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Effectiveness of Total Worker Health Interventions

W. Kent Anger and Diane L. Elliot
Oregon Health & Science University

Todd Bodner
Portland State University

Ryan Olson and Diane S. Rohlman
Oregon Health & Science University

Donald M. Truxillo
Portland State University

Kerry S. Kuehl
Oregon Health & Science University

Leslie B. Hammer
Portland State University

Dede Montgomery
Oregon Health & Science University

Total Worker Health (TWH) was introduced and the term was trademarked in 2011 by the National Institute for Occupational Safety and Health (NIOSH) to formally signal the expansion of traditional occupational safety and health (OSH) to include wellness and well-being. We searched PubMed, PsycInfo, and other databases using keywords TWH, health promotion, health protection, and variants for articles meeting the criteria of (a) employing *both* occupational safety and/or health (OSH, or health protection) and wellness and/or well-being (health promotion, or HP) in the same intervention study, *and* (b) reporting *both* OSH and HP outcomes. Only 17 published studies met these criteria. All but 1 of the 17 TWH interventions improved risk factors for injuries and/or chronic illnesses, and 4 improved 10 or more risk factors. Several TWH interventions reported sustained improvements for over a year, although only 1 is readily available for dissemination. These results suggest that TWH interventions that address both injuries and chronic diseases can improve workforce health effectively and more rapidly than the alternative of separately employing more narrowly focused programs to change the same outcomes in serial fashion. These 17 articles provide useful examples of how TWH interventions can be structured. The promise of simultaneous improvements in safety, health, and well-being leads to the call to pursue TWH research to identify and disseminate best practices.

Keywords: TWH, Total Worker Health, health protection, health promotion, safety, wellness, intervention

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W. Kent Anger, Oregon Institute of Occupational Health Sciences, Oregon Health & Science University; Diane L. Elliot, Division of Sports Medicine and Health Promotion, Oregon Health & Science University; Todd Bodner, Department of Psychology, Portland State University; Ryan Olson, Oregon Institute of Occupational Health Sciences, Oregon Health & Science University; Diane S. Rohlman, Oregon Institute of Occupational Health Sciences, Oregon Health & Science University; Donald M. Truxillo, Department of Psychology, Portland State University; Kerry S. Kuehl, Division of Sports Medicine and Health Promotion, Oregon Health & Science University; Leslie B. Hammer, Department of Psychology, Portland State University; Dede Montgomery, Oregon Institute of Occupational Health Sciences, Oregon Health & Science University.

Diane S. Rohlman is now in the Department of Occupational and Environmental Health, The University of Iowa.

The PHLAME programme is listed on the Cancer Control P.L.A.N.E.T. website of evidence-based programmes, and the PHLAME TEAM programme is distributed through the Center for Health Promotion Research at Oregon Health & Science University (OHSU). OHSU and Drs. Kuehl and Elliot have a financial interest from the commercial sale of technologies used in this research. This potential conflict of interest has been reviewed and managed by the OHSU Conflict of Interest in Research Committee. OHSU and Drs. Anger and Rohlman have a significant financial interest in Northwest Education Training and Assessment [or NwETA], a company that may have a commercial interest in the results of this research and technology (used in the SHIFT study). This potential individual and institutional conflict of interest has been reviewed and managed by OHSU.

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Correspondence concerning this article should be addressed to W. Kent Anger, Oregon Institute of Occupational Health Sciences, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, L606, Portland, OR 97239. E-mail: anger@ohsu.edu

The medical costs associated with occupational injury and disease in the United States have been estimated at $67 billion and indirect costs at nearly $183 billion, based on 2007 data (Leigh, 2011). Yet injuries and many chronic diseases are preventable (National Center for Chronic Disease Prevention and Health Promotion, 2009). Indeed, the U.S. Affordable Care Act depends on prevention playing a major role in controlling health care costs.

National Institute for Occupational Safety and Health (NIOSH) Director John Howard (2013) points to the workplace as having the greatest potential for broad-scale prevention because much of the U.S. population is employed and because of the value to industry of having a healthy workforce and lower health care costs. Specifically, Howard noted it depends on comprehensive programs that reduce injuries and illnesses suffered on the job and also reduce risk factors for the development of chronic diseases that cut across the domains of work and home or community.

NIOSH has promoted the integration of health promotion (HP) or wellness programs with the traditional programs to protect worker safety and health (occupational safety and/or health, OSH). The rationale for this integration consisted of 4 principles outlined by Sorensen and Barbeau (NIOSH, 2012), each with an evidence base:

1. *Workers' risk of disease is increased by both exposures to occupational hazards and risk-related behaviors* (e.g., heat from burning tobacco increases the toxicity of workplace and tobacco-related chemicals inhaled as the cigarette is smoked).
2. *The workers at highest risk for exposure to hazardous working conditions often are also those most likely to engage in risk-related health behaviors* (e.g., people with the least education have the highest levels of obesity and also tend to work in blue collar jobs where there is the greatest exposure to safety and chemical hazards).
3. *Integrating worksite HP with traditional occupational health and safety may increase program participation and effectiveness for high-risk workers* (e.g., workers may be less skeptical of workplace HP programs that are paired with hazard reduction programs and thus participate at a higher rate).
4. *Integrated occupational health and safety/worksite HP efforts may benefit the broader work organization and environment* (e.g., coordination of, rather than competition for, resources may multiply their impact).

In June 2011, NIOSH defined and trademarked a new term, Total Worker Health (TWH), as a "strategy integrating occupational safety and health protection with HP to prevent worker injury and illness and to advance health and well-being" (http://www.cdc.gov/niosh/twh/totalhealth.html). The American College of Occupational and Environmental Medicine (Hymel et al., 2011) expanded the definition: ". . . workplace health protection and promotion is the strategic and systematic integration of distinct environmental, health, and safety policies and programs into a continuum of activities that enhances the overall health and well-being of the workforce and prevents work-related injuries and illnesses." The seminal papers in TWH have been published as a compendium by NIOSH (2012) that can be downloaded from their website (http://www.cdc.gov/niosh/twh/totalhealth.html). This was followed by a special issue in the *Journal of Environmental and Occupational Medicine*, highlighting current theory and research on TWH (Merchant & Hall, 2013).

Comprehensive programs that integrate both organizational and individual approaches to reducing stress and injury in the workplace have also been advocated by Occupational Health Psychology (OHP; Quick & Tetrick, 2011). OHP is a discipline that integrates environmental and individual approaches to OSH (Sauter & Hurrell, 1999). With a focus on interventions that target the work environment, as well as interventions that target the individual, OHP provides a psychological and theoretical basis for intervention approaches that are consistent with integrated programs of HP and OSH, or what NIOSH has termed TWH.

The body of published empirical studies that employed integrated HP and OSH interventions, however, appears sparse.

Purpose

The purpose of this article is to identify, evaluate, and critique the *empirical intervention studies* that have *combined or integrated OSH and HP in the workplace* and that would be described as TWH programs by the NIOSH definition (http://www.cdc.gov/niosh/twh/totalhealth.html). We sought to describe examples of the component pieces found in TWH programs and of ways these diverse elements have been combined or integrated into TWH programs.

Method

Published TWH interventions were identified from a variety of sources to develop a systematic review of the TWH literature. An initial search of PsycINFO, Medline, Eric, and Academic Search Complete for "Total Worker Health," "well-being," "occupational safety and health," "health promotion," "health protection," and "intervention" yielded a basic set of articles to review for common terms, in November, 2013. We then conducted a search of PubMed using the terms "TWH," "health protection," "health promotion," "safety and health," "wellness," "intervention" combined with "workplace" or "occupational"; a start date was not applied to limit the search. That search yielded 917 titles. A search conducted in PsycINFO using "occupational" or "workplace" combined with the terms "Health Protection," "Health Promotion," "wellness," and "safety" produced 2,777 titles. These 3,694 titles, many overlapping between the various searches, were examined. Titles were reviewed, abstracts were reviewed when warranted by the titles, and the articles were read when the abstracts suggested HP and OSH interventions. In addition, references were reviewed from the empirical research studies database of the NIOSH/TWH program (http://www.cdc.gov/niosh/twh); the two datasets contained the same core articles although the NIOSH dataset included articles that did not meet our criteria.

In total, 183 potentially eligible articles were identified in the searches; these were subjected to our criteria for inclusion. We selected intervention evaluation studies, analyzed with inferential statistics, and published in the peer-reviewed literature, that: (a) employed *both* traditional occupational safety and/or health (OSH, or health protection) AND wellness and/or well-being (HP) in the same intervention study; *and* (b) reported outcomes relevant to *both* OSH and HP, whether those results were statistically significant or not. We defined OSH interventions and outcomes as those included in the NIOSH TWH "Health Protection" category on their issues website (http://www.cdc.gov/niosh/twh/totalhealth

.html), a list included in Schill and Chosewood (2013). Reducing or eliminating work stress was thus included in the definition of OSH programs and measures (i.e., health protection; Hammer & Sauter, 2013), while interventions to help workers cope with nonwork stress were included under HP programs and measures. We defined HP interventions and outcomes as those included on the same website (under "optimal well-being") and found in Schill and Chosewood (2013). We excluded articles that simply described a program or a case study but did not analyze the results with inferential statistics. Of the 183 articles considered, 17 articles (interventions) were qualified by one author and confirmed by a second author as meeting our criteria. The original 17 articles and the supplementary articles describing each intervention are marked with an asterisk in the References.

