Review

Design Characteristics of Worksite Environmental Interventions for Obesity Prevention

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Abstract

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Objective: This paper describes the design characteristics of the National Heart, Lung, and Blood Institute (NHLBI)-funded studies that are testing innovative environmental interventions for weight control and obesity prevention at worksites.

Research Methods and Procedures: Seven separate studies that have a total of 114 worksites (~48,000 employees) across studies are being conducted. The worksite settings include hotels, hospitals, manufacturing facilities, businesses, schools, and bus garages located across the U.S. Each study uses its own conceptual model drawn from the literature and includes the socio-ecological model for health promotion, the epidemiological triad, and those integrating organizational and social contexts. The interventions, which are offered to all employees, include environmental- and individual-level approaches to improve physical activity and promote healthful eating practices. Environmental strategies include reducing portion sizes, modifying cafeteria recipes to lower their fat contents, and increasing the accessibility of fitness equipment at the workplace. Across all seven studies about 48% ($N = 23{,}000$) of the population is randomly selected for measurements. The primary outcome measure is change in BMI or body weight after two years of intervention. Secondary measures include waist circumference, objective, and self-report measures of physical activity, dietary intake, changes in vending machines and cafeteria food offerings, work productivity, healthcare use, and return on investment.

Discussion: The results of these studies could have important implications for the design and implementation of worksite overweight and obesity control programs.

Key words: environmental-level interventions, individual-level interventions, physical activity, dietary intake

Introduction

Overweight and obesity in the U.S. population have reached epidemic proportions, with about 66% of U.S. adults being overweight or obese (1). The dramatic increase in prevalence of obesity over the past two decades cannot be explained by genetic changes, but by environmental factors that encourage increased energy intake and decreased energy expenditure (2). Environmental, community, and societal factors influence dietary and physical activity behaviors and may foster a positive energy balance (2,3), suggesting that strategies for addressing the obesity epidemic must include environmental approaches.

Environmental approaches use policies, programs, or organizational practices to influence behaviors by, for example, increasing the availability of, and providing access to, healthful food choices and facilities for physical activity,

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and by creating a socially supportive environment. Such approaches do not require individuals to self-select to defined educational programs (4). Worksites are viable settings for reaching large numbers of working adults of varying socioeconomic levels and ethnic backgrounds. A key hypothesis for research is that interventions to promote behavior change in such settings could be generalizable, cost-effective, and sustainable. If proven effective and widely implemented, environmental interventions could have a major impact on the health of employees and, thus, on the health of the nation, as well as provide a positive return on corporate investments.

In September 2004, the National Heart, Lung, and Blood Institute (NHLBI)[1] funded seven institutions to collaborate with worksites across the country to test interventions emphasizing environmental approaches to behavior change for overweight and obesity control. These institutions are Cornell University, Washington, DC; Kaiser Permanente, Honolulu, HI; Tulane University, New Orleans, LA; the University of Massachusetts Medical School, Worcester, MA; the University of Minnesota, Minneapolis, MN; the University of Rochester, Rochester, NY; and the University of Washington, Seattle, WA. Each study is conducted independently under the direction of a local principal investigator. Unlike multi-site clinical trials, these studies are being conducted in different types of worksites (e.g., hotels, hospitals, and businesses) that have diverse employee populations.

The purpose of this paper is to describe these NHLBI-supported studies, focusing on their design characteristics, interventions, common measures, and study collaboration. These are innovative studies that emphasize environmental strategies to change or modify behaviors related to diet and physical activity for weight control and obesity prevention at worksites as well as examine the economic benefits of such strategies. Information on the design, implementation, and evaluation of worksite obesity management programs could be useful to researchers designing such programs. Also, if found effective, such studies could lead to policies and practices that enhance employee health and contribute to the financial well being and reduced healthcare needs of employees and employers.

