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Department of Social and
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RE: Final Rep011: Grant#: 5Ul90H008861

Dear Dr. Lioce:

We are submitting the Harvard Center for Work, Health, and Wellbeing, Grant #5U190H008861 Final Report for the grant period September 1, 2011 -February 28, 2017.

As instructed, we are attaching one signed PDF document and one editable Microsoft Word file. Included in the files are:

1.) The Final Progress Report Narrative sections
2.) The federal financial report SF-425
3.) The Equipment and Inventory Report SF-428-B
4.) Final Invention Statement and Certification Form HHS 568

Please let us know if you need additional information.

Sincerely,

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Harvard T.H. Chan Center for Work, Health, and Wellbeing
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Final Progress Report

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Overall Center Abstract

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The Harvard T.H. Chan School of Public Health Center for Work, Health, & Well-being, was first funded in 2006 as a NIOSH Total Worker Health® (TWH) Center for Excellence. The *vision* of the Center is to achieve optimal worker safety and health and employer outcomes through improved conditions of work. The Center's successful past performance is demonstrated through cross-project results and publications; a conceptual framework to advance TWH research and practice; common metrics; transdisciplinary workforce development; and solid partnerships with employers and other organizations who are contributing to ongoing dissemination and translation of the Center's research into practice. During the last project period (2011-2017, including a no-cost extension), the Center's specific aims focused on **knowledge production** (research); **knowledge reproduction** (training and education); and **knowledge transfer and exchange** (translating research into practice and policy). We operationalized these aims through two research projects and a knowledge transfer project, along with training, outreach, and educational activities. The work of the Center during this project period focused on two high-priority, high-risk industries, health care and construction, as well as on small- and medium-sized businesses, which employ over half of U.S. workers.

Significant Findings: Across the Center's research, we found that worker safety and health outcomes share common pathways in the conditions of work, underscoring the need for system-level changes. The Center's three projects contributed to improving understanding of the roles of the conditions of work in worker safety and health, and examined the feasibility and efficacy of integrated policies, programs, and practices to reduce these risks. In our study in healthcare, findings across two intervention studies pointed to the need for embedding unit-level efforts into system-wide initiatives that respond to conditions of work. The relationships of working conditions to worker safety and health outcomes were further documented through an integrated database, including administrative data, injury incidents and worker compensation claims, and healthcare utilization, along with survey data. In our research in the construction industry, we demonstrated in a cluster randomized trial that a general contractor-based integrated program had positive and statistically significant effects on worker's diet and physical activity. We learned that the program activities were adaptable to different worksites and that effective program implementation required empowering subcontractor companies in the program through trade-specific targeted ergonomics interventions. In our knowledge translation study, conducted in partnership with healthcare vendor, we identified key barriers to implementing TWH approaches in small- to medium-sized businesses (SMBs), and facilitators and barriers to the dissemination and implementation process in three manufacturing SMBs. In addition, the Center funded 12 pilot projects that identified and supported innovative research, education, and translation activities conducted junior and senior scientists paired together on each study.

Translation of Findings: To increase the number of work environments that adopt and implement integrated policies, programs, and practices, the Center updated its *SafeWell Practice Guidelines: An Integrated Approach to Worker Health,* tested these guidelines in our knowledge transfer project, and applied its principles in our research projects. The Center expanded its network

of collaborative partnerships and stakeholder engagement for Practice-to-Research and Research-to-Practice activities. Key partnerships included with the Massachusetts Department of Public Health, the Veterans' Health Administration (VHA) and the Boston Firefighters. The Center also sponsored two courses annually through the Harvard Chan School's Executive and Continuing Professional Education program. We worked closely with a Worksite Advisory Board, including vanguard employers, unions, and vendors, who helped ensure our use of state-of-the-art methods and the most effective channels for knowledge transfer.

Research Outcomes / Impact: The Center established a set of unifying principles that we have articulated in our Center-wide research—our common conceptual model, shared definition and a common set of indicators of integrated approaches, multi-level partnerships, and successes in translating our research to practice. We developed a shared definition of integrated approaches to worker safety and health, with validated metrics that have informed the field. Our impact and productivity were further demonstrated by 54 publications. Our Center-wide commitment to mentoring junior investigators further defines the Center's ongoing impact. Through its focus on the critical importance of working conditions for a range of worker safety and health outcomes, the Center provided consistent messages through its outreach and scientific communications.

SECTION 1: OVERALL CENTER

BACKGROUND AND SPECIFIC AIMS

The Harvard T.H. Chan School of Public Health Center for Work, Health, & Well-being, was first funded in 2006 as a NIOSH Total Worker Health® (TWH) Center for Excellence. The *vision* of the Center is to achieve optimal worker safety and health and employer outcomes through improved conditions of work. The Center's successful past performance is demonstrated through cross-project results and publications, a conceptual framework to advance TWH research and practice, common metrics, and transdisciplinary workforce development. During the last project period (2011-2017, with no-cost extension), the Center's specific aims focused on **knowledge production** (research); **knowledge reproduction** (training and education); and **knowledge transfer and exchange** (translating research into practice and policy). We operationalized these aims through two research projects and a knowledge transfer project, along with training and educational activities. The work of the Center in the last project period focused on two high-priority, high-risk industries: health care and construction. We placed additional priority on small- and medium-sized businesses, which represent more than 99% of U.S. businesses and employ more than 52% of U.S. workers.[1] These targeted efforts responded to critical regional needs. Health care is the largest employer in the U.S. economy as well as in Massachusetts, comprising almost 17% of the total workforce,[2-7] and has the highest injury rates among occupational groups.[8] Construction is the ninth largest workforce in Massachusetts, making up approximately 4%[9] of the total workforce; workers in this industry face high physical demands and risk of injury, and have an exceptionally high prevalence of smoking and heavy alcohol use risk-related behaviors.[6, 7, 10, 11]

SIGNIFICANT FINDINGS

Common Center Finding: Worker health and safety outcomes share common pathways in the organization of work. In the past funding period, we found across our studies that worker safety and health outcomes share common pathways in the conditions of work, underscoring the need for system-level changes.[12] For example, in our studies of hospital patient care workers, we observed that low supervisor support, harassment on the job, and high job demands each contribute to multiple health behaviors, such as sleep deficiency and inadequate physical activity, as well as increased risk of injury and self-reported pain.[13-17] In our work with employers, however, we observed that the usual first-line of action is not implementation of system-level policies and practices, but rather programs for individual workers, a trend we have labeled "regression to the individual."[12, 18] For many workers employed in fast-paced and demanding work settings, participating in programs, regardless of how relevant, may be challenging in the face of competing priorities.[12] We also observed that programs for individual workers are most effective when they are preceded by improvements in organizational policies and practices that communicate the leadership's value of worker safety and health.[19] Employers may be more likely to engage in system-level improvements when these changes are linked to business outcomes, such as decreased worker turnover and increased indicators of productivity.