Results and Discussion

The 17 studies that met our criteria are listed in Table 1 and summarized in the Appendix (available online as supplemental material). The summaries were assembled by one author and reviewed by a second author. Two studies published by authors of the present article are included in this review as noted in the author notes; these interventions are referred to in this article by their program acronyms PHLAME (Promoting Healthy Lifestyles: Alternative Models' Effects, Elliot et al., 2007) and SHIFT (Safety and Health Involvement for Truckers, Olson, Anger, Elliot, Wipfli, & Gray, 2009). The summaries describing those studies in the Appendix were written by two authors who were not also authors of those publications.

Only four of the 17 studies published effect sizes (SHIFT), odds ratios (Tveito & Eriksen, 2009; Wellworks-2), or risk ratios (Ott et al., 2009). Publications from eight studies provided sufficient information to calculate effect sizes, but the remaining five studies either did not have significant results (Eriksen et al., 2002) or did not provide the information to calculate effect sizes (Healthy Directions, Dalton & Harris, 1991; Take-a-Stand, Rasmussen et al., 2006). As a result, we did not attempt to use effect sizes to compare studies because the number of comparable studies was very small. For the same reasons, we did not perform a meta-analysis of outcomes. Although only 17 studies met inclusion criteria, sorting them by different dimensions and comparisons across studies provided perspective on design issues, industries and populations studied, intervention rigor and targeted outcomes. There is much to be learned from these 17 studies.

Intervention Programs

The interventions, listed in Table 1 and described in the middle column of the Appendix, can be categorized as: (a) very large-scale company-wide makeover programs (HP + OSH-W); (b) programs that have substantial and relatively evenly addressed wellness/well-being, health and safety components (HP + OSH); (c) programs in which either the HP or OSH component of the intervention was addressed in a more complete or broader fashion than the other component (HP + osh and hp + OSH); and (d) programs addressing a single problem or using a specific method (hp-osh-S) relevant to safety and health and wellness or well-being. We consider each to be a legitimate TWH intervention program; they offer examples of how both broadly and narrowly constituted TWH programs can be constructed.

Study Designs

Most studies were designed exclusively to evaluate an intervention program. Only 3 studies compared different intervention methods (Eriksen et al., 2002; PHLAME; Wellworks-2). The research designs and the samples used in the 17 studies are summarized in Table 2 (all relevant references for each study are included in this table). From the perspective of the internal validity of study results (i.e., one's confidence that outcome differences across study arms are attributable to intervention effects), the 17 studies in Table 2 varied in the strength of causal inference that could be drawn from the design.

Six of the studies have what might be considered small sample sizes (e.g., $N < 100$), and half of these studies appear in the category with the best design strength for causal inference. Although using small sample sizes does not affect the internal validity of studies, small sample sizes generate lower levels of statistical power than may be considered ideal. Thus, small sample size studies are likely to detect only larger intervention effects at the expense of the ability to detect smaller but still important intervention effects.

To acknowledge both design strength and the size of the *N* in each study, Table 2 is organized by the design strength ranking (1–5; randomized experimental studies to nonexperimental designs) and then by the size of the Study *N* within each design strength category.

Nine of the 17 studies employed a randomized experiment design, the "gold standard" design (Rank 1) for causal inference; in six of these studies, random assignment was conducted at the level of a work unit, group, or organization (i.e., a cluster randomized design). The PHLAME intervention was analyzed separately for OSH and HP outcomes; the HP and some OSH variables were based on a randomized design (Elliot et al., 2007) and the OSH variable analysis was based on a quasi-experimental design (Kuehl et al., 2013). It is placed in design rank 1 in Table 2 because the intervention was aimed primarily at the HP endpoints that were studied using a randomized design (design rank 1). Seven of the 17 studies employed a quasi-experimental design (PHLAME falls in both randomized and quasi-experimental design categories) where the researcher controlled intervention group assignments but did not make group assignments randomly. Four of the seven quasi-experiments employed a nonequivalent control group pretest/posttest design or interrupted time series design with control series (rank = 2), often considered two of the best quasi-experimental designs (Sackett & Mullen, 1993; Shadish, Cook, & Campbell, 2002). PHLAME's OSH study design fits in this category as a fifth study, so the study is counted twice. Two of the seven quasi-experiments employed a single-group design with a single pretest and multiple posttest assessments (rank = 3), often considered a weaker quasi-experimental design or "preexperimental" design. The final quasi-experiment employed a nonequivalent control group design with posttests only (rank = 4), perhaps one of the weakest quasi-experimental or "preexperimental" designs (Sackett & Mullen, 1993; Shadish et al., 2002). The strength of causal inferences is best (within this set of three quasi-experimental designs) for the first design

Table 1
Categories of Intervention Programs

Intervention program category	Study/primary reference	Focus of intervention program	Intervention methodology
a. Very large-scale, company-wide makeover programs (HP + OSH-W)	Bertera (1990)	Broad HP and OSH program.	Risk assessments, training, self-directed behavior change, incentives
	Dalton and Harris (1991)	Broad HP and OSH program.	Prevention services, targeted messages, counseling, feedback, incentives
b. Programs that had substantial and evenly addressed HP and OSH components (HP + OSH)	Eriksen et al. (2002)	Physical exercise (PE), stress management training (SMT), and an integrated program (IHP) of exercise, stress management coping, and nutrition were compared.	Training, exercise programs
	Wellworks-2: Sorensen et al. (2002)	Comprehensive OSH program targeted at reducing workplace exposure hazards and an HP program to reduce tobacco consumption and increase healthy eating.	Participatory intervention, professional consultation, training
	SHIFT: Olson, Anger, Elliot, Wipfli, and Gray (2009)	Weight loss and safe driving competition, with training/coaching in healthy eating, exercise, and injury prevention.	Training, competition (team strategies), motivational interviewing, self-monitoring, feedback, incentives
c. Programs in which either the HP or OSH component of the intervention was addressed in a stronger or broader fashion than the other component (HP + osh and hp + OSH), and programs with narrowly focused HP and OSH components (hp + osh)	Healthy Directions: Sorensen et al. (2005)	Broad wellness program combined with an OSH program focused on reducing exposure to carcinogens that synergize with cancers associated with smoking (HP + osh).	Training, interactive activities, industrial hygiene recommendations
	Peters and Carlson (1999)	Broad wellness and well-being program with largely unspecified safety training information (HP + ohs)	Training, self-assessments, goal setting, behavior contracting, self-management, feedback, incentives
	PHLAME: Elliot et al. (2007)	Broad wellness and well-being program with largely unspecified safety training information (HP + ohs)	Scripted training, team strategies, feedback, motivational interviewing
	Rasmussen et al. (2006)	OSH program focused on psychosocial factors to reduce eczema and occupational accidents, and to improve mental health (hp + OSH).	Group participatory process to target and solve problems (team strategies)
	Tsutsumi, Nagami, Yoshikawa, Kogi, and Kawakami (2009)	Broad OSH program focused on reducing job stress and on improving mental health (hp + OSH).	Group participatory process to target and solve problems (team strategies)
	Tveito and Eriksen (2009)	Broad OSH program focused on physical exercise, stress and stress management, and job redesign with smoking and lifestyle components (hp + OSH).	Professional exercise trainers to implement exercise program, group participatory processes to plan/implement job redesign, training on lifestyle issues
	Wellworks: Sorensen et al. (1995)	Programs targeted at reducing tobacco consumption and workplace exposure hazards, and increasing healthy eating (hp + osh).	Participatory intervention, professional consultation, training
d. Programs addressing a single problem or using a single method that addresses both HP and OSH needs (hp + osh-S)	MASSbuilt: Okechukwu, Krieger, Sorensen, Li, and Barbeau (2009)	Program aimed at reducing smoking and reducing exposures to chemicals that synergize with smoking (thus increasing cancer risk) to reduce cancer risk.	Health risk appraisal, training, feedback, motivational interviewing
	Alkhajah et al. (2012)	Program designed to reduce sitting and increase exercise to improve both health and safety.	Training and experience using a sit-stand station
	Take-a-Stand: Pronk, Katz, Lowry, and Payfer (2012)	Program designed to reduce sitting and increase exercise with implications for safety (e.g., reducing musculoskeletal injuries).	Experience using sit-stand station, incentives
	Konradt, Schmook, Wilm, and Hertel (2000)	Program to reduce job stress with safety and efficiency benefits.	Group processes (team strategies) to identify and solve problems
	Ott et al. (2009)	Company-wide program that used the medical exam as a health and safety management tool.	Medical exams as a tool to target problems, training

Note. HP = health promotion; OSH = occupational safety and health.

