

**Steps to a Healthier US Workforce:
Integrating Occupational Health and Safety and Worksite Health Promotion:
State of the Science**

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Abstract

This paper presents the rationale and scientific evidence for coordinating and integrating worksite health promotion and occupational health and safety as a means of enhancing the effectiveness of efforts to promote and protect worker health. Commissioned by NIOSH for its 2004 Steps to a Healthier US Workforce Symposium, this paper is intended to stimulate discussion and improve communication between the fields of worksite health promotion and occupational safety and health. We describe the parameters of each approach and suggest common goals and areas to increase coordination, with special attention to the implications of a rapidly changing labor market on future research priorities. We present recommendations for future research, barriers to be overcome to advance knowledge in this area, and suggestions for creating additional opportunities for scientists from a broad range of disciplines to engage in integrated occupational health and safety/worksite health promotion research aimed at improving worker health.

A. Introduction

In this paper, we review the scientific evidence for coordinating and integrating worksite health promotion and occupational health and safety as a means of enhancing the effectiveness of efforts to promote and protect worker health. The overall aim of this paper is to introduce the parameters for a research agenda aimed at improving worker health through such integrated and coordinated efforts.

Specifically, we summarize here the rationale for integrating occupational safety and health (OSH) and worksite health promotion (WHP). As a basis for considering integration of these fields, we briefly examine the types of research conducted to date examining the efficacy of occupational health and safety interventions and of worksite health promotion interventions, although we note that a full review of these literatures is beyond the scope of this paper. We review the emerging evidence on the efficacy of integrated interventions targeting occupational health and safety and worksite health promotion together. We hope that this paper might serve as a bridge to improve communication between the fields of worksite health promotion and occupational health and safety. With that in mind, we have sought to clarify the parameters of each approach and suggest common goals and areas to increase coordination. We use this review as the foundation for recommended research priorities and future directions.

As we described in an earlier paper,¹ the National Institute for Occupational Safety and Health (NIOSH) concluded in 1984 that simultaneously addressing worksite occupational safety and health and worksite health promotion would “make possible a ‘synergism of prevention’ to improve the health of workers through comprehensive risk reduction.”² As illustrated in Figure 1, in this paper we define occupational safety and health and worksite health promotion as the content being addressed by intervention efforts potentially aimed across multiple levels of influence.^{3,4} At the individual/interpersonal level, interventions aim to educate individual

workers and build social norms supportive of worker health, for example through educational classes or one-on-one training programs. Interventions at the environmental/organizational level of influence aim to modify the work environment or organization in support of worker health outcome. By the term “environmental/organizational,” we mean to encompass both the work environment or organization, including for example work climate and organizational policies, and the physical environment, including for example the potential for exposures to dusts, fumes, vapors, noise, ambient temperature, and other potential hazards. Increasingly, interventions are coordinating efforts across the individual/interpersonal and environmental/organizational levels in recognition of the mutually reinforcing capabilities of comprehensive approaches to worker health, which we term here multi-level interventions.^{5,6}

Figure 1 about here

Occupational safety and health (OSH) interventions are designed to minimize workers’ exposures to job-related risks, including exposures to physical, biological, chemical, ergonomic and psychosocial hazards.⁷ These interventions may include changes in the organization and environment, such as the use of product substitution, engineering controls, and job re-design, as well as through individual efforts, including use of personal protective equipment, generally seen as a supplemental measure. These interventions are predominantly within the domain of management decisions, rather than of individual worker actions,^{8,9} and may also be the subject of joint decision-making by labor and management through collective bargaining or less formal means.

Individual health-related behaviors are the prime target of worksite health promotion (WHP), which aims to promote healthy behaviors such as not using tobacco, weight control, a

healthy diet, physical activity, seat belt use, influenza vaccinations, adherence to screening guidelines (e.g., mammography screening, blood pressure, cholesterol), substance abuse prevention, case management (e.g., diabetes), and sun exposure prevention, as key examples.¹⁰⁻¹²

In a classic article, Walsh and her colleagues termed behavioral or personal exposures “life risks,” to be differentiated from occupational exposures they termed “job risks.”¹³ Worksites provide an important setting for influencing life risks through educational efforts designed to reach large numbers of workers not accessible through other channels. Worksites offer the potential for support of long-term behavior changes, mobilization of peer support, use of environmental supports, and the possibility of offering comprehensive multi-level interventions repeatedly over time as a means of building and sustaining interest in behavior changes.^{9, 14-17} In general, corporate interest in and support for worksite health promotion has been considerable.^{4,}

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Despite addressing differing subject matter and aims, occupational health and safety and worksite health promotion clearly share the common goal of promoting worker health, with complementary functions in protecting and enhancing the health of workers, and thereby provide an important opportunity for coordinated and integrated efforts.^{1, 5, 19, 20} Coordination between occupational health and safety and health promotion in the workplace has not been the norm in the United States, however. The two fields approach their objectives with differing assumptions, set differing priorities, and utilize different methods. Understanding the distinct underpinnings of these two fields may shed light on historic and present-day tensions associated with the integration of occupational health and safety and worksite health promotion, and can set the stage for productive dialogue toward a shared goal of improving worker health.

Flourishing worksite health promotion efforts over the last two decades have often spawned concerns and suspicions within the field of occupational safety and health that

employers are shifting the burden for worker health away from management to individual workers.^{8, 13, 21-23} This trend may reflect a shift in public health practice away from environmental/organizational determinants of disease to a focus on individual risk-taking behaviors, indicative of a broader political movement toward reducing corporate social and environmental responsibility.²³ In this vein, resources for workplace public health practice have been increasingly directed toward improving workers' personal health behaviors, such as smoking, diet, and exercise, while de-emphasizing traditional occupational health and safety issues such as physical exposures and stressful working conditions. Even within the field of occupational safety and health, behavior-based safety programs have become prominent, directing attention toward "accident-prone" workers rather than redesigning hazardous processes.²³ Thus, for example, while many unions and working people recognize that smoking is a health threat, they may be mistrustful of worksite health promotion programs that provide smoking cessation services but ignore workplace safety concerns. It is therefore not surprising that relationships between health promotion professionals and those in occupational health and safety may be strained, particularly in situations where there might be competition for scarce resources devoted to worker health.^{8, 13, 22, 24} The result has all too often been a fragmented approach to worker health.^{16, 20}

Despite these tensions, there have been increasing calls for a comprehensive approach to worker health, based on multidisciplinary, integrated methods aimed at creating health-promoting workplaces.^{5, 9, 13, 15-17, 19, 20} Integrating worksite health promotion and occupational health and safety is a core principle of numerous international efforts and declarations in support of worker health.²⁵⁻²⁹ Evidence is beginning to accumulate, documenting the potential benefits of interventions integrating efforts to reduce behavioral risks with OSH initiatives, particularly for worker health behaviors.^{5, 30-32}

B. Rationale for integrating occupational health and safety and worksite health promotion

Worksite health promotion and occupational health and safety provide two parallel pathways for promoting worker health within healthy workplaces. The argument we make in this paper is that these parallel efforts will be strengthened when they are coordinated and integrated, rather than separate and independent. We outline here four overarching reasons for integrating these two parallel approaches. These reasons provide a balance between the “business case” for integrated programs – focusing on potential cost savings and productivity gains for employers – with the “worker case” for integrated programs – focusing on clear benefits for workers as a result of a holistic approach to worker health. As we recognize the potential benefits, we are cognizant, too, that there are potential risks associated with integrated approaches. For workers, creating opportunities for management to gather personal information about health behaviors may present concerns that managers could misuse this information. For example, ill-intentioned managers could allow information about workers’ health habits to unfairly influence decisions about raises and promotions, or as evidence to argue against work-relatedness of illnesses in workers’ compensation disputes. It is essential, therefore, as we contemplate the integration of health promotion and health protection, that we recognize the vast potential value as well as the risks to be guarded against.

1. Workers’ risk of disease is increased by exposures to both occupational hazards and risk-related behaviors. Occupational disease and injury continue to account for a considerable proportion of the burden of disease in the US. Current occupational health and safety surveillance data indicate that 6.1 million illnesses and injuries occurred in 1997 in private-sector employment settings; 6,238 workers died of occupational diseases in that same year. Between 1973 and 1997, the number of lost workdays attributable to occupational illnesses and injuries

rose from 1.9 million to 2.9 million per year.³³ Health behaviors also play a significant role in a range of health outcomes; for example, according to a recent assessment of contributors to overall mortality in the US, tobacco accounts for 18% of total mortality, and diet and physical activity, 17%.³⁴

The effects of these life risks and job risks are not independent of one another.³⁵ Take, as an example, exposure to tobacco.⁵ Some of the same toxic agents present in tobacco smoke are also hazards in the worksite (e.g., benzene), and thus, workers who smoke may be doubly exposed through their exposures on the job. In addition, tobacco smoke and toxic agents found in the worksite may interact synergistically, increasing the profound effect beyond the simple addition of the two exposures alone (e.g., asbestos). Workplace chemicals may also be transformed into more harmful agents by smoking. For example, the heat generated by burning tobacco may increase the toxicity of other chemicals inhaled as smoker inhales a cigarette. Similarly, tobacco use has been associated with another type of occupational risk, stressful work organization, such as low job control.^{36, 37}

2. The workers at highest risk for exposure to hazardous working conditions are also those most likely to engage in risk-related health behaviors. Exposure to both job and life risks are concentrated among those employed in working class occupations, meaning those employed in blue-collar or service occupations as typically defined in US studies^{38, 39} or in lower supervisory, technical, semi-routine or routine occupations, as defined by the United Kingdom's new National Statistics Socio-Economic Classification System (NS-SEC).⁴⁰ Workers in these occupations are more likely to be injured or become ill due to workplace hazards than are professional employees. For example, 1997 data indicate that truck drivers and laborers were the occupations with the most injuries and illnesses involving days away from work, followed by nursing aides and orderlies.³³ Life risks also are concentrated in working class occupations and

workers with lower levels of education. The smoking prevalence among blue-collar workers (including craftpersons and kindred workers, operatives, transportation operatives, and laborers) is 37% for men and 33% for women,³⁸ compared to 23% for the population overall.⁴¹ *National Health Interview Survey* data for 2000 indicates that smoking prevalence is highest for persons employed in working class jobs, with less education, and with low incomes, and that while there is no socioeconomic gradient in quit attempts, those with the most socioeconomic resources are most successful with quitting. Similarly, overweight status is inversely associated with education level⁴²⁻⁴⁵ and occupation.^{42, 43} According to the 2001 Behavioral Risk Factor Surveillance System, prevalence of obesity among adults ranges from 16% for person with greater than a college education to 23% for those with high school and 27% for those with less than high school.⁴⁵

There is evidence as well that exposures to job hazards and health behaviors are correlated. For example, we found that blue-collar workers exposed to hazards on the job were more likely to smoke than their unexposed counterparts.⁴⁶ Similarly, increased exposure to hazards on the job has been linked by others with unhealthy dietary habits among blue-collar workers^{47, 48} and with binge drinking.⁴⁹

These dual exposures are associated with a range of short-term adverse outcomes. Walsh and her colleagues¹³ surveyed workers and managers from a large manufacturing firm about their occupational risks and health behaviors. Workers with high levels of job risks and life risks missed an average of three additional absence days per year, and reported five times as much psychological distress, including depression, anxiety and sleep disturbances, as workers in the low-risk group. In addition, they reported more symptoms of physical pain, poorer general health, and lower job satisfaction than the sample overall.

3. Integrating worksite health promotion and occupational health and safety may increase program participation and effectiveness for high-risk workers. Workers at highest risk for job exposures may be more likely to participate in integrated OSH/WHP than in worksite health promotion programs alone. There is evidence from the risk communication field that people place highest priority on those risks that are involuntary, outside personal control, undetectable, and that seem unfair,⁵⁰⁻⁵² features that often characterize occupational hazards. Accordingly, workers may perceive management actions to reduce workers' exposures to occupational hazards as of greater importance than personal health behavior changes, and may feel that the benefits of individual health behavior changes are insignificant in the face of exposures to workplace hazards.⁵ Skepticism about management's commitment to improve worker health may reduce workers' interest in participating in health promotion programs at work.^{20, 53, 54} Conversely, employer efforts to create a safe and healthy work environment may foster a climate of trust and thereby enhance workers' receptivity to messages from their employer regarding health behavior change. In a study of blue-collar workers, we found that workers who reported that their employers had made changes to reduce hazardous exposures on the job were significantly more likely to have participated in smoking cessation and nutrition programs than workers not reporting management changes.⁵⁵ Reduction of job risks may be required to gain credibility with this audience, and to increase its receptivity to health education messages about individual health behaviors.^{22, 31}

In addition, programs integrating messages about job risks and risk-related behaviors may increase workers' motivations to make health-behavior changes. For example, one study found that blue-collar smokers exposed to chemical hazards on the job were more than three times more likely than those unexposed to be thinking of quitting smoking or taking action to quit.⁴⁶ Wellness programs that fail to address the hazards of work miss significant sources of health-related problems and costs, both to individual workers and employers. At the same time, occupational

health and safety programs that ignore life risks may be underestimating workers' understanding of the complexities of health and well-being.¹³

We describe findings of the efficacy of interventions integrating worksite health promotion and occupational health and safety for high-risk workers in Section E.

