in detail below). However, as NIOSH points out, it can also influence the level of exposure to physical hazards on the job, for example, workers working extended work hours may be at risk of exceeding

permissible exposure limits to hazardous substances. Increased public contact and alternative work schedules (such as night work), common in the growing service sector, may expose workers to an increased risk of violence on the job. NIOSH also argues that worker health and safety may also be indirectly affected by cuts in occupational health services or the loss of accumulated health and safety knowledge (due to downsizing), lack of safety training (among temporary workers) or by the growth of voucher-style health benefit programs¹, (p. 4).

The NORA team suggests that further research is also needed to assess newer human resource programs, such as incentive pay programs, flex-time, telecommuting (work at home), and strict absenteeism policies, which “may ease or exacerbate risk of stress, illness, and injury among workers. Such programs may reduce stress by harmonizing work and family demands and minimizing daily commutes. However, risks include loss of safety oversight, introduction of occupational hazards into the home, blurring of work and family roles, isolation from peers and feeling constantly tethered to the workplace”¹, (p. 12). The limited number of studies on trends in work organization and worker health and safety are briefly summarized below.

Occupational Accidents and Injuries

Downsizing has been associated with increased rates of fatal occupational injuries in the United States,⁴⁴ and reduced staffing has been associated with injuries among nurses.⁴⁵ Needle stick injuries have been associated with work restructuring in United States hospitals that increases stressful working conditions⁴⁶ and with understaffing and poor organizational climate.⁴⁷ Overtime work has been associated with work accidents and injuries.^{8,48–51}

Recent reviews of studies on organizational factors have found lower injury rates to be associated with

empowerment of the workforce, good relations between management and workers,^{52,53} autonomy, efficacy, delegation of control, low stress, low grievance rates,⁵² and encouragement of long-term commitment of the workforce.⁵³

Work-Related Musculoskeletal Disorders

Musculoskeletal injuries and pain have been associated with organizational downsizing in Finland,⁵⁴ “reengineering” in a Canadian hospital,⁵⁵ low staff density combined with high nursing-unit workloads,^{56,57} lean production in the auto industry in the United States and Canada,¹⁸ overtime work^{58,59} and contingent or temporary work.⁶⁰ A substantial body of research has linked work-related musculoskeletal disorders (WMSDs) to stressful aspects of work organization, such as machine-paced work, inadequate work-rest cycles, wage incentives, time pressure, overload, low job control, low social support, and repetitive work/lack of task variability.^{58,59,61–68} It has been suggested that the dramatic increase in the number of reported WMSDs in the United States, beginning in the mid-1980s, resulted, in part, from work intensification. For example, the meat-packing industry, in response to global competition, had “rationalized” production—increased line speed, introduced machine pacing and fragmented jobs,⁶⁹ which contributed to dramatic increases in WMSDs⁷⁰, (pp. 5 to 6).

The NIOSH NORA musculoskeletal disorders team states that further “research is needed in the areas of task assignment and work/rest schedules, job rotation, job enlargement and length of the workday”⁷¹, (p. 11), and calls for studies on “the impact of downsizing, labor shortages, or increased overtime on the occurrence of MSD”⁷¹, (p. 17).

Psychological/Behavioral Disorders

Downsizing has also been associated with minor psychiatric disorders among English male government employees.⁷² Long work hours have been associated with psychological distress, including “burnout”,⁸ psychological symptoms,⁷³ and unhealthy behaviors such as excessive alcohol use^{8,74} and smoking.^{74,75} The International Labor Office reports that “. . . while the origins of mental instability are complex and the workplace practices and income and employment patterns differ widely among the countries studied, a number of common threads appear to link the high prevalence of stress, burnout and depression to changes taking place in the labor market, due partly to the effects of economic globalization.”⁷⁶

Cardiovascular Disease

Few studies have examined the effect of new organizational practices on cardiovascular outcomes. In a study of English male government employees, downsizing was associated with increases in blood pressure.⁷² However, a body of research exists examining the impact of task level risk factors that have been increasing—job strain and long work hours.

Job strain, the most widely studied job stressor, has been increasing in prevalence in Europe in the past decade and may be increasing in the United States. As of 2000, there had been 24 studies of job strain and CVD among men,⁷⁷ and 6 studies among women,⁷⁸ most with significant positive associations.

