Ann. Occup. Hyg., Vol. 52, No. 7, pp. 555–566, 2008
Published by Oxford University Press
on behalf of the British Occupational Hygiene Society
doi:10.1093/annhyg/men055

A Framework for the Concurrent Consideration of Occupational Hazards and Obesity

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Received 19 May 2008; in final form 8 July 2008; published online 2 September 2008

Occupational hazards and obesity can lead to extensive morbidity and mortality and put great financial burden on society. Historically, occupational hazards and obesity have been addressed as separate unrelated issues, but both are public health problems and there may be public health benefits from considering them together. This paper provides a framework for the concurrent consideration of occupational hazards and obesity. The framework consists of the following elements: (i) investigate the relationship between occupational hazards and obesity, (ii) explore the impact of occupational morbidity and mortality and obesity on workplace absence, disability, productivity and healthcare costs, (iii) assess the utility of the workplace as a venue for obesity prevention programs, (iv) promote a comprehensive approach to worker health and (v) identify and address the ethical, legal and social issues. Utilizing this framework may advance the efforts to address the major societal health problems of occupational hazards and obesity.

Keywords: obesity; occupational safety and health; hazards; health promotion; overweight

INTRODUCTION

Should occupational safety and health and attention to obesity in workers be considered together? The significance and impact of occupational morbidity, mortality and injury and obesity are extensive and well documented (Steenland *et al.*, 2003; Fingerhut, 2005; Flegal *et al.*, 2005; Schulte, 2005; Calabro, 2007). Both work exposures and obesity are major causes of disease and injury and create substantial financial and societal burdens globally (Fig. 1). However, the value of addressing obesity and work hazards together to develop public health strategies has not been explored. There are four reasons to consider occupational hazards and obesity together. First, there is a relationship between occupational hazards and obesity; while seemingly independent, occupational hazards and obesity can be, and often are, interrelated although most of the epidemiological studies related to obesity and occupational hazards were not designed to assess the presence of interaction or effect modification (Van Amersvoort *et al.*, 1999; Yamada *et al.*, 2001; Perbellini *et al.*, 2004; Pollack *et al.*, 2007; Schulte *et al.*, 2007). Work and workplace exposures can lead to obesity while obesity can modify occupational morbidity, mortality and injury risks. Second, each can affect workplace absence, disability, productivity and healthcare costs (Ricci and Chee, 2005; Schulte, 2005; Benavides *et al.*, 2007; Østbye *et al.*, 2007). Third, the workplace is potentially a good venue to deliver obesity prevention and control programs (Dejoy and Southern, 1993; Winick *et al.*, 2002; Yamada *et al.*, 2002; Katz *et al.*, 2005). As found in previous studies, these programs may be more effective if they also address workplace safety and health issues. The fourth reason to consider occupational hazards and obesity together is that it may be time in the evolution of occupational safety and health disciplines to think comprehensively about worker health (Yamada *et al.*, 2002; Kaijtser, 2005; Schulte, 2005; Vainio, 2005; Yassi, 2005; Levy *et al.*, 2006). The joint consideration of occupational hazards and obesity is a sensitive matter requiring consideration of related ethical, legal and social issues. In this paper, we will explore the rationale for considering occupational hazards and obesity together and some of the ethical, legal and social issues that may arise in doing so.

A framework for the concurrent consideration of occupational hazards and obesity can be developed from this rationale. The framework (Table 1) has the following five elements:

1. Investigate the relationship between occupational hazards and obesity.

2. Explore the impact of occupational morbidity and mortality and obesity on workplace absence, disability, productivity and healthcare costs.
3. Assess the utility of the workplace as a venue for preventive programs.
4. Promote a comprehensive approach to worker health.
5. Identify and address the ethical, legal and social issues associated with the framework.

Both occupational hazards and obesity are part of a complex matrix of risk factors. At the broadest level, occupational hazards are a function of technological development as well as the product of economic, social and demographic trends (Walker, 1989; Raine, 2004; Levy *et al.*, 2006). In many countries, a tripartite approach of government, industry and labor has served as a driving force for addressing occupational safety and health and controlling workplace hazards. At a more elemental level, the organization of work, extent of contracting out work, management commitment and the presence or absence of a union are some of the features that determine workplace safety and health. For obesity, the determinants are more than just the direct factors influencing energy expenditure and intake. They also include an array of biological factors as well as the level of technological and economic development, social and economic policies and investment and the impact of national, community, work, school and home organization (Philipson, 2001; Lakdawalla and Philipson, 2002; Raine, 2004; Finkelstein *et al.*, 2005a; Lyon *et al.*, 2006; Callabero, 2007; Callabero and Yeh, 2007).