4. Integrated occupational health and safety/worksite health promotion efforts additionally may benefit the broader work organization and environment. A growing literature demonstrates the benefits of worksite health promotion programs in terms of both direct costs (e.g., reduction in health care costs)⁵⁶⁻⁵⁸ and indirect costs (e.g., reductions in costs resulting from lost production as a result of reductions in productivity or increases in work absence).^{57, 59-65} In addition, research is also indicating the cost effectiveness of OSH interventions to prevent occupational diseases.⁶⁶⁻⁶⁹ As an indicator of the mounting interest in this area of research, a recent supplement to the *Journal of Occupational and Environmental Medicine*[‡] devoted an entire issue to effects of disease on workplace productivity. Within this growing literature, comprehensive programs integrating employee wellness, disability management, employee assistance, and occupational medicine have been shown to result in long term savings in medical care utilization and expenditures⁵⁶ and reductions in sickness absence.³⁰ These findings are underscored by other papers prepared for this NIOSH Symposium.^{70, 71} In addition, some experts have posited that the overall success of the organization is enhanced through coordination of rather than competition for resources.^{6, 9, 15, 27} For example, the World Health Organization's Regional Guidelines for the Development of Healthy Workplaces defines a healthy workplace as one that aims to create a healthy and safe work environment, ensure that worksite health promotion and occupational health and safety are an integral part of management practices, foster work styles and lifestyles conducive to health, ensure total organizational participation, and extend the positive impacts to the surrounding community and environment.²⁷ This

document further underscores the benefits of such coordinated efforts, including their contributions to a positive and caring image for the company, improvements in staff morale, reduced turnover and absenteeism, and improved productivity.²⁷ It is imperative that future research document ways in which integrated OSH/WHP programs may further the mission of the organization through support for a healthy and productive workers within a healthy work organization.

C. Occupational safety and health programs

Occupational safety and health (OSH) programs have traditionally been concerned with reducing hazardous exposures at work that can lead to work-related injury, illness and disability, and also may include emergency response programs.⁷² The US Department of Health and Human Services has defined national health goals to be reached by the year 2010 in its *Healthy People 2010 Report*,¹⁰ including several objectives related to OSH. Two broadly-stated goals are to reduce deaths from work-related injuries from 4.5 to 3.2 deaths per 100,000 workers aged 16 and older per year across all industries, and to reduce work-related injuries resulting in medical treatment, lost time from work, or restricted work activity 6.2 to 4.3 injuries per 100 full-time workers per year aged 16 and older. Additional OSH objectives relate to reducing injury and illness associated with overexertion or repetitive strain, deaths from pneumoconiosis, work-related homicides, elevated blood lead levels from work exposures, occupational skin diseases and disorders, work-related stress, occupational needle-stick injuries among health care workers, and work-related noise-induced hearing loss.¹⁰

[‡] *Journal of Occupational and Environmental Medicine*, June 2004 46(6).

Prevalence of occupational safety and health activities

To our knowledge, there have been no national surveys of employers to determine the prevalence of OSH initiatives, though measuring such initiatives may prove infeasible given the varied nature of hazards across industries, occupations, and worksites. Furthermore, unlike health promotion activities, which employers choose to offer on a voluntary basis, OSH activities may either be initiated because employers are required to do so to comply with specific Occupational Safety and Health Administration (OSHA) standards that apply to their industry (e.g. cotton dust standard), or because they choose to go beyond regulatory requirements to provide additional health and safety measures. Even attempts to determine the prevalence of health and safety practices based on OSHA compliance or violations would yield incomplete and inaccurate data, because worksites are not routinely inspected. In 1996, 1,200 OSHA inspectors were assigned protection of 105.8 million workers at 6.4 million workplaces.⁷³ One crude and incomplete estimate of the prevalence of OSH activity is the number of worksites that have achieved Voluntary Protection Program (VPP) status. This program provides regulatory relief for companies meeting OSH performance criteria.⁷⁴ In 2002, OSHA reported 864 VPP sites in the US,⁷⁵ a very small proportion of the total number of worksites in the US and a reflection only of the number of worksites that apply for and receive this status.

Selected frameworks for occupational safety and health interventions

Occupational health and safety initiatives can take many different forms in different types of worksites, depending not only on the hazards present, but also on management practices. In unionized worksites, unions may also play a role in determining how hazards are addressed. Interventions to protect workers' health can operate at multiple levels of influence (individual, organizational, or both), as depicted in Figure 1. Many occupational health practitioners would

argue for an approach that targets organizational-level change over individual worker behavior, following a well-recognized “hierarchy of controls” model. This model calls for adherence to a recommended sequence for control of hazards beginning with control as close to the source as possible.⁷⁶ The ideal choice is the substitution of safer substances for those that are hazardous, thereby removing the potential hazard. Engineering controls provide a second line of defense for the control of hazards, followed by administrative controls, such as job redesign or job rotation. Personal protective equipment used by workers is recommended only as a last line of defense when substitution or engineering controls are not possible. By itself, it is not an acceptable method of control because its effectiveness is highly variable and not reliable. In a manufacturing setting, for example, a hierarchy of controls model would call first for elimination of substitution of a chemical that gives off toxic fumes, followed by engineering efforts to provide ventilation to reduce workers’ exposure to fumes, and then by administrative controls such as rotating workers on and off jobs that involve the chemical so as to reduce total exposure to any one worker, and finally by personal protective equipment such as respirators. Another example might be addressing medical errors in a health care setting by focusing at the organizational-level to assess whether the staffing plan is adequate to avoid excessive worker overload, rather than at the individual level to educate workers how to cope with stress and overwork.

Useful as it is, the model was not intended to address other important aspects of OSH, including the role of managers and workers in creating “programmatic” or “systematic” approaches to occupational safety and health. Such approaches are rapidly emerging internationally as the preeminent strategy for employers to reduce occupational illness and injury.⁷⁷ Several countries have developed OSH program regulations or guidelines,⁷⁸ including the US. OSHA has promoted a set of voluntary guidelines for OSH programs since 1989,⁷⁹ and

released a draft OSH program rule to the public in 1998.^{80, 81} Despite the rising prominence of the OSH program approach as a strategy for reducing occupational illnesses and injuries, there are few peer-reviewed empirical research reports about OSH programs or methods for assessing them,^{77, 82, 83} yet these programs provide a useful framework for discussing such initiatives. The four program elements defined by OSHA are: (1) *management commitment to and employee participation in OSH activities* (e.g., management sets health and safety goals for company on regular basis; company allocates money specifically for health and safety, managers directly accountable for health and safety in their areas; employees participate in health and safety committees; means available for employees to report health & safety hazards, problems, concerns); (2) *workplace analysis* (e.g., new processes, machinery, methods, materials reviewed for health and safety before being introduced in work environment; health and safety audits; investigations of injuries, property damage, near misses); (3) *hazard prevention and control* (e.g., specific time deadlines set for correction of identified hazards; follow-up inspections made to determine whether corrective action taken; engineering controls designed to eliminate or substitute hazards are considered before adopting personal protective equipment or administrative controls; and (4) *education and training* (e.g., health and safety training provided to all employees; additional training provided to employees that might encounter new hazards when changing jobs in company; training provided to contract or part-time employees).

The description of these two OSH intervention frameworks is presented here in the hope of providing a structure for readers outside the discipline of occupational safety and health, in order to provide a basis for conceptualizing OSH interventions beyond addressing a particular hazard.

Intervention effectiveness research in occupational safety and health

Before reviewing intervention research in OSH, we describe the political and economic context in which such interventions are undertaken in the US, primarily intended for readers less familiar with the field. The patterns of worker morbidity and mortality flow directly from the choices of technology made by employers.⁸⁴ Employer choices, at least in the US, are structurally driven by market forces that aim to maximize profit and minimize costs, the latter of which can include the costs of materials, technology, and systems to protect workers' health.⁸⁵ Intense competition may force firms to cut the costs of production and increase productivity as much as possible, which in many cases, may pit resources for health and safety against corporate profits, and may additionally increase worker stress. These are structural factors that shape decisions made by employers, regardless of their individual dispositions toward the health of their workers. This phenomenon explains, in part, why businesses and worker organizations, such as labor unions, battle intensely with one another over regulatory standards proposed by the Occupational Safety and Health Administration (OSHA), in addition to their ideological clashes about the appropriate role of the state in governing private employers.^{84, 85} This is to say that interventions to improve worker health and safety – whether undertaken voluntarily by employers or imposed upon them by regulatory standards – are situated in a political and economic context that must be considered when planning for interventions in worksites – be they OSH-specific or integrated OSH/WHP.

The aim of intervention effectiveness research in OSH is to evaluate the impact of interventions to prevent work-related injuries and illnesses. This type of research is relatively new to the OSH field compared to the worksite WHP field. The historical roots of occupational safety and health practice and research in the US can be found in factory inspections performed at the start of the twentieth century by politically and socially progressive occupational physicians such as Alice Hamilton, who called attention to lead dust and other hazards.⁸⁶ For the

next several decades, occupational health researchers engaged mainly in surveillance-oriented research, using epidemiologic and exposure assessment methods. This research attempted to determine associations between working conditions and worker illness and injury, which in turn provided a scientific basis for addressing hazardous exposures through regulation or other means, on the assumption that removing or reducing certain hazards would result in fewer injuries and illnesses. More recently, the field has begun to embrace research aimed at determining the efficacy and effectiveness of interventions to prevent or ameliorate hazards.⁸⁷

The peer-reviewed literature contains only a limited number of intervention effectiveness studies conducted in the 1980s and early 1990s, which have been reviewed by others.^{88-94‡} Most reviews to date have concluded that OSH intervention studies were more likely to focus on improving workers' knowledge and behavior of hazards than on engineering or administrative improvements in the work environment – priorities that are at odds with the hierarchy of controls model described above. Inherent in any such review is identification of methodologic limitations, which for some studies included small sample sizes of workers within a single worksite, quasi-experimental or non-experimental study designs, lack of a theoretical framework to guide intervention and evaluation, and outcome measures based solely on worker self-reports rather than additional and perhaps more objective outcomes, such as reductions in hazardous exposures. Similar such concerns have been raised in reviews of worksite health promotion intervention studies. (See Section D.) As is also the case in worksite health promotion research, most OSH studies have been conducted in large businesses. With a few exceptions, small businesses have been largely understudied,^{83, 95} despite their centrality in the US economy: 99% of employers employ less than 500 workers and approximately 50% of all workers.⁹⁶

In 1996, the National Institute for Occupational Safety and Health (NIOSH) and its partners announced the National Occupational Research Agenda (NORA), as a guide for OSH

research into the future, not only for NIOSH but for the entire occupational safety and health community.^{97, 98} NIOSH sought the input of a approximately 500 organizations and individuals from the OSH community at large to develop the Agenda, which was the first such research guide in the field.⁹⁹ The NORA process resulted in identification of 21 research priorities, including intervention effectiveness research. The NORA intervention effectiveness website¹⁰⁰ lists some 40 current intramural and extramural projects designed to assess the effectiveness of a wide range of interventions, such as: a machine guarding intervention to reduce injuries in metal stamping and machine shops; ergonomic and work organizational interventions to reduce arm and hand pain, reduce lost time, and improve hand function in computer-based customer service work; crime prevention strategies to protect cab drivers; and training interventions targeting injuries occurring among small business workers.