The link between job strain and cardiovascular disease (CVD) appears to be mediated in part by blood pressure (BP). While few studies of job strain and casual clinic BP have shown associations,⁷⁹ strong evidence of an association is found in studies where BP is measured by an ambulatory (portable) monitor.⁷⁷ Ambulatory BP (AmBP) is a better

predictor of target organ damage and CVD than is casual clinic BP.⁸⁰ Most cross-sectional studies of job strain and AmBP in men⁷⁷ and in women⁷⁸ have shown significant positive associations, with an effect of job strain (as a dichotomous measure) in the range of 4 to 8 mm Hg systolic AmBP. In the only long-term prospective study of job strain and AmBP (in New York City), men with chronic exposure to job strain over 3 years had 11 to 12 mm Hg higher systolic work AmBP than the group unexposed at both times.⁸¹

Expanding the use of AmBP monitoring, and other forms of BP monitoring in the workplace,⁸² will allow us to identify “occult” (hidden) work-related hypertension, characterized by normal casual clinic BP and elevated work AmBP. Such occult hypertension remains undetected, despite its potential clinical importance.⁸³

Overtime. A few early studies suggested that long working hours may increase risk of heart disease.^{84–86} A 1992 study in the Netherlands found “self-reported prolonged overtime” associated with an excess risk of acute myocardial infarction (MI) among men.⁸⁷ Two recent Japanese case-control studies found an association between long work hours and first acute MI in men, with a 2-fold increase in risk for weekly hours >60 in one study.⁸⁸ The other study found increased risk for either short (<7) or long (>11) daily hours in the previous month.⁸⁹ (The authors speculated that the shorter hours may have been a manifestation of early disease.) Two recent Japanese studies also found some evidence linking overtime work with BP among men working >55 hours per week,^{90,91} with the second study only finding an association among men >50 years old.⁹¹

Socioeconomic Status. The impact of job strain is more consistent and stronger for blue-collar men than among men with higher socioeconomic status (SES), both for CVD⁷⁷ and for AmBP.⁹² Among women,

similar (though not completely consistent) patterns were seen for heart disease in the Framingham Heart Study.^{93–96}

Trends in Incidence of CVD. While there has been a large decline in the CVD mortality rate in the United States over the past 40 years,⁹⁷ CVD incidence does not appear to be declining, at least over the past 20 to 25 years.^{98–100} There is conflicting evidence regarding trends in the prevalence of hypertension.^{101–103}

In Sweden, a decline in the incidence of heart attacks began among some groups in the 1980 s,¹⁰⁴ however, there has also been a growing gap between social class groups. In 1971, risk among blue-collar workers was only 20% higher than white-collar workers, but by 1992, the relative risk had increased to 2. Similarly, in Denmark, there has been an increasing gap in coronary heart disease incidence between white-collar workers and blue-collar workers between 1981 to 1993.¹⁰⁵

On going surveillance and further research is needed to test the hypothesis suggested by these data that trends in stressful job characteristics (job strain and overtime) and stressful new systems of work organization (such as lean production) may be increasing the risk of work-related illness, particularly among lower SES workers.

Work Organization Interventions to Protect Safety and Health

Intervention efforts to decrease the health risks from stressful work organization may take many forms, including individual stress management, education, surveillance, job redesign, collective bargaining, labor-management committees, workers compensation, and government regulations.^{67,106–109} The NIOSH NORA team pointed to studies showing “small, inconsistent and short-term effects” of common workplace job redesign or participa-

tory interventions. However, they also suggest that “organizations cannot be readily changed or improved by attempts to systematically manipulate their individual parts. . . .”¹ (p. 19–20)

Job Redesign

Interventions to improve employee health may well require systematic and sustained efforts to improve work organization. For example, an intervention on an inner city bus line in Stockholm was designed to diminish time-pressure and promote traffic flow. There was a significant decline in systolic BP (–10.7 mm Hg) in the intervention group that was greater than in the comparison group (–4.3).¹¹⁰ An intervention among Swedish civil servants included worker committees which developed and carried out action plans to reduce work stressors. A significant decrease in apolipoprotein B/AI ratio occurred in the intervention group, but not in the control group. Stimulation from and autonomy over work significantly increased in the intervention group but remained the same in the control group.¹¹¹ A Swedish field study also showed that systolic BP, heart rate, epinephrine and self-reported tiredness increased significantly from the start to the end of a day shift at a traditional auto assembly line, but not at a more flexible work organization with small autonomous groups having greater opportunities to influence the pace and content of their work.¹¹²

Individual Health Promotion

Stress management interventions may have positive effects, however, if employees return to an unchanged work environment and high levels of job stressors, those beneficial effects are likely to be eroded.¹¹³ Cardiac risk factor counseling in isolation may have poor efficacy, particularly among occupational groups with a heavy burden of exposure to occupational stressors. For example, Fisher and Belkic state: “despite devotion

of substantial time and the use of state-of-the-art methods. . . . our efforts applied systematically among professional drivers were, at best, only minimally effective, unless there was a concomitant amelioration in stressful working conditions."¹¹⁴