Obesity prevention at various settings, including worksites, emerged as a priority during NHLBI strategic planning meetings held in 2000 and 2002. Documents supporting worksite intervention studies include the Healthy People 2010 Objectives (5) and the Surgeon General's Call for Action (6). A review of published worksite intervention studies for overweight and obesity control indicated that most interventions focused on individual-directed approaches of minimal intensity and short-term duration (6 months or less). Some had modest but significant intervention effects on weight after 6 months (7,8). Studies that addressed environmental influences or psychosocial factors as mediators or moderators of weight control were rare (8). Most of the studies were conducted in large worksites (>500 employees) with few racial and ethnic minorities, and a limited number had worksites as units of randomization and analysis. The theoretical bases of the interventions and studies on cost-effectiveness or benefits were rarely reported (8). These gaps suggest a need to determine the effects of environmental interventions on weight and weight-related outcomes. Toward this goal, the NHLBI supported seven independent studies for a two-phase, four-year program. Phase I activities include formative assessment using methods such as focus groups, interviews with employees and administrators, surveys, assessments of the worksite environment and pilot testing of intervention components. Phase II includes a two-year intervention study to test innovative strategies that have strong theoretical underpinnings, seem to be practical, cost-effective, and sustainable without incurring undue costs, and are being refined based on Phase 1 activities and results.

Research Methods and Procedures

Design Characteristics

Table 1 presents the design characteristics of the seven funded studies. Across the seven studies, there is a total of 114 worksites (range, 4 to 30 per study site) with about 48,000 employees (range 1200 to 10,600 per study site), mostly low- to middle-income and from diverse racial and ethnic groups. A total of about 23,000 employees are randomly selected for measurement. Worksites are units of randomization in all of the studies; they are randomly assigned to intervention or comparison groups, with prior pair matching used in three studies. In all of the studies, the inclusion criteria consist of stable worksites (i.e., low turnover rates) whose administrators agree to 1) have worksites randomly assigned to intervention or comparison groups, 2) allow assessment of consenting employees at various timepoints within the worksite, 3) provide space or support for intervention targeting the employees, and 4) encourage employee participation. All assessments are being conducted on work time or directly before or after shift changes and on site. Worksites provide time off for measurement. Each study was approved by a local Institutional Review Board and has a data and safety monitoring plan as well as Data and Safety Monitoring Board or other safety monitoring entity.

Intervention

All of the studies use conceptual frameworks for their interventions (Table 1), including the socio-ecological framework that combined theoretical views of the environ-

[1] Nonstandard abbreviation: NHLBI, National Heart, Lung, and Blood Institute.

Table 1. Characteristics of the national worksite overweight and obesity control studies