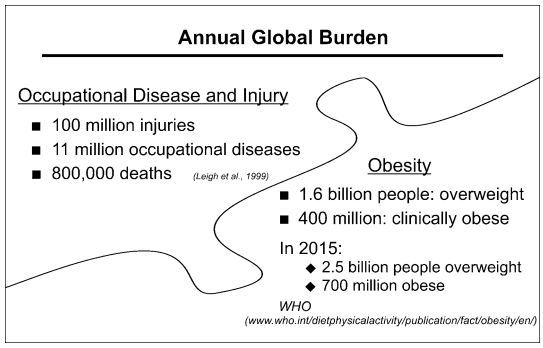

Fig. 1. Global burden of occupational morbidity and mortality and obesity.

Investigate the relationship between occupational hazards and obesity

There is a growing body of research linking occupational hazards and diseases with obesity (Table 2). Obesity has been shown to affect the relationships between exposure to occupational hazards and disease or injuries. It may also be a co-risk factor for them. Obversely, workplace hazards may affect obesity–disease relationships, be co-risk factors for disease or injuries or for obesity. Workplace design, work organization and work culture also may influence disease risk. It is important to realize that the relationship between occupational exposure and obesity is quite complex and obesity is not a 'necessary and sufficient' cause of work-related morbidity, mortality and injury (Pollack and Cheskin, 2007). Moreover, the issue of the interaction between obesity and occupational hazards is difficult to assess. A more accurate description of the relationship is to view the relationship as indicative of co-current risk factors or 'potential' interaction. In some cases, occupational factors may be surrogates for socioeconomic status in assessments of the relationship of work and obesity. In disentangling the roles of obesity and occupational hazards, much of the research on workers is limited by small samples, inadequacy in addressing confounding and temporality, poor study designs and weak statistical methods (Pollack and Cheskin, 2007). Since obesity can be an effect, susceptibility, modifying or causal factor, it has been treated inconsistently in epidemiological literature. Varying degrees of methodological arbitrariness have impaired the interpretation and communication of results and have limited their application in the context of prevention (Hoffmann *et al.*, 2002). For some relationships such as effects of specific chemicals modified by obesity, animal studies have been quite informative and avoid some of the complex issues in human studies (Sriram *et al.*, 2002; Li *et al.*, 2007).

Various heuristic models, based on the scientific literature, can describe the relationship among occupational hazard exposures, work and obesity (Schulte *et al.*, 2007). These models, in some cases, are based on known associations and in others on hypothesized ones. It is appreciated that competing models may explain the same condition and have various policy implications (Räisänen *et al.*, 2006). The models

Table 1. Framework for joint consideration of occupational hazards and obesity

Elements
Investigate the relationship between occupational hazards and obesity
Explore the impact of occupational morbidity and mortality and obesity on workplace absence, disability, productivity and healthcare costs
Assess the utility of the workplace as a venue for obesity prevention programs
Promote a comprehensive approach to worker health
Identify ethical, legal and social issues associated with the framework

Table 2. Potential associations of obesity, occupational hazards and health conditions in animal and human studies