Return to Work After Cardiac Events

Advances in cardiovascular therapy permit the cardiovascular function of many patients to be restored so as to make returning to work potentially possible.¹¹⁵ However, should heart attack patients return to jobs with a stressful work organization? In one study, among men who had suffered a first MI below age 45, the predictive strength for 5-year heart disease mortality of returning to a high strain job was of similar magnitude to the degree of coronary atherosclerosis, and more powerful than left ventricular ejection fraction.¹¹⁶ Occupational physicians need to work with cardiologists and other health professionals to identify potentially modifiable cardioxious stressors in the patient's work environment, and then together formulate and implement a plan to provide a safer return to work after cardiac events.

Worksite Health Promotion

A number of researchers have recommended integrating workplace health promotion and occupational health, to develop complementary behavioral and environmental interventions.^{117,118} One example of such a program is the WellWorks Project conducted in 24 worksites in Massachusetts. A "significant association was observed between participation in nutrition and [environmental] exposure-related activities, suggesting that participation in programs to reduce exposures to occupational hazards might contribute to blue-collar workers' participation in health promotion activities." In addition, "when workers were aware of change their employer had made to

reduce exposures to occupational hazards, they were more likely to participate in both smoking control and nutrition activities"¹¹⁹, (p. 191). Barriers to participation, such as blue-collar workers' time constraints and job responsibilities, were addressed, for example, through negotiation of time-off for participation in health promotion activities.¹²⁰

Conclusions

Recent trends in the organization of work may affect worker health through a variety of pathways—by increasing the risk of stress-related illnesses, such as cardiovascular disease, musculoskeletal disorders and psychological disorders, by increasing exposure to hazardous substances and violence on the job, or by affecting occupational health services and training programs. Much remains to be learned about the nature of changes in work organization, and how they affect worker health and safety. While available evidence is limited, such evidence suggests that recent trends in work organization may be increasing the risk of occupational illnesses.

In a groundbreaking publication,¹ NIOSH has provided a concise summary of available knowledge and a detailed agenda for research and development. The agenda includes the need: for better data collection efforts; to understand the health and safety effects of prominent trends in organizational practices, for more intervention research; and to formalize and promote organization of work as a distinctive field of study within occupational safety and health. I would add a few additional specific recommendations:

1. Despite practical difficulties, we need to assess the health effects of working conditions among contingent, part-time, temporary, undocumented and lower SES workers, who may be facing greater health risks as a result of economic trends and trends in the organization of work.

2. Measurement of blood pressure while employees are working holds great promise as a surveillance technique to detect cases of occult work-related hypertension, sentinel events indicating a stressful work organization.⁸²
3. There is a growing understanding of the various biological pathways by which work organization affects health, especially for cardiovascular disease¹² and for musculoskeletal disorders.⁶⁸ Further research on these pathways should be encouraged.
4. Use of imprecise measures of exposure to work stressors generally leads to a dilution of effect estimates, and thus, an underestimation of the importance of work organization in occupation health. The use of standard generic work stressor questionnaires needs to be encouraged, including the Job Content Questionnaire,¹²¹ the Effort-Reward Imbalance Questionnaire,¹²² the Occupational Stress Index¹²³ and the NIOSH Job Stress Questionnaire.¹²⁴ Researchers also should be encouraged to use additional approaches, such as questions specific to a particular occupation, assessing work history (cumulative exposures), job title averages, and expert-observer assessment.¹²⁵
5. Surveillance, identification of high-risk workplaces and occupations, the provision of clinical care, and design and implementation of workplace interventions can be effectively accomplished by a team approach involving clinicians, occupational health psychologists, health educators, ergonomists, epidemiologists, and other health professionals working with labor-management committees (as in¹²⁶).
6. We need to better estimate the economic costs, including medical costs, workers' compensation costs and absenteeism, of the potential health effects of new trends in work organization. Much of this cost, as with all

occupational illness, is likely borne by workers, their families, and taxpayers.^{127,128} Recognition by employers of the costs they currently bear of work organization-related illnesses through lost work-time and some workers' compensation payments, as well as acceptance of the larger social costs of these illnesses, can help to spur prevention efforts.