Table 2
Study Design, Design Causal Inference Strength Rank, Sample Size, and Industry

Study	Rank	Study design	Intervention package	Sample (*N*), industry, Country
WellWorks-2: Sorensen et al. (2002); Sorensen et al. (2003); LaMontagne et al. (2004); Hunt et al. (2005); LaMontagne, Stoddard, Youngstrom, Lewiton, and Sorensen (2005)	1	Sorensen: Pre/post cluster randomized trial LaMontagne: Using the same recruited group, LaMontagne focused on intervention effects on organizational support elements as the dependent variable rather than employee health	Integrated participatory management-labor intervention that provided exemplary policy changes on tobacco and healthy food options and a health education program on individual lifestyle changes coupled with industrial hygiene walk-throughs leading to written assessments, individual consultations, recommendations on upstream exposure prevention, policies, written materials, and educational programs on reducing exposure hazards. An HP-only group was compared with an HP + OSH group to test the value of integration of HP and OSH.	Sorensen: 7,327 participants in 15 U.S. manufacturing companies received an HP-only (n = 3,710) or an HP + OSH (n = 3,617) program. LaMontagne: >400 workers from manufacturers with, and probable use of, hazardous substances. Workers randomly assigned within blocks (e.g., union vs. non-union) to HP + OSH and HP only (comparison) groups.
MASSbuilt: Okechukwu et al. (2009); Okechukwu, Krieger, Sorensen, Li, and Barbeau (2011)	1	Pre/multiple-post cluster randomized trial	Intervention taught the additive or synergistic cancer risks from smoking tobacco *and* exposures to hazardous chemicals, dusts, fumes at work, supported by motivational interviewing.	1,213 workers at 10 apprenticeship sites in the U.S. building trades. Data collected baseline, 4 months (1 month post 3-month intervention).
Healthy Directions: Barbeau et al. (2004); Sorensen et al. (2005); Stoddard et al. (2005); Sorensen et al. (2007)	1	Pre/post cluster randomized trial	Intervention improved workplace environment (e.g., healthful food at meetings), taught improved lifestyle choices, and provided industrial hygiene walkthroughs to recommend methods to reduce exposures to carcinogens.	974 participants at 22 U.S. worksites with multiracial, multiethnic workforces completed both baseline and follow-up surveys.
Eriksen et al. (2002)	1	Four-group randomized controlled trial (RCT) with one pretest and two posttest assessments	Intervention compared effectiveness of: (1) physical exercise (PE), (2) stress management training (SMT), and (3) an integrated program of exercise, strength training, stress management, alternative working positions, coping and lifestyle factors related to sleeping and eating behaviors (IHP) to a Control group (C).	671 Norwegian postal service employees randomly assigned to Control group (N = 344), PE (N = 189), SMT (N = 162), IHP (N = 165). At follow-up, N was reduced in groups: C (N = 166), PE (N = 114), SMT (N = 98), IHP (N = 94).
PHLAME: Moe et al. (2002); Elliot et al. (2007); MacKinnon et al. (2010); Ranby et al. (2011); Elliot et al. (2012); Pirlott, Kisbu-Sakarya, Defrancesco, Elliot, and Mackinnon (2012); H. Kuehl, Mabry, Elliot, Kuehl, and Favorite (2013); K. S. Kuehl. Elliot, et al. (2013)	1 OSH Data: 2	Pre/post cluster randomized trial (Elliot: HP) Two-group Nonequivalent Control Group pretest/posttest Quasi-Experimental Design (Kuehl: OSH)	Intervention compared: (1) a scripted team-based healthy lifestyle curriculum, to (2) individual-based motivational interviewing following topics including nutrition, physical activity, sleep, stress. A fitness guide on musculoskeletal injuries related to work activities was provided to each group.	Elliot HP analysis: 599 U.S. firefighters (579 male) randomized to: (1) team-centered training (T), (2) individual-centered motivational interviewing (MI), or (3) control (survey and fitness results only) group. Kuehl OSH data: 1369 (total) firefighters compared to controls (I = 624; C = 745 at end of study).
WellWorks: Sorensen et al. (1995); Sorensen, Stoddard, Ockene, Hunt, and Youngstrom (1996); Sorensen et al. (1998)	1	Cluster randomized (matched-pairs) design; 1996 article focuses on health program participation rather than worker health as a direct outcome; 1998 article focuses on health outcomes	Integrated participatory management-labor intervention that provided exemplary policy changes on tobacco and healthy food options and a health education program on individual lifestyle changes coupled with consultation and principles of industrial hygiene (e.g., substitution) to reduce exposure hazards.	Over 250 workers using known or suspected carcinogens in work processes at 24 U.S. worksites (primarily manufacturers). Random sample of 2,386 workers (subgroup n not identified) from the 24 worksites for the pre- and postassessments.

Table 2 (*continued*)

Study	Rank	Study design	Intervention package	Sample (*N*), industry, Country
Tsutsumi et al. (2009)	1	Pre/post cluster randomized trial	Participatory intervention in factory workers that taught the benefits of workplace improvements including job redesign and team-based problem solving to improve mental health, safety and productivity.	47 employees in 6 automobile assembly lines; 50 controls in 5 automobile assembly lines, in Japan.
Peters and Carlson (1999)	1	Two-group RCT with one pretest and two posttest assessments	Intervention incorporated a standardized health risk appraisal, stress management training, educational workshops and counseling, and a self-directed behavior change program including meditation and self-monitoring focused on lifestyle changes and unsafe work practices.	40 maintenance employees from the Building and Grounds Department at the University of Hawaii (I = 21; C = 19).
Tveito and Eriksen (2009)	1	Pre/post two-group randomized trial	Intervention provided a physical exercise program, stretching, stress management training and health information to motivate lifestyle changes. Employee discussions designed to change job organization based on a practical examination of the workplace.	19 intervention and 21 comparison nursing home employees in Norwegian elder care nursing homes.
Bertera (1990); Bertera (1993)	2	Two-group nonequivalent control group pretest/posttest quasi-experimental design	Intervention provided a comprehensive workplace health promotion program focused on illness absences not related to occupational causes, including health risk appraisals, health education options on healthy lifestyles, vending option improvements, incentive programs for fitness, weight control and smoking cessation, and education on healthy backs and stress management plus safety meetings linked to the program.	7,178 blue collar workers at 41 intervention sites vs. 7,101 workers at 19 control sites in diversified U.S. industrial company that had not adopted the program; some analyses may have used larger *N*s.
Rasmussen et al. (2006)	2	Two-group nonequivalent control pretest/posttest quasi-experimental design	Participatory intervention involving occupational risk assessments, work observations, better personal protective equipment, education on psychosocial factors and safety, safety walk-arounds, and accident and injury and toxicology databases.	575 intervention participants vs. 270 comparison wind turbine manufacturing employees (minimum n; larger numbers in some parts of analyses) in Denmark.
Take-a-Stand: Pronk et al. (2012)	2	Reversal interrupted-time-series quasi-experimental design (participants self-selected to the intervention group, but subsequently the sit-stand desks were withdrawn and data collected in a postintervention period)	Intervention was a health, wellness and psychological well-being program with incentives to participate in physical activity combined with the introduction of sit-stand workstations.	24 intervention vs. 10 control health promotion employees in Minnesota's (U.S.) Health Partners health system.
Alkhajah et al. (2012)	2	Two-group non-equivalent control group pretest/posttest quasi-experimental design	Introduced and trained participants to use sit-stand workstations to modify time sitting and standing, health biomarkers, and acceptability.	18 intervention and 12 comparison University of Queensland (Australia) office workers.

(*table continues*)

Table 2 (*continued*)

Study	Rank	Study design	Intervention package	Sample (*N*), industry, Country
Dalton and Harris (1991)	3	One-group preprogram/postprogram multiple time point design (although the preprogram measures were in 1984, the same year the various programs were implemented so the "pre" part may be considered to be pretty weak)	Health promotion program providing healthy food options, cigarette vending removed, smoking prohibition policy, on-site screening and chronic disease monitoring, counseling, incentives to join HMOs, augmented safety and industrial hygiene program with accident frequency targets, surveys, job redesign, safety improvement competitions and medical management of disabilities.	U.S. Telecommunications equipment supplier employees (no *N* for most results); *N* = ~600 for health behavior prevalence; *N* = 78 for self-reported health behaviors.
SHIFT: Olson et al. (2009); Wipfli, Olson, and Koren (2013)	3	Olson: One-group preprogram/postprogram design Wipfli: Multiple postprogram design	Weight loss and safe driving (hard braking, percent time overspeed, moving violations) competition supported with computer-based training on diet, exercise, and safety; behavioral self-monitoring activities; motivational interviewing sessions with a health coach.	29 truck drivers from four U.S. companies (Olson); 15 drivers in follow-up at 36 months from the initiation of the intervention (Wipfli).
Konradt et al. (2000)	4	Two-group nonequivalent control group posttest-only quasi-experimental design	Health circles led by a facilitator were designed to engage employees to develop workplace improvements in ergonomics and to develop coping strategies to deal with stress (at work and outside).	17 intervention versus an unspecified number of controls in a convenience sample in German telecommuting (services) company workers with non-random assignment. 11 intervention versus 12 control participants at 2 months postintervention follow-up.
Ott et al. (2009); Ott et al. (2010)	5	Multiple group non-experimental design	Used health exams to focus changes in health retreats, health seminars and prevention steps such as respirator use, physical activity, reducing chemical exposures.	14,128 male wage employees in German chemical manufacturing company assigned to 1 of 2 rotating shift work schedules at some time between 1995 and 2005 and who completed at least 1 year of rotating shift work versus 17,218 reference male wage employees assigned to day work for at least 1 year.

Note. HP = health promotion; OSH = occupational safety and health; I = intervention; C = control.

mentioned and worst for the last design mentioned. Last, one of the 17 studies employed a multiple-group nonexperimental design where participants, rather than the researcher, controlled intervention arm assignment (i.e., self-selection; rank = 5). This design is considered the weakest with respect to the strength of causal inference compared with the stronger experimental and quasi-experimental designs.