Occupational exposures/ diseases/conditions	Potential associations	References
Exposures		
Chronic work stress	Work stress is a risk factor for obesity	Ostry *et al.*, 2006; Brunner *et al.*, 2007
Heat stress	Obesity is a co-risk factor for occupational heat stress	Henschel, 1967; Maeda *et al.*, 2006
Exposure to trichloroethylene	Increase risk of renal cell carcinoma is modified by BMI	Charbotel *et al.*, 2006
Exposure to respirable workplace contaminants (solvents, dusts and irritants)	Increased prevalence of obesity in men with blood group O phenotype and long-term occupational exposure	Suadicani *et al.*, 2005
Neurotoxicant exposure	Obesity may enhance susceptibility to nervous system toxicants	Sriram *et al.*, 2002; Choi *et al.*, 2005
Carbon nanotubes	High-fat diets may accelerate development of plaque in the circulatory system following exposure to carbon nanotubes	Li *et al.*, 2007
Immunogenic chemicals	Various chemicals and obesity may modify the immune system	La Cava *et al.*, 2003; Marcos *et al.*, 2003; Collins *et al.*, 2004
Vibration	Damage—resulting from obesity or obesity-related changes may compromise muscular, neural and vascular tissues making them more susceptible to vibration-induced injury	Wieslander *et al.*, 1989
Motor vehicle driving	Increased risk of death due to motor vehicle crashes among obese men	Zhu *et al.*, 2006
Contingent work	Exacerbates poor eating and exercise habits	Cummings and Kreiss, 2008
Organization of work–shift work	Results in weight gain and obesity	Van Amersvoort *et al.*, 1999; Gelibeter *et al.*, 2000; Yamada *et al.*, 2001; Morikawa *et al.*, 2007
Sedentary work	Workers with high levels of sitting are more at risk for overweight or obesity	Brown *et al.*, 2003
Diseases/conditions		
Asthma	Workplace exposures and obesity are both risk factors for asthma	Balmes *et al.*, 2003; King *et al.*, 2004
Knee osteoarthritis	Obesity affects the association of work exposure and osteoarthritis	Coggon *et al.*, 2000
Carpal tunnel syndrome	Both obesity and repetitive trauma are independent risk factors for carpal tunnel syndrome	Roquelaure *et al.*, 2001; Kortt and Baldry, 2002
Other musculoskeletal disorders	Obesity is a risk factor of various musculoskeletal disorders	Miranda *et al.*, 2001; Koleva and Kostava, 2003
Cardiovascular disease	Both obesity and various work conditions are independent risk factors for cardiovascular disease	Schnall *et al.*, 2000; Flegal *et al.*, 2005; Mark, 2005; Netterstrom *et al.*, 2006
Traumatic injuries	Obesity may be a risk factor for occupational traumatic injuries	Froom *et al.*, 1996; Chau *et al.*, 2004; Pollack and Cheskin, 2007; Pollack *et al.*, 2007
Occupational cancers	The role of obesity in occupational cancer is unclear but how the body handles calories and the amount of calories are risk factors for cancer	Yoshida *et al.*, 2006
Liver and kidney damage	Obesity predisposes rats to liver and kidney damage by chemicals acting through different mechanisms	Corcoran and Wong, 1987; Salazar *et al.*, 1994
High ambulatory blood pressure	Blood pressure is elevated in men with abdominal obesity who experienced low job control	Steptoe *et al.*, 1999
Cutaneous melanoma	Obesity associated with cutaneous melanoma in agricultural workers	Dennis *et al.*, 2008
Short-term disability	BMI was found to be an independent predictor for short-term disability events	Arena *et al.*, 2006

Table 2. *Continued*

Occupational exposures/ diseases/conditions	Potential associations	References
Illness absence/productivity	Obesity is a risk factor for illness absence and productivity decrease	Tucker and Friedman, 1998; Sturm *et al.*, 2004; Ricci and Chee, 2005; Klarenbach *et al.*, 2006; Ferrie *et al.*, 2007; Gates *et al.*, 2008; Tsai *et al.*, 2008
Workforce participation	Obesity is associated with lower workforce participation on a population basis; this is independent of comorbidity and socioeconomic factors	Klarenbach *et al.*, 2006; Tunceli *et al.*, 2006
Workers' compensation claims	Linear relationship between BMI and rate of claims	Østbye *et al.*, 2007

Many of the studies in this table are cross sectional and cannot effectively elucidate causality and interaction. Nonetheless, they illustrate a potential relationship between obesity and workplace hazards with disease.

presented here will require further elaboration or validation and they merely serve to categorize relationships and point to possible future research.

Model A: obesity affects occupational exposure–disease associations. In this model (Fig. 2), exposure to an occupational risk factor results in a greater risk at increasing levels of obesity. For example, the odds ratio (OR) of the association of knee osteoarthritis with occupational kneeling and squatting increases as body mass index [BMI = weight (kg)/height (m^2)] increases. Thus for BMIs of <25.0, 25.0–29.9 and ≥ 30.0, the ORs for knee arthritis are 2.2, 6.1 and 14.7, respectively (Coggon *et al.*, 2000). Another example of the model involves how obesity affects neurotoxicant exposures as illustrated in studies of mice where the neurotoxicity caused by a variety of compounds is increased in obese mice (Sriram *et al.*, 2002; Choi *et al.*, 2005). This model can also be applied to risk factors for obesity, such as high-fat diets. For example, mice on an atherogenic (high-fat) diet had accelerated development of plaque in the circulatory system following exposure to carbon nanotubes (Li *et al.*, 2007). Additionally, obesity may limit the availability or effectiveness of personal protective equipment in reducing exposures to occupational hazards (Schulte *et al.*, 2007).