References

- National Institute for Occupational Safety and Health. The Changing Organization of Work and the Safety and Health of Working People. Cincinnati: NIOSH; 2002. Report No.: 2002. p. 116.
- Womack J, Jones D, Roos D. The Machine That Changed the World. New York: Rawson; 1990.
- The Tokyo Declaration. *J Tokyo Med Univ*. 1998;56(6):760–7.
- Sauter S, Hurrell J. Occupational health psychology: origins, content and direction. *Prof Psychol Res Pract*. 1999;302:17–22.
- International Labour Office. Key Indicators of the Labour Market 1999. Geneva: International Labour Office; 1999.
- Bluestone B, Rose S. Public policy brief: the unmeasured labor force: the growth in work hours. In: Blithewood, Annandale-on-Hudson, NY: The Jerome Levy Economics Institute of Bard College, Bard Publications Office; 1998.
- U.S. Department of Labor. Report on the American workforce. Washington, D.C.: U.S. Department of Labor; 1999.
- Spurgeon A, Harrington JM, Cooper CL. Health and safety problems associated with long working hours: a review of the current position. *Occup Environ Med*. 1997;546:367–75.
- European Foundation. Time constraints and autonomy at work in the European Union. Dublin: European Foundation for the Improvement of Living and Working Conditions; 1997.
- Bond JT, Galinsky E, Swanberg JE. The 1997 National Study of the Changing Workforce. New York: Families and Work Institute; 1998.
- Walters D. Health and safety strategies in a changing Europe. *Int J Health Serv*. 1998;282:305–1.
- Schnall P, Belkic K, Landsbergis PA, Baker D (Eds.). The workplace and cardiovascular disease. In: Occupational Medicine: State-of-the-Art Reviews. Philadelphia, PA: Hanley and Belfus; 2000.
- Paoli P, Merlié D. Third European Survey on Working Conditions. Dublin: European Foundation for the Improvement of Living and Working Conditions; 2001.
- Burr H. Job control in Danish national surveys. Copenhagen: National Institute of Occupational Health, 2002.
- Vogel J. Swedish Level of Living Survey data. Stockholm: Statistics Sweden; 2002.
- Appelbaum E, Batt R. The New American Workplace. Ithaca: ILR Press; 1994.
- Bjorkman T. The Rationalisation Movement in perspective and some ergonomic implications. *Appl Ergonom*. 1996;272:111–7.
- Landsbergis PA, Cahill J, Schnall P. The impact of lean production and related new systems of work organization on worker health. *J Occup Health Psychol*. 1999;42:108–30.
- Babson S. Lean or mean: the MIT model and lean production at Mazda. *Labor Stud J*. 1993;18:3–24.
- Babson S. Lean production and labor: Empowerment and exploitation. In: Babson S, ed. Lean Work: Empowerment and Exploitation in the Global Auto Industry. Detroit: Wayne State University Press; 1995. pp. 1–37.
- Berggren C, Bjorkman T, Hollander E. Are They Unbeatable? Report from a Field Trip to Study Transplants, the Japanese Owned Auto Plants in North America. Stockholm: Royal Institute of Technology; 1991.
- Adler PS, Goldoftas B, Levine DI. Ergonomics, employee involvement, and the Toyota Production System: a case study of NUMMI's 1993 model introduction. *Ind Labor Relations Rev*. 1997;50:416–437.
- Delbridge R, Turnbull P. Human resource maximization: The management of labour under just-in-time manufacturing systems. In: Blyton P, Turnbull P (eds.). Reassessing Human Resource Management. London: Sage Publications; 1992.
- Lewchuk W, Robertson D. Working conditions under lean production: a worker-based benchmarking study. *Asia Pac Bus Rev*. 1996;2:60–81.
- Lewchuk W, Roberts B, McDonald C, Robertson D. Working Conditions Study: Benchmarking Auto Assembly Plants. Willowdale, Ontario: Canadian Auto Workers; 1996.
- Lewchuk W, Robertson D. Production without empowerment: work reorganization from the perspective of motor vehicle workers. *Capital Class*. 1997;63:37–64.
- Parker SK, Sprigg CA. A move backwards? The introduction of a moving assembly line. In: British Psychological Society Annual Occupational Psychology Conference; 1998.
- Parker SK, Myers C, Wall TD. The effects of a manufacturing initiative on employee jobs and strain. In: Robertson SA (ed.). Contemporary Ergonomics 1995. London: Taylor and Francis; 1995.
- Robertson D, Rinehart J, Huxley C, et al. The CAMI Report: Lean Production in a Unionized Auto Plant. Willowdale, Ontario: Canadian Auto Workers; 1993.
- Kaminski M. Wayne integrated stamping and assembly plant, Ford Motor Co./UAW local 900. In: Kaminski M, Bertell D, Moye M, Yudken J (eds.). Making Change Happen: Six Cases of Unions and Companies Transforming Their Workplaces. Washington, D.C.: Work and Technology Institute; 1996. pp. 25–44.
- Bailey T. Organizational innovation in the apparel industry. *Indust Relations*. 1993;32:30–48.
- Berg P, Appelbaum E, Bailey T, Kalleberg AL. The performance effects of modular production in the apparel industry. *Ind Relations*. 1996;35:356–73.
- Batt R, Appelbaum E. Worker participation in diverse settings: does the form affect the outcome, and if so, who benefits? *Br J Ind Relations* 1995;33:353–78.
- Punnett L, Robins JM, Wegman DH, Keyserling WM. Soft tissue disorders in the upper limbs of female garment workers. *Scand J Work Environ Health*. 1985;11:417–25.
- Brisson C, Vinet A, Vezina M, Gingras S. Effect of duration of employment in piecework on severe disability among female garment workers. *Scand J Work Environ Health*. 1989;15:329–34.
- Richardson T. Reengineering the hospital: Patient-focused care. In: Parker M, Slaughter J (eds.). Working Smart. Detroit: Labor Education and Research Project; 1994. pp. 113–20.
- Sochalski J, Aiken LH, Fagin CM. Hospital restructuring in the United States, Canada, and Western Europe. *Med Care*. 1997;35suppl(10):OS13–25.
- Greiner A. Cost and Quality Matters: Workplace Innovations in the Health Care Industry. Washington, D.C.: Economic Policy Institute; 1995.
- Brannon RL. Restructuring hospital