In summary, almost half of the studies employed the strongest design to support causal inferences for intervention effects, but half did not.

Industries and Samples

The samples studied were drawn from diverse industries (see column 5 of Table 2, left column of the Appendix). Thirteen of the TWH studies were conducted in manufacturing (six studies), services (five studies), and health care (two studies), and one study each was conducted in construction, telecommunications, transportation, and a diversified industrial company. The countries where they were conducted were Australia, Denmark, Germany (two), Japan, Norway (two), and the United States (10). The number of participants (*N*) ranged from 29 to 31,346; the median *N* was 671 participants. This suggests that TWH intervention programs can be relevant and implemented in diverse industries and in small or large groups.

Theoretical Models

Five intervention programs identified a theoretical basis for why the intervention was expected to work. Four theoretical models were named in the publications: (a) Socioecological (SE) Model (e.g., Stokols, 1996; Stokols, Allen, & Bellingham, 1996), the theoretical frame based on multilevel influences affecting or controlling behavior was behind the Wellworks and Wellworks-2 studies (Sorensen et al., 2005; Sorensen et al., 2007; Sorensen et al., 2002, 2003; Sorensen, Stoddard, Ockene, Hunt, & Youngstrom, 1996); (b) Job Demand-Control (JDC) Model (Karasek, 1979) that relates job demands to an individual's control over the demands, which is cited by Tsutsumi, Nagami, Yoshikawa, Kogi, and Kawakami (2009) and by Aust and Ducki (2004) when describing the Health Circles used by Konradt, Schmook, Wilm, and Hertel (2000); (c) Social–Cognitive theory (Bandura, 1986), which explains behavior change as a result of reciprocal interactions between a person's behavior, cognition, and environmental influences, including team processes, behind PHLAME's team (T) intervention (Elliot et al., 2007) and the similar individual and social motivation enhanced by team competition identified by the SHIFT study (Olson et al., 2009); and (d) Phenomenological theory (Rogers, 1961, which calls on intrinsic motivation as a means for change behind the motivational interviewing (MI) method from the PHLAME study (Elliot et al., 2007). These theoretical models are listed in Table 6, which summarizes key results. The remaining articles did not specifically identify a theoretical basis, although some provided a rationale for why their intervention should be effective or what their goals were.

Hunt et al. (2007) and Hunt et al. (2005), respectively, in the Healthy Directions and Wellworks-2 interventions examined the intervention processes and concluded that worker awareness and the frequency of contacts between management and employees were relevant factors in their interventions, and that management support, worker input, and a history of social interaction contributed to participation in the interventions that were designed to reduce smoking and chemical exposures. The PHLAME study tested meditational models and assessed the factors involved in the intervention (Elliot et al., 2012; Kuehl, Mabry, Elliot, Kuehl, & Favorite, 2013; Pirlott, Kisbu-Sakarya, Defrancesco, Elliot, & Mackinnon, 2012; Ranby et al., 2011). Process analyses were conducted for the Wellworks-2 (Hunt et al., 2005) and Healthy Directions (Hunt et al., 2007) interventions. These are the only TWH studies to examine the reasons why the interventions were effective.

Intervention Packages

The intervention packages are shown in column 4 of Table 2 and described in more detail in the middle column of the Appendix. Interventions can be grouped into those that primarily employed scripted training or education on wellness and safety and health (PHLAME), and those that combined scripted training or education on wellness and safety with (a) industrial hygiene walk-throughs and recommendations (Healthy Directions, MASSbuilt, Wellworks, Wellworks-2), (b) incentives for participation (Bertera, 1993, Take-a-Stand; Dalton & Harris, 1991) or accomplishments (SHIFT), (c) MI or counseling (Peters & Carlson, 1999; PHLAME, SHIFT), (d) exercise or activities (Eriksen et al., 2002; Tveito & Eriksen, 2009), (e) sit-stand work stations (Alkhajah et al., 2012; Take-a-Stand), (f) participatory processes (Konradt et al., 2000; Rasmussen et al., 2006; Tsutsumi et al., 2009), or (g) health exams as a focusing tool (Ott et al., 2009). Most relevant to the principle of program integration in TWH interventions is the Wellworks-2 comparison between an HP program and an HP + OSH program. Some studies compared two intervention packages, so they are assigned to multiple categories.

Intervention Program Features

The intervention packages are diverse, but they do have features in common that were designed to influence individual behavior change. In Table 3, the features (left column) are categorized as "antecedents" or events that occur prior to targeted individual behaviors of employees (with four subcategories of organizational structure, environment changes, assessments, training/education), "behavior processes" designed to support the behavior as it occurs, and "consequences" that occur subsequent to the behaviors that the interventions were targeted to change. The number of studies employing each feature is listed in column 2, and the primary reference or the intervention program names are listed in column 3.

Organizational structure changes were seen in many programs, most often in environment changes/facilities and job design or redesign (six interventions each). Assessments were widely used (11 interventions), and educational classes conducted by professional trainers or facilitators were used in seven interventions and scripted training or workbooks were used in six interventions, some of which did include support

Table 3
Categorization of Methods Used in Health Promotion (HP) and Occupational Safety and Health (OSH) Intervention Program Studies, the Number of Studies Addressing Each Category, and the Reference or Program Name

Category	Number of studies	Reference/program identifier
Antecedents: Organizational structure		
Systems or policy changes	7	Healthy Directions; Wellworks; Wellworks-2; Rasmussen et al. (2006); Take-a-Stand; Dalton and Harris (1991); Ott et al. (2009)
Employee involvement in program design or implementation	9	Healthy Directions; PHLAME; Tsutsumi et al. (2009); Tveito and Eriksen (2009; Wellworks; Wellworks-2; Bertera (1993); Rasmussen et al. (2006); Konradt et al. (2000)
Antecedents: Environment changes		
Environment changes/facilities (e.g., exercise equipment, healthy food options, removal of cigarette vending machines, increased availability of Personal Protective Equipment)	6	Healthy Directions; Wellworks; Wellworks-2; Bertera (1993); Rasmussen et al. (2006); Dalton and Harris (1991)
Environment changes/healthy management or supervision practices (e.g., stress reduction)	3	Tsutsumi et al. (2009; Rasmussen et al. (2006); Konradt et al. (2000)
Environment changes/health care access	1	Dalton and Harris (1991)
Environment changes/process reviews (e.g., Industrial Hygiene walk-throughs or use of Industrial Hygiene principles)	4	Healthy Directions; Wellworks; Wellworks-2; Rasmussen et al. (2006)
Physical environment/tool (e.g., sit-stand stations)	2	Alkhajah et al. (2012); Take-a-Stand
Job design/redesign	5	Tsutsumi et al. (2009); Tveito and Eriksen (2009); Wellworks; Rasmussen et al. (2006); Dalton and Harris (1991)
Antecedents: Assessments		
Health risk assessments, organizational assessments: safety/health/wellness/well-being	11	Healthy Directions; Peters and Carlson (1999); PHLAME; Tsutsumi et al. (2009); Wellworks; Wellworks-2; Bertera (1993); Rasmussen et al. (2006); Dalton and Harris (1991); SHIFT; Ott et al. (2009)
Antecedents: Training/education		
Scripted training/workbook	6	Eriksen et al. (2002); Healthy Directions; MASSbuilt; Peters and Carlson (1999); PHLAME; Bertera (1993)
Newsletters, written communications or information	2	Wellworks; Wellworks-2
Computer-based training	1	SHIFT
Educational classes by professional trainers or facilitators	7	Eriksen et al. (2002); Healthy Directions; MASSbuilt; Peters and Carlson (1999); Tveito and Eriksen (2009); Konradt et al. (2000); Ott et al. (2009)
Educational classes by internal trainers or facilitators	6	PHLAME; Tsutsumi et al. (2009); Wellworks; Wellworks-2; Bertera (1993); Rasmussen et al. (2006)
Activities (e.g., health fairs, nicotine patches, newsletters, posters, contests, advertisements/ promotion)	8	Healthy Directions; MASSbuilt; PHLAME; Wellworks-2; Bertera (1993); Dalton and Harris (1991); SHIFT; Ott et al. (2009)
Behavioral processes		
Self-management/self-monitoring	2	Peters and Carlson (1999); SHIFT
Motivational interviewing/counseling	6	MASSbuilt; Peters and Carlson (1999); PHLAME; Bertera (1993); Dalton and Harris (1991); SHIFT
Meditation/relaxation	1	Peters and Carlson (1999)
Group or team change strategies	5	PHLAME; Tsutsumi et al. (2009); Rasmussen et al. (2006); SHIFT; Konradt et al. (2000)
Self-directed behavior change	2	Peters and Carlson (1999); Bertera (1993)
Consequences		
Feedback, including feedback as part of training, motivational interviewing, behavioral contracting, self-monitoring	5	MASSbuilt; Peters and Carlson (1999); PHLAME; Dalton and Harris (1991); SHIFT
Incentives for participation	4	Bertera (1993); Take-a-Stand; Dalton and Harris (1991) (for HMOs); SHIFT
Incentives for improvement/behavioral contracting	4	Peters and Carlson (1999); Bertera (1993); Dalton and Harris (1991) (company level); SHIFT

from facilitators. These subcategories are not mutually exclusive, and some interventions used multiple approaches. The most widely used behavior resource was MI or counseling (six). Of the consequences, five programs used feedback, while only four interventions used incentives to stimulate participation and four programs linked incentives to outcome improvement.