Project-specific Findings: The Center's three projects contributed to improving understanding of the roles of the conditions of work in worker safety and health, and examined the feasibility and efficacy of integrated policies, programs, and practices to reduce these risks. We conducted this research in three settings: health care, construction, and small- to medium-sized manufacturing businesses.

Be Well, Work Well: Integrated Approaches to Improving the Health and Safety of Health Care Workers (Sorensen, PI, with Hashimoto, Sabbath, Boden, Stoddard, Dennerlein, Nagler, and others). This study represents a 11-year partnership between the Center and Partners HealthCare. The research in the last project period was designed to address two aims: (1) To estimate the efficacy and determine the feasibility of an integrated intervention that addresses both health protection and health promotion in order to reduce musculoskeletal disorder (MSD) symptoms and improve health behaviors among health care workers; and (2) To determine the factors in the work environment that contribute over time to reductions in MSD symptoms and improvements in safe and healthy behaviors. We successfully completed these aims.

We developed an *integrated intervention for direct patient care workers* and tested it in a proof-of-concept trial in eight in-patient care units.[12] The 12-month intervention included consultation for nurse managers to implement changes on patient care units and educational programming for patient care staff to facilitate improvements in safety and health behaviors. We found no significant intervention effects on our primary outcomes. We identified challenges to implementing the intervention due to the physical demands, time constraints, patient care priorities, and psychological strains of patient care. Because the intervention was implemented on only four inpatient care units rather than hospital-wide, it may have missed opportunities for organization-wide support. We also evaluated a *hospital-wide safe patient handling and mobilization program* that engaged multiple departments with upper management support. This 8-month intervention successfully employed hospital-wide strategies to effect change, including introduction and enforcement of a hospital-wide safe patient handling policy, hospital-wide communications endorsed by upper management, training mandated by upper management, and coordination of efforts across departments. This intervention resulted in reductions in recordable injuries associated with lifting and exertion.[19] Taken together, these findings point to the *need for embedding unit-level efforts into system-wide initiatives that respond to conditions of work.*

To examine *determinants of safety, health and wellness outcomes in the hospital work environment,* we expanded our employee administrative database; Partners HealthCare provided unusual access to their employee record databases, making this research possible. We identified five cross-cutting themes from this body of work: (1) Injury, musculoskeletal pain, and health behaviors share diverse determinants within the work environment and vary by socioeconomic status of workers. (2) The psychosocial work environment shapes safety and health behaviors and health outcomes. (3) Health behaviors are partially rooted in conditions of work, suggesting that conditions of work must be addressed to improve health behaviors. (4) Administrative data, both on its own and in combination with self-report data, can produce robust TWH-relevant conclusions that are not possible with self-report data alone. (5) The workgroup is a key unit of analysis and intervention.

All the Right Moves: Integrated Approaches to Health and Safety in Dynamic Construction Work Environment (Dennerlein, PI, with Manjourides, Okechukwu, others). This research project was designed to develop and evaluate an integrated and comprehensive worksite-based program targeting MSD's, physical activity, and tobacco use. Our two aims were to: (1) Develop a worksite-based, multi-component, and integrated MSD prevention and health promotion intervention for workers in commercial construction; and (2) Complete a feasibility study of the developed worksite-based intervention on 10 sites, randomly assigned to either intervention (5 sites) or control (5 sites) groups. We completed these two aims and expanded our overall knowledge of the working conditions and the work organization for the commercial construction industry. These accomplishments set the stage for the new research project in the current funding cycle, that focuses on subcontractor-based interventions and determine methods to span the multiple organizations involved on a construction worksite.

We *successfully developed a general contractor-based integrated program* that included two programs based on existing industry programs: a Soft Tissue Injury Prevention Program and a

Health Week, focusing on ergonomics, tobacco use, and diet within the context of energy balance.[20] Through pilot work funded by the Center, we learned that the occupational physical activity of construction workers greatly surpasses the recommended weekly minutes of moderate activity and thus changed our intervention target from physical activity to diet with respect to the energy balance needed.

We also *successfully evaluated the program* on 10 construction sites. Our baseline worker surveys indicated that a *range of worker health and safety outcomes share common factors*, which supported the Center's conceptual model. We learned that the program activities were adaptable to different worksites and Health Week increased the program's visibility and provided one-on-one engagement of workers. The cluster randomized control trail demonstrated that the *program had positive and statistically significant effects on worker's diet and physical activity*.[21]

An additional finding was that *effective program implementation required empowering subcontractor companies* in the program through trade-specific targeted ergonomics interventions. We had previously hypothesized that the general contractor had more control of the specific physical working conditions; however, many ergonomic solutions required involvement of the subcontractor. In addition, many benefits workers received come from either their union or the subcontractor, as the subcontractors are the primary employer for workers.[22]

During the last project period, we greatly *expanded the knowledge-base of the work organization in the construction industry* for health and safety research and program implementation. As part of this, we *further built our successful partnerships* with construction companies. We gained new knowledge to navigate the construction site, including the flow of communication between work units and day-to-day activities.

SafeWell: Education and Dissemination to Promote Integrated Approaches to Worker Health in Small- to Medium-sized Businesses (McLellan, PI, with Pronk, Sorensen, Katz, others). This project was built on the Center's *SafeWell Practice Guidelines.*[23] We partnered with HealthPartners, a not-for-profit, member-governed health care system headquartered in Minneapolis, MN that provides health and safety services to small- to medium-sized businesses (SMBs) that often lack in-house resources. As a knowledge transfer study, the research aims were to: (1) Identify facilitators and barriers to adoption of integrated approaches to worker health among SMBs; (2) Develop a business case and implementation package to promote adoption of this integrated approach among SMBs; and (3) Assess the feasibility, acceptability, degree of implementation, and preliminary impact of the integrated approach delivered by HealthPartners among three SMBs. We accomplished these aims, and will build on our findings in the renewal.