- nursing: reversing the trend toward a professional workplace. *Int J Health Serv.* 1996;264:643–54.
40. McClure ML, Poulin MA, Sovie MD, Wandelt MA. Magnet Hospitals: Attraction and Retention of Professional Nurses. Kansas City, MO: American Academy of Nursing; 1983.
 41. Kramer M, Schmalenberg C. Magnet hospitals: Part II, institution of excellence. *J Nurs Admin.* 1988;182:11–9.
 42. Aiken LH, Sloan D, Klocinski JL. Hospital nurses' occupational exposure to blood: prospective, retrospective, and institutional reports. *Am J Public Health* 1997;87:103–7.
 43. Joint Commission on Accreditation of Healthcare Organizations. Health Care at the Crossroads. Oakbrook Terrace, IL: Joint Commission on Accreditation of Healthcare Organizations; 2002.
 44. Richardson D, Loomis D. Trends in fatal occupational injuries and industrial restructuring in North Carolina in the 1980s. *Am J Public Health.* 1997;87:1041–43.
 45. Shogren E, Calkins A. Findings of Minnesota Nurses Association Research Project on Occupational Injury/Illness in Minnesota between 1990–1994. St. Paul, MN: Minnesota Nurses Association; 1997.
 46. Aiken LH, Fagin CM. Evaluating the consequences of hospital restructuring. *Med Care.* 1997;35suppl(10):OS1–4.
 47. Clarke S, Sloane D, Aiken L. Effects of hospital staffing and organizational climate on needlestick injuries to nurses. *Am J Public Health.* 2002;927:1115–9.
 48. Daltroy LH, Larson MG, Wright EA, Malspeis S, Fossel AH, Ryan J, et al. A case-control study of risk factors for industrial low back injury: implications for primary and. *Am J Ind Med.* 1991; 204:505–15.
 49. Lowery JT, Borgerding JA, Zhen B, Glazner JE, Bondy J, Kreiss K. Risk factors for injury among construction workers at Denver International Airport. *Am J Ind Med.* 1998;342:113–20.
 50. Leigh JP. Individual and job characteristics as predictors of industrial accidents. *Accid Anal Prev.* 1986;183:209–16.
 51. Hanecke K, Tiedemann S, Nachreiner F, Grzech Sukalo H. Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population. *Scand J Work Environ Health.* 1998;24suppl(3):43–8.
 52. Hale A, Hovden J Management and culture: the third age of safety. A review of approaches to organizational aspects of safety, health and environment. In: Feyer A-M, Williamson A (eds.). Occupational Injury: Risk, Prevention and Intervention. London: Taylor & Francis; 1998.
 53. Shannon H, Mayr J, Haines T. Overview of the relationship between organizational and workplace factors and injury rates. *Safety Sci.* 1997;263:291–17.
 54. Vahtera J, Kivimaki M, Pentti J. Effect of organizational downsizing on health employees. *Lancet.* 1997;350:1124–8.
 55. Shannon H, Woodward C, Cunningham C, et al. Changes in general health and musculoskeletal outcomes in the workforce of a hospital undergoing rapid change: a longitudinal study. *J Occup Health Psychol.* 2001;61:3–14.
 56. Laese F, Fiorito A. Musculoskeletal disorders in hospital nurses: a comparison between two hospitals. *Ergonomics.* 1994;377:1205–1211.
 57. Yassi ea. Early intervention for back-injured nurses at a large Canadian tertiary hospital: an evaluation of the effectiveness and cost benefits of a two-year pilot project. *Occup Med.* 1995; 45(4):209–14.
 58. Bernard B, Sauter S, Fine L, Peterson M, Hales T. Job task and psychosocial risk factors for work-related musculoskeletal disorders among newspaper employees. *Scand J Work Environ Health.* 1994;20:417–26.
 59. Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. *Ergonomics.* 1995; 384:763–76.
 60. European Agency for Safety and Health at Work. The Changing World of Work. Bilbao, Spain: European Agency for Safety and Health at Work; 2002.
 61. Bongers PM, deWinter RR, Kompier MAJ, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease: a review of the literature. *Scand J Work Environ Health.* 1993;19:297–312.
 62. Ahlberg-Hulten GK, Theorell T, Sigala F. Social support, job strain and musculoskeletal pain among female health care personnel. *Scand J Work Environ Health.* 1995;21:435–9.
 63. Leino PI, Hanninen V. Psychosocial factors at work in relation to back and limb disorders. *Scand J Work Environ Health.* 1995;21:134–42.
 64. Krause N, Ragland DR, Greiner BA, Syme SL, Fisher JM. Psychosocial job factors associated with back and neck pain in public transit operators. *Scand J Work Environ Health.* 1997;23:179–86.
 65. Kerr MS, Frank JW, Shannon HS, et al. Biomechanical and Psychosocial Risk Factors for Low Back Pain at Work. *Am J Public Health.* 2001;91:1069–1075.
 66. Warren N, Dillon C, Morse T, Hall C, Warren A. Biomechanical, psychosocial, and organizational risk factors for WRMSD: population-based estimates from the Connecticut Upper-Extremity Surveillance Project (CUSP). *J Occup Health Psychol.* 2000;51:164–81.
 67. Warren N. U. S. regulations for work organization. *Occup Med State-of-the-Art Rev.* 2000;151:275–80.
 68. Moon SD, Sauter SL, eds. Beyond Biomechanics: Psychosocial Aspects of Musculoskeletal Disorders in Office Work. London: Taylor & Francis; 1996.
 69. Novek J, Yassi A, Spiegel J Mechanization, the labor process and injury risks in the Canadian meatpacking industry. *Int J Health Serv.* 1990;20(2):281–96.
 70. NIOSH. Participatory Ergonomics Interventions in Meatpacking Plants. Cincinnati: National Institute for Occupational Safety and Health; 1994.
 71. NIOSH. National Occupational Research Agenda for Musculoskeletal Disorders. Cincinnati: National Institute for Occupational Safety and Health; 2001. Report No.: 2001, p. 117.
 72. Ferrie JE, Shipley MJ, Marmot M, Stansfeld S, Smith GD. The health effects of major organisational change and job insecurity. *Soc Sci Med.* 1998;46: 243–54.
 73. Sparks K, Cooper C, Fried Y, Shirom A. The effects of hours of work on health: A meta-analytic review. *J Occup Organ Psychol.* 1997;70:391–408.
 74. Steptoe A, Wardle J, Lipsey Z, et al. A longitudinal study of work load and variations in psychological well-being, cortisol, smoking, and alcohol consumption. *Ann Behav Med.* 1998;202: 84–91.
 75. Westman M, Eden D, Shirom A. Job stress, cigarette smoking and cessation: the conditioning effects of peer support. *Soc Sci Med.* 1985;20:637–44.
 76. Gabriel P, Liimatainen M-R. Mental Health in the Workplace. Geneva: International Labor Office; 2000.
 77. Belkic K, Landsbergis PA, Schnall P, et al. Psychosocial factors: review of the empirical data among men. In: Schnall P, Belkic K, Landsbergis PA, Baker D (eds.). The Workplace and Cardiovascular Disease. Occupational Medicine: State of the Art Reviews. Philadelphia,