D. Worksite health promotion programs

Historically, worksite health promotion (WHP) has focused on promoting worker health through reduction of individual risk-related behaviors such as tobacco use, substance use, a sedentary lifestyle, poor nutrition, stressors and reactions to them, reproductive risks, and other preventable health behaviors.^{6, 101} WHP may incorporate or be coordinated with employee assistance programs, clinical prevention services, disease management programs, and other health benefits.¹⁰¹ Worksites may plan programs with worker input, and may set priorities based on their own assessment of needs, and/or emphasizing those behaviors associated with the largest decrements in mortality and morbidity, increases in disability, decreases in work productivity, or potential for cost savings relative to health impact.¹⁰²⁻¹⁰⁴

Healthy People 2010 defines two specific goals for worksite health promotion: to increase the proportion of worksites offering a comprehensive employee health promotion

[‡] For further reading: *American Journal of Preventive Medicine* May 2000 Supplement, 18(4, Suppl 1).

program to their employees, targeting 75% participation by the year 2010; and to increase the proportion of employees who participate in employer-sponsored health promotion programs, again, targeting 75% participation rates by the year 2010.¹⁰ These recommendations include five elements in defining a comprehensive worksite health promotion program: (1) health education, including a focus on skill development for health behavior change, and information dissemination and awareness building, preferably tailored to employees' interests and needs; (2) supportive social and physical environments, including implementation of policies that promote health and reduce risk of disease; (3) integration of the worksite program into the worksite's organizational structure; (4) linkage to related programs, such as employee assistance programs and programs to help employees balance work and family; and (5) worksite screening programs, ideally linked to medical care to ensure follow-up and appropriate treatment as necessary.¹⁰⁵

Prevalence of and participation in worksite health promotion programs

The 1999 National Worksite Health Promotion Survey found that a third (34%) of employers with 50 or more employees offered comprehensive health promotion programs that met Healthy People 2010 criteria, and that these programs were offered by half of the nation's largest employers (those with 750+ employees).¹⁰ This survey also found that over 90% of surveyed worksites offered at least one health promotion activity, providing a solid foundation for future efforts.

As noted above, the Healthy People 2010 goals also aim to increase the proportion of workers participating in health promotion programs. According to the National Health Interview Survey, in 1994, 61% of U.S. employees aged 18 years and older in 1994 took part in employer sponsored health promotion activities, defined to include one or more elements of a comprehensive worksite health promotion program.¹⁰⁶

Worksite health promotion programs are not equally available to all workers. Using results from the 1994 National Health Interview Survey, Grosch et al found that nonprofessionals, blacks, and individuals with lower education levels were less likely to work in worksites that offered some type of health promotion programming.¹⁰⁷ Even when programs are available, participation rates are not equivalent across workers. Participants are likely to be salaried, white-collar employees whose general health is better than average.¹⁰⁸ Blue-collar workers are less likely to participate in worksite health promotion programs than are white-collar workers.^{10, 54, 55, 109-112} Low participation also is associated with lack of access to and extent of health insurance coverage.^{10, 113} Low participation may be in part a consequence of ineffective “marketing” of programs to these workers,^{10, 113} as well as structural barriers to participation. For example, supervisors often function as gatekeepers controlling worker access to worksite health promotion activities, and may be reluctant to allow workers to attend programs on work time in order to keep production lines moving, thus presenting the greatest barriers for those workers with the least amount of discretion over their time.^{54, 114} Further barriers may include working over-time, shift work, having a second job, car-pooling to work, long distances between the plant and the employee’s home, and responsibilities at home.¹¹⁵

Frameworks for worksite health promotion interventions: Programs across multiple levels of influence

WHP programs are delivered at multiple levels of influence, as illustrated in Figure 1. At the individual and interpersonal levels of influence, worksite health promotion programs aim to help individual workers make health behavior changes. These interventions include intensive programs for high-risk individual workers, as well as worksite-wide programs designed to reach a breadth of the workforce. Intensive programs are likely to attract workers most interested in

health behavior change, and thus most motivated to change behavior. Worksite-wide programs instead generally aim to influence health behaviors among workers at varying stages of readiness for health behavior change. Not surprisingly, these two types of programs differ in their ability to change behaviors. For example, smoking cessation studies have found that more intensive programs, with multiple sessions and multiple components, yield higher quit rates than shorter term, less intensive interventions.^{18, 116, 117} It is important to keep in mind, however, that because these programs are designed for highly motivated volunteers who are ready to commit to a behavior change program, they may miss important segments of the working population who are not interested in participating in intensive programs. From a public health perspective, the “*impact*” of an intervention is a product of both its *efficacy* in changing behavior and its *reach*, meaning the proportion of the population reached either through their direct participation, or indirectly through diffusion of intervention messages throughout the community, worksite or school.^{118, 119}

One promising avenue for individually-focused interventions is the growing area of tailored interventions. Moving away from the one-size-fits-all approach to interventions, “tailoring” is one strategy for increasing the intensity of interventions delivered to at-risk populations. Tailored interventions typically use print communication¹²⁰⁻¹²² or telephone counseling¹²³ to enhance the relevance of interventions to the daily lives of the target population, thereby increasing the likelihood of achieving short-term or sustained intervention effects.^{118, 124} Individually tailored interventions are typically algorithm-based and utilize expert systems or computer-based programs to match a large library of messages to individuals’ varying information needs and levels of motivation to change, combining specific statements and graphics into personalized interventions for specific individuals.^{121, 123, 124}

WHP programs also target the worksite environment, for example through tobacco control policies aimed both at protecting non-smokers from the hazardous effects of environmental tobacco smoke and promoting an environment supportive of non-smoking; by increasing the availability of healthy foods in worksite cafeterias; or by modifying the built environment to promote physical activity. For example, worksite policies on tobacco have been shown to decrease worker exposure to environmental tobacco smoke¹²⁵⁻¹²⁷ and contribute to worker reductions in smoking, including quitting.^{116, 128-133} Employer efforts to promote compliance with smoking policies can contribute to an overall climate supportive of nonsmoking.¹³⁴ Similarly, studies have examined the effects of cafeteria-based programs, for example through point-of-choice food labeling, as a location for media-based nutrition education, and through increasing the variety of foods and reducing prices; while these programs hold promise for changing food purchasing patterns at work, it is less clear whether changes extend to dietary patterns outside work.^{135, 136}

Increasingly, WHP programs are focusing on multiple levels of influence, and growing attention is being placed on comprehensive programming, as illustrated in the Healthy People 2010 described above. The definition for “comprehensive” programs has not been consistent across reviews; for example, Pelletier defined comprehensive programs as “those programs that provide an ongoing, integrated program of health promotion and disease prevention that integrates the particular components (i.e., smoking cessation, stress management, lipid reduction, etc.) into a coherent, ongoing program that is consistent with corporate objectives and includes program evaluation.”¹³⁷

As noted in the previous section on OSH, laws and regulatory standards, such as those issued by federal or state OSHA agencies, can have an important impact on health and safety conditions at work. These are, by definition, policy interventions to protect workers’ health and

that fall outside of the discretion of individual employers and worksites. Likewise, in the health promotion field, laws and regulations, such as the smoke-free worksites bills passed in several states, serve as environmental cues for workers to quit smoking as well as protect workers from exposure to second-hand smoke on the job.

Efficacy of worksite health promotion interventions

WHP research has documented the efficacy of these programs across a wide array of outcomes, including changes in anthropometric measures, health behaviors, life satisfaction indicators, and measures of morbidity and mortality. In general, results from randomized studies of worksite health promotion have found modest yet promising effect sizes.^{4, 108, 138-140} Figure 2 summarizes the results of meta-analyses of programs targeting physical activity, nutrition/cholesterol, smoking cessation and tobacco control policy, alcohol use, stress, and cancer risk factors, as well as multi-component programs. The studies included in these meta-analyses represent a range of study designs; although authors of these meta-analyses place the most weight on the results on randomized controlled studies, other study designs were included. Methodological limitations to the studies included in these meta-analyses are not dissimilar to those described in Section C for studies of OSH interventions, including inadequate sample sizes; the use of non-randomized designs; differential attrition across study groups; analysis at the individual level failing to take into account of group randomization; and the use of inadequate measures, including sole reliance on worker self-reports rather than additional objective measures, such as biochemical assessments.

Insert Figure 2 about here

One concern sometimes raised in the interpretation of the results of these studies has been the magnitude of effect sizes, even when statistically significant changes in behavior are found. Some observers continue to apply the standard of clinical significance in assessing the value of the magnitude of the results of these trials. Yet as Rose noted,^{141, 142} small changes in behavior observed across entire populations are likely to have large effects on disease risk. For example, Tosteson and colleagues¹⁴³ estimated the cost-effectiveness of population-wide strategies to reduce serum cholesterol, and found that community-based interventions to reduce serum cholesterol are cost-effective if serum cholesterol is reduced by only two percent or more.¹⁴³ It is important that the standards used for interpretation of the results of worksite intervention studies be based on the public health significance of the effects.

A key challenge: Identifying interventions to reduce class-based disparities in health behaviors

This research provides an important foundation for future worksite health promotion endeavors.

A key priority for future research in this arena is attending to the persistent, and in some cases growing class-based disparities in health behaviors. These disparities point to an important gap in current worksite health promotion efforts and suggest a critical need for new approaches to behavioral interventions for working class populations. These disparities may be due, in part, to less access to worksite health promotion programs for blue-collar and service workers,^{107, 144} less participation by these workers in programs when they are available,¹⁰⁸ lower efficacy of interventions among blue-collar and service workers compared to white-collar workers, and/or increasing stress among blue-collar and service workers.¹⁴⁵ Integrated OSH/WHP approaches, as we describe in the following section, are designed to attend to workers' dual concerns about life risks and job risks. Promising results suggest that in comparison with tradition worksite health

promotion approaches, these interventions can lead to greater worker participation and improved health outcomes than among blue-collar manufacturing workers.

E. Integrated Occupational Safety and Health/Worksite Health Promotion (OSH/WHP)

Programs

Despite a clear rationale for integrating and coordinating worksite occupational health and safety and worksite health promotion and increasing discussions of the benefits of integrated OSH/WHP interventions,^{6, 9, 15-17, 146-150} as described in Section B, empirical evidence supporting the promise of this approach is only beginning to emerge. Early research in this area focused on worker surveys simultaneously assessing job risks and life risks,^{151, 152} and small scale studies¹⁵³⁻

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There are a growing number of reports of best practice within single worksites. For example, Johnson and Johnson “Live for Life” program encompasses health promotion, occupational health and safety, employee assistance, disability management and other benefits.¹⁵⁷ Administrative systems were established to promote cross-utilization of resources rather than “silos of service.” A financial impact study found that this effort resulted in a cost savings on employee health care and administrative costs of about \$8.6 million per year. Other companies have similarly reported the benefits of worker health programs that integrated health promotion, occupational health and safety and other benefits supporting worker health, among them UAW-GM,¹⁵⁸ Chevron,¹⁵⁹ 3M,¹⁶⁰ Glaxo Wellcome,¹⁶¹ and Citibank.^{162, 163} These initiatives by vanguard companies have begun to change the dialogue about approaches to employee health, increasing to focus on integration within companies.

In addition, there is a growing literature reporting results of studies that have systematically assessed the efficacy and effectiveness of integrated OSH/WHP interventions.

The strongest evidence available, summarized below, supports the efficacy of this intervention model in promoting smoking cessation, particularly among blue-collar workers; some evidence additionally indicates significant effects for other health behaviors. Little evidence is available to date documenting the impact of these programs on occupational health and safety outcomes.

Defining integrated OSH/WHP programs

As illustrated in Figure 1, integrated OSH/WHP studies may be conducted across multiple levels of influence – targeting individual workers, the worksite organization and environment, or across multiple levels. Because reductions in job risks rest heavily on employers while individual workers must be included in any efforts to reduce life risks, integrated interventions are most likely to be aimed at multiple levels of influence. There are circumstances, nonetheless, where interventions may separately target individual or organizational/ environmental levels of influence, as we illustrate below.

Ideally, integration of OSH and WHP requires a change from the traditional organizational structure, in which OSH and WHP are situated in different locations within the organization, with little communication between these functions. In some cases, it may be possible for worksites to unify these functions within the organization, with a single budget and reporting structure, thereby integrating roles and responsibilities related to worker health. In other cases, it may be more likely for worksites to increase coordination across these functions, allowing for joint decisions about such key issues as priority-setting and resource allocation. This coordination across previously-disconnected functions provides a foundation for bringing various groups together within the organization, including those representing benefits/employee relations, employee assistance, health promotion, medical services, and occupational safety and health.⁹

Following standards for rigorous testing interventions, optimal assessment of the efficacy of integrated OSH/WHP programs generally relies on random assignment of worksites to the intervention, in order to control for secular trends in worksite initiatives and in worker health behaviors. Yet there are some research questions that cannot be effectively addressed in randomized trials, such as the impact of interventions that change the structure of OSH and WHP within the worksite organization, given the need for management initiative and commitment to such structure changes. Research to date has tested the efficacy of integrated OSH/WHP programs delivered by researchers; there remains a significant need for observational research to estimate the effects of structural changes in the operations and functioning of OSH and WHP.