	Program name, institution						
	Lighten Up, Cornell University, Institute for Health and Productivity Studies, Washington DC	Work, Weight and Wellness, Kaiser Permanente, Hawaii	Step Ahead, University of Massachusetts Medical School, Massachusetts	ACTION!, Tulane University, Louisiana	Route H, University of Minnesota—Twin Cities	Images of a Healthy Worksite, University of Rochester, New York	PACE Fred Hutchinson Cancer Research Center, and the University of Washington, Seattle, Washington
Number of worksites, type, and location	12 Dow Chemical Company plants in Texas, Louisiana, New Jersey, and West Virginia	30 hotels on the island of Oahu, Hawaii	Six hospitals in central Massachusetts	20–23 public elementary schools in Jefferson Parish, Louisiana	Four transit bus garages in the Minneapolis-St Paul metropolitan area	12 sites in a large manufacturing facility in Rochester, New York	30 worksites within 40 miles of the Seattle metro area
Employee population	~10,600: 94 to 4202 employees per worksite: 18% female, 74% white, 8% black, 7% Hispanics, 11% Asian; age 18–65 years (mean 44 years)	~10,000: 18 to 1800 employees per hotel: 60% female, 20% white, 50% Asian, and 30% Native Pacific Islanders; age 18–65 years	~8400: 350 to 3500 employees per hospital: 79% female, 87% white, 6% black, 5% Hispanics; age 18–65 years	~1500: about 30 employees per school: 93% female, 70% white, 27% black, 2.6% Hispanics; age 18–65 years	~1200–1500: about 300 employees per garage: 20% female, 64% white, 34% black, 2% Hispanics; age 18–65 years (mean 47 years)	~13,000: about 1000–1500 employees per facility: 20% female, 82% white, 11% black, 6% Hispanics, 1% Asian, American Indian or Alaskan Native; age 18–65 years	~6000: 100 to 350 employees per worksite: 33% female, 80% white, 3% black, 5% Hispanics, 10% Asians; age 18 to 70 years
Number of employees randomly selected for measurement	6000	6000	540	600	1200	4000	3000
Study design; primary outcome measurement; time points	Three arm design with worksites randomly assigned to moderate ($N = 4$), intensive ($N = 5$), or comparison ($N = 3$) arm; change in BMI, effect size = 2.2% points; power = 80%; type 1 error = 0.05; ICC = 0.001; baseline, 12 and 24 months	14 matched pairs of worksites with each member of a pair randomly assigned to one of two levels of intervention; change in BMI, effect size = 0.11 kg/m^2; power = 80%; type 1 error = 0.05; ICC = 0.005; baseline, 12 and 24 months	3 matched pairs of worksites randomly assigned to intervention or comparison arm; change in BMI; effect size = 0.5 kg/m^2; power = 80%; type 1 error = 0.05; ICC = 0.015; baseline, 12 and 24 months	Worksites are randomized to intervention ($N = 10$) or comparison ($N = 10$) arm, stratified by East or West Bank of the Mississippi River; change in BMI; effect size = 1.0 kg/m^2; power = 80%; type 1 error = 0.05; ICC = 0.04; baseline, 12 and 24 months	Worksites are randomized to intervention ($N = 2$) or comparison ($N = 2$) arm; change in BMI and body weight; effect size, BMI = 0.25 kg/m^2; power = 80%; type 1 error = 0.05; ICC = 0.005; baseline and 24 months	6 matched pairs of worksites randomly assigned to intervention or delayed intervention; change in BMI; effect size = 0.8 kg/m^2; power = 80%; type 1 error = 0.05; ICC = 0.0005; baseline and 24 months	15 matched pairs of worksites randomly assigned to intervention or comparison arm; change in BMI; effect size = 1.5 kg/m^2; power = 87%; type 1 error = 0.05; ICC = 0.04; baseline and 24 months
Formative research	Focus groups and individual interviews with employees and managers; "Leading by Example" organizational climate survey; analysis of baseline medical claims and absenteeism data; environmental assessment	Quantitative and qualitative assessments of worksite environments and employee weight loss intentions	Key informant interviews with administrative leadership; focus groups with employees; quantitative environmental assessments; leadership and employee advisory groups	Focus groups with school employees; school principal survey; environmental audit completed by study personnel	Interviews with bus operators; employee advisory groups; pilot testing of instruments, recruitment methods, and intervention components	In-depth interviews and focus groups with employees; social mapping of facilities; qualitative environmental assessment	Interviews and focus groups with employees at pilot worksite to identify key barriers and facilitators to weight loss

Table 1. Continued

	Program name, institution						
Intervention	An integrative organizational model including work environment, job demands and worker characteristics; physical activity and healthy eating opportunities for employees, access to fitness equipment, weight reduction classes, healthful food choices in cafeteria and vending machines, and engagement of site leadership in changing worksite culture	Social-ecological model of health behavior; education on diet and physical activity directed at individuals; weekly group instructional modules, and 90-minute weekly "Reinvent Yourself," a 6-month program for highly motivated employees with BMI >30	Social-ecological model of health behavior; a social marketing campaign, leadership support, changes in menu options and portion sizes in cafeteria, changes in vending options, a website, weekly email newsletters, organization of walking groups, pot luck lunches, social activities, and group-level educational programs	Social-ecological model of health behavior; modification of the physical activity environment at schools, development of on-site physical activity programs, modifications to the cafeteria and vending machines, and a social marketing campaign promoting healthy diet and increased physical activity; intervention schools develop Wellness Committees for health promotion	Social-ecological model of health behavior; increase in the availability of healthful vending machine foods and beverages, provision of snack packs for drivers to take along on their bus route; enhancement of fitness rooms at the garages, and organized outdoor physical activities for drivers	Epidemiologic triad model; employee motivation and awareness through social marketing, recipe modification, changes in vending machine offerings and subsidies, portion size reduction at reduced prices, take home healthy meals, stair use, active commute program, active travel within company	Conceptual framework focusing on the worksite social and environment contexts, and individual behavior change; intervention activities occur at three levels: the worksite environment level, the intermediate level, and the individual level, as is consistent with the conceptual framework and include portion size control at cafeteria, changes in vending machine food offerings and instituting employee advisory groups
Comparison worksite	Health risk assessment, environmental and organizational climate assessments; administrative medical claims and absenteeism data	Level 1 intervention; strategies include education on diet and physical activity directed at individuals after completion of the study	Pair-matched comparison worksites continue usual policies and activities; intervention activities will be disseminated to control hospitals at the conclusion of the study	Intervention activities will be disseminated to control schools at the conclusion of the study	Usual offerings by the health and fitness provider in the garages (none targets nutrition or physical activity)	Delayed intervention at conclusion of the study	Delayed intervention at conclusion of the study