- PA: Hanley and Belfus; 2000. pp. 24–46.
78. Brisson C. Women, work and cardiovascular disease. In: Schnall P, Belkic K, Landsbergis PA, Baker D, (eds.). *The Workplace and Cardiovascular Disease*. Occupational Medicine: State of the Art Reviews. Philadelphia, PA: Hanley and Belfus; 2000. pp. 49–57.
 79. Schnall PL, Landsbergis PA, Baker D. Job strain and cardiovascular disease. *Ann Rev Public Health*. 1994;15:381–411.
 80. Verdecchia P, Clement D, Fagard R, Palatini P, Parati G. Task force III: target-organ damage, morbidity and mortality. *Blood Press Monit*. 1999;4:303–17.
 81. Schnall PL, Landsbergis PA, Schwartz J, Warren K, Pickering TG. A longitudinal study of job strain and ambulatory blood pressure: results from a three-year follow-up. *Psychosom Med*. 1998;60:697–706.
 82. Schnall P, Belkic K. Point estimates of blood pressure at the worksite. *Occup Med State-of-the-Art Rev*. 2000;151:203–8.
 83. Belkic KB, Schnall PL, Landsbergis PA, et al. Hypertension at the workplace—an occult disease? The need for work site surveillance. *Adv Psychosom Med*. 2001;22:116–38.
 84. Russek HI, Zohman BL. Relative significance of heredity, diet, and occupational stress in coronary heart disease of young adults. *Am J Med Sci*. 1958;235:266–75.
 85. Theorell T, Rahe RH. Behavior and life satisfactions of Swedish subjects with myocardial infarction. *J Chron Dis*. 1972;25:139–47.
 86. Alfredsson L, Spetz C, Theorell T. Type of occupation and near-future hospitalization for myocardial infarction and some other diagnoses. *Int J Epidemiol*. 1985;14:378–88.
 87. Falger PRJ, Schouten EGW. Exhaustion, psychologic stress in the work environment and acute myocardial infarction in adult men. *J Psychosom Res*. 1992;36:777–86.
 88. Liu Y, Tanaka H. Overtime work, insufficient sleep, and risk of nonfatal acute myocardial infarction in Japanese men (The Fukuoka Heart Study Group). *Occup Environ Med*. 2002;59:447–51.
 89. Sokejima S, Kagamimori S. Working hours as a risk factor for acute myocardial infarction in Japan: case-control study. *Br Med J*. 1998;317:775–80.
 90. Hayashi T, Kobayashi Y, Yamaoka K, Yano E. Effect of overtime work on 24-hour ambulatory blood pressure. *J Occup Environ Med*. 1996;38(10):1007–11.
 91. Iwasaki K, Sasaki T, Oka T, Hisanaga N. Effect of working hours on biological functions related to cardiovascular system among salesmen in a machinery manufacturing company. *Ind Health*. 1998;36:361–7.
 92. Landsbergis P, Schnall P, Pickering T, Warren K, Schwartz J. Is the association of job strain with blood pressure greater for men with lower socioeconomic status? *Scand J Work Environ Health*. (In press.).
 93. Haynes SG, Feinleib M. Women, work and coronary heart disease: prospective findings from the Framingham Heart Study. *Am J Public Health*. 1980;70(2):133–41.
 94. Eaker ED, Packard B, Thom TH. Epidemiology and risk factors for coronary heart disease in women. In: Douglas PS (ed.). *Heart Disease in Women*. Philadelphia: FA Davis & Co.; 1989. pp. 129–45.
 95. Eaker ED. Myocardial infarction and coronary death among women: psychosocial predictors from a 20-years follow-up of women in the Framingham study. *Am J Epidemiol*. 1992;135(8):854–64.
 96. LaCroix AZ. High demands/low control work and the incidence of CHD in the Framingham cohort [PhD thesis]. Chapel Hill, NC: University of North Carolina; 1984.