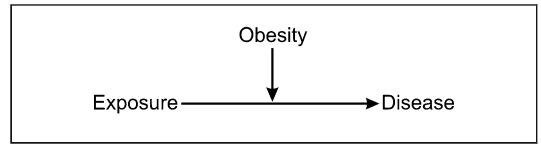

Fig. 2. Model A: obesity affects occupational exposure–disease associations.

Fig. 3. Model B: workplace factors can lead to obesity.

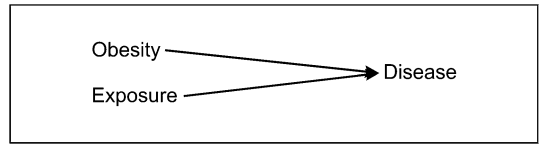

Fig. 4. Model C: obesity and occupational exposures are independent risk factors for the same disease.

Model B: Workplace factors can lead to obesity. This model (Fig. 3) is illustrated by the impact of the organization of work on weight gain and obesity. Increased body weight has been reported among shift workers in numerous studies (Shields, 1999; Van Amelsvoort *et al.*, 1999; Geliebter *et al.*, 2000; Yamada *et al.*, 2001; Morikawa *et al.*, 2007). Another illustration of this model is the relatively large number of studies that investigated the association of some measure of job stress with BMI. Various models of job stress were used. While results were mixed, in 4 of 8 studies using the demand–control model, there was a positive statistically significant relationship with BMI (Netterstrom *et al.*, 1991; Hellerstedt and Jeffrey, 1997; Martikainen and Marmot, 1999; Ostry *et al.*, 2006). Stress also has been shown to alter eating patterns in humans and animals (Epel *et al.*, 2000; Pecoraro *et al.*, 2004) and results in deposition of abdominal fat (Kuo *et al.*, 2007).

Model C: Obesity and occupational exposures are independent risk factors for the same disease. This model (Fig. 4) is illustrated by considering the literature on the roles of repetitive trauma and obesity in carpal tunnel syndrome. Both repetitive trauma and obesity are independent risk factors for carpal tunnel syndrome (Bernard, 1997; Lam and Thurston, 1998; Moghtaderi *et al.*, 2006). It is not known whether these effects are additive in a statistical sense as well as biologically.

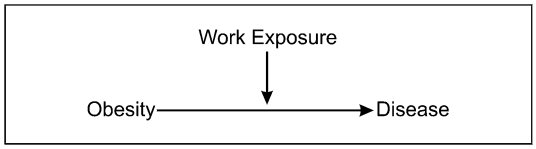

Fig. 5. Model D: work or workplace exposures affect obesity and disease relationships.

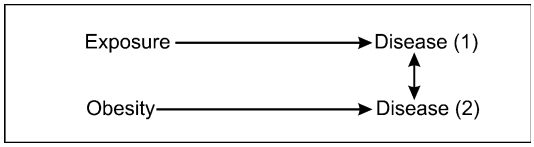

Fig. 6. Model E: occupational exposures cause one disease and obesity causes another and the two diseases interact.

Another example of this model involves cardiovascular disease. Certain work characteristics (high-paced work, shift work, high demand low control jobs, high job strain) can be risk factors for development of cardiovascular disease (Netterstrom *et al.*, 1991; Olsen and Kristensen, 1991; Schnall *et al.*, 2000). Obesity also is a risk factor for cardiovascular disease (Flegal *et al.*, 2005; Mark, 2005). Whether it is an independent or a contributing risk factor is still in question; however, people with excess body fat especially at the waist are more likely to develop heart disease (Kivimaki *et al.*, 2006). Nonetheless, both stressful work characteristics and obesity are risk factors for cardiovascular disease.

Model D: Work or workplace exposures affect obesity–disease relationships. In this model, workplace exposures affect the relationship between obesity and disease (Fig. 5). For example, obesity has been identified in epidemiological studies as a possible risk factor for asthma, but the mechanism is not known. Obese mice exhibit innate airway hyperresponsiveness and augmented responsiveness to certain asthma triggers, further supporting a relationship between obesity and asthma (Shore, 2007). Occupational exposure to various agents increases asthma risk (Lombardo and Balmes, 2000) and may modify the relationship between obesity and asthma.