We conducted in-depth interviews and a web-based survey of decision makers in SMBs in the upper Midwest using an instrument developed by the Center to assess the application of TWH approaches.[24, 25] We identified key *barriers to implementing TWH approaches that included limited staffing and financial resources*. Respondents widely valued worker health, reported strong management support for health and safety, and most indicated their organization was open to making changes to improve worker health.[26] We also determined that company size was not necessarily a barrier;[18] leadership support was significantly associated with implementing occupational safety and health but not health promotion; and organizational capacity, including having dedicated staff, budgets, and committees, was significantly associated with implementation of occupational health and health promotion.[18]

We *evaluated the dissemination and implementation process in three manufacturing SMBs,* and assessed the preliminary impact on organizational and individual-level outcomes.[25, 27, 28] We used in-depth interviews, focus groups, and process-tracking data to identify factors that influenced companies' adoption and implementation of the program provided through the vendor. Factors associated with successful implementation of TWH approaches included openness to change and innovation; sustained and articulated

leadership support; allocation of dedicated staff, budgets, and committees; collaborative organizational cultures that also value and prioritize employee safety and health; existing organizational processes that could be leveraged for new approaches; and realistic implementation timelines to account for organizational changes.[27, 28] Using a learning collaborative model, we engaged leaders from these SMBs to discuss successes and barriers with executives and managers from other companies; this leader-to-leader strategy was successful in prompting companies to self-organize and host site visits to learn from each other.[25, 29]

Pilot project findings: The Center's pilot project program identified and supported innovative research, education, and translation activities conducted by its investigators. We implemented *12 pilot projects* in the last project period. These pilot projects also expanded our mentoring opportunities; we paired junior and senior scientists on each of these studies. These included the following:

National Worker Health Survey: Organizational Characteristics Associated with Integrated Worker Health Initiatives (Allen and Pronk) included a systematic review of the literature.[30]

Physical Activity among Commercial Construction Workers (Arias and Dennerlein) found that the amount of occupational physical activity of construction workers far exceeds the national guidelines for minutes of moderate activity,[31] resulting in modified intervention targets in the All the Right Moves research project.

Determining Effective Strategies for Integrated Health Promotion and Health Protection Programs in Small- to Medium-Sized Construction Subcontractors (Grant and Dennerlein) found that subcontractors are the primary employer for workers and that core teams based on work tasks at construction sites exist.

Feasibility of Integrating Worker Health Insurance (Medstat/now Truven) and Occupational Health Data (Hopcia and Hashimoto) investigated the feasibility of adding health insurance data to the Partners database.

Integration of Health Care Worker Health Insurance Information with Integrated Worker Health Initiatives (Hopcia and Hashimoto) incorporated worker health insurance data into the employee database using the vendor's occupational health software module.

Standing up Against Sedentary Behavior (John and Dennerlein) used treadmills among office workers to reduce sedentary behavior, leading to a funded R21, in addition to multiple presentations.

Simulation Modeling of Construction Workers (Manjourides and Dennerlein) estimated the effect of an intervention under varying levels of workplace mobility and quantified the resulting biases.[32]

Establishing relationships between work organization, worker behaviors, and productivity indicators in small manufacturing companies (McLellan and Pronk) expanded analyses of the SafeWell project.

Enhancing an Integrated Intervention for Patient Care Workers: Program Implementation and Evaluation (Nagler and Sorensen) supported evaluation of expanded intervention methods in Be Well, Work Well.

SafeWell Implementation Package: Designing Tools and Training for Dissemination (Nagler and Sorensen) led to the development of an implementation manual to help companies adopt TWH interventions.

Employee Wellness in Nursing Homes (Okechukwu and Sorensen) identified confounders of the associations between TWH and nursing homes' performance on occupational injuries and quality of care.

Mental Health Among Construction Workers (Reme and Dennerlein) found that construction workers have a high prevalence of mental distress, which is associated with both injury rate and self-reported pain.[33]

TRANSLATION OF FINDINGS

We developed and refined our Center's guidelines for implementing TWH approaches, which provide the foundation for translating research into practice. To increase the number of work environments that adopt and implement integrated policies, programs, and practices, the Center updated its *SafeWell Practice Guidelines: An Integrated Approach to Worker Health* in 2012.[23] We tested these guidelines in our knowledge transfer project, and our research projects employed this resource in their interventions. We have recently completed the development of *implementation guidelines* that will further contribute to building organizational capacity for integrated approaches to worker safety and health.[34]

The Center expanded its network of collaborative partnerships and stakeholder engagement for Practice-to-Research and Research-to-Practice activities. This was accomplished in the last project period in several ways. First, each project included a close collaboration with employer partners. These partners included: (1) Partners HealthCare System, Inc. in our Be Well, Work Well study; (2) Skanska of North America, Shawmut, Suffolk, John Moriarty and Associates, Gilbane, and others in our All the Right Moves study; and (3) HealthPartners, Inc. as a collaborating vendor, and TURCK, Quality Bicycle Products, and Bühler Inc. in our SafeWell study.

Second, we worked closely with a Worksite Advisory Board (WAB), which met annually and provided sustained guidance and counsel of vanguard employers, unions, and vendors, and helped ensure our use of state-of-the-art methods and the most effective channels for knowledge transfer. The WAB provided input on and disseminated Center worksite materials, consulted on the feasibility of implementing proposed methods and products in their organizations, provided advice on employer priorities, participated in Center seminars and conferences, and provided pilot sites for Center research.

Third, we engaged other critical stakeholders in our outreach and dissemination efforts. The Massachusetts Department of Public Health was (and continues to be) actively engaged in our External Advisory Board, provided significant input into planning future directions, and contributed to linking Center investigators to key networks. We established a productive relationship with the Veterans' Health Administration (VHA), which provided a foundation for work in the new funding cycle. Our partnership and pilot research with the Boston Firefighters is funded by the NIOSH funded Harvard Education and Research Center (ERC). We are further collaborating with Sodexo, Inc. in a new RO1 funded by NIOSH, building on work conducted during the prior funding cycle.

RESEARCH OUTCOMES / IMPACT

Center-wide Product: We developed a shared definition of integrated approaches to worker safety and health, with validated metrics that have informed the field. We defined an integrated approach to worker safety, health, and well-being as "*a strategic and operational coordination of policies, programs, and practices designed to simultaneously prevent work-related injuries and illnesses and enhance overall workforce health and well-being*."[24] We described a set of indicators of integrated approaches; we operationalized these indicators in a measure to examine correlates of integrated approaches,[25] and validated the measure in two samples.[35, 36] The impact of this activity has reached well beyond our own Center. NIOSH used our definition in the Center FOA; we validated our measure in collaboration with the Veterans Health Administration (VHA), and others have used it as part of needs assessments. These indicators also articulate our Center's common finding about the importance of system-level approaches.