 97. Liao Y, Cooper RS. Continued adverse trends in coronary heart disease mortality among blacks, 1980–91. *Public Health Reports*. 1995;110:572–579.
 98. Rosamond WD, Chanbless LE, Folsom AR, et al. Trends in the incidence of myocardial infarction and in mortality due to coronary heart disease, 1987 to 1994 [abstract]. *N Engl J Med*. 1998;339:863.
 99. Wilson PWF, D'Aostino RB, Levy D, et al. Trends in coronary heart disease: a comparison of the Original (1956–1968) and Offspring Framingham Study Cohorts. In: American Heart Association; 1991 November 11–14; Anaheim, CA; 1991.
 100. Sytkowski PA, D'Agostino RB, Belanger A, Kannel WB. Sex and time trends in cardiovascular disease incidence and mortality: the Framingham Heart Study, 1950–1989. *Am J Epidemiol*. 1996;143(4):338–50.
 101. Kannel WB, Garrison RJ, Dannenberg AL. Secular blood pressure trends in normotensive persons: the Framingham Study. *Am Heart J*. 1993;125:1154–8.
 102. Brody JE. Heart Diseases are Persisting in Study's Second Generation. *New York Times*; January 5, 1994.
 103. Burt VL, Cutler JA, Higgins M, et al. Trends in the prevalence, awareness, treatment, and control of hypertension in the adult US population. *Hypertension*. 1995;26:60–9.
 104. Hallqvist J, Lundberg M, Diderichsen F, Ahlbom A. Socioeconomic differences in risk of myocardial infarction 1971–1994 in Sweden: time trends, relative risks and population attributable risks. *Int J Epidemiol*. 1998;27:410–5.
 105. Tuchsén F, Endahl LA. Increasing inequality in ischaemic heart disease morbidity among employed men in Denmark 1981–1993: the need for a new preventive policy. *Int J Epidemiol*. 1999;28:640–4.
 106. Landsbergis PA, Schurman SJ, Israel BA, et al. Job stress and heart disease: evidence and strategies for prevention. *New Solutions*. 1993;Summer:42–58.
 107. Landsbergis P. Collective bargaining to reduce CVD risk factors in the work environment. *Occup Med State-of-the-Art Rev*. 2000;151:287–92.
 108. Levi L. Legislation to protect worker CV health in Europe. *Occup Med State-of-the-Art Rev*. 2000;151:269–73.
 109. Shimomitsu T, Odagiri Y. Working life in Japan. *Occup Med State-of-the-Art Rev*. 2000;151:280–1.
 110. Rydstedt LW, Johansson G, Evans GW. The human side of the road: Improving the working conditions of urban bus drivers. *J Occup Health Psychol*. 1998;3:161–71.
 111. Orth-Gomer K, Eriksson I, Moser V, Theorell T, Fredlund P. Lipid lowering through work stress reduction. *Int J Behav Med*. 1994;13:204–14.
 112. Melin B, Lundberg U, Soderlund J, Granqvist M. Psychophysiological stress reactions of male and female assembly workers: a comparison between two different forms of work organization. *J Organ Behav*. 1999;20:47–61.
 113. Nowack K. Screening and management of the workplace in relation to cardiovascular disease risk. *Occup Med State-of-the-Art Rev*. 2000;151:231–3.
 114. Fisher J, Belkic K. A public health approach in clinical practice. In: Schnall P, Belkic K, Landsbergis PA, Baker D (eds.). *The Workplace and Cardiovascular Disease*. Occupational Medicine: State of the Art Reviews. Philadelphia: Hanley and Belfus; 2000. pp. 245–56.
 115. deGaudemaris R. Clinical issues: return to work and public safety. *Occup Med State-of-the-Art Rev*. 2000;151:223–30.
 116. Theorell T, Perski A, Orth-Gomer K, Hamsten A, de Faire U. The effects of