mental, individual, social, cultural, and policy factors that influence behaviors (9). One study uses an integrative model of worksite health promotion that emphasizes organizational and work environmental factors (10). This model, which is based on a systems perspective, argues that workplace health promotion efforts must address 1) organizational factors (e.g., socio-cultural, economic), 2) the work environment (e.g., physical and structural), and 3) job demands and worker characteristics. Thus, the intervention targets job demands and worker characteristics, physical work environment, and the socio-organizational environment. For example, in some worksites, specific job requirements or conditions limit or facilitate opportunities for physical movement. Thus, weight management strategies address these job demands in such worksites. Another study uses a framework that posits that the obesity epidemic can best be controlled by targeting the epidemiological triad: hosts, vectors of agents, and environments (11). The study targets the employee (or host), energy intake and output (or vectors of the agent, positive energy balance, for example, energy dense foods, large portion sizes and physical inactivity), and the obesogenic environment (11).

Formative research (Phase I) is being used to refine, modify, enhance, or develop the intervention strategies. The studies are using combinations of intervention strategies that have been shown to be successful in the literature (e.g., vending machines) or were pilot-tested in Phase I. Further, the studies employ employee advisory boards whose members suggest additional interventions or modifications to planned interventions and serve as program champions/advisors to help implement the intervention. Also, process evaluation data (e.g., number of people who used pedometers, weighed themselves daily, take the stairs, or read study-specific newsletters) are collected and are being used to improve the intervention (12). Table 2 presents examples of environmental strategies addressing diet and physical activity, and promotional activities used by the studies. The environmental intervention strategies include portion size reduction and recipe modifications of cafeteria foods, preferential pricing for healthful foods in vending machines, and provision of fitness equipment. Individual-level interventions are also included, for example, group or individual weight loss management programs for highly motivated employees with BMI >30 (Work, Weight and Wellness Program, Kaiser Permanente, Hawaii) or group-level educational programs are being offered to all employees (Step Ahead Program, Massachusetts; and the Lighten-Up Program, Cornell). All interventions are about two years in duration (Table 1).

Table 2. Examples of promotional activities and strategies of environmental intervention for physical activity and diet

Promotional activities
Use pamphlets, fliers, posters and signage to "saturate" the workplace with messages on physical activity and healthful eating
Physical activity
Mark walking paths inside and outside buildings and promote their usage
Create more inviting stairwells in buildings with staircases
Facilitate the development of exercise/fitness groups
Offer a pedometer challenge program
Provide fitness equipment at workstations and encourage their usage
Facilitate assess to and encourage use of exercise equipment and bike racks
Provide discounts to local fitness facilities
Provide equipment (e.g., LifeClinic Health Station) for measuring body weight and other indicators of health
Dietary
Label healthful food choices in vending machines and cafeteria
Provide preferential pricing for healthful foods
Provide "healthy cupboard" space and snack stations for healthful eating choices
Coordinate a local Farmers' Market on site
Provide scales to weigh foods and control portion sizes
Require healthful food choices at company-sponsored meetings, events, and training programs
Encourage consumption of water by placing filtration systems near vending machines
Promote area restaurants that offer healthful food choices