Center-wide Product: Our Center developed and refined our conceptual model based on our common findings that place a central focus on the conditions of work.[37-40] We developed this conceptual model through an iterative, Center-wide process that incorporated our experiences in our research projects. The model expresses the Center's common finding about the pathways through which the conditions of work influence worker safety and health and enterprise outcomes.

Knowledge Transfer and Exchange: The Center's accomplishments are further demonstrated through our publications and presentations. Our productivity is demonstrated by 54 publications across our studies in the last project period. (See *Publication list*.)

Training and Education: The Center contributed to the development of the next generation of researchers in TWH through junior faculty, K-awards, and training of postdoctoral fellows and doctoral students. Across the multiple institutions and disciplines included in the Center, the Center contributed to the training of a cadre of 4 junior investigators, 12 postdoctoral fellows, and 9 graduate students in the last project period. These junior investigators first-authored 29 manuscripts from the Center's research during this period. Several of these junior investigators play leadership roles in the Center's current funding cycle, including Cassandra Okechukwu, ScD, Assistant Professor at the Harvard Chan School and co-investigator on the All the Right Moves research project, who leads the *Enterprise Outcomes Research Project*; Justin Manjourides, PhD, Assistant Professor at Northeastern University, who received Center pilot funding and is the co-PI of the *Intervention Effectiveness Research Project*; and Erika Sabbath, ScD, Assistant Professor at Boston College and a former postdoctoral fellow with the Center, mentored on her NIOSH-funded K01 by Dr. Sorensen, who leads the *Examining Pathways Research Project*. As a result of mentoring provided by the Center, NIOSH funded an R21 (John) and two career development awards (K01s) for junior investigators associated with the Center, one of whom leads one of the renewal application research projects (Sabbath).

Training and Education: The Center contributed to strengthening the TWH workforce through Executive and Professional Education. The Center sponsored two courses annually through the Harvard Chan School's Executive and Continuing Professional Education program[41] "Work, Health, and Well-being: Integrating Wellness and Occupational Health and Safety in the Workplace" (led by Drs. Sorensen and Pronk) and "Ergonomics and Human Factors: Strategic Solutions for Health and Safety" (led by Dr. Dennerlein). The Center incorporated TWH principles into courses at the Harvard Chan School, Northeastern, and Boston College; and sponsored 14 seminars in collaboration with the Harvard ERC.

The Center successfully established mechanisms that allow it to serve as the hub for cultivating a shared vision among Center investigators and facilitating communication across research projects. The Center put planning processes and procedures in place, including a strategic planning process, for setting priorities for future directions and facilitating transdisciplinary input. The Center's Internal and External Advisory Boards coalesced to provide scientific guidance and support. The Center established a well-functioning evaluation structure that provides for ongoing feedback, and facilitates tracking of measurable results.

SUMMARY IMPACT: The Center's well-defined unifying principles, established transdisciplinary team of researchers working across a broad spectrum of fields, strong partnerships, and engaged stakeholder groups provide a foundation for continuity of the Center's impact. The track-record of the Center and our investments in the next generation of researchers in the TWH field ensure that the Center for Work, Health & Well-being will exert a sustained, powerful influence on the safety, health and well-being of the 21st century workforce. We established a set of unifying principles we have articulated in our Center-wide research—our common conceptual model, shared definition and a common set of indicators of integrated approaches, multi-level partnerships, and successes in translating our research to practice. Our Center-wide commitment to mentoring junior investigators shaped the ongoing composition of our investigator team. Our findings in the last project period provided a clear direction for our next phase of research aimed at understanding and influencing the conditions of work that are critical to worker safety and health, and incorporating effective strategies to improve the work organization and environment into TWH interventions that can be broadly disseminated. These directions are evident in the Center's next cycle of funding.

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ADMINISTRATIVE, PLANNING AND OUTREACH (APO) CORE
Harvard T.H. Chan Center for Work, Health, and Wellbeing
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Administrative, Planning and Outreach (APO) Core Abstract

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Background and Aims
The objective of the Administrative, Planning, and Outreach (APO) Core was to provide overall scientific and administrative leadership for the Center and ensure synergies and collaboration across the participating projects; to provide training and education environments to new researchers and practicing professionals; and to provide opportunities to transfer our knowledge through growing and sustaining close collaborations with representatives of industry, labor, and other key stakeholders. The specific aims targeted knowledge production, reproduction of our developed knowledge, and knowledge exchanges.

Significant Findings

Knowledge Production: The Core created opportunities for building synergies across the research projects, including common measures; shared intervention materials, messages, and approaches; and process tracking measures. Center investigators collaborated on cross-Center products that guided our work and further informed the field, including our common conceptual model, shared definition and standard metrics for the TWH integrated approach, and common intervention products, building from the *SafeWell Practice Guidelines.*

Knowledge reproduction: The Core led efforts to build the capacity of the TWH workforce through mentoring, education, and training of researchers and practitioners **.** The Center has contributed to the development of the next generation of researchers in TWH through training and mentoring a cadre of new investigators, including 4 junior investigators, 13 postdoctoral fellows, and 7 graduate students in the last project period alone. These junior investigators have first-authored 29 papers. period.

Knowledge exchange: The Center translated research to practice through its expanded collaborative partnerships, outreach, and education efforts, and dissemination research. Also, the Center expanded partnerships with employers, labor unions, and other stakeholders, and incorporated their input into the methods and products we developed.

Translation of findings
The APO Core contributed to the development of pivotal partnerships for dissemination, evidence-based resources for practice, and research evidence from which to launch new initiatives related to translation research, practice, capacity building, and policy efforts. The Core planned and coordinated our education efforts; and coordinated training opportunities for junior faculty, students, and post-doctoral fellows.

Research Outcomes / Impact
Key outputs include: (1) a model for providing TWH approaches to employers through vendors, (2) a definition of integrated approaches to worker health; (3) a validated measure of Indicators of Integration; (4) translation of these Indicators of Integration into a scorecard for dissemination in research and practice; (5)pilot testing the Dimensions of Corporate Integration, with the TWH assessments and tools, available on the Center's website; (6) a successful plan of TWH

implementation at HealthPartners, which is encouraging its client companies to incorporate TWH approaches into efforts to protect and promote worker health and safety; (7) pilot project with Veteran's Health Administration that resulted in testing and development of additional tools for assessing and building capacity on TWH; (8) more than five graduate level courses to train the next generation of TWH researchers; (9) two ECPE courses offered annually to train practitioners in TWH; (10) eight manuscripts published or in press to date from the research-to-practice research project, with additional manuscripts in preparation; and (11) 15 conference abstracts presented on the research-to-practice research project.