Management and Employee Participation

Management participation in the development of the interventions was found in six programs, and employee participation was found in 10 programs (two via feedback in the pilot study phase of the project). Five interventions took the form of joint worker-

management advisory boards (Healthy Directions, Wellworks, Wellworks-2; Bertera, 1990; Rasmussen et al., 2006). Dalton and Harris (1991) implemented a management program, while the MASSbuilt study recruited organizations through unions, although union participation in developing the program appeared limited. PHLAME piloted the intervention program with firefighters and adopted their feedback, workers provided the content of the discussions in the Konradt et al. (2000) intervention, and employees worked in groups to identify and plan environment and design improvements in the Tsutsumi et al. (2009) and Tveito and Eriksen (2009) interventions. Participation in the intervention is listed in Table 6 (column 4) as "M" for management, "U" for union, or "E" for employee participation and is detailed in the Appendix.

Intervention Program Integration

Integration is central to two of the principles in the NIOSH (2012) rationale for developing or recommending TWH. NIOSH (2012) defined integration in the TWH context as a change from separate organizational locations of the OSH and HP responsibilities to a unified department with a single budget and reporting structure. This is likely to have occurred in the large-scale, company-wide programs (Bertera, 1990; Dalton & Harris, 1991; Ott et al., 2009). Only one TWH publication, Wellworks-2, specifically addressed the potential enhanced effectiveness of integration of OSH and HP, and did so in a quantitative fashion (Hunt et al., 2003). Wellworks-2 compared a program of HP alone with a program with both HP and OSH, and it was conducted as a randomized controlled trial. This intervention was aimed at increasing smoking quit rates. The HP + OSH program produced significantly greater smoking quit rates, participation in healthy eating/nutrition programs, participation in healthy/wellness programs, management commitment and employee participation in OSH (based on objective observational data), manufacturing process protection (also based on ratings with objective criteria), and reduced hazardous substance exposure ratings, than did the HP-only program (Sorensen et al., 2003) as detailed in the Appendix. This is experimental evidence of the effectiveness of integrated intervention programs, but it is the only experimental evidence published thus far. Indeed a description of integration has been identified as a gap in the TWH literature by Sorensen et al. (2013), who listed four indicators of integration: organizational leadership and commitment, collaboration between health protection and worksite HP, supportive organizational policies and practices, and the development of comprehensive program content.

Outcomes Improved

The statistically significant changes in outcomes reported in the 17 publications are listed in the left column of Table 4, with the 17 study identifiers listed along the top row and in the right column (bolded) in the Appendix. The outcomes in each study are represented as dots in Table 4. The interventions designed as randomized trials (rank 1, above) are the first 9 columns of studies (Wellworks-2 through Tvieto & Eriksen, 2009) (note that in the PHLAME study only the HP data analysis was from a randomized trial).

A total of 79 outcome measures were reported to be changed significantly in the 17 studies. Across studies, the number of reported significant changes ranged from 0 (Eriksen et al., 2002) to 19 (Dalton & Harris, 1991); this is seen in the bottom row of Table 4 (total risk factors changed). All but one of the TWH intervention programs improved outcomes that are risk factors for injuries and/or chronic diseases, and four reduced 10 or more risk factors, accidents, or illness measures. The TWH interventions have affected a broad range of outcomes, including objectively measured biomarkers (e.g., weight, blood pressure) and behaviors, self-reported behavioral changes, self-reported symptoms, and measures of factors that support change (beliefs and supports). It is noteworthy that (a) only 16 of the 79 outcome measures are related to safety (they are italicized in the left column of Table 4), and (b) as most obvious from a visual observation of Table 4, there was little consistency in the outcomes changed across studies. Smoking was changed in six studies, weight in four, and interventions and all other measures were changed in three or fewer interventions. When compared against the TWH outcomes (or "issues") listed by NIOSH (Schill & Chosewood, 2013), the outcome measures in Table 4 and the Appendix are not comprehensive of TWH. Examples of outcomes missing from the articles included in Table 4 and the Appendix that are important aspects of TWH are sleep, fatigue, noise, vibration, chemical or particulate exposures, personal protective equipment usage, and work–life stress. The Appendix, which also lists outcome measures that were not significantly changed in the 17 studies, reveals that these missing measures were also not present in the nonsignificant measures.

Degree of Improvement in Outcomes

The quantitative improvements in outcomes in the 17 studies are detailed in the Appendix. To examine the impact of the changes, we identified the measures that were significantly changed in three or more TWH interventions. In the 17 studies, there were five such measures: weight, exercise, smoking cessation, blood pressure, and cholesterol. With the exception of weight, the changes produced by the TWH studies were in a positive (healthy) direction (Table 5, column 2). The Olson et al. (2009) TWH intervention produced a weight loss of 7.8 pounds over a 6-month program, while the other TWH studies slowed the weight gain (PHLAME), reduced the number of overweight employees in the sample (Peters & Carlson, 1999), or were (unfortunately) associated with an increase in participants over ideal weight (Bertera, 1993) or an increase in overweight participants (Dalton & Harris, 1991). Regarding exercise, the Healthy Directions (Sorensen et al., 2005) TWH intervention increased by 18% the number exercising more than 2.5 times per week, the Peters and Carlson (1999) TWH intervention increased exercise events 0.96 times per week, and Bertera (1990) increased by 14.53% the number of low-exercisers who reported exercising more than 3 times per week (Table 5). Four TWH intervention studies produced smoking quit rates of between 4.07% and 11.8% estimated at 5 months to 2 years after the intervention began (MASSbuilt, Wellworks, Wellworks-2; Bertera, 1993; Table 5). Three TWH interventions (Bertera, 1993; Dalton & Harris, 1991; Peters & Carlson, 1999) reported systolic blood pressure reductions ranging from −6 mm|Hg to −12.79 mm|Hg (Table 5). The Alkhajah et al. (2012) TWH intervention reported an increase of 0.26 mmol/L in fasting HDL cholesterol, and the Peters and Carlson (1999) and Bertera (1993) comprehensive TWH interventions found total cholesterol reductions, respec-

Table 4
Significant Outcome Measure Changes Reported by Study

Significantly changed measures	No. measuring	Study Identifier																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Objectively measured changes																		
Weight	4					•			•		•					•		
Blood pressure (systolic)	3								•		•				•			
Cholesterol (total)	3								•		•			•				
Body mass index	2					•										•		
Waist circumference, body fat, VO2max, eczema cases, sit and reach flexibility, fitness/sit-ups, reduced hazardous exposures, frequency of hard braking (truck drivers), lost time accidents, workers compensation claims/year, worker's compensation rates, worker's compensation costs/employee, illness days, days absent, MD visits, health expenses, hospital admissions, length of hospital stays, health conditions costs	1 each	•				•					•	•			•	•		
Self-reported behaviors																		
Smoking (% quitting)	6	•	•				•		•		•				•			
Exercise frequency	3			•					•		•							
Sitting time	2												•	•				
Health risk age/risk factor calculations	2								•		•							
Fruit and vegetable intake	2					•	•											
Drinking alcohol frequency	2										•				•			
Self-reported health status	2									•					•			
Seat belt use	2										•				•			
Multivitamin consumption, fat intake, fat in food, sugary snacks consumption, sugary drink consumption, fast foods eating frequency, % calories from fat in food consumed, heavy drinking frequency, occupational and safety health (OSH) programs at worksites, standing time, sit-to-stand transitions, fatigue after exercise, weight, dietary understanding, positive dietary behaviors, healthy/wellness program participation, nutritious eating program participation, healthy behaviors, hospital admissions reported, seat belt—% using all/most of time, risk of death, World Health Organization (WHO) health and work performance, time management, communication issues	1 each	•		•		•	•	•	•					•	•	•	•	•
Symptoms																		
Depression	2								•				•					
Pain, work stress, hypertension—uncontrolled—prevalence, mental health symptoms, fatigue, tension, confusion, state/trait-curiosity, overall mood, ergonomic issues	1 each							•	•				•		•		•	
Beliefs and supports																		
Health self-efficacy, exercise self-efficacy, stress management self-efficacy, healthy nutrition self-efficacy, healthy practices self-efficacy, intention to change to become healthier, perception of change in the environment/support, perception of access to health care, perception of social support, safety climate, social climate, social support for nutritious diet, social support for physical activity	1 each					•			•			•						
Total risk factors changed		**5**	**1**	**2**	**0**	**12**	**3**	**2**	**18**	**1**	**9**	**4**	**7**	**4**	**19**	**11**	**3**	**1**

Note. 1 = Wellworks-2; 2 = MASSbuilt; 3 = Healthy Directions; 4 = Eriksen et al. (2002); 5 = PHLAME; 6 = Wellworks; 7 = Tsutsumi et al. (2009); 8 = Peters and Carlson (1999); 9 = Tveito and Eriksen (2009); 10 = Bertera (1993); 11 = Rasmussen et al. (2006); 12 = Take-a-Stand; 13 = Alkhajah et al. (2012); 14 = Dalton and Harris (1991); 15 = SHIFT; 16 = Konradt et al. (2000); 17 = Ott et al. (2009). The main PHLAME study design was ranked 1; the PHLAME OSH data analysis had a design rank of 2. Dalton and Harris (1991) had both a pilot and a company-wide implementation, so some results appear twice in the Appendix but only one time in Table 4; 10 changes were reported in the pilot and 9 were reported in the company-wide implementation.