Model E: Occupational exposures cause one disease and obesity causes another and the two diseases interact. This model (Fig. 6) illustrates that obesity may cause one disease and occupational exposure may cause another disease and there may be some interaction between the two diseases. For example, work-related vibration can cause vibration-induced injury (Bernard, 1997) and obesity can lead to diabetes (Kahn *et al.*, 2006). The two conditions could affect each other. The impact of diabetes may compromise vascular tissues making them more susceptible to vibration-induced injury.

Explore the impact of occupational morbidity and mortality and obesity on workplace absence, disability, productivity and healthcare costs

The separate impacts of occupational hazards and obesity on workplace absence, disability, productivity and healthcare costs have long been apparent but not thoroughly characterized. This is in part due to the absence of needed data, the extensive undercounting of occupational illnesses, deaths and injuries, the shifting of workplace costs to other societal sectors and the absence of efforts to link hazard exposures to productivity characteristics (Azaroff *et al.*, 2002; Stewart *et al.*, 2004). Nonetheless, in recent years, an expanding body of literature is beginning to characterize these outcomes (North *et al.*, 1996; Landsbergis, 2003; Stewart *et al.*, 2003; Elmer *et al.*, 2004; Goetzel *et al.*, 2004; Melchior *et al.*, 2004; Pronk *et al.*, 2004; Schulte, 2005; Labriola *et al.*, 2006; Schmier *et al.*, 2006; Benavides *et al.*, 2007; Hoogendorn *et al.*, 2007; Østbye *et al.*, 2007; Trogdon *et al.*, 2008).

The general finding that the increasing prevalence of overweight and obesity in the population leads to increasing rates of disability also has been shown in occupational populations. Schmier *et al.* (2006) reviewed published literature on the relationship between obesity, absenteeism and disability and found that overweight or obese workers had higher levels of sick leave and disability. The extent to which obesity affects productivity, absence and disability can vary by demographics and the characteristics of the workplace (Ricci and Chee, 2005). Østbye *et al.* (2007) reported a positive linear relationship between BMI and the number of workers' compensation claims, lost workdays and indemnity and claims costs. Although this study focused on young workers and middle-aged workers, it also confirmed previous findings that demonstrated strong positive associations between obesity, disability and healthcare costs in older workers (Sturm *et al.*, 2004; Ferrucci and Alley, 2007). The nature of the link of obesity to disability is still not clear. Although obesity is a strong risk factor for many chronic conditions, such as osteoarthritis, diabetes, heart disease and stroke, accounting for the presence of these diseases does not explain the relationship between obesity and disability (Ferraro *et al.*, 2002; Ferrucci and Alley, 2007).

There is a growing body of literature showing that overweight and obese employees take more sick leave and spend less time at work than their lower weight counterparts and experience a higher rate of disability (Schmier *et al.*, 2006; Tunceli 2006). Although BMI has been found to be an independent predictor of short-term disability events, it is difficult to isolate the effects of BMI since there are multiple interaction possibilities. After adjusting for baseline, sociodemographic characteristics, smoking status,

exercise and self-reported health, Tunceli *et al.* (2006) observed that obesity was associated with reduced employment at follow-up by 4.6% ($P < 0.10$) for men and 5.8% ($P < 0.05$) for women. Among employed women, being either overweight or obese was associated with an increase in self-reported work limitations compared with normal weight women of 3.9% ($P < 0.01$ for overweight women and 12.6% $P < 0.01$ for obese women). Among men, the relationship between obesity and work limitations was not statistically significant (Tunceli *et al.*, 2006).

The possible links between obesity and workplace injury have been assessed by Pollack and Cheskin (2007) in a review of 12 studies in the literature. The risk of injury for obese compared with non-obese workers was slightly increased, although many of the estimates were not statistically significant. The studies varied in methodological quality in terms of study design, missing data, modeling, classification of BMI, sample size, measurement and the ability to control for potential confounders. Optimum BMI levels may vary between specific population groups and this variation may explain inconsistencies in previous studies conducted in different settings and populations. For example, in a study of physically demanding construction work, Arndt *et al.* (2007) found that BMI levels commonly considered to reflect overweight were not associated with increased mortality in 20 000 male construction workers. However, the role of obesity and mortality is not clear-cut and the utility of using BMI in studies of muscular individuals is an issue. Snih *et al.* (2007) used a large data set of the Established Population for Epidemiologic Studies of the Elderly and found that the lowest mortality in older adults was observed in people with a BMI between 25 and 35 who are typically considered overweight. In part, these findings may be due to the fact that BMI may be a poor indicator of adiposity in older people. Although obesity is clearly associated with increased rates of many chronic diseases, it seems paradoxically protective for mortality among those diagnosed with heart failure and coronary artery disease (Curtis *et al.*, 2005; Ferrucci and Alley, 2007).