ADMINISTRATIVE, PLANNING AND OUTREACH (APO) CORE

BACKGROUND AND SPECIFIC AIMS

The central objective of the Administrative, Planning, and Outreach (APO) Core was to provide overall scientific and administrative leadership for the Center and ensure synergies and collaboration across the participating projects, to provide training and education environments to new researchers and practicing professionals, and to provide opportunities to transfer our knowledge through growing and sustaining close collaborations with representatives of industry, labor, and other key stakeholders. The Core was designed to facilitate efforts to translate the Center's findings into recommendations and policies. The specific aims and functions of the APO Core were to:

1. Lead and develop opportunities for *knowledge production* across the Center's research.
2. Lead, develop, and sponsor *reproduction of our developed knowledge* through training and education of future and practicing professionals with a stake in the health of working people on needed skills and methods for integrating health protection and health promotion.
3. Lead and expand *knowledge exchanges* by assuring effective outreach and collaborations across disciplines and institutions as well as with industry, labor, and other key stakeholders through a variety of outreach activities.

SIGNIFICANT FINDINGS

Knowledge Production: The Core created opportunities for building synergies across the research projects, including common measures, such as surveys and walkthrough assessments; shared intervention materials, messages, and approaches, particularly at the organizational level; and process tracking measures. Beyond the work of the individual research projects, Center investigators collaborated on cross-Center products that guided our work and further informed the field, including:

- Conceptual Model: The Center's common conceptual model articulates the central role of the conditions of work in shaping health and safety outcomes as well as enterprise outcomes.[1]
- Shared Definition and Standard Metrics for the Total Worker Health® (TWH) Integrated Approach: We developed and validated an Indicators of Integration measure that captures implementation of TWH.[2-4]
- Common Intervention Products: The Core coordinated the use of common intervention messages and approaches, building from the *SafeWell Practice Guidelines*, which provides a framework for using TWH approaches, specific strategies, organizational processes, concrete tools, and links to other resources.

Knowledge reproduction: The Core led efforts to build the capacity of the TWH workforce through mentoring, education, and training of researchers and practitioners**.** The Center has contributed to the development of the next generation of researchers in TWH through training and mentoring a cadre of new investigators, including 4 junior investigators, 11 postdoctoral fellows, and 7 graduate students in the last project period alone. These junior investigators have first-authored 32 papers from the Center during this period. Several of these junior investigators play leadership roles in the renewal, including Cassandra Okechukwu, Justin Manjourides, and Erika Sabbath. We sponsored and co-sponsored 14 seminars through the NIOSH-funded Harvard Education Research Center (ERC), with topics ranging from work organization and health to intervention effectiveness.

The Center incorporated TWH approaches in multidisciplinary courses to build the research capacity of the TWH workforce and disseminate findings from research to larger public health audiences and professionals: The Center has sponsored two courses annually through the Harvard Chan School's Executive and Continuing Professional Education (ECPE) Program.[5] We have incorporated TWH principles in the content of existing courses at the Harvard Chan School,

Northeastern, and Boston College, and have engaged students and post-doctoral fellows in our research.

Knowledge exchange: The Center translated research to practice and policy to research through its expanded collaborative partnerships, outreach, and education efforts, and dissemination research. During the last project period, the Center expanded partnerships with employers, labor unions, and other stakeholders, and incorporated their input into the methods and products we developed. Each of our projects was a close collaboration with employer partners, who have facilitated our work and sharpened our research questions. These partners include: (1) Partners HealthCare, Inc. in our Be Well Work Well study; (2) Skanska of North America, Harvard University Construction Services, Shawmut Design and Construction, Suffolk Construction, John Moriarty and Associates, and Gilbane, and others in our All the Right Moves study; and (3) HealthPartners as a collaborating vendor, and TURCK, Quality Bicycle Products, and Bühler Inc**.** in our SafeWell study. We also established a productive partnership with the Veterans' Health Administration (VHA) for further testing and development of related capacity building tools. In addition, we worked closely with a Worksite Advisory Board that provided the guidance and counsel of vanguard employers, unions, and vendors, and helped ensure our use of state-of-the-art methods and the most effective channels for knowledge transfer.

Administrative and Planning Functions: The Core provided a coordinated and cohesive structure for work across the Center's projects**.** The Core provided a vehicle to leverage opportunities for research and practice across disciplines and with employers and stakeholders, and led the Center's overall evaluation based on defined benchmarks. Additional Core accomplishments included:

- Established and used processes and procedures for efficient and effective management and resource utilization.
- Facilitated and coordinated the Center's publications and presentations.
- Directed the Center's pilot project program.
- Developed and maintained transdisciplinary scientific advising and planning for all research and outreach activities across the Center's advisory groups.
- Guided the consistent application of the Center's conceptual model and shared measures.
- Used a coordinated Center-wide strategic planning process, and evaluated the success of the Center in meeting its goals.
- Coordinated our communications and partnerships within and outside the Center.

TRANSLATION OF FINDINGS

The APO Core provided an important mechanism for translation of the Center's research findings into practice. It contributed to the development of pivotal *partnerships* for dissemination, important evidence-based *resources for practice*, and *research evidence* from which to launch new initiatives related to *translation research, practice, capacity building, and policy* efforts. The Core also planned and coordinated our education efforts, including courses offered through the Harvard Chan School Executive and Continuing Professional Education (ECPE) Program, on-going refinement of the *SafeWell Practice Guidelines*, the jointly sponsored ERC/Center seminars, and updates to the website. The Core coordinated training opportunities for junior faculty, students, and post-doctoral fellows. The Core shared Center resources such as intervention strategies, evaluation tools, and problem solving across research projects, and facilitated new partnerships with outside stakeholders. For example, we incorporated findings and lessons learned from our international collaborations, including with collaborators in India, Brazil, Chile, and Australia. The Center established a collaboration with Sodexo, LLC., including a partnership on a grant application on "Organizational Approaches to Total Worker Health for Low-income Workers," (Sorensen PI, 2016-2020; 1R01 OH010811). The Center conducted a broad array of outreach activities with its expanded partnerships regionally, nationally, and globally.