Research assessing integrated OSH/WHP programs

Table 1 summarizes key studies assessing the effectiveness of integrated OSH/WHP interventions. Included in this table are summaries of a series of studies we have conducted to examine the efficacy of interventions integrating worksite health promotion and occupational health and safety across multiple levels of influence. The first of these studies, WellWorks-1, was conducted as part of the Working Well Trial, in which four research intervention sites tested the effects of a comprehensive worksite cancer prevention model aimed at nutrition and smoking; this study found statistically significant effects for smoking cessation and smoking cessation.¹⁶⁴

Insert Table 1 about here.

Our second study, WellWorks-2, asked the question: Does the addition of worksite occupational health and safety increase the effectiveness of worksite health promotion only?¹⁶⁴

Using a randomized, controlled design, 15 mid- to large-size manufacturing worksites were randomly assigned to receive either worksite health promotion only (WHP Group, eight worksites); or worksite health promotion plus occupational safety and health (WHP/OSH Group, seven worksites). The intervention components are summarized in Table 2. This comparison tested the integrated intervention, which aimed to reduce occupational hazards.

Insert Table 2 about here

We hypothesized *a priori* that the integrated OSH/WHP intervention would have the most relevance to workers in hourly positions where exposures to hazards on the job were more common than among salaried jobs. Results of this study for tobacco use cessation for blue-collar (hourly) and white-collar (salaried) workers are presented in Figure 3. Smoking quit rates among hourly workers in the OSH/WHP condition more than doubled relative to those in the WHP condition (11.8% vs 5.9%; $p=0.04$), and were comparable to quit rates of salaried workers. We found no differences in quit rates between groups for salaried workers. We found no significant changes in fruit and vegetable consumption, either in the sample overall or by job type. These findings nonetheless indicate the potential significant contribution of an integrated OSH/WHP intervention in promoting smoking cessation among blue-collar workers.

Insert Figure 3 about here

Turning to OSH results, we found (1) worksites in the HP/OSH condition made statistically significant improvements in their health and safety programs compared to HP only sites,⁸² and (2) significant improvements in an exposure prevention summary rating (developed

as part of this study)¹⁶⁵ in the intervention worksites, which was offset by a smaller and non-significant improvement in the control worksites, rendering the pattern of results promising but not statistically significant.¹⁶⁶ We also found that worker participation in intervention programs was significantly higher in the OSH/WHP condition than in the WHP condition,¹⁶⁷ as measured by process tracking of the intervention “dose” delivered in intervention sites. According to estimates by Colditz, if this intervention was disseminated to the population of blue-collar smokers in Massachusetts, an estimated 2,880 cases of lung cancer could be avoided, with additional benefits expected to accrue in other tobacco-related diseases.¹⁶⁸

We have additionally recently completed a study testing the efficacy of an integrated OSH/WHP intervention in small manufacturing businesses employing working class, multi-ethnic workers.³² This study provides evidence of the efficacy of integrated interventions in improving physical activity and diet among working class, ethnically diverse workers employed in small manufacturing businesses. Two additional studies still underway are testing the efficacy of integrated OSH/WHP interventions delivered at the individual/interpersonal level of influence. In one study, designed to promote tobacco use cessation and increased consumption of fruits and vegetables among construction laborers, a one-on-one telephone counseling intervention was based on motivational interviewing and a set of written materials designed specifically for this audience, and messages around occupational hazards and fitness for work were incorporated into the intervention.¹⁶⁹ In a second study, we are promoting tobacco use cessation among building trade apprentices during on-site training programs; again, messages about occupational health and safety are incorporated into the intervention. These interventions were designed to target the individual/interpersonal level of influence because the intervention is not delivered at a specific worksite setting, as is appropriate for construction workers who often move from job to job. Nonetheless, messages about job risks are clearly incorporated into

intervention messages. Preliminary results of these studies suggest promising intervention findings.

A final study included in Table 1 provides important evidence on the promise of integrated interventions targeting work organization factors as part of the OSH focus.³⁰ This study found that manufacturing employees in the intervention condition made significantly greater changes than those in a non-intervention control groups on key outcomes, including reduction in ergonomic risks, cardiovascular health risk, and job stressors such as psychological job demands and low job control. Overall, sickness absence in the intervention dropped (15.5% to 7.7%) versus control (14.3% to 9.5%) groups, which yielded a positive financial return on its investment in the project.

To summarize, although research testing the efficacy of OSH/WHP interventions is only in its infancy, emerging evidence to date suggests that these interventions hold significant promise for improving worker health behaviors, especially among working class populations, and have the potential to contribute to OSH programs and outcomes. This research provides a useful foundation for future research in this area.

F. Worker health in a changing economy

As we begin to define a research agenda to explore the integration of WHP and OSH, it is important to consider several key changes that have influenced the nature of work in the U.S. over the last few decades. These labor market trends have important implications for future research aimed at interventions integrating worksite health promotion and occupational health and safety, recognizing that “one size doesn’t fit all.” Interventions may need adaptation and re-tooling to fit specific worksite settings as well as changes in the overall labor force.

First, there are important shifts in the proportions of workers employed across sectors of the labor market. Importantly, the proportion of workers in manufacturing jobs has decreased from 26.1 % in 1960 to 12.3% in 2003, and over the same period, the proportion in agricultural jobs has decreased from 8.4% to 1.7%. Meanwhile, employment has shifted to the service sector; the proportion of employment in the service sector in 2003 was 78.3%, up from 58.1 % in 1960.¹⁷⁰ The integrated WHP-OSH studies presented above were conducted mainly in manufacturing settings; additional studies testing the integrated model are needed to assess its effectiveness in service sector jobs.

Second, a growing number of workers are affected by corporate restructuring, mergers and acquisitions, and downsizing.¹⁷¹ For example, Fortune 500 companies alone reduced their total workforce from 14.1 million employees to 11.6 million between 1983 and 1993. With approximately 500,000 U.S. employees facing job loss each year as a result of these transitions, job security in this population as well others around them is affected.¹⁷² Job insecurity may result in job dissatisfaction,^{173, 174} increasing work withdrawal behaviors,¹⁷⁵ an increase in negative physical health outcomes,¹⁷⁶⁻¹⁷⁸ and higher reports of psychological distress,^{175, 179} and risk of heart disease.^{180, 181} In addition, workers with perceptions of low job security commonly report lower organizational commitment, leading to greater employee turnover.^{173, 174} Another trend is towards the implementation of new systems of work organization, such as lean production,¹⁸² which can increase employee stress and health risks. Finally, national surveys in the US, Europe and Japan over the past 20 years have shown large increases in job demands and “time constraints.”¹⁴⁵ These trends point to the importance of understanding the influence of job insecurity and work organization on health behaviors, and of addressing related stressors within integrated OSH/WHP interventions.

Third, employers have increased their reliance on contingent labor, in order to reduce costs through short-term hiring of employees, to provide employers greater flexibility to adjust to downturns in the business cycle, and to provide employers with a means of assessing new employees prior to making a full commitment to hiring them on a permanent basis.^{183, 184} Many companies are hiring contract managers to meet their rapidly changing needs for new and unique managerial perspectives and talent.¹⁸⁵ The 1995 Bureau of Labor Statistics Report (BLS) revealed that the number of workers in contingent jobs ranged from 2.7 to 6.0 million employees, representing between 2.2% and 4.9% of the total U.S. Labor Force.¹⁸⁶ While some have noted these trends as a means of increasing the flexibility of the workplace,¹⁸⁴ others have expressed concerns with consequent reductions in employee rights^{187, 188} or increased illness risks among temporary employees.¹⁸⁹ These trends have important implications for research on integrated OSH/WHP interventions. With short job tenures, workers may have less exposure to interventions and measurement of behavioral changes associated with interventions is likely to be difficult. In addition, managers may be less committed to contingent workers, as evidenced by the lower level of benefits these workers are often given. In designing integrated OSH/WHP interventions, it is important that contingent workers have the same access to programs and meet the same OSH training requirements as regular workers, in order to promote and sustain worksite health promotion and health protection across all workers in a setting.

Fourth, employer coverage of health care benefits for employees has declined, and payment has shifted significantly from employers to employees.^{190, 191} From 1979 to 1998, the percentage of private sector workers receiving coverage from their employers declined sharply across almost all industries and occupations, with the largest declines among low-income workers, blue-collar and service workers and for workers employed in large firms. In 1983, 45.5 percent of private-sector employees had coverage paid in full by their employer, compared to

26.6% in 1998.^{190, 191} Benefits coverage has particular implications for health promotion interventions; limited financial coverage of services supporting health behavior changes, such as for nicotine replacement therapy or gym memberships, may reduce workers' success with health behavior change.

Fifth, income inequality is increasing and wages are falling for many workers.^{192, 193} Between 1979 and 2000, the real income of households in the lowest fifth grew 6.4%, while that of households in the top fifth grew 70%, with the top 1% increasing 184%. Over three-fourths of those who started out in the low end of the income scale in the late 1980's remained at the low end of the income scale ten years later. Since 2000, unemployment has been high, with slow recovery in the jobs lost in the recent economic downturn. The average hourly wage of blue-collar workers in 2001 was \$13.73 per hour (equivalent to \$28,558 per year),¹⁹⁴ placing them at only 1.6 times (i.e., 100-199% of) the 2001 poverty line of \$17,960 for a family of two adults and two children.¹⁹⁵ Unemployment disproportionately affects minority workers and those with lower levels of education.¹⁹³ The fact that many workers are at the low end of the pay scale is of importance given the long-standing recognition of the relationship between social class and health outcomes.¹⁹⁶⁻¹⁹⁸ As we describe in Section B, point 2, integrated OSH/WHP programs may be particularly salient in addressing the concerns of workers at highest risk due to their dual exposures to job risk and life risks.

Sixth, rates of unionization are declining. In 2002, 13.2% of all workers in the US belonged to a labor union, down from 20.1% in 1983, the first year for which comparable data are available.¹⁹⁹ Labor unions have played a significant role in advocating for the health of workers. The private health care system in the US was developed largely as a result of collective bargaining.²⁰⁰ Unions have been strong allies in efforts to promote healthy and safe working conditions.⁸⁴ More recently, several unions have become active on worksite health promotion

issues such as smoking cessation.⁸³ Despite their falling membership, unions can be powerful allies for interventions to protect and promote workers' health, particularly among blue-collar and service workers, who are more likely than white-collar workers to belong to a union. The declining union membership additionally underscores the ongoing need for representation of and responsiveness to workers' concerns in the design of broad-based initiatives to protect their health.

Additional changes are on the horizon. The proportion of workers who are immigrants is likely to increase in the coming decades, as has already been observed. Immigration is expected to continue to account for a sizable part of population growth and will further diversify the labor force. Projections suggest that the Hispanic and Asian population will rise from 14% in 1995 to 19% in 2020. Women's projected share in the workforce is expected to increase slightly (46% to 48% between 1998 and 2008). The racial/ethnic mix is also expected to change across this timeframe, with decreases in the percentage of whites, little or no change for blacks, and increases for Hispanics (of any race), Asians and other races.³³ Thus, it is important that integrated OSH/WHP interventions attend not only to working class populations, but also be designed in recognition of the increasing racial/ethnic diversity in workforce, and with attention to cultural differences, the implications of acculturation, the potential for discrimination, and related social contextual issues. Of course, race and class are inextricably linked in the US; in many cases, interventions designed for working class populations are likely also to reach racial/ethnic minority groups, who are over-represented among working class groups. Notwithstanding, it is essential to examine efficacy of OSH and WHP interventions among racial-ethnic subgroups.