- the strain of returning to work on the risk of cardiac death after a first myocardial infarction before age 45. *Int J Cardiol.* 1991;30:61–7.
117. Heaney CA, Goetzel RZ. A review of health-related outcomes of multi-component worksite health promotion programs. *Am J Health Promotion* 1997;11:290–308.
 118. Dejoy DM, Southern DJ. An integrative perspective on work site health promotion. *J Occup Med.* 1993;35:12:1221–30.
 119. Sorensen G, Stoddard A, Ockene JK, Hunt MK, Youngstrom R. Worker participation in an integrated health promotion/health protection program: results from the WellWorks Project. *Health Educ Q.* 1996;23:191–203.
 120. Sorensen G, Himmelstein JS, Hunt MK, et al. A model for worksite cancer prevention: integration of health protection and health promotion in the WellWorks Project. *Am J Health Promot.* 1995;10:1: 55–62.
 121. Karasek RA, Gordon G, Pietrokovsky C, et al. Job Content Instrument: Questionnaire and User's Guide. Los Angeles/Lowell, MA: University of Southern California/University of Massachusetts, Lowell; 1985.
 122. Siegrist J, Peter R. Measuring Effort-Reward Imbalance at Work: Guidelines. Dusseldorf: University of Dusseldorf; 1996.
 123. Belkic K, Savic C, Theorell T, Cizinsky S. Work Stressors and Cardiovascular Risk: Assessment for Clinical Practice. Part I. Stockholm: National Institute for Psychosocial Factors and Health. Section for Stress Research, Karolinska Institute, WHO Psychosocial Center; 1995. Report No.: 256.
 124. National Institute for Occupational Safety and Health. NIOSH generic job stress questionnaire. Cincinnati: NIOSH; 1997.
 125. Landsbergis PA, Theorell T. Measurement of psychosocial workplace exposure variables. *Occup Med State-of-the-Art Rev.* 2000;15:1:163–88.
 126. Herbert R, Plattus B, Kellogg L, et al. The union health center: a working model of clinical care linked to preventive occupational health services. *Am J Indust Med.* 1997;31:263–73.
 127. Leigh P, Schnall P. Costs of occupational circulatory disease. *Occup Med State-of-the-Art Rev.* 2000;15:1:257–68.
 128. Markowitz SB, Fischer E, Fahs MC, Shapiro J, Landrigan PJ. Occupational disease in New York State: a comprehensive examination. *Am J Indust Med.* 1989;16:417–35.