RESEARCH OUTCOMES / IMPACT

The Core contributed to the Center's productivity related to translating research to practice and outreach. Key outputs include: (1) a model for providing TWH approaches to employers through vendors,[6] (2) a definition of integrated approaches to worker health, used in the FOA for the renewal of the TWH Centers of Excellence;[2] (3) a validated measure of Indicators of Integration;[2-4] (4) translation of these Indicators of Integration into a scorecard for dissemination in research and practice;[6] (5) Dimensions of Corporate Integration pilot tested, with the TWH assessments and tools,[4, 6] available on the Center's website; (6) a successful plan of TWH implementation at HealthPartners, which is encouraging its client companies to incorporate TWH approaches into efforts to protect and promote worker health and safety; (7) pilot project with VHA that resulted in testing and development of additional tools for assessing and building capacity on TWH; (8) more than five graduate level courses to train the next generation of TWH researchers; (9) two ECPE courses to train practitioners in TWH; (10) five manuscripts published or in press to date from the research-to-practice research project, with additional manuscripts in preparation; and (11) 14 conference abstracts presented on the research-to-practice research project.

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RESEARCH CORE
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Project A: Intervention Research and Observational Studies: Integrated Approaches to Improving the Health and Safety of Health Care Workers
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Project B: Intervention Research: Integrated Approaches to Health and Safety in Dynamic Construction Work Environments
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Project C: Knowledge Transfer Project: SafeWell: Education and Dissemination to Promote Integrated Approaches to Worker Health in Small-to-Medium-sized businesses
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Research Core Abstract

The Research Core included two research projects and a knowledge transfer project. This work focused on two high-priority, high-risk industries: health care and construction. We placed additional priority on small- and medium-sized businesses, which represent more than 99% of U.S. businesses and employ more than 52% of U.S. workers. These targeted efforts responded to critical regional needs. Health care is the largest employer in the U.S. economy as well as in Massachusetts, comprising almost 17% of the total workforce, and has the highest injury rates among occupational groups. Construction is the ninth largest workforce in Massachusetts, making up approximately 4% of the total workforce; workers in this industry face high physical demands and risk of injury, and have an exceptionally high prevalence of smoking and heavy alcohol use risk-related behaviors. The Center's three projects contributed to improving understanding of the roles of the conditions of work in worker safety and health, and examined the feasibility and efficacy of integrated policies, programs, and practices to reduce these risks.

Be Well, Work Well: Integrated Approaches to Improving the Health and Safety of Health Care Workers
Principal Investigator: Glorian Sorensen, PhD, MPH

This study tested two interventions for direct patient care workers in two large hospitals. Although in one study we found no significant intervention effects, in a second study we demonstrated that a hospital-wide safe patient handling program implemented at the system level resulted in reductions in recordable injuries associated with lifting and exertion. *Taken together, these findings point to the need for embedding unit-level efforts into system-wide initiatives that respond to conditions of work.*

Using data from an employee administrative database and survey data, we found that: (1) Injury, pain, and health behaviors share common work-related determinants and vary by socioeconomic status. (2) The psychosocial work environment shapes safety and health outcomes. (3) Health behaviors are at least partially rooted in conditions of work. (4) Administrative data can produce robust TWH-relevant conclusions not possible with self-report data alone. (5) The workgroup is a key unit of analysis and intervention.

Project B: Integrated Approaches to Health and Safety in Dynamic Construction Work Environment (PI: Dennerlein, Jack T)

In 2011, the Harvard T.H. Chan School of Public Health Center for Work Health and Well-being was funded for five years to develop and evaluate an integrated and comprehensive worksite-based program for Total Worker Health ® (TWH) targeting musculoskeletal disorders (MSDs), physical activity, and tobacco use among workers on commercial construction sites. We successfully developed and evaluated a general contractor-based, integrated program targeting soft tissue injuries, tobacco use, and diet within the context of energy balance. The program was successful in reducing new incidences of low back pain, improving worker intake of fruits and vegetables, and increasing leisure time physical activity. Qualitatively the program expanded the knowledge-base of work organization in the construction industry for health and safety research and program implementation.

Knowledge Transfer Project: SafeWell: Education and Dissemination to Promote Integrated Approaches to Worker Health in Small- to Medium-sized Businesses. (Project C) PI: Deborah McLellan, PI

Integrated approaches to worker health and safety are feasible and acceptable to vendors and Small- to Medium-sized Businesses (SMBs), but barriers and facilitators exist to their adoption and implementation. Key barriers include limited staffing, and lack of leadership support and financial resources. Facilitators include: openness to innovation to improve worker health; sustained strong management support for health and safety; dedicated staff, budgets, and committees; existing organizational processes that could be leveraged for new approaches; realistic implementation timelines for organizational changes.

This project demonstrated that health and safety vendors can successfully disseminate TWH approaches: Vendors are a major resource for providing health and safety services to SMBs, and have well-established relationships with employers who often lack in-house resources to provide these programs. This project was conducted in partnership with HealthPartners, a not-for-profit, health system headquartered in Minneapolis, MN offering health improvement solutions for employers.

SECTION 1

Background and Specific Aims

The *long-term goal* of this project was to improve the overall health and well-being of healthcare workers by making available evidence-based worksite policies, programs, and practices that foster a healthy work environment, reduce potential hazardous job exposures, and promote safe and healthy behaviors. Healthcare workers are the fastest-growing segment of the U.S. labor force, but workers may be at risk of poor health themselves due to their work environment. Worker health could affect not only workers and their families, but also their employers and their patients. Thus, protecting and promoting the safety and health of healthcare workers is both an occupational health priority and a public health imperative. Although studies have documented the worker health impact of the physical hospital environment, major gaps in knowledge remain. This study represents a solid partnership, in place since 2006, between the Harvard T.H. Chan School of Public Health Center for Work, Health & Well-being and Partners HealthCare, Inc., a multi-hospital network of 10 hospitals including Massachusetts General Hospital (MGH) and Brigham and Women's Hospital (BWH). The study had two aims:

1. To estimate the efficacy and determine the feasibility of an integrated intervention, addressing both health protection and health promotion in order to reduce MSD symptoms and improve health behaviors among healthcare workers. (Research type: Intervention research) We examined the working hypothesis that: Workers employed at baseline in patient-care units receiving the Integrated Intervention will report greater reductions in their MSD symptoms *(primary outcome)* and greater improvements in health behaviors, compared with workers employed at baseline in units assigned to the Usual Care control group. We also explored this aim in a second intervention study.

2. To determine the factors in the work environment which contribute over time to reductions in MSD symptoms and improvements in safe and healthy behaviors. (Research type: Social epidemiology/etiology) This study examined the working hypothesis that: (1) The work environment, work organization, and psychosocial factors, measured in our current study, will be associated with changes in workers' health behaviors and health outcomes between the assessments in the current and proposed studies.