Measurements

Table 3 presents a list of tools and instruments that are being used by the studies. These include weight scales for body weight/BMI, the Godin survey for assessing physical activity, fast foods and fruit and vegetable consumption questionnaire, the Work Limitations Questionnaire, short form, to measure worker productivity, and a healthcare use and absenteeism survey. The primary outcome measure for all studies is change in BMI or body weight. Secondary measures include waist circumference, individual dietary intake, objective measures of physical activity (e.g., accelerometry), self-reported measures of physical activity (e.g., questionnaires assessing free-time physical activity), work productivity, healthcare use, and cost benefit (e.g., return on investment and programmatic and medical costs). Study-specific measures include blood pressure, depressive symptoms, social support, tobacco and alcohol use, and self-

Table 3. List of measures by worksite program

Measure	Lighten Up, Cornell University	Work, Weight and Wellness, Kaiser Permanente	Step Ahead, University of Massachusetts Medical School	ACTION!, Tulane University	Route H, University of Minnesota—Twin Cities	Images of a Healthy Worksite, University of Rochester	PACE Fred Hutchinson Cancer Research Center and the University of Washington
Weight outcomes							
Weight (kg)*	X	X	X	X	X	X	X
BMI (kg/m^2)*	X	X	X	X	X	X	X
Waist circumference (cm)		X	X	X		X	X
Dietary outcomes							
24-hour dietary recall				X	X	X	X
Specific food choices (e.g., fast foods and fruits and vegetables)*	X	X	X	X	X	X	X
Environmental measures of diet availability (e.g., low-fat cafeteria and vending machine foods)*	X	X	X	X	X	X	X
Physical activity outcomes							
Environmental measures of physical activity resources (e.g., facilities for physical activity)*	X	X	X	X	X	X	X
Physical activity, using accelerometer				X	X	X	X
Selected questions from the International Physical Activity Questionnaire (24)	X		X		X	X	X
Modified Godin Survey: Leisure-time Physical Activity (21)*	X	X	X	X	X	X	X

Table 3. Continued

Measure	Lighten Up, Cornell University	Work, Weight and Wellness, Kaiser Permanente	Step Ahead, University of Massachusetts Medical School	ACTION!, Tulane University	Route H, University of Minnesota—Twin Cities	Images of a Healthy Worksite, University of Rochester	PACE Fred Hutchinson Cancer Research Center and the University of Washington
Work productivity, health utilization, and economic outcomes							
Work productivity (e.g., number of days absent from work, attendance) (25)*	X	X	X	X	X	X	X
Healthcare utilization (e.g., number of doctor's visits, emergency room admissions) (26)*	X	X	X	X	X	X	X
Economic outcomes (e.g., return on investments, program and medical costs, cost benefits) (27)*	X	X	X	X	X	X	X

X denotes those tools used by a site. "Other measures" (without asterisks) are those that are used by three or more sites.
* Same instruments used by all sites.

report measures of sleep. Lack of sleep has been positively correlated with obesity and could mediate intervention effects on body weight (13,14).

Dietary intake is being assessed by 24-hour recalls (2 weekdays and 1 weekend) conducted by three studies. Common questionnaires are being used to assess patterns of intake of specific foods such as fast foods, soft drinks, and fruits and vegetables. Such foods correlate significantly with body weight or healthful eating (15–19). Environmental measures of diet and physical activity are assessed using a modified version of the Checklist of Health Promotion at Worksites (20), which has been found to have reliability coefficients ranging from 0.8 to 1.0.

Physical activities of participants are assessed by the Godin leisure-time physical activity questionnaire, which typically has moderate-to-high reliabilities for assessing light, moderate, and strenuous physical activity. The Godin questionnaire has Cronbach's α ranging between 0.62 and 0.74 (21). For all of the studies, the Godin questionnaire was modified for clarity by listing the intensity of physical activity for days per week, and minutes of activity in 10- to 15-minute increments, from 0 minutes to 60 minutes. Four studies use accelerometers to provide objective measures of physical activity. Physical activity thresholds and imputation methods are defined by the methods proposed by Treuth et al. (22) and Catellier et al. (23).