Excess weight has been shown to have an impact on direct and indirect costs for employers (Finkelstein *et al.*, 2005b; Trogdon *et al.*, 2008). The annual direct medical and absenteeism costs in the US attributable to excess weight range from $175 to $2027 for men and $588 to $2164 for the BMI categories ranging from 25 to >40 (Finkelstein *et al.*, 2005b). Additionally, high indirect costs are related to what is known as 'presenteeism' (the degree to which workers are on the job but not fully functioning because of medical or psychological conditions) which makes up 63% of the indirect costs (Hemp, 2004; Pronk, 2007). Overall, the annual direct and indirect costs in the US of obesity and overweight are estimated at $117 billion (Finkelstein *et al.*, 2005b). The cost of occupational disease and injuries in the US has also been widely studied and are estimated to range from $128 to $155 billion (Schulte, 2005). These costs are likely underestimated due to underreporting, filtering of data or difficulty assessing complex linkages of occupational hazards or obesity with various diseases (Azaroff *et al.*, 2002; Trogdon *et al.*, 2008).

Assess the utility of the workplace as a venue for obesity prevention programs

The interaction of obesity with workplace hazards and the impact of obesity on direct and indirect medical costs and productivity are the reasons for considering whether the workplace is an appropriate site for preventive interventions on weight-related outcomes in workers (DeJoy and Southern, 1993; Janer *et al.*, 2002; Yamada *et al.*, 2002; Pronk *et al.*, 2004; Katz *et al.*, 2005; Franz, 2007; Pronk, 2007).

A systematic review conducted of 20 studies of worksite obesity prevention and control (Katz *et al.*, 2005) found strong support for multicomponent interventions aimed at diet, physical activity and cognitive changes but insufficient evidence for diet, physical activity or cognitive changes alone. Rarely, in systematic reviews of worksite interventions, were there studies that looked simultaneously at addressing workplace hazards and personal obesity risk factors. This approach has been shown to be effective for cigarette smoking and may also be effective for obesity and weight gain given the growing evidence of interaction between work and obesity work factors (Barbeau *et al.*, 2004; Sorensen *et al.*, 2005; Sorensen and Barbeau, 2006). Most workplace interventions for obesity have involved employees working in office environments and few studies have explored whether such interventions will be effective with blue-collar workers. (Harrell *et al.*, 1996; Winick *et al.*, 2002; Yancey *et al.*, 2004; Katz *et al.*, 2005; Franz *et al.*, 2007). Moreover, not all workplaces will be equally conducive to intervention for obesity. Special approaches will be needed for very small businesses, contingent workers and individuals in certain jobs such as truck driving. Additionally, modifying the work environment or organization to lead to worker weight reduction may be useful (Geliebter *et al.*, 2000; Papas *et al.*, 2007).

Other systematic reviews of published literature on interventions may provide useful information for worksite programs. For example, Franz *et al.* (2007) addressed the question 'What lifestyle strategic and/or treatment components contribute to successful weight management [defined as 5–7% of starting (baseline) body weight and 5% loss maintained for one year or longer]? The review included randomized control trials published after January 1997 that were ≥12 months in duration and observation periods ≥5 years in duration. The interventions that were

assessed included advice only, diet only; diet plus physical activity, exercise only; meal replacements, very low-calorie diets and antiobesity medication. Across all the studies, the average weight loss was 11–18.7 lbs (5–7%). Weight loss was observed during the first 6 months, from interventions involving reduced energy diets and/or weight loss medication. Weight loss plateaued at ~6 months. In studies extending to 48 months, a mean weight loss of 6.6–13.2 lbs (3–6%) was maintained (Franz *et al.*, 2007).