Significant Findings

Aim 1: Intervention Research. We assessed this aim in two intervention studies. First, we conducted a proof-of-concept trial to estimate the efficacy and determine the feasibility of an integrated intervention, addressing both health protection and health promotion in order to reduce MSD symptoms and improve health behaviors among health care workers.[1] Using process tracking and qualitative data, we observed challenges to implementing the intervention due to physical demands, time constraints, and psychological strains of patient care. This was attributed to challenges of providing around-the-clock care, physically demanding work, and a dominant culture of putting patients first. Through focus groups, we learned that while both managers and patient care workers were aware of safety and health risks within their work environments and health behaviors, patient care work took precedence. We found no significant differences in the outcomes between intervention and control units for pain, fruit/vegetable servings per day, sugary drinks per day, total weekly physical activity, or sleep deficiency.

Second, we collaborated with Partners HealthCare to evaluate a hospital-wide safe patient handling and mobilization program that engaged multiple departments with upper management support,[2] and compared results with a non-intervention hospital. We observed changes in all injury types and causes, particularly those related to lifting and exertion. During the same time period, there were no changes in these injury rates at the non-intervention hospital. An important part of this

program's success was the hospital leadership's commitment. Both upper- and middle-level managers created the appropriate climate, supported workforce development, and provided the resources needed for all aspects of this comprehensive program. Because of the high-level support for the program, communications and other efforts across departments were well coordinated. These results support the idea that activities and responsibilities for protecting workers' health and safety as well as patient safety must be shared and integrated over all aspects of the organization.

Taken together, findings from the two intervention studies point to the need for embedding unit-level efforts into system-wide initiatives that respond to conditions of work.

Aim 2: Observational studies: Determinants of health and wellness outcomes among hospital workers.

In parallel to our intervention studies, we pursued a second aim to determine the factors in the work environment that contribute to reductions in MSD symptoms and improvements in safe and healthy behaviors over time. Following our conceptual model and using data from three surveys of patient care workers along with an integrated administrative database coordinated by Partners HealthCare, we explored relationships among conditions of work, worker health and safety behaviors, and health outcomes. Research completed for this Aim illustrates the pathways specified in the conceptual model, summarized in **Figure 1** (see Section 2), focusing particular attention on the relationships of the conditions of work to worker health-related behaviors, MSD symptoms, and occupational injury.

Translation of Findings: These findings have significant implications for prevention of work-related illness and injury, as illustrated by the following examples:

- Effective integration of patient care improvement with a safe patient handling program in an acute care hospital can reduce injuries among workers; there is a significant need for strong leadership commitment and support and a cross-organizational infrastructure to implement a model approach that integrates improvements in patient care and safe patient handling.[2]
- Addressing working conditions that are common determinants of both pain and health and safety behaviors could positively impact both outcomes, improving worker health overall. We identified the health impact of exposures in the work organization, demonstrating the important role of factors such as supervisor support, harassment on the job, job flexibility, and job demands.[3-10]
- Patient-care worker injury rates can be reduced by stronger people-oriented culture and supervisor support.[5]
- There is a need for continued emphasis on preventing back and sharps injuries and reducing risks faced by aides in the hospital setting. Uniform injury definitions and work time measures can help benchmark safety performance and focus prevention efforts.[11]
- The medical costs of occupational injuries paid by employers include substantially more than just the workers' compensation medical costs. As a consequence, when considering their occupational injury costs in making prevention decisions, these extra group medical costs should be counted.[12]
- Better safety leadership, greater safety diligence, better ergonomic practices, stronger people-oriented culture, and higher social support from coworkers are organizational policies and practices that can be used to improve workplace injury rates among nurses in acute-care settings.[13]
- Exposure to workplace abuse may be a risk factor for injuries among hospital workers. The association between workplace verbal abuse and higher risk of injury was particularly pronounced when patients or their families perpetrated the abuse. Interventions to reduce the prevalence of this type of workplace abuse may benefit both the worker, in terms of decreased injury, and the employer, in terms of potentially decreased costs associated with worker injury.[10]
- Safe patient handling, ergonomics, and safety practices are good targets for worker safety and wellness interventions; longer intervention periods may reduce the risk of MSDs. Linking the intervention to hospital priorities, such as safe patient handling, may improve feasibility of the intervention.[1, 2, 6]

- Administrative data on occupation injuries may systematically underestimate injury rates among racial minority healthcare workers, potentially obscuring disparities in injury rates. Employers and researchers need to put into place mechanisms to address the underlying reasons for the differences in reporting and use parallel methods to measure injury rates while working to shrink the disparity in injury rates.[14]
- Employer policies that support schedule control by nursing employees may be associated with lower psychological distress, a factor in mental illness in workers.[15]
- Consistent meal breaks might be daily opportunities to promote mental health and fatigue recovery.[7]

Research Outcomes / Impact: Findings from this research have been used by Partners to integrate traditional occupational health services with employee health promotion within Partners Healthcare. This provides a model approach for other organizations. The database, including survey and administrative data, is a product of our unique partnership with Partners HealthCare. It links employees' administrative records on outcomes such as injury with their survey responses, permitting unique analyses, and offers a model tool for other organizations. We have summarized outcomes and impact in the Outcomes and Outputs section.

SECTION 2

Procedures and Methodology: We describe our study methods by aim:

Aim 1: We conducted two studies as part of this aim. First, we conducted a proof-of-concept trial to estimate the efficacy and determine the feasibility of an integrated intervention, addressing both health protection and health promotion in order to reduce MSD symptoms and improve health behaviors among health care workers (Aim 1).[1] Eight in-patient care units from one hospital were randomly assigned to intervention (4 units, 245 workers) and control (4 units, 237 workers) groups. The 12-month unit-level intervention included consultation for nurse managers to implement changes on patient care units and educational programming (in the form of a series of intervention events on the unit) for patient care staff to facilitate improvements in safety and health behaviors. The outcome targets were physical activity, sleep deficiency, diet, and pain. We used process evaluation and qualitative data to assess intervention delivery, and used survey data to assess between-group differences in the intervention outcomes.

Second, we collaborated with Partners HealthCare to evaluate a hospital-wide safe patient handling and mobilization program that engaged multiple departments with upper management support.[2] Only one of the two hospitals in our study received this intervention, providing us with a strong concurrent control group as well as pre/post data on injuries at each hospital. Our 2012 and 2014 patient care worker surveys were timed to compare worker self-reported outcomes before and after the intervention. This eight-month intervention consisted of introduction and enforcement of a hospital-wide safe patient handling policy, hospital-wide communications and mandatory training endorsed by upper management, and coordination of efforts across departments. We compared changes in worker injuries (measured by the occupational health database) and worker proximal outcomes (measured by our survey) to the non-intervention hospital.