Questions from the International Physical Activity Questionnaire (24) that focus on job-related physical activity are being used by five of the studies. The International Physical Activity Questionnaire has been tested in 12 countries and found to have acceptable measurement properties for use in many settings, including worksites. It has a moderate-to-high test-retest reliability coefficient of $\sim$0.8.

All of the studies use the Work Limitations Questionnaire to assess work productivity (25). The short, 8-item version of the Work Limitations Questionnaire is used to measure the degree to which health problems interfere with ability to perform job roles. It assesses employees' perceived health problems, such as physical, mental, and interpersonal demands, and how these problems interfere with specific aspects of job performance (on-the-job disability) (25). Cronbach's α statistics are typically between 0.7 and 0.9.

Employees who have been randomly selected to be measured complete the healthcare use questionnaire, which assesses sick days and doctor's visits and has been examined for face validity (26). The studies assess cost benefit by calculating the return on investment, which can be defined either as net present value (i.e., the ratio of inflation-adjusted discounted savings to program expenses), or as the benefit-to-cost ratio (27,28). All sites collect data on healthcare use, absenteeism, and presenteeism to estimate program savings. Data are monetized and savings are compared with program expenses to calculate return on investment (27).

Other study-specific assessments (two studies) include the effects of sleep duration on body weight. The Sleep Symptoms Questionnaire has good internal consistency reliabilities, with Cronbach's α coefficients ranging from 0.91 to 0.98 (13).

In addition to the outcome measures, each study uses process measures to examine intervention dose, fidelity, and reach (12). Examples include number of promotional activities (dose), intervention staff's delivery of intervention according to established protocol (fidelity), and participation in worksite food and physical activity contests (e.g., percent attending compared with that expected) (reach).

Although the investigators focus on different populations, use diverse intervention strategies, and address their own specific research questions, the studies have similar primary and secondary outcome measures (Table 3) and similar designs, which encourage common statistical analytical approaches. Selected data from two or more studies would be pooled for secondary analyses to obtain greater statistical power or to examine age, gender, or racial differences. This collaborative process has the potential to enhance comparability of results and create a synergy of creative expertise of investigators to address the obesity problem through worksite environmental intervention strategies. Despite these benefits, there are challenges in this procedure. For example, all sites must adhere to similar procedures in data collection and must develop common analytical plans to establish comparability and generalization of the results. However, successful results from two or more worksites have the potential to be translated to other businesses.

Study Collaboration and Monitoring

The Center for Health Research of Kaiser Permanente, Northwest, serves as the coordinating center for the seven projects. It facilitates communication, cooperation and scientific collaboration among the seven projects. To accomplish study objectives, the NHLBI established a steering committee for the overall research program to facilitate communication among the scientists and staffs. The overall leadership of the research program is the responsibility of the steering committee consisting of the principal investigators of each study and the NHLBI Project Scientist. The coordinating center maintains a program Web site, which allows secure access to study protocols, procedures for data collection, assessment tools, and secure transfer and sharing of data among investigators to facilitate across-site data analyses.

In summary, the worksite intervention studies program is a unique collaborative program among seven studies with the common aim of testing the effectiveness of worksite environmental strategies to control overweight and obesity in adults.

The findings from the studies could be useful to researchers and employers because they could provide guidance for

designing, implementing, and evaluating worksite obesity interventions, and for making such interventions an integral part of employee health promotion. Interventions found to be cost-effective and implemented in the worksite setting have the potential to improve health and reduce medical care costs for employers, and could motivate others to implement such programs within their worksites. Data pooled from these studies could enhance the translation to, and data sharing with, other worksites. Findings from this program of studies have the potential to guide other worksite obesity interventions and influence worksite policies for overweight and obesity control. The studies could also provide qualitative data on how to secure management support and organizational commitment to conduct scientific research in business settings, and methods to encourage participation of employees.

The emphasis on environmental strategies (or a combination of environmental and individual strategies) and the focus on large-scale changes in dietary and physical activity behaviors are promising approaches to improve dietary and physical activity behaviors, thereby curtailing the obesity epidemic (29,30).

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