Table 5
Changes in Total Worker Health (TWH) and Focused Interventions With Comparable Outcome Measures (Shaded Studies Are in Design Rank 1)

Measure	TWH study	TWH intervention changes (and time outcomes were measured after the program began)	Focused intervention changes	Meta- or systematic analysis of focused interventions
Weight	PHLAME	0.9 pound (O) *increase* in Team group, 1.2 pound (O) *increase* in MI group, 3.4 pound (O) *increase* in controls (all at 1 year)	No comparison located	—
Weight	Peters and Carlson (1999)	3.96% reduction in overweight (O) members in intervention group (at 10 weeks)	No comparison located	—
Weight	Bertera (1993)	1.05% *increase* in those over ideal weight (O) (at 2 years)	No comparison located	—
Weight	Dalton and Harris (1991)	17% *increase* in overweight (S) participants (at 4 years)	No comparison located	—
Weight	SHIFT	7.8-pound loss (O) in intervention group (at 6 months)	6.5 pounds median weight loss	Archer et al. (2011) meta-analysis of 12 weight loss programs relying on weight loss competitions and incentives
Exercise	Healthy Directions	8% increase of intervention participants achieving at least 2.5 hours/week of physical activity (S) vs. 10% less in control group (at 18 months)	9.7% increase of intervention group participants achieving 2.5 hours of moderate exercise/week (at 1 year)	Müller-Riemenschneider, Reinhold, Nocon, and Willich (2008) systematic review of 39 programs designed to increase exercise; most effective of the 39 programs (Elley, Kerse, Arroll, & Robinson, 2003) listed here.
Exercise	Peters and Carlson (1999)	0.96x/week increase of exercise (S) in intervention group vs. 0.26x/week in Controls (at 10 weeks).	0.95x/week increase in exercise sessions per month (based on conversion of 3.90x/month).	Largest impact shown from King, Taylor, Haskell, and Debusk (1988) in Foster, Hillsdon, Thorogood, Kaur, and Wedatilake (2013) systematic review of 19 interventions.
Exercise	Bertera (1993)	14.53% of a low-exercise group began exercising more than 3 days/week (at 2 years) (S).	15% increase of intervention participants meeting the target of 30 min of exercise 5 days/week.	Müller-Riemenschneider et al. (2008) systematic review of 39 programs designed to increase exercise. Most comparable study that was judged by the review to be of high quality was by Petrella, Koval, Cunningham, and Paterson (2003) who used physician counseling and activity "prescriptions," shown here.
Smoking	Wellworks-2	11.8% of hourly workers quit smoking in the HP + OSH group; 5.9% of the HP-only group quit smoking (at approximately 2 years) (S)	4.2% higher abstinence rate in intervention groups than in controls	Myung, McDonnell, Kazinets, Seo, and Moskowitz (2009) meta-analysis of 22 web- or computer-based smoking cessation programs.
Smoking	MASSbuilt	9.2% quit smoking (S) (I = 26% vs. C = 16.8%) (at 5 months); effect became non-significant at 11 months.	4.2% higher abstinence rate in intervention groups than in controls	Same as above.
Smoking	Wellworks	6% quit smoking (S) (I = 15% vs. C = 9%) (at 6 months)	4.2% higher abstinence rate in intervention groups than in controls	Same as above.
Smoking	Peters and Carlson (1999)	3.25 less cigarettes smoked (time period not specified) in intervention participants vs. a decrease of 0.4 in controls (at 10 weeks) (S), though significance disappeared at 3 months	No comparison located	—
Smoking	Bertera (1993)	4.07% quit smoking (S) (at 2 years)	4.2% higher abstinence rate in intervention groups than in controls	Same as above.
Blood pressure	Peters and Carlson (1999)	12.79 mm|Hg reduction in systolic blood pressure (O) in intervention group; significant at 10 weeks but not at 3 months	4.44 mm|Hg mean reduction in systolic blood pressure	Neter, Stam, Kok, Grobbee, and Geleijnse (2003) meta-analysis of 25 interventions using energy restriction (diet), increased physical activity, or both
Blood pressure	Bertera (1993)	10.6 mm|Hg decrease in systolic blood pressure (O) High risk group (>140 mm|Hg) (at 2 years)	4.44 mm|Hg reduction in systolic blood pressure	Same as above.
Blood pressure	Dalton and Harris (1991)	6 mm|Hg decrease in systolic blood pressure (O) (at 2 years)	4.44 mm|Hg reduction in systolic blood pressure	Same as above.

(*table continues*)

Table 5 (*continued*)

Measure	TWH study	TWH intervention changes (and time outcomes were measured after the program began)	Focused intervention changes	Meta- or systematic analysis of focused interventions
Cholesterol	Peters and Carlson (1999)	21.5 mg/dl (0.56 mmol/L) reduction in total cholesterol (O) in intervention group; control group decreased 15 mg/dl (at 10 weeks)	0.17 mmol/L reduction in mean total cholesterol compared to groups with a high glycemic index diet	Kelly, Frost, Whittaker, and Summerbell (2004) meta-analysis of 17 focused interventions that produced a low glycemic diet
Cholesterol	Bertera (1993)	11.41 mg/dl (0.63 mmol/L) reduction of total cholesterol (O) in high risk (>221 mg/dl) group (~2 years)	0.17 mmol/L reduction in total cholesterol	Same as above.
Cholesterol	Alkhajah et al. (2012)	0.26 mmol/L increase in fasting HDL cholesterol (O) (at 1 week and 13 weeks)	0.065 mmol/L mean increase in HDL cholesterol	Kodama et al. (2007) meta-analysis of 25 focused interventions that reported a minimal increase in exercise

Note. O = objective measure; S = self-report measure; I = intervention group; MI = motivational interviewing.

tively, of 6.5 mg/dl (0.36 mmol/L) relative to controls and 11.41 mg/dl (0.63 mmol/L; Table 5).

It is possible that improvements in multiple outcomes in TWH interventions may come at a cost of reduced impact when compared with the impact of programs focused on single outcomes. The peer-reviewed research literature was sampled for meta-analyses or systematic reviews of focused interventions using comparable measures to those found in the TWH studies by searching PubMed and Google Scholar using the terms "meta-analysis" and the five outcome measures. We selected the most recent analysis that reported these five outcomes measured in the same way as in the TWH interventions and/or had the most similar intervention methodology. The outcome changes seen in the focused intervention with the most similar methodology or measure located from meta-analyses or systematic reviews are listed across from the outcome change in the TWH interventions in Table 5. In every case where a comparator was identified, the measured change in the TWH studies is either approximately the same or greater than the change reported in the focused studies, suggesting that TWH studies produce changes in the same range as the focused studies.

Ratio of Significant to Nonsignificant Measures

The effectiveness of the interventions may also be evaluated by the ratio of significant to nonsignificant findings for individual studies. Presumably most investigators would invest only in measures they hypothesized would change because of the intervention, since measures add to the expense of a study. The number and ratio of significant to nonsignificant changes are shown in Table 6 (column 5). The highest ratios of significant to nonsignificant outcomes are 1.0 (Konradt et al., 2000) though they had only 3 measures, 0.76 (Dalton & Harris, 1991), 0.73 (Bertera, 1990) and 0.64 (Peters & Carlson, 1999; Take-a-Stand), while the lowest are below one third and range from 0.10 to 0.29 (Healthy Directions, MASSbuilt; Alkhajah et al., 2012; Tveito & Eriksen, 2009). There may be a large degree of arbitrariness or bias in these ratios because some authors may not have included some nonsignificant measures in the publication because they deemed them unimportant, or editors may have required the authors to remove the nonsignificant measures from the publication to conserve on space. However, those interventions that measured a large number of outcomes tended to also produce a large number of improvements in risk factors (Table 6).

Sustainability of Changes

The large-scale ongoing programs with broad interventions and a large number of improved measures (Bertera, 1993; Dalton & Harris, 1991) show sustainability in that the measures were collected 2–4 years after the introduction of the program and several other interventions (Healthy Directions, PHLAME, Wellworks, Wellworks-2; Konradt et al., 2000; Ott et al., 2010; Rasmussen et al., 2006; Tsutsumi et al., 2009; SHIFT) demonstrated significant outcome improvements at 1 or more years (see Table 6 and the Appendix). The significant PHLAME HP outcomes and group differences became nonsignificant after 3 years, although PHLAME's significantly better workers' compensation outcomes compared to controls (measured separately in a design rank 2 analysis) were based on data from up to 5 years after the baseline period. SHIFT obtained self-report measures from 15 of their original contingent of 29 participants at 30 months poststudy, when the weight had continued to decline to a mean of 18.3 pounds lost (based on self-reports) from a mean 7.8 pounds (measured objectively) at 6 months, and the BMI also continued to decline to −2.7 units at 30 months by self report (vs. −1.2 units objectively measured at 6 months). The *N* is small and the design is rank 3, but this is by far the largest improvement in a measure of body weight loss or BMI reduction reported by any TWH intervention, and it proved to be sustainable in those they could contact.