In addition, it is expected that the proportion of older workers in the labor force will increase. In contrast to prior decades, in which most of the growth in the labor force was

accounted for by workers between 25 and 54 years of age, over the next decade fewer than one in three (31%) of the added workers will be in this category. Instead, nearly half of the additional workers will come from the 55-and-older category, while about one in five will come from the youth labor force.²⁰¹ By 2008, the percentage of workers aged 45 and older is expected to increase from 33% to 40% of the workforce, and those aged 25 to 44 to decrease from 51% to 44%.³³ It is important that the design of future integrated OSH/WHP interventions take into account the specific needs of older workers.^{202, 203}

G. Research agenda: Gaps in current literature and key issues to be addressed in future research

This review provides promising evidence about the potential importance of integrating and coordinating worksite health promotion and occupational health and safety as a means of enhancing worker health. This research, however, is in its infancy, and there remains a broad range of research questions needing to be addressed in order to maximize the potential impact of these interventions. Figure 4 presents an organizing framework for our discussion of five overarching research directions, and specific recommendations are summarized in Table 3. This outline follows research frameworks describing the appropriate sequencing of research within cancer prevention and control²⁰⁴ and cardiovascular disease prevention.²⁰⁵ Such research does not always proceed in a linear fashion, but may require circling back to “earlier” steps in the process to address newly-defined research questions.^{204, 206} We begin with two key foundations for intervention research. First, social epidemiological research is needed to identify key work-related factors associated with hazardous occupational exposures and risk-related behaviors, and to identify the underlying causes of social disparities in worker health. Second, there is a need for methods development research aimed at developing both appropriate measurement tools and new

intervention approaches to integrating worksite health promotion and OSH. We describe key directions for testing integrated OSH/WHP interventions, focusing, third, on efficacy studies examining the effects of integrated interventions on both occupational health and safety outcomes as well as health behavior changes, and fourth, on effectiveness studies aimed at evaluating the generalizability of tested interventions to new settings or with new populations. Fifth, we describe research to address the need for assessing the process of intervention implementation, including intervention implementation evaluation, cost assessments, and process-to-outcome assessments. Finally, we look at ways to assess the long-term applicability of these intervention approaches through dissemination and durability research, that is, testing methods to promote the sustainability and dissemination of programs where sufficient evidence is available to indicate that an integrated intervention is efficacious, and to promote maintenance of changes in health behaviors and the work environment resulting from interventions.

This sequence of research phases will necessarily be conducted in a political, economic, and social context that surrounds worksite-based research.^{84, 207} Researchers from the WHP and OSH fields are certainly aware of the challenges of this terrain, replete with power differences between managers and workers; management's interest in controlling costs and increasing productivity, and how these factors play into their support or lack thereof for OSH and WHP; and workers' concerns about maintaining privacy and other essential rights, and their resistance to management-initiated efforts to 'correct' workers' 'poor' health behaviors.^{108, 208}

Acknowledgement and articulation of these realities is not only critical to conducting sound research in the workplace, but also helps to clarify the very questions we pose and the assumptions underlying them. By questioning these basic assumptions – the “taken-for-granted ‘truths,’” to use Eakin's phrase, we are able to shed light on ideologies underlying our research questions.²⁰⁷ For example, we recognize that for employers, it is critical to have information

about the economic implications of integrated approaches for the ‘bottom line,’ and several WHP and OSH studies have calculated outcomes such as cost-effectiveness and return-on-investment.^{66, 70, 71} Equipped with this information, employers can determine whether and how to pay for WHP or OSH interventions in the overall economic context of their businesses. By addressing these questions through our research, however, it is essential to acknowledge the limited scope of these research questions from a public health perspective. In addition, cost-based research could be characterized by workers and their advocates as a callous calculation of what workers’ health is *worth* to the business. Being clear on our questions, assumptions, and methods is particularly critical for scientists attempting to work across disciplines. Within our own disciplines, we often take for granted many shared assumptions and fail to challenge one another. There is, thus, an inherent set of challenges in inter-disciplinary collaboration, as well as an enormous opportunity to pause, question, and reflect on comfortable assumptions held by individual disciplines.²⁰⁹

In this section, following the framework in Figure 1, we describe key directions for future research aimed at integrating OSH and worksite health promotion, with the hope that this framework and discussion will provide a structure for delineating additional research priorities. We additionally examine barriers to accomplishing this research agenda.

Insert Figure 4 here

Insert Table 3 here

G.1. Social epidemiological research

Other research frameworks have noted that a first phase of research progresses from hypotheses development aimed at understanding the basic etiology of the health issue of concern.²⁰⁴⁻²⁰⁶

Interventions to improve worker health must be solidly based on an understanding of the patterns and distributions of worker illnesses and injuries in the population, including attention to differences in hazardous exposures and health outcomes by race/ethnicity, gender, and occupational class.²¹⁰⁻²¹² and of the broader social, cultural, economic and political processes underlying these disparities.²¹³ Setting priorities for integrated approaches requires a thorough understanding of the populations that are at greatest risk for adverse health events.

As we examine underlying work conditions influencing worker health, it is important to consider the role of a range of social toxicities in the workplace – including, for examples, workplace-based discrimination and harassment, organizational factors like hierarchical and authoritarian authority structures, and systemic disrespect.²⁰⁸ Ascribing worker health risks to either the field of WHP (smoking, diet exercise) or OSH (dust, safety hazards, job strain) poses the risk of keeping these other threats to worker health off the radar screen of our research endeavors. Social epidemiological inquiry is needed that broadly examines a range of influences on worker health, and that additionally explores how ‘traditional’ OSH and WHP health risks intersect with these types of social hazards at work.

Lack of OSH data by race/ethnicity and gender

In the WHP field, there is a deep literature on the distribution of risk-related health behaviors by race/ethnicity, gender, and various dimensions of social class. By contrast, there is a dearth of data on the distribution of occupational hazardous exposures, illnesses, and injuries by race/ethnicity or gender. What literature does exist, however, indicates that workers of color and low-paid workers, both men and women, suffer disproportionate exposures to workplace hazards. For example, in a review of the literature on workers of color, Frumkin et al²¹² assembled data from the mid-1990s confirming the persistence of historical trends in

racial/ethnic disparities in occupational exposures, with occupations employing the most black and most Hispanic workers being more hazardous and having higher rates of job-related injuries and illnesses than occupations employing mostly white workers. Work-related illness and injury rates, in cases per 100 full-time workers per year, are 4.34 and 2.16 in occupations with the most black and Hispanic workers, respectively, compared to 0.85 for occupations with the most white workers.²¹² Little data are available to describe the distribution of exposure to job-related hazards among working women, or comparisons of their exposures to those among men.^{33, 212} Additional research is needed to document the distribution of OSH hazards by socio-demographic characteristics in order to determine priorities for integrated interventions.

Need for expanding our understanding of social contextual determinants of worker health outcomes

In addition to examining the nature of workers' exposures to occupational hazards, understanding the nature and extent of social conditions at work and the ways in which these exposures influence health behaviors and other worker health outcomes is critical to efforts to improve worker health. In addition, it is important to improve our understanding of the ways in which these factors vary across important worker socio-demographic characteristics, as a basis for addressing disparities in worker health outcomes. To guide research on the social determinants of worker health outcomes, we have suggested a social contextual conceptual framework aimed at illuminating the "black box" through which population characteristics influence worker health, focusing initially on health behaviors while also considering the role of occupational exposures within this framework.^{5, 214} This framework examines the influence of workers' socio-demographic characteristics and socioeconomic position on health behavior outcomes through social contextual factors considered across multiple levels of influence. For

example, at the individual level, following the work of Graham,²¹⁵⁻²¹⁷ we might hypothesize that tobacco use prevalence will be highest among workers with the most numerous and complex role responsibilities; responsibilities at home may have important intersections with workload or job strain (i.e., high demand-low control work) in influencing behavioral outcomes. At the organizational level, it is important to understand the complex interplay between workers' potential occupational exposures and other characteristics of their work (e.g., shift work), job setting (e.g., industry or size of worksite),¹⁴⁶ and the social environment of the work setting.¹⁴⁴ Likewise, Devine, et al, found that food choice strategies in low- and moderate-income urban households were differentiated by experiences of work. Individuals who felt their work was demanding but manageable viewed food choices for themselves and family members as a source of pride and satisfaction (positive spillover of work to home), whereas those who felt their work was demanding and limiting characterized food choices as a source of guilt and dissatisfaction (negative spillover).²¹⁸ Such information can guide intervention development by identifying modifiable elements of the social context that may be addressed through interventions, and can enhance the relevance of intervention messages by incorporating an understanding of the day-to-day realities of workers experiences.

Need for understanding the dual impact of job and life risk exposures over the life course

There have been increased calls for epidemiologic research that addresses health risks accumulated across the life-course, from infancy to old age.^{219, 220} Within WHP and OSH, as in other public health scientific fields, most studies capture workers' health burden at a given point in time through cross-sectional surveys, or at best over a series of cross-sectional surveys that spans the life of a typical three- to five-year grant period. Attempts to capture life-course experiences through survey questions that ask respondents to recall events from childhood can be

fraught with threats to validity. There is a need for long-term cohort studies focused on workers' health that can measure and disentangle the complex web of risks encountered over the life-course and their resulting health impacts. Prospective studies would be able uncover the joint roles of work exposures and health behaviors in early life on later health outcomes, and the intersections of these exposures with a range of job experiences.

G.2. Methods development research

A second phase of research is aimed at methods development, including the development of intervention tools and research methods.²⁰⁴⁻²⁰⁶ Before large scale, randomized controlled trials can be appropriately launched, important challenges must be addressed, such as identification of the overall risks and risk perceptions of this population; assessment of the feasibility and acceptability of the intervention in a specific population; assessment of potential participation in an intervention study; development and testing of reliable, valid measures for assessing outcomes within the defined setting; and preliminary small-scale tests of planned interventions.²⁰⁴ We have identified two broad categories of methods development research that are likely to facilitate integrated OSH/WHP interventions: intervention development and measures development.

Need for further specification of integrated interventions

There is a need for further development and articulation of intervention methodologies that effectively integrate WHP and OSH. Critical issues include: (1) development of interventions for various occupational contexts and groups of workers within those contexts, (2) development of interventions for a broad cadre of occupational exposures and health behaviors, and (3) further specification and operationalization of “integrated interventions.” Beginning with the first issue,

we note that interventions conducted for a specific worksite context and audience of workers – such as blue-collar workers in manufacturing settings (where much of the research to date has been conducted) – cannot be directly applied to other contexts and/or types of workers. For example, interventions in manufacturing worksites would need to be adapted and tested in service sector settings, such as restaurants or retail stores. Likewise, one cannot assume that within a particular worksite context all workers will benefit equally from the intervention, as was shown in the Wellworks-2 study, in which the integrated intervention made a difference in increasing smoking cessation among blue-collar but not white-collar workers. Looking ahead, research findings on the social contextual determinants of worker health provide an important foundation for the development and refinement of integrated interventions designed in response to the work experiences and broader life experiences of diverse settings and groups of workers in those settings.

Second, integrated intervention studies need to investigate additional behavioral and OSH outcomes. Most such studies to date have focused on manufacturing-related job hazards and select health behaviors (e.g., tobacco, physical activity, and diet). Additional studies are needed to examine a broader range of health behaviors and occupational exposures, such as the development and preliminary testing of intervention methods to reduce job strain and identify methods for integrating such interventions with health behavior interventions. In methods development studies, it is critical to pre-test and refine intervention protocols, including process measures to assess implementation (see G.5), because subsequent efficacy and effectiveness studies will rely on careful articulation and implementation of these of standardized intervention protocols in order to assess changes associated with the intervention. Pre-testing intervention protocols allows for assessing management's and workers' receptivity to the interventions; for

example, workers may provide feedback regarding the extent to which the materials are usable, understandable, relevant, attention-getting and memorable, and credible.

And third, it is essential that in conducting these types of studies that researchers be explicit in their definition and operationalization of “integrated interventions.” According to Figure 1, integrated interventions, by definition, address both life and job risks. Important to note, however, is that the unit of intervention can either be at the individual or organizational level, or both. For example, the Wellworks-2 intervention described above targeted both the individual worker and at the organizational level for managers. At the individual level, we provided educational messages to workers about the importance of smoking cessation in the context of hazardous job exposures, which together could increase risk for adverse health events, for example. At the managerial level, we attempted to change management behaviors, focusing on developing systematic approaches to reducing job hazards, as well as policies that would promote healthy behaviors (e.g., providing healthful food options in the cafeteria). In a more recent pair of studies currently underway (see Section E) with unionized building trades workers and apprentices, we are intervening only at the individual level with workers, but integrating messages about how OSH conditions can increase health risks associated with smoking and poor diet. Researchers need to consider and define the unit of intervention for integrated messages.