Three issues are important in considering the workplace as a venue for weight control programs. First is the issue that health protection (occupational safety and health) and health promotion have historically been separate efforts with little interaction or coordination. Historically, occupational safety and health, at least in the US under the OSH Act of 1970, has been focused on the responsibility of the employer to provide a safe and healthy workplace. In contrast, health promotion, noted by Marmor and Mashaw (1994) (cited by Vainio, 2005), had 'individualized both the root of the problem and many of the remedies. In this way, they had avoided challenging either the conventional world of work, income distribution, control over the environment or the conventional medical establishment'. However, health promotion has since evolved to include the influence of broader social policies and to address environmental and workplace factors as well as individual factors (Vainio, 2005). Today, there is a growing realization that both occupational safety and health and health promotion can work together. In the US, the National Institute for Occupational Safety and Health sponsors the Worklife Initiative to foster this collaboration http://www.cdc.gov/niosh/worklife/. The second issue is that neither employers nor occupational safety and health professionals are trained to address obesity or overweight interventions. There will be a need to work with specialists in health promotion to develop programs (Pratt *et al.*, 2007). The third issue is that workplace interventions for obesity and overweight are not the only approaches, they should be complemented by population and policy approaches as well (Raine, 2004; Hämäläinen, 2007).

Promote a comprehensive approach to worker health

From an occupational safety and health perspective, it is appropriate to question whether personal health risk factors such as obesity should be addressed in the workplace. This question is vexing to many in the field of occupational safety and health because of concerns that focus on personal risk factors might dilute and diminish focus on the employer responsibility for preventing work-related disease or injury. The US Occupational Safety and Health Act stipulates that all workers shall have a safe and healthy workplace, but there has been a long and contentious history of efforts to blame workers for health effects believed by workers to be related to work and by employers to be related to personal risk factors (Rest *et al.*, 2006). Today, have such a set of conflicting views evolved to where there is a case to be made for the importance of considering personal risk factors along with work-related risk factors in occupational safety and health research and intervention? Or does the mere acknowledgement of two types of risk factors automatically and fundamentally change the ethical and legal framework for thinking about occupational safety and health?

Risks of occupational disease and injury are generally involuntary—they are risks of the work, working conditions and workplace exposures. These risks are not the result of workers' choices and responsibilities. There has, however, been a continual effort to implicate worker behavior as opposed to working conditions as a prominent causal factor in work-related injuries and diseases (discussed in Levy *et al.*, 2006). On the other hand, some personal risk factors (e.g. obesity, smoking and excessive drinking) are often thought of as the result of personal choices. This reductionist view is, in reality, an inadequate assessment of complex sets of factors in which personal choice is but one aspect and workplace characteristics might also be involved. Other personal risk factors such as genetics are clearly not choices, but factors over which a worker has no control.

An examination of the risk factors for work-related injuries, illness and death leads many to conclude that the involuntary nature of workplace risks takes precedence in assessment of causality and responsibility. This view is bolstered by historic assessment of the roles of ownership, labor, worker and employer rights and their particular contribution to the labor market, a struggle that has been richly characterized (Ashford, 1976; Walker, 1989; Levy *et al.*, 2006). Nonetheless, many of the most prevalent and significant health conditions of workers are not caused solely by workplace hazards. Given the impact of such conditions on healthcare costs, it may be appropriate for the occupational safety and health community to broaden its focus to include all the factors that influence a workers' health. There is a spectrum of causal conditions, from those health effects that are completely work related to those that have personal risk factors as a contributor. Moreover, there is a complex interplay between the two types of factors. Acknowledging that some work-related health effects also may be related to personal risk factors raises two other issues. First, regardless of whether there is personal risk factor involvement, the fact that a health effect is work-related means that a condition or characteristic of work is a necessary component. The second issue is that risk factors often identified

as residing within the individual may not be solely personal; they may also be results of workplace exposure as described earlier for obesity (e.g. shift work). The interplay between workplace risks and personal risk factors is complex, particularly because some conditions or behaviors (e.g. obesity, excessive drinking and smoking) may also be outcomes of work organization, exposures and pressures.

The extensive changes in the nature of work, workplaces and the workforce require occupational safety and health practitioners, researchers and policy makers to take a broader view of the factors that influence the health of workers (Baker *et al.*, 1996; Barsh *et al.*, 2000; Hoffman *et al.*, 2002; Vainio and Stayner, 2002; IOM, 2005; Hämäläinen, 2007). Ultimately, a healthy workplace can be defined as one that maintains and promotes the physical and mental health of the employees (Vainio, 2005). Similar thinking is occurring in the health promotion disciplines. Workplace Health Promotion as espoused by the European Network for Workplace Health Promotion includes all processes that are directed at improving and developing the work environment, work community or work itself in order to optimize workers' health, work ability and well-being (Hämäläinen, 2007).