Return on Investment

Only two studies estimated the costs and benefits of their interventions, allowing them to report a definitive return on investment (ROI). In PHLAME, the ROI of the team-based (T) program was $4.61 returned for every $1.00 invested, while the ROI of the MI portion of the study was $1.80 to $1.00 based on medical and workers' compensation costs; workers' compensation claims rates had declined 8% from the baseline period and were significantly lower in the intervention group than in the comparable control organizations. In the Bertera (1990) study, the ROI based on the cost of disability days was $1.11 for each

Table 6
Summary of Results

Study identifier duration of intervention	Intervention focus[a]: Industry	Theoretical model	Intervention program participation[b]: Features[c]	Number of significant outcomes Changed and S/S + NS Ratio S/NS	Ratio	Sustained[a]	Intervention cost factors[d] C	T	S	E	I
			Design Rank: 1								
Wellworks-2: Sorensen et al. (2002); Sorensen et al. (2003); LaMontagne et al. (2004); Hunt et al. (2005); Stoddard et al. (2005)	HP + OSH Manufacturing	Socioecological model	ME	5/10	0.33	Yes: HP and OSH at 16 months					
Duration: HP: 16 month intervention											
MASSbuilt: Okechukwu et al. (2009); Okechukwu et al. (2011)	hp + ohs-S Construction	Socioecological model	U — motivational interviewing; feedback	1/3	0.25	Yes: HP at 5 months	•		•		
Duration: 4 months; follow-up surveys at 1 and 6 months post-intervention						No: HP at 10 months					
Healthy Directions: Hunt et al. (2003); Barbeau et al. (2004); Sorensen et al. (2005); Stoddard et al. (2005); Hunt et al. (2007)	HP + osh Manufacturing	Socioecological model	ME	2/5	0.29	Yes: HP at 18 months	•		•		
Duration: 18 months											
Eriksen et al. (2002)	HP + OSH Services			0/9		Not applicable			•		
Duration: 12 weeks											
PHLAME[e]: Moe et al. (2002); Elliot et al. (2007); MacKinnon et al. (2010); Ranby et al. (2011); K. S. Kuehl et al. (2013)	HP + osh Services	Social-Cognitive theory (for T)	E — team strategies; motivational interviewing	12/9	0.57	Yes: HP at 1 year	T	T	T	T	T
Duration: Team (T): 11 weeks; Motivational Interviewing (MI): 4 individual meetings with optional following meetings at 6 and 10 months						No: HP at 3 years	•		•		
Workers' compensation study duration: Data from a 5 year period after baseline		Phenomenological theory (for MI)				Yes: OSH at 5 years	M	M	M	M	M
							•		•		

(*table continues*)

Table 6 (*continued*)

Study identifier duration of intervention	Intervention focus[a]: Industry	Theoretical model	Intervention program participation[b]: Features[c]	Number of significant outcomes Changed and S/S + NS Ratio		Sustained[a]	Intervention cost factors[d]				
				S/NS	Ratio		C	T	S	E	I
Tsutsumi et al. (2009)	HP + osh Manufacturing		E — team strategies	2/4	0.33	Yes: HP at 1 year	•	•	•		
Duration: 16 months											
Peters and Carlson (1999)	HP + osh Services		self-management; counseling; meditation/relaxation; self-directed behavior change; incentives for improvement	18/9	0.66	Yes: HP at 4 months	•				•
Duration: 10 weeks; follow-up at 3 months											
Tveito and Eriksen (2009)	hp + OSH Health care		E	1/9	0.10	Yes: HP at 9 months		•	•		
Duration: 12 month intervention; follow-up in 4 months after intervention ended											
			Design Rank: 2								
Bertera (1990); Bertera (1993)	HP + OSH-W Diversified		ME — self-directed behavior change; counseling; incentives for participation, improvement	9/5	0.64	Yes: HP and OSH at 2 years				•	•
Duration: 2 years											
Rasmussen et al. (2006)	hp + OSH Manufacturing		ME — team strategies; incentives for participation	4/8	0.33	Yes: HP and OSH at 3.5 years	•				
Duration: 3.5 years											
Take-a-Stand: Pronk et al. (2012)	hp + OSH Health care			7/6	0.54	Yes: HP and OSH at 6 weeks				•	
Duration: 4 week intervention; data collected before (for 1 week) and after (2 weeks)											
Alkhajah et al. (2012)	hp + osh-S Services			4/13	0.24	Yes: HP and OSH at 12 weeks				•	
Duration: 12 weeks											

Table 6 (*continued*)

Study identifier duration of intervention	Intervention focus[a]: Industry	Theoretical model	Intervention program participation[b]: Features[c]	Number of significant outcomes Changed and S/S + NS Ratio		Sustained[a]	Intervention cost factors[d]				
				S/NS	Ratio		C	T	S	E	I
			Design Rank: 3								
Dalton and Harris (1991)	HP + OSH-W Telecom		M — counseling; feedback; incentives for improvement	19/8	0.70	Yes: HP and OSH at 2 and 4 years				•	•
Duration: Data collected at about 2 years (pilot) and 4 years into the program											
SHIFT: Olson et al. (2009); Wipfli et al. (2013)	HP + OSH Transportation	Individual and social motivation	E — self-monitoring; motivational interviewing; feedback; incentives for participation, improvement; team competition	11/32	0.34	Yes: HP and OSH at 6 months; HP at 30 months	•	•			•
Duration: 6 months; follow-up of selected HP data at 30 months											

(*table continues*)

Table 6 (*continued*)

Study identifier duration of intervention	Intervention focus[a]: Industry	Theoretical model	Intervention program participation[b]: Features[c]	Number of significant outcomes Changed and S/S + NS Ratio: S/NS	Ratio	Sustained[a]	Intervention cost factors[d]: C	T	S	E	I
Design Rank: 4											
Konradt et al. (2000) Duration: 11 months (+ 2 month follow-up)	hp + osh-S Services		E — team strategies	3/0	1.0	Yes: HP and OSH at 13 months					
Design Rank: 5											
Ott et al. (2009); Ott et al. (2010) Duration: Approximately 11 years	hp + osh-S Manufacturing			1/8	0.11	Yes: HP at about 7.5 years	•				

[a] Intervention focus: HP = Health promotion (in caps = major program; lower case = limited in scope); OSH = traditional occupational safety and health program + work stress; W = Broad-based company-wide program; S = Specific endpoint or method addressed by the intervention. [b] Intervention program participation: M = management participation; E = Employee participation; ME = management/employee boards; U = union participation. [c] Features from Behavioral Processes and Consequences listed in Table 3. [d] Cost factors: C = external consultants; T = externally-developed training; S = external trainers/intervention specialists; E = Significant equipment or materials provided; I = incentive programs. [e] PHLAME: T = Team; MI = Motivational Interviewing intervention methods.

$1.00 invested in Year 1 and $2.05 for each $1.00 invested in Year 2. To provide a point of reference, a systematic review of cost-benefit analyses of safety interventions (e.g., installation of patient lifts in hospitals, work process changes) in the peer-reviewed scientific literature by Verbeek, Pulliainen, and Kankaanpää (2009) could locate only 26 pre-to-post comparisons. While an ROI was not calculated, recovery of investment, primarily in reduced sick leave time costs within a year, occurred in 19 of the 26 reports. A more direct comparison with the TWH interventions was not located. Baicker, Cutler, and Song (2010) conducted a meta-analysis of the 22 most rigorously evaluated HP (only) programs, calculating a mean return on investment of $3.27 in medical cost savings for every $1 spent on wellness programs.

Intervention Cost Factors

While most TWH intervention programs did not identify costs, there are three categories of factors that would make the interventions more expensive or conversely would lend themselves to economical interventions: The use of external trainers or facilitators to plan or implement the intervention, new training and programs, and the purchase of new equipment.

External trainers or facilitators. The cost factor most clearly revealed in the TWH publications is the use of outside personnel to plan or implement the interventions. Eriksen et al. (2002) used professional instructors including an aerobics instructor to provide training and exercise sessions. Healthy Directions used Industrial Hygienists to consult on OSH programs and wellness professionals consulted on the HP programs, while MASSbuilt provided training materials but state-certified tobacco treatment specialists presented the materials. The academic team behind Wellworks facilitated and provided consultation to a joint Management-Labor Advisory Board in the organizations that carried out the intervention, while in Wellworks-2 they employed the board and added extensive industrial hygiene consultation. Tveito and Eriksen (2009) used an apparently external physician and psychologist for courses and interviews, and research staff facilitated meetings. Konradt et al. (2000) provided a trained psychologist as a facilitator.

New training and programs. Rasmussen et al. (2006) provided training materials for company teams and presentations to supervisors on mental health issues. PHLAME provided scripted training materials and supported the team meetings conducted by the study participants to learn the information (the motivational interviewing arm of the study that used counselors was more expensive but was slightly less effective than the team processes arm). Tsutsumi et al. (2009) developed new seminars, but this program refocused the regular medical exams on prevention and safety issues, so existing medical personnel carried out the intervention. SHIFT provided computer-based wellness and safety training supported by motivational interviewing and self-monitoring with incentives in a weight loss and safety competition. Ott et al. (2009) and Bertera (1990) developed company-wide programs that included environment changes, incentive programs and training for site coordinators. Take-a-Stand provided a comprehensive corporate health and well-being program that included physical activity resources and incentives for activity to complement the introduction of new equipment (below). Dalton and

Harris (1991) provided training materials and included self-monitoring and reinforcement.