In addition to defining the level of intervention, it is likewise critical to determine what is actually meant by “integration.” As noted in Section E, a worksite may make organizational changes to fuse OSH and WHP within a single box on an organizational chart, assigning responsibility for worker health to a single department or other organizational unit. In other instances, worksites may make organizational changes to structure improved collaboration and communication among those responsible for OSH and WHP. For researchers implementing an integrated OSH/WHP intervention from outside the work organization, it may be necessary to

grapple with such questions as: if OSH and WHP initiatives are being undertaken in a worksite – in parallel – should that be considered an “integrated approach” to worker health? Or is some deeper level of intersection required, such as *embedding* smoking cessation messages and programs in the context of efforts to reduce exposure to toxic fumes, for example? And what would “embedding” actually look like within a given setting? Implied in such a question is whether the ‘whole’ of an integrated approach is greater than or equal to the sum of its WHP and OSH parts. Can we, in fact, achieve a ‘synergism of prevention’ with integrated approaches – a notion proposed by NIOSH twenty years ago and endorsed in a recent speech by current NIOSH director, John Howard.^{2, 221}

Need for further development of measurement tools

There is a crucial need for development of valid measures that permit testing of the efficacy of interventions. Of highest priority is the need for measures of change in occupational health and safety outcomes that can be used across types of settings/exposures. In designing integrated OSH/WHP interventions, it is critical to set priorities for OSH intervention targets and to select appropriate outcomes that can be reliably and accurately measured. In OSH research, quantitative exposure assessment, using such measures as air sampling techniques, is the gold standard for assessing intervention effectiveness; in integrated interventions, however, this type of assessment may not be feasible for a few reasons.¹⁶⁵ First, quantitative exposure assessment may be best applied in settings where only one or a few hazards are being assessed (e.g., the recent Minnesota Wood Dust Study²²²) and is less feasible in settings with multiple exposures, regardless of whether outcomes are measured using exposure assessment methods or by self-report through worker surveys. In contrast, it is feasible to measure health promotion outcomes across a range of worksites and different types of occupations using the same measures, whether

through self-report on surveys or through more objective measures, such as biological samples to verify presence of a nutrient.

Second, statistical power issues must be considered. Assessing intervention effectiveness for OSH outcomes at the worksite level requires that many worksites be included in the study in order to detect intervention-related changes, depending on the type of intervention. Consider, for example, the type of OSH intervention applied in the WellWorks-2 study described above, which aimed to assess efficacy by comparing the extent to which worksite management in the control and intervention conditions made voluntary improvements in OSH conditions and programs at the urging of the intervention researchers, as measured at organizational and environmental levels. The sample size of 15 worksites may have been too small to detect statistically significant differences in the mean changes in outcomes (OSH program score and exposure prevention rating) between the two conditions. On the other hand, classic industrial hygiene interventions that aim, for example, to test whether an intervention such as installing a ventilation system reduces workers' exposure to levels of airborne contaminants, would require fewer worksites to demonstrate the efficacy of the intervention. In the case of the WellWorks-2 type of intervention, conducting quantitative exposure assessments across many worksites, and many different hazardous exposures within and across worksites, would have been difficult and very costly.

In an attempt to advance methods research in this area, as part of the WellWorks-2 study, LaMontagne et al¹⁶⁵ developed an exposure prevention rating method for the purposes of (1) setting priorities for interventions on hazardous substance exposures in manufacturing worksites, and (2) evaluating intervention effectiveness. Theoretically grounded in the “hierarchy of controls” model,⁷⁶ the rating method includes indicator variables to assess the potential for and prevention of exposures at three levels: *materials* (source of the hazard), *process* (path between source and worker), and *human interface* (worker). Initial field application of this rating method

in the Wellworks-2 study demonstrated its capability of providing common metrics across various hazardous substances encountered in 131 separate work processes in the study worksites. Additional research on this instrument is needed to refine indicator variables, validate the rating method against quantitative exposure assessment methods and other exposure metrics, and modifying the instrument for non-manufacturing settings.¹⁶⁵

G.3. Assessing intervention efficacy

The third phase in our research framework is the testing of intervention efficacy. A distinction is generally made between efficacy trials, which provide tests of an intervention under “optimal” conditions, and effectiveness trials, where testing is conducted under “real world” conditions.^{204,}

²⁰⁶ Although the distinction between these phases may be blurred in some tests of public health interventions, we maintain this distinction here to underscore the need for full examination of the generalizability of an intervention to a range of populations and settings, as would be the focus of an effectiveness study (see Section G.4). An efficacy trial provides a test of a well-specified intervention, made available in a uniform manner and standard settings, to a specified target audience.²⁰⁶ Here, the test would aim to determine an intervention’s ability to reduce the potential for workers’ exposures to job hazards and/or to produce changes in targeted health behaviors. As outlined in Sections C and D, in the past two decades an increasing number of studies have assessed the efficacy of workplace interventions targeting health behaviors; a growing number of studies have been initiated to assess OSH outcomes. In general but not always, the randomized controlled design is the accepted standard for assessing the efficacy of these interventions, with change being assessed from baseline to follow-up and compared between conditions, as a means particularly of controlling for secular trends.^{31, 223-225}

These recommendations build on research conducted separately on worksite health promotion interventions and OSH interventions, as well as on the nascent research evaluating integrated interventions. As we described in Section E, few randomized controlled studies have assessed the efficacy of worksite interventions integrating worksite health promotion and occupational health and safety. The studies conducted to date have focused particularly on assessing change in cancer risk-related behaviors, with particular emphasis on tobacco; and among blue-collar workers, particularly in manufacturing settings. To move the field forward, we need to know if integrated OSH/WHP interventions are efficacious in changing both workers' health behaviors and their potential for exposures to hazards on the job. Following the description in Section G.2 above, integrated interventions need to be designed to address a range of job exposures and health behaviors, and the breadth of these interventions needs to be tested, in comparison to both traditional health promotion programs and standard OSH programs.

Need for assessment of intervention efficacy for OSH and worksite health promotion outcomes

Following Figure 1, it is important that we test the efficacy of integrated OSH/WHP interventions in terms of both occupational health and safety and health behavior outcomes, at both the individual and organizational/environmental levels.

Occupational health and safety outcomes: In addition to issues of measurement across a range of worksites and types of hazards, as described above, researchers must also consider the level at which to measure effects of interventions on OSH conditions, and among whom. For example, there is a need for assessing the effectiveness of integrated programs in terms of OSH outcomes at both the worksite and individual levels. At the individual level, measures may include the use of self-report surveys, injury and illness records, or biomarkers for exposures among workers. At the worksite level, outcomes may be measured using quantitative exposure

assessment, visual inspections, record audits, a rating method such as one reported by LaMontagne et al,¹⁶⁵ or surveys of a single or multiple representative of the worksite.

Health behavior outcomes: As we describe in Section E, to date the strongest available evidence supports the efficacy of integrated OSH/WHP interventions in promoting smoking cessation, with emerging evidence pointing to additional significant effects for physical activity and diet. There is a need to examine the efficacy of integrated interventions in influencing a range of other behavioral outcomes. For example, in light of the growing epidemic of overweight and obesity in the US,³⁴ a high priority among these outcomes is the ability of integrated interventions to influence weight control and weight management.

Health behavior outcomes are usually assessed by measuring change in worker health behaviors, either through surveys of workers or through other tracking measures (e.g., use of pedometers to measure changes in physical activity or through review of medical records to validate self-reports of participation in prevention screening). As noted in Figure 2, worksite health promotion research has also looked at a range of other individual outcomes, including biological outcomes such as blood pressure, or changes in serum cotinine to verify smoking cessation. In addition, there are measurement instruments to detect worksite-level changes to promote healthy behaviors^{226, 227} For example, the Heart Check²²⁶ is a 226-item instrument that uses a dichotomous scoring system, with points awarded for favorable characteristics, such as a worksite smoking ban. It has been shown to be sensitive to detecting pre-post intervention changes.

Need for assessment of the efficacy of diverse types of integrated OSH/WHP interventions

In addition to assessing the efficacy of integrated interventions on an expanded breadth of OSH and health behavior outcomes, across multiple levels of influence (see Figure 1), it is necessary

to design studies with careful attention to the comparison point of an intervention assessment, as we illustrate in Figure 5. Comparison of integrated OSH/WHP interventions against controls that offer no intervention addresses one key element in understanding the potential of these interventions. It is important, in addition, that we understand the contributions of integrated OSH/WHP interventions *over and above* the effects of either worksite health promotion alone, or OSH programs alone. The integrated OSH/WHP studies described in Section C were primarily intended to address whether the addition of OSH helped to boost the effectiveness of WHP outcomes. WellWorks-2, for example, compared the results of an integrated OSH/WHP intervention with results of worksite health promotion alone. Additional research is needed to examine the question: Does the integration of OSH and health promotion help to improve OSH outcomes compared to OSH alone? It may also be beneficial to examine health behavior change within the context of this comparison. It bears noting that powering a study to detect change at the worksite-level requires a substantially larger number of worksites than studies for which the individual-level outcomes drive the sample size.

Inset Figure 5 about here

G.4. Assessing intervention effectiveness

Effectiveness studies provide validation of the generalizability of interventions whose efficacy has already been tested. Effectiveness trials require thorough assessments of program implementation, availability and acceptance, in order to allow researchers to determine if the lack of effectiveness is the result of inadequate program delivery, insufficient participation, or an inefficacious intervention.²⁰⁶ Here, we focus on the need to understand how the integrated OSH/WHP programs work for diverse populations of workers when implemented in a range of

worksite settings. We also recommend the application of a range of research methodologies, in order to maximize the lessons to be learned from different study designs.

Need for assessment of the efficacy of interventions for diverse groups of workers

In Section G.2, we recommended development of interventions for various occupational contexts and groups of workers within those contexts. It is important that we examine the generalizability of evidence-based integrated OSH/WHP interventions, based on adapting interventions for new settings and with different populations, using as a foundation lessons learned from prior research. As we describe in Section F, the changing trends in the workforce and the social inequalities in the distribution of workers' risks provide important information for setting priorities for this replication research. To summarize, key changes in the labor force that have implications for future adaptation and testing this intervention model include: (1) the growing service sector, and the increasing number of contingent workers; (2) the changing demographics of the workforce, including the growing number of immigrant workers and older workers; (3) increasing job insecurity arising from corporate downsizing, mergers, and acquisitions; (4) rising income inequalities and related social disparities in risk-related behaviors and hazardous occupational exposures; and (5) declining unionization rates. These changes point to key priorities for future research, to assure that integrated OSH/WHP interventions are generalizable across a range of industry settings, to workers in different occupations and representing diverse backgrounds, and addressing key job and life risks for these settings and populations.

Consideration of a range of research methodologies

As future studies are designed to examine the efficacy and effectiveness of integrated interventions, it is important that the pros and cons of different study designs and methods be

considered. In the field of community intervention research, some have raised concerns that exclusive application of the randomized controlled design may restrict our ability to consider the complexity of social settings such as worksites.^{224, 228} For example, as noted in Section E, the randomized controlled trial may not be an appropriate research design for assessment of the effects of the structural changes in the workplace, that clearly require management's leadership and initiative. The randomization of worksites to condition raises further challenges for intervention research in terms of both expense and statistical power.²²⁹⁻²³¹ The required standardization of the intervention in the randomized controlled trial may limit the intervention's effectiveness by failing to tailor to the needs of the site and to provide a vehicle for incorporating worker input.²³² In addition, it may not be feasible to randomize; indeed, full-scale implementation of integrated OSH/WHP programs must by necessity be initiated by management in collaboration with labor, thereby assuring that programmatic efforts can be systemically incorporated throughout all levels of the organization. Research on the effectiveness of such efforts may need to rely on non-randomized studies, including demonstration research conducted among convenience samples of worksites. Through the diversification of research methods, including observational studies, qualitative research, and participatory action research, it may be possible to address broader range of questions that will contribute to improved effectiveness of integrated OSH/WHP interventions.²³³⁻²³⁵

G.5. Process evaluation

We suggest four overarching aims for process evaluation: intervention implementation evaluation; cost analyses; assessment of worksite characteristics associated with participation; and process-to-outcome analyses.

Need for intervention implementation evaluation

The parameters of implementation evaluation have been defined to include assessment of how a program is implemented, what intervention is provided, under what conditions, with delivery by whom and to whom.²⁰⁶ It is important that future intervention research examine program implementation issues. Recent worksite health promotion trials have included rigorous assessments of the implementation of interventions through process tracking systems measuring such indicators as dose, or the amount of intervention delivered; fidelity, or the extent to which the intervention was delivered as planned; and program coverage, including participation in programs and awareness of environmental changes.²³⁶⁻²⁴³ Likewise, in OSH aspects of the intervention, it is critical to systematically document how an intervention was carried out.²²⁵ These data provide important information that enhances the ability to interpret outcome assessments, identify competing explanations for observed effects, and measure exposure to the intervention.^{228, 243-246} For example, it is important to determine the dose of intervention necessary to achieve the targeted changes in health behaviors and potential for hazardous occupational exposures. Through intervention implementation evaluation, it may be possible to identify the minimum amount of intervention needed to have an impact, thereby defining cost-effective strategies that efficiently maximize intervention outcomes without sacrificing intervention quality.²⁴⁷

Need for cost and related analyses

Second, there is a need for future research to include cost analyses and related measures (e.g., productivity, absenteeism) to assess costs, effectiveness, and benefits of integrated interventions. These findings will provide a basis for decision-making by employers and regulatory agencies, and may be useful in meeting the aim of creating the “business case” for integrated

interventions.⁹ Such analyses can make use of new systems that allow for tracking costs via insurance claims and disability claims, with links provided to data on program participation and program costs.