Identify and address ethical, legal and social issues

Employment decisions, research and intervention involving obesity and weight are not value-neutral actions. These actions trigger ethical, legal and social concerns. The consideration of obesity in the workplace requires ethical reflection because obesity-related actions taken by employers or researchers can be harmful to workers. Obesity (and overweight) can be effects and modifiers of workplace exposures as well as independent risk factors for disease and how obesity is considered can lead to various ethical issues. These issues may arise in the following areas: hiring, risk assessment, investment in workplace controls, research, intervention and risk communication (Roehling, 2002; Schulte *et al.*, 2007).

The critical, ethical issues pertain to nonmaleficence, discrimination, stigmatization and prejudice as well as injustice, privacy, autonomy, individual and cultural identity and societal interference. In the US, there are strong social, legal and ethical principles that value the autonomy of individuals and their right to be treated in a nondiscriminatory, nonstigmatized manner. Conversely, there is an expectation of protection against paternalism or interference in personal choice as a result of an employment or other power relationship. Workers have a reasonable expectation that they will have informed choice about participation in workplace health promotion programs or research that is incidental to their work responsibilities. Privacy of medical and medically related information has historically been valued and protected. Obesity interventions in the workplace raise ethical questions regarding the appropriateness of employers to promote a worker's health or well-being if employees do not want the intervention or even attention to the subject.

In the US, workers have legal protection from being discriminated against on the basis of actual or perceived disabilities that limit a major life function (Maranto and Stenoinen, 2000). Obese workers may have significant limitations and may also be perceived, because of their obesity, as being disabled. There is no consistent legal record that indicates whether obesity is considered a disability under the Americans with Disabilities Act (Moorman and Eickhoff-Shemek, 2005). However, in recent years, there has been a rise in the number of 'perceived disability' discrimination claims (Roehling *et al.*, 2007).

The US Occupational Safety and Health Act requires employers to provide workplaces free of recognized hazards, even if the hazards are only a risk to a more susceptible subset of the workforce. Based on the research described in this paper, obese and overweight workers may be considered a susceptible group (Hoffman *et al.*, 2002).

Ultimately, many of the ethical issues concerning obesity arise from the ways in which discourse around it has been socially constructed and publicly represented (Rich and Evans, 2005). Various papers in the literature and popular press seem to offer 'certainty' and 'authority' of fact and knowledge about the relation of obesity to disease, injury, illness, absenteeism, presenteeism and medical costs. However, such relationships are not all well established or validated. Moreover, while obesity is an important public health problem, overweight is not always associated with excess mortality (Flegal *et al.*, 2005). There is a need for public dialogue that takes a more humanistic approach to weight and shape and values the diversity of body types (Rich and Evans, 2005).

CONCLUSIONS

While there is a growing evidence base, there still is a need for continuing to examine the interaction of workplace hazards with those risk factors that may appear genetic or personal, such as obesity. Societal development in the areas of labor saving devices, reduced need for physical activity and broad availability of energy-dense foods conflicts with the biological adaptation to store fat in times of hardship in obtaining food. Moreover, adipocytes are more than passive repositories for fat. Scientific knowledge now is beginning to view adipose tissue as an endocrine organ that interacts with many systems (Lyon *et al.*, 2006; Maggio *et al.*, 2006; Calabro and Yeh, 2007). To think of obesity as a result of moral weakness rather than as an evolutionary

response may fail to appreciate the general work, environmental, societal, organizational and genetic determinants. It is critical to look at the design and organization of work and the hazardous exposures in specific work environments to better understand the complex relationship between obesity and work. Clearly, more research is needed to understand the role of these determinants, yet there is a substantial evidence base that supports consideration of obesity and weight gain in various workplace settings and interventions to address them. However, if obesity is considered a 'susceptibility' or risk factor in occupational disease or injury, an outcome of occupational exposure will require attention to how society considers characteristics that can have these various interpretations.

If implemented, the framework presented in this paper may be helpful in addressing two significant public health problems, occupational hazards and obesity, confronting society by filling knowledge gaps and suggesting needed research and intervention programs. To use this framework effectively, there will need to be collaboration among investigators and practitioners from many different disciplines.

Acknowledgements—The authors are grateful to Keshia Pollack, Truls Østbye, Marilyn Batan, Gia Rutledge and John Bailer for their comments on earlier drafts. This paper is based on the Warner Lecture, given at the annual conference of the British Occupational Hygiene Society, Bristol, May 2008.

Disclaimer—The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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