New equipment. Some programs used fairly expensive program components. Alkhajah et al. (2012) and Take-a-Stand provided sit-stand workstations.

Dissemination/Availability

All first authors of the 17 studies were contacted to determine whether a packaged program for implementing the intervention was available that included the training, ordering information on measurement equipment, and other necessary materials, and specified the intervention steps or protocol. Of the 17 interventions, only PHLAME reported a packaged program (via the Cancer Planet website) that is available for ready dissemination, although the sit-stand workstations are commercially available but the study protocols are not (Take-a-Stand; Alkhajah et al., 2012).

Recommendations

Key program factors that define the 17 intervention programs, their degree of success, sustainability, and cost factors are summarized in Table 6. Table 6 reinforces the picture of diversity that emerges from Tables 1–5. TWH research is heterogeneous and can best be viewed as a developing area of research and practice. There is not yet a sufficient literature from which to extract factors that are associated with successful programs or even to glean which would be the most efficient and cost-effective. Rather, the literature offers examples of a variety of ways to structure TWH interventions and measure their effectiveness that future investigators can adopt. Viewed from that perspective they are instructive.

Hastening the Impact

There are hundreds of articles on the effectiveness of wellness (HP) intervention programs (O'Donnell, 2013) and hundreds more on health protection or OSH, but there are only 17 on the combination of HP and OSH; that is, TWH intervention programs. The results argue that TWH programs are effective. Indeed, an observation of this review is that TWH programs can achieve changes in multiple outcomes that are not inferior to interventions focused on only one outcome. This speeds the improvement of risk factors compared with addressing individual risk factors in serial fashion over time as has occurred in the past. While others concentrate on the cost efficiency of TWH programs (e.g., Goetzel in NIOSH, 2012), which may also be true, we are focusing instead on the number of risk factors changed per intervention. This is a topic in HP research, termed multiple behavior change (King, Taylor, Haskell, & Debusk, 1988; Nigg & Long, 2012; Noar, Chabot, & Zimmerman, 2008; Prochaska, 2012), where there is evidence to support the effectiveness of simultaneous interventions (King et al., 2013; Vandelanotte, 2013) or even synergy in interventions that change multiple behaviors (Johnson et al., 2014).

Should Interventions Always Be Integrated?

Integrated TWH is a strategic approach that management should take at the company level, but it can be problematic at the employee level. The SHIFT study in truck drivers provides a good example of this challenge, which is not described in the publications. Health and safety are strongly interconnected in trucking, which compelled addressing both in the intervention. Body weight-associated health conditions are associated with increased crash risk, so Olson et al. (2009) integrated driving safety into their SHIFT training and competition intervention. However, drivers reported that they volunteered because they wanted to lose weight, so they did not understand how the behaviors involved in weight loss and safety were related in any practical way. What the drivers didn't realize is that weight is a risk factor for adverse driving events (Laberge-Nadeau et al., 1996; Stoohs, Guilleminault, Itoi, & Dement, 1994), though not linked to driving skills or habits per se. All targets will ultimately impact driving safety, but for the participant or employee, behavior change targets may be expected to appear more naturally interconnected. We conclude that building into an integrated program incrementally and initially at the management level may often be the wise choice, and there is reason to think that this is happening in industry led by practitioners outside the arena of experimental research (NIOSH, 2013). Ways of measuring integration at all levels of the organization are described by Sorensen et al. (2013). In sum, the complete integration of components into a TWH program should be seen more as a long-term goal than an immediate imperative. Admittedly, however, while several intervention programs that improved risk factors and included in our review have been described as integrated (Pronk, 2013), the evidence that integration confers a significant benefit is lacking, perhaps the most glaring gap in the TWH literature. This point is also made by Sorensen et al. (2013) who offered measures of integrated approaches that could be applied in interventions and thus provide quantitative evidence of integration such as employed by LaMontagne et al. (2005).

Dissemination

Only one of the TWH programs is available in a packaged form suitable for "off-the-shelf" dissemination and thus the only realistic choice for practitioners from the TWH options identified here; other programs could be difficult to replicate outside the academic setting where most of these TWH interventions were developed. Perhaps it is premature to press for dissemination of the TWH programs until their effectiveness is better established. The effectiveness of the TWH interventions should be a major basis for identifying intervention programs to disseminate. TWH programs should be evaluated by at least four factors: (a) the number of risk factors or injuries and chronic diseases they reduced, (b) how much they reduced injuries and chronic diseases or the risk factors for injuries and diseases, (c) whether they show evidence of sustained improvement in risk factors beyond the end of the intervention, and (d) cost. As dissemination plans are developed for TWH interventions, there is a parallel need for dissemination research to determine what works and thus what to include in future dissemination plans (Glasgow & Emmons, 2007).

Theoretical Models

Less than half the TWH studies offered models or even clear rationales for how they expected the interventions to change the organization or behavior. This lack of theory limits understanding

of underlying processes. Furthermore, only two TWH studies offered process evaluations, and only two addressed moderating and mediating analyses. The PHLAME and Wellworks studies addressed the factors that may have been responsible for producing the behavior changes by assessing mediating and moderating variables. Mediation analyses can be useful for testing specific theoretical pathways of behavior change (MacKinnon, 2008). Moderation analyses can be useful for identifying factors that enhance or undermine intervention effectiveness (Aiken & West, 1991). This lack of theory is a serious omission that must be corrected in future research if TWH is to contribute to the science of intervention research. OHP offers a theoretical lens through which to view such mechanisms and it is suggested that drawing on psychological theories to help develop approaches and understand the mechanism behind TWH approaches would enhance our understanding and lead to improved integrated interventions (Landsbergis et al., 2011).

Strengthening TWH Intervention Studies and the Reporting of Them

The TWH literature is not yet a strong literature on which to base conclusions or generalize to new settings. The omissions of basic information in many TWH publications suggest a range of planning and design factors and results and reporting improvements that could enhance the impact of the future TWH literature:

Planning. Study planning and design steps.

- Develop a rationale or theoretical basis for how the intervention is expected to have an effect
- Develop measures of intervention fidelity and at least rudimentary process evaluations
- Develop measures of the social acceptability/desirability of the intervention goals, procedures, and outcomes
- Employ a strong design such as a randomized controlled trial (RCT), although quasi-experimental designs also have a great deal of value and may be the only practical approach in some work settings
- Conduct a power analysis and select the sample size based on the numbers needed to detect changes in each of the endpoints considered critical to detecting changes in TWH.

Results. Information to include in the Results.

- Evaluate organizational level TWH integrations where primary outcomes are organizational savings (time, personnel, money) and downstream or indirect effects on worker participation in prevention programs
- Describe how HP and OSH were integrated
- Include effect size statistics along with the data used to calculate them, for both significant and nonsignificant results
- Conduct analyses that address the mechanism for the effect or that will identify mediators and/or moderators of the intervention's effectiveness based on the expectations set up by the rationale or theory.

Discussion. Topics to discuss.

- Discuss the long-term impact of the intervention through maintenance of effects or dissemination potential
- Relate the findings of TWH interventions to those of focused interventions
- Provide a description in plain language that can be understood by a practitioner, manager or CEO of a company or union of (a) the outcomes or effects of the intervention that are linked to control or reduction of risk factors, and (b) the intervention program
- Provide a repository where materials such as training and processes such as protocols can be obtained.

An introduction to intervention research in the workplace is provided by Brownson, Colditz, and Proctor (2012).

Summary

Overall, the TWH literature is developing and heterogeneous in nature. There is insufficient evidence or replication to identify best practice interventions based on this literature. And there is only one study that can be used to make recommendations for the value of integration (Wellworks-2: Sorensen et al., 2003), a glaring gap. However, all but one of the 17 TWH intervention programs improved outcomes that are risk factors for injuries and/or chronic diseases and 4 improved 10 or more risk factors; in some cases the injuries or illnesses were reduced. The TWH interventions effectively improved risk factors in a wide range of industries (from manufacturing to services to construction) and the one TWH program that compared HP + OSH to OSH-only programs demonstrated that the HP + OSH program led to significantly greater improvements in multiple risk factors than the HP-only program (Wellworks-2). The degree of improvement in the TWH programs meets the test of making changes that have been associated with improved risk factors important to health (viz., smoking cessation, increased exercise, blood pressure decreases, cholesterol changes, weight reduction), the workers compensation cost rates and cost reductions in one case and the ROIs reported by two of the TWH programs were positive. These results suggest that TWH interventions can effectively address both injuries and chronic diseases simultaneously. The promise of simultaneously reducing multiple risk factors important to national health provides an added rationale for pursuing TWH research using clear theories or rationales, strong designs, and multiple objective and self-report outcomes that can lead to the identification of best practices with an evidence base behind them. The results should thus be measured in health improvement and accident reduction, not cost savings to industry, though such savings to industry and employees must surely follow if the interventions are effective. Good workforce health is in the interest of both industry and employees (from the shop floor to the boardroom), and to the nations where they live, and there is evidence that integrated programs are a route to that goal (Sauter, 2013; Schulte, Pandalai, Wulsin, & Chun, 2012). This returns us to the call to action of NIOSH Director Howard (2013): "to make prevention work as cost containment . . . depends . . . on . . . Total Worker Health program." Our review suggests that this is a hypothesis rather than an axiom, but it is a hypothesis with support and one certainly worth testing aggressively in the interest of the health of the workforce, nationally and internationally.

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