Assessment of worksite characteristics associated with participation

It is necessary to gain an understanding of the full range of factors that would promote and inhibit employer participation in integrated programs, as a first step toward developing strategies to engage employers in evidence-based OSH/WHP programs. Glasgow and colleagues have provided a framework for this research through their RE-AIM model, describing several components of intervention impacts.¹¹⁹ They recommend that studies assess adoption, or the percent and representativeness of worksites that are willing to adopt a program. Within the context of worksite intervention research, for example, we might assess adoption rates in terms of the proportion of worksites that agree to participate in the study among those meeting study eligibility criteria, and compare the characteristics of adopters and non-adopters. In this way, it is possible to assess the external validity of worksite-based studies, that is, the extent to which worksites recruited into trials represent other worksites.^{55, 248, 249}

Surveys of management may provide further information on factors influencing management interest and willingness to participate in integrated programs.²⁵⁰ While it is clear that cost assessments can help to make the “business case” for employer participation based on an identification of potential savings in direct and indirect costs as a result of these programs, such research additionally can help to understand other motivators, such as employer concern for employee well-being, ability to recruit personnel and reduce turnover rates by offering comprehensive approaches to worker health, and positive community public relations. A better

understanding of the full range of motivators would help to identify strategies to promote participation in research and eventual adoption of programs shown to be effective.

Need for process-to-outcome analyses

Third, there is a need for process-to-outcome evaluations in order to improve specification of effective intervention methods through assessment of the pathways through which interventions operate. That is, understanding-centered research that goes beyond an exclusive focus on outcomes to explore mechanisms and processes by which the outcomes occur. As we outline in Section G.1., clear specification of the theoretical or causal model guiding the intervention is needed in order to clarify the ways in which the “black box” of the intervention is expected to work.^{223, 251} We have suggested a social contextual framework, as described in Section G.1, which specifies mediating mechanisms, meaning the pathways by which the intervention will influence the outcomes, such as social support; and modifying conditions, or the factors that are not influenced by the intervention but can independently influence outcomes, such as social class.⁵ Mediating mechanisms and modifying conditions are specified according to a defined theoretical framework. This theory-driven approach offers numerous advantages, including the ability to identify pertinent variables and how, when, and on whom they should be measured; the ability to evaluate and control for sources of extraneous variance; and the ability to develop a cumulative knowledge base about how and when programs work.²⁵²⁻²⁵⁵ When an intervention is unsuccessful at stimulating change, data on mediating mechanisms can allow investigators to determine whether the failure is due to the inability of the program to activate the causal processes that the theory predicts, or to an invalid program theory.²⁵⁵

This understanding-centered research is likewise able to elucidate the benefits and downsides of integrated OSH/WHP programs for workers as well as employers. Cost and related

analyses described above contribute to our ability to make a business case for these programs. In addition, we need to understand incentives and benefits for workers to participate in programs and to change health behaviors as a result, and to explore disadvantages and costs to their participation.

There is a need as well to consider the implications of a given intervention for secondary outcomes, determined based on the nature of the intervention. For example, work organization strategies designed to improve productivity and product quality (e.g., total quality management, reengineering, team concept, lean production, and patient-focused care) also impact on levels of employee participation, job stress and health risks.^{182, 225}

G.6. Dissemination and durability research

The overarching aim of this research agenda is broad-based dissemination of evidence-based interventions that can be effectively sustained in worksites across the nation, thereby contributing to long-term improvements in worker health. In general, however, there remains a sizable gap between prevention science and prevention practice.^{256, 257} Research in the final phase can inform this process by identifying, for example, effective dissemination processes, programmatic characteristics most likely to be adopted and sustained over time, and organizational characteristics associated with readiness for change.

Need for research on the sustainability of organizational and behavioral changes

Research is needed to examine the sustainability of a program within a worksite, as well as the maintenance of health behavior changes and OSH-related changes over time. For example, at the organizational level, it is important to consider: (1) the durability of the effects of the program on health benefits (e.g., worker illnesses, injuries, health behaviors) over time, beyond the initial

program; (2) continuation of the program activities within the organizational structure (e.g., continuation of engineering controls to reduce job hazards, continuation of worksite smoking policies); and (3) building the capacity of the worksite to sustain the intervention (e.g., training workers and managers to identify and ameliorate job hazards; increasing knowledge of community-based health promotion resources).²⁵⁸ Assessing organizational/environmental changes only at the completion of the intervention may reflect a mismatch between the research timeline and the timeline of change as it occurs in workplaces, and therefore may underestimate intervention impact. Thus, there is a need for studies that examine changes well beyond the intervention period, bearing in mind that the validity of extended follow-up assessments relies on the capability of obtaining high response rates beyond the completion of the intervention. Theories of organizational change and innovation provide a conceptual approach for how new programs (“innovations”) become incorporated or “institutionalized” within organizations.²⁵⁸⁻²⁶⁴ Institutionalization reflects a process of mutual adjustment whereby changes are made in both the intervention and the organization.²⁶⁵ Accordingly, the innovation loses its separate identity and becomes embedded within organizational structures and a routinized part of the organization’s regular activities.^{259, 260, 266}

Need for research on the process of dissemination of tested interventions

To bridge the gap between research and implementation of evidence-based research, researchers and practitioners need to assure that the intervention has been shown to be effective, and that employers and workers are prepared and ready to adopt, implement, disseminate and institutionalize the intervention. Planning for dissemination must be structured into intervention design and made an integral part of planning from program inception, rather than a post-hoc consideration.

Dissemination of effective interventions requires the identification of both core and adaptive elements of the intervention.²⁶⁷⁻²⁶⁹ Core elements are those features of a program or policy that *must* be replicated to maintain the integrity of the interventions as they are transferred to new settings. For example, core elements might include factors such as the inclusion of tested, theoretically-based behavior change strategies, targeting multiple levels of influence, and the involvement of empowered community leaders.^{270, 271} Adaptive elements include those features of an intervention that can be tailored to organizational, social and economic realities of the new setting without diluting the intervention's effectiveness.²⁶⁷ These adaptations might include timing and scheduling issues or modifications in culturally meaningful themes through which the educational and behavior change strategies are delivered. Dissemination research could help to identify alternatives to conceptualizing transfer of intervention technology from research to the practice setting. Rather than disseminating an exact replication of specific tested interventions, program transfer might be based on core and adaptive intervention components at both the individual and community/organizational levels, through dissemination research and process evaluation.^{240, 272, 273}

There is a need to learn more about how dissemination occurs in order to increase the effectiveness of the process. Goldenhar and colleagues²²⁵ pointed to several important questions for dissemination research in OSH that are clearly applicable to dissemination of integrated OSH/WHP interventions, including: (1) What factors hinder and facilitate the dissemination of effective interventions to appropriate worksites? (2) How can we increase the speed and improve the effectiveness of the dissemination process?²²⁵ Dissemination research may additionally explore: What characteristics of worksite and union leaders are associated with dissemination of integrated programs? What personnel and material resources are needed to implement and maintain prevention programs? How can we provide both written materials

and training in program implementation that will preserve fidelity to core elements?²⁶⁷

Dissemination research may also examine worksite organizational factors that may facilitate or hinder the adoption, implementation and maintenance of integrated OSH/WHP programs.

Diffusion theory assumes that the unique characteristics of the adopter (i.e., worksite) interact with the specific attributes of the innovation (risk factor targets) to determine whether and when an innovation is adopted and implemented.^{260, 274, 275}

Dissemination research can also help to identify strategies to increase participation in programs among worksites with limited resources to provide their own integrated OSH/WHP programs, such as businesses employing fewer than 50 people.^{111, 276} Through effective dissemination of community programs, it may be possible to engage employers through outsourcing and in collaborating with other small worksites to purchase services.²⁷⁷

G.7. Barriers to research

To accomplish this research agenda, it is important to attend to several key challenges. First, several methodological issues require careful consideration. As we discuss in Section G.4, there is a need for *diversification of research methods*, with particular attention to the development and adaptation of methods that bridge OSH and WHP. For example, although the randomized controlled design provides one rigorous method for assessing the efficacy of interventions, this study design may not be feasible or even desirable for some research questions, for example, for assessing the impacts of broad-based structural changes that require a level management commitment going beyond that which could be randomly assigned. It is important that a range of both inductive and deductive methodologies be articulated, taking advantage of the strengths of both OSH and WHP research traditions, in order to design rigorous, credible and reproducible investigations across the full range of research phases. In addition, studies must be designed with

careful attention to *maximizing the generalizability* of research findings. Too often only larger, more affluent, stable worksites are available for study, and the results of investigations may not be applicable to small businesses or those with more transient workforces. Worksites selected for inclusion in the studies must be representative of a larger population of worksites, and when individual workers are surveyed as part of the outcome assessment, it is important that they represent the work force from which they were sampled. The self-selection of worksites into studies may contribute to a response bias at the worksite level. In addition, there is a need for *valid and reliable measurement tools* that permit consistent assessment of outcomes across worksites participating in the research, and that are appropriate for diverse groups of workers. Finally, measurement of the full range of outcomes resulting from integrated OSH/WHP interventions requires *access to worksite data* permitting measurement of morbidity indicators, health care utilization, absenteeism, and related issues.

To accomplish the most useful research, investigators need access to a range of populations, through close collaborations with industry and labor. These relationships are best fostered over the long-term, through on-going partnerships based on a shared commitment to worker health. Such collaborations are likely to foster opportunities for observing the benefits to be derived from broad-based organizational changes integrating OSH and WHP. It is imperative that these relationships reflect the growing diversity of the labor market and the range of settings in which workers are employed, as we illustrate in our discussion of labor trends. To be effective with a range of audiences, intervention programs must take into account the assets and health strengths as well as health risks of workers of low socioeconomic status and from racial and ethnic minority groups.

Full implementation of these recommendations regarding interventions and research needed may also require changes in the ways that funders view and support OSH and WHP.

Categorical funding of research initiatives has furthered the segregation of these fields. A comprehensive view of worker health would be supported by systematic funding of interdisciplinary, collaborative research and training.

H. Conclusions

In conclusion, as we move forward with an agenda for integrating OSH and worksite health promotion, it is critical that rigorous scientific evidence be the cornerstone of our planning. Advancing knowledge in this area requires that we attend to barriers for scientists, including the real work of assembling multi-disciplinary teams and identifying funding sources to support integrated studies. Research to develop and test effective intervention strategies integrating OSH and WHP requires an interdisciplinary approach. Experts in these areas read different journals, attend different professional meetings, and employ different research methodologies. Indeed, these diverse backgrounds have contributed to differing ideological perspectives about responsibility for worker health. The belief that worker health begins with individual behavior change sets in motion a different set of intervention strategies from the legal formulation in the Occupational Safety and Health Act, which starts from the assumption that management bears primary responsibility for worker health and safety on the job.¹ Overcoming the segmentation of these fields ultimately will require an inclusive, comprehensive model of work and health, providing for resolution – or at least understanding – of our differences assumptions, vocabulary, research methods, and intervention approaches.²⁷⁸ It is possible to expand communication streams across disciplines to support transdisciplinary/inter-disciplinary strategies, for example, through shared journals or further shared symposiums such as the NIOSH symposium for which this document was created.

One vehicle to promote this requisite collaboration may be through the creation of multidisciplinary centers of excellence, bringing together researchers across disciplines and with diverse perspectives, yet with a shared focus on a common endpoint: the health of workers. To advance the field, it is important that these multidisciplinary teams include representation of occupational health and safety, industrial hygiene, behavioral and social sciences, organizational change, health promotion, labor education, and cost analysis, among other areas, with the ability to apply both quantitative and qualitative research methods.^{1, 148} Together, researchers in such centers may be able to create broad-based partnerships with industry and labor in the design and evaluation of feasible and innovative interventions integrating OSH and WHP. An emerging science of interdisciplinarity can help to inform the development and structure of these centers. Stokols has articulated, for example, key processes that can contribute to the success of transdisciplinary collaboration.²⁰⁹ Through careful planning and purposeful and strategic operations, these centers of excellence may further advance the field by developing and applying rigorous research methodologies to evaluate the efficacy, generalizability, sustainability, and disseminability of these integrated interventions across a range of worksite settings.

Implementation of these research recommendations is also likely to necessitate changes in the ways that funding agencies like the National Institutes of Health and NIOSH view worker health proposals. The budgets for these agencies are also vastly discrepant, with NIOSH receiving far fewer resources than NIH institutes such as the National Cancer Institute. An interagency collaboration to jointly support integrated OSH/WHP interventions would provide much-needed resources to advance scientific discovery. It is important that such inter-agency funding extends rather than supplants current NIOSH efforts, thereby protecting the central function of NIOSH focused on worker health protection. A related issue is the way that funders currently review research proposals. At present, proposals to address health behavior

interventions are handled by certain review panels in NIH, while occupational health intervention proposals are separately addressed by a special occupational health review panel. Given the unique expertise represented by these panels, it may be difficult for investigators to convince members of one or the other review panel of the importance of integrated interventions, let alone to receive a sophisticated critique of study methods unique to each discipline. If NIH agencies and NIOSH join forces to support integrated intervention research, it would also be important to convene an ad hoc reviewer panel representing expertise in multiple relevant disciplines.

We have attempted to define a comprehensive agenda for future work, structured in a step-by-step fashion. The development and dissemination of effective intervention methods will be enhanced as research is implemented across the full spectrum of the phases of research – from methods development studies through dissemination research. By combining what we have learned to date from testing of worksite health promotion interventions and OSH interventions, we are well poised to launch the next generation of research in support of worker health.

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J. Figures and Tables

Figure 1. Matrix of interventions supporting worker health

Content	Level of Influence		
	Individual/Interpersonal	Organization/Environment	Multi-Level
Occupational health and safety (OSH)			
Health promotion (WHP)			
Integrated OSH/WHP			

Figure 2. Health risk reduction through various WHP by significant findings

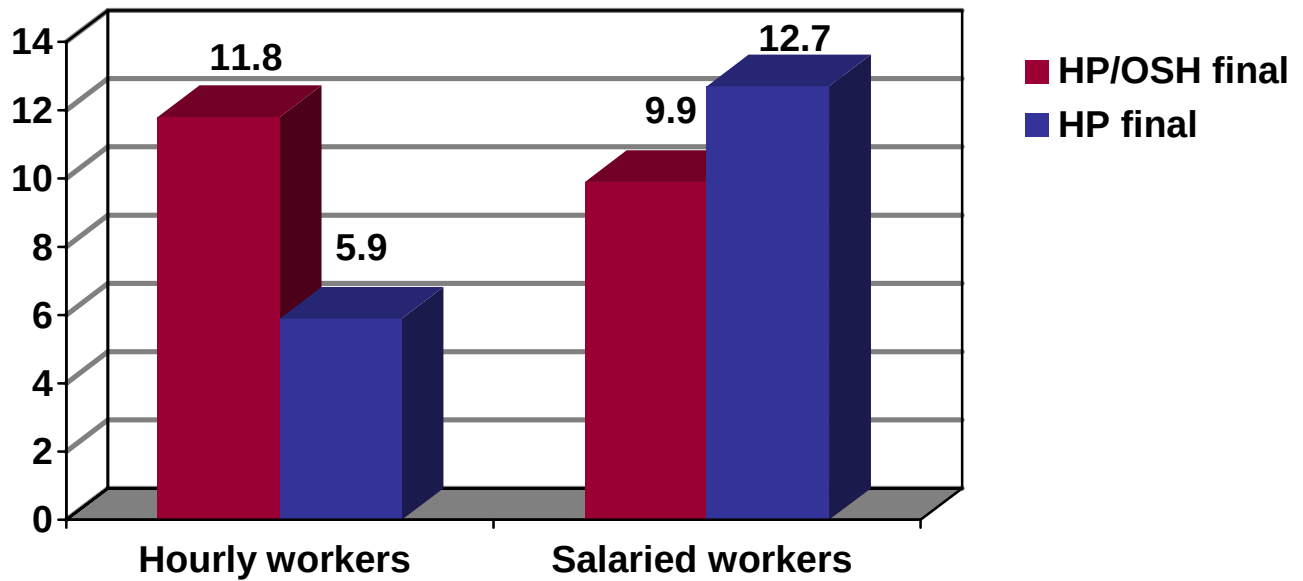
		Physical Activity			Nutrition/ Cholesterol	Weight control	Smoking cessation/ policy		Alcohol	Stress		Cancer risk factors	Multi- component programs			
	Significant Findings ↓	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
Anthropometrics	Weight loss															
	BMI reduction															
	% body fat reduction															
	Blood pressure reduction															
	Cholesterol reduction															
	Improved glycemic control															
	Physical activity increase															
Health promotion behaviors	Reduced smoking incidence															
	Improved endurance/ fitness															
	Nutrition choices															
	Reduced alcohol															
	Increased seatbelt use															
Life satsifaction/ attitudinal	Increased life satisfaction/ well-being															
	Increased job satisfaction/ well-being															
	Reduced stress/anxiety/ somatic complaints															
	Nutrition attitude															
	Alcohol attitude															
Morbidity/ Mortality	Reduced mortality															
	Fewer visits to doctors/ hospitalizations															
	Reduced flu and complications															
	Ealier cancer diagnosis (breast)															
	Reduced back pains															
	Decrease in overall disease risk															
Organizational outcomes	Fewer accidents															
	Reduced absenteeism/ sick days															
	Increased productivity															
	Sickness costs															
	Positive return on investment															

Meta-analysis study, number of studies (years)

- a. Shephard 1996 52 (1972-1994)
- b. Dishman et al 1998 26 (1979-1995)
- c. Proper et al 2002 8 (1981-1999)
- d. Glanz et al 1996 Nutr=10, Chol=16 (1980-1995)
- e. Hennrikus et al 1996 43 (1968-1994)
- f. Cochrane
- g. Erikson et al 1998 81 (1968-1994)

- h. Roman et al 1995 24 (1970-1995)
- i. Bamberg et al 1996 27 (1983-1992)
- j. Murphy 1996 64 (1974-1994)
- k. Janer et al 2002 45 (1984-2000)
- l. Heaney et al 1997 47 (1978-1996)
- m. Pelletier 1996 26 (1992-1995)
- n. Pelletier 1999 11 (1994-1998)
- o. Pelletier 2001 12 (1998-2000)

Figure 3. Adjusted Six-Month Quit Rates at Final by Intervention and Job Type
(cohort of smokers at baseline: n=880)



Sorensen G, et al. Reducing social disparities in tobacco use: A social contextual model for reducing tobacco use among blue-collar workers. *American Journal of Public Health* 2004; 94: 230-239.

Figure 4. Framework for research on integrating OSH and health promotion

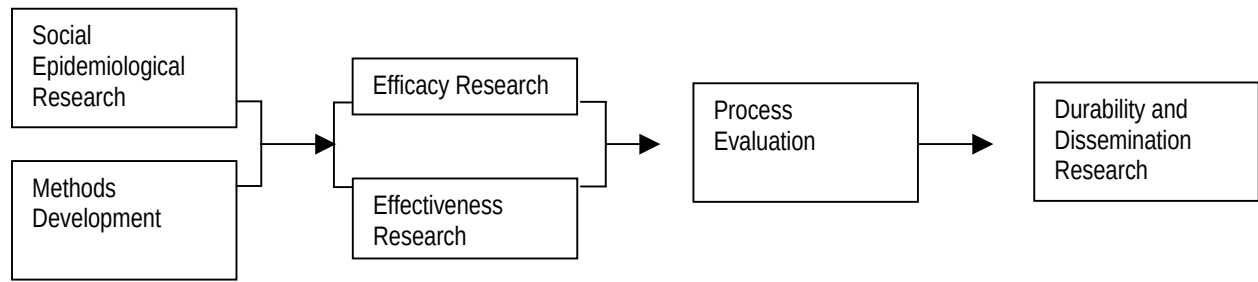
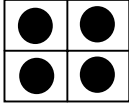
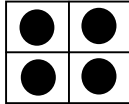
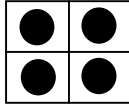
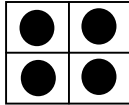
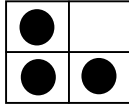
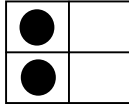


Figure 5. Study design: Appropriate comparisons in assessing integrated OSH/WHP interventions

		Inclusion of OSH in intervention?	
		NO	YES
Inclusion of WHP in intervention?	NO	Non-Intervention Control	OSH-Only Intervention
	YES	WHP-Only Intervention	Integrated OSH/WHP Intervention

Table 1. Studies Integrating OSH and Health Promotion

Study	Design	Intervention Outcomes	Intervention†	Results	Setting
WellWorks-1 (Sorensen, et al, 1998)	RCT* worksites	Smoking cessation Dietary habits		- Significant improvements in smoking cessation and fruit and vegetable consumption for all workers - Significant improvements in fiber consumption for laborers	Mid-to-large manufacturing worksites (N=24 sites)
WellWorks-2 (Sorensen, et al, 1998)	RCT* worksites	Smoking cessation Fruit and vegetable consumption OSH exposures		- Significant improvements in smoking cessation among hourly workers - Significant improvements in OSH programs	Mid-to-large manufacturing worksites (N=15 sites)
The Brabantia Project (Maes, et al, 1998)	Quasi-experimental pre/post design	Lifestyle score (smoking, physical activity, hours sleep, BMI alcohol use, fat intake) Health risk General stress reactions Working conditions Absenteeism		- Improved cardiovascular health (due to improved serum cholesterol in men) - Improved working conditions (due to improved perceived psychological demand and improved ergonomic conditions) - Reduced absenteeism (8.1% reduction in experimental group, 4.8% reduction in the control group)	Three Dutch Brabantia worksites (N=3 sites)
Healthy Directions/ Small Business (Sorensen, et al, in press)	RCT* worksites	Fruit and vegetable consumption Red meat consumption Multi-vitamins Physical activity		- Significant improvements in physical activity and multi-vitamin use for all workers - Larger effects for workers than managers for fruits and vegetables and physical activity	Small manufacturing worksites (N=24 sites)
MassBuilt (Barbeau, et al)	Methods development	Smoking cessation		Not yet available	Construction apprentices in union program
United for a Healthy Future (Sorensen, et al)	RCT* worksites	Smoking cessation Fruit and vegetable consumption		Not yet available	Unionized construction laborers

* Random controlled trial with levels of randomization

† Intervention: Individual Organization

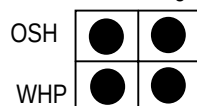


Table 2. Intervention Activities in the WellWorks-2 Study

Intervention Components	Health Promotion	WHP + OSH
Joint worker-management participation	Representation: ▪ Workers ▪ Management ▪ Various departments ▪ Variety of racial/ethnic groups represented in the workplace	Representation: ▪ Workers ▪ Management ▪ Various departments ▪ Variety of racial/ethnic groups represented in the workplace ▪ Occupational Health and Safety Manager ▪ Coordination with occupational health and safety committees
Interventions targeting workplace organizational and environmental change	Consultation to management regarding: ▪ Tobacco control policies ▪ Food catering policies* ▪ Cafeteria and vending machine signage of healthful food choices	Consultation to management regarding: ▪ Tobacco control policies ▪ Food catering policies* ▪ Cafeteria and vending machine signage of healthful food choices ▪ Recommended changes to reduce occupational hazards based on walk-through assessment
Interventions targeting change in individual health behaviors	Traditional interventions addressing tobacco and nutrition: ▪ Group discussions ▪ Worksite-wide events	Traditional plus integrated [‡] interventions addressing tobacco, nutrition and occupational health: ▪ Group discussions ▪ Worksite-wide events

* Catering policies specify offering healthful food options when food is served at company activities

[‡] Integrated interventions address occupational health and nutrition, smoking, or both.

Sorensen G, et al. Reducing social disparities in tobacco use: A social contextual model for reducing tobacco use among blue-collar workers. *American Journal of Public Health* 2004; 94: 230-239.

Table 3. Research agenda: Key directions for future research

Social epidemiological research
OSH data by race/ethnicity and gender
Expanding our understanding of social contextual determinants of worker health outcomes
Understanding the dual impact of job and life risk exposures over the life course
Methods development research
Further specification of integrated interventions
Further development of measurement tools
Assessing intervention efficacy
Assessment of intervention efficacy for OSH and worksite health promotion outcomes
Assessment of the efficacy of diverse types of integrated OSH/WHP interventions
Assessing intervention effectiveness
Assessment of the efficacy of interventions for diverse groups of workers
Consideration of a range of research methodologies
Process evaluation
Intervention implementation evaluation
Cost and related analyses
Assessment of worksite characteristics associated with participation
Process-to-outcome analyses
Dissemination and durability research
Research on the sustainability of organizational and behavioral changes
Research on the process of dissemination of tested interventions