Aim 2: In parallel to our intervention study, we pursued a second aim to determine the factors in the work environment that contribute to reductions in MSD symptoms and improvements in safe and healthy behaviors over time. Following our conceptual model and using data from three surveys of patient care workers along with an integrated administrative database coordinated by Partners HealthCare, we explored relationships among conditions of work, worker health and safety behaviors, and health outcomes. The database is a product of our unique partnership with Partners HealthCare. It links employees' administrative records on outcomes such as injury with their survey responses, permitting unique analyses.

Results

Aim 1. Intervention Research.

Intervention #1: TWH proof-of-concept trial.[1] Using process tracking and qualitative data, we observed challenges to implementing the intervention due to physical demands, time constraints, and psychological strains of patient care. For example, while 73% of workers attended the kickoff event, average time spent at the event was six minutes; most events were attended by approximately 50% of workers. The relatively low level of exposure to the intervention was attributed to challenges of providing around-the-clock care, physically demanding work, and a dominant culture of putting patients first. Through focus groups, we learned that while both managers and patient care workers were aware of safety and health risks within their work environments and health behaviors, patient care work took precedence; nurse managers restricted their units' intervention activities to one per shift per month. This limited workers' exposure to the intervention. Using survey data, we found no significant differences in the outcomes between intervention and control units for pain (p=0.271), fruit/vegetable servings per day (p=0.456), sugary drinks per day (p=0.254), total weekly physical activity (p=0.364), or sleep deficiency (p=0.734). We also did not find differences in the proximal outcomes of ergonomic practices (p=0.237), supervisor support (p=0.584), or meal break frequency (p=0.358). Given workers' limited exposure to the intervention, this was not surprising.

Intervention #2: Evaluation of a safe-patient-handling initiative.[2] The intervention produced statistically significant increases in workers' self-reported safe patient handling practices (mean difference=0.35, 95% CI: 0.27, 0.43), decreases in unsafe patient handling (mean difference=-0.11, 95% CI: -0.18, -0.04), and improvements in ergonomic practices (mean difference=0.08, 95% CI: 0.00, 0.15). The comparison hospital showed no changes in these measures. The intervention also produced changes in worker injuries, comparing the 12 months before the program to the 12 months after the program. We observed changes in all injury types and causes, although not all changes reached statistical significance. Specifically, injuries to the neck and shoulder were significantly decreased (RR 0.68, 95% CI: 0.46, 1.00), as were injuries related to lifting and exertion (RR 0.73, 95% CI: 0.60, 0.89) and injuries consisting of pain or inflammation (RR 0.78, 95% CI: 0.60, 0.89). During this time period, there were no changes in these injury rates at the non-intervention hospital.

Aim 2: Observational studies: Determinants of health and wellness outcomes among hospital workers

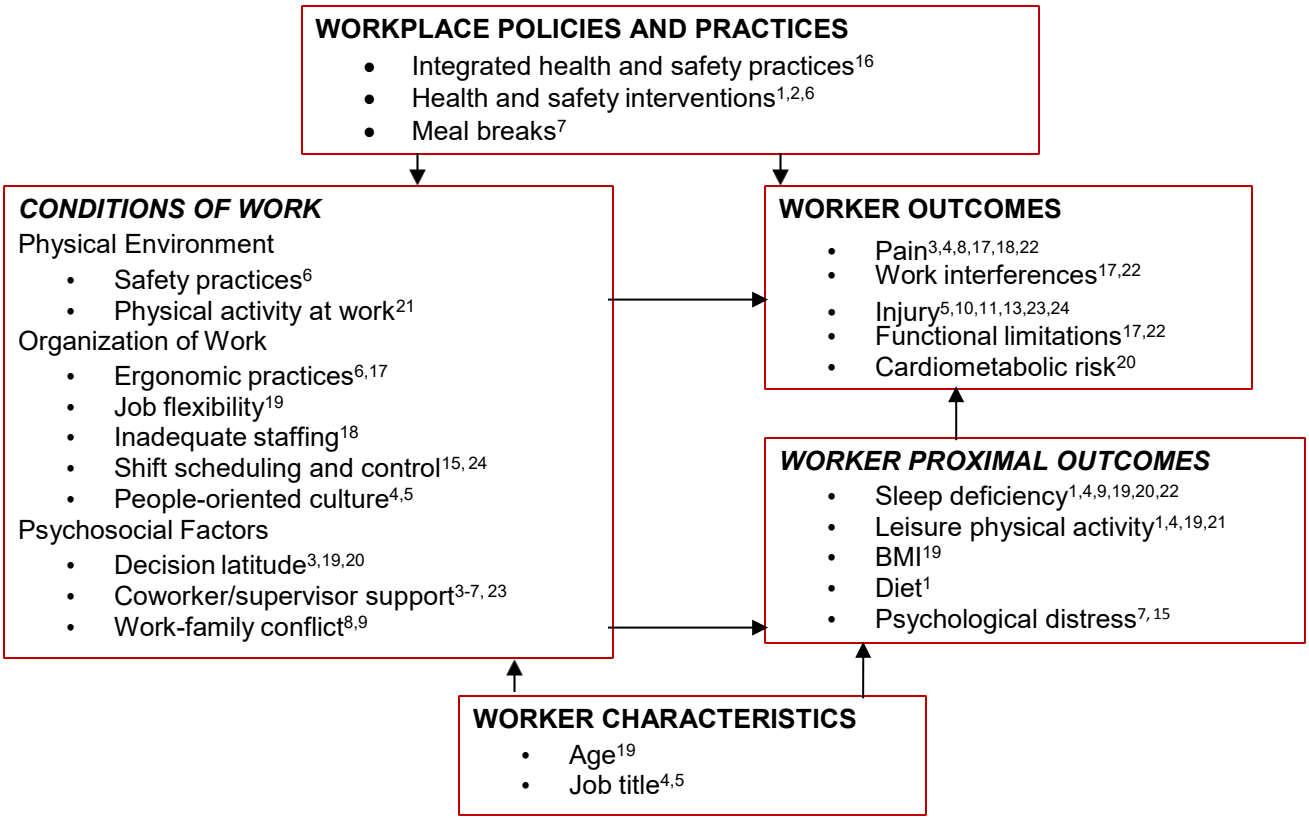
Research completed for this Aim illustrates the pathways specified in the conceptual model (**Figure 1)**, focusing particular attention on the relationships of the conditions of work to certain worker health-related behaviors, MSD symptoms, and occupational injury.[16] In studying determinants of worker health and safety outcomes, *five cross-cutting findings* emerged from the body of work we produced during the last project period. These findings have direct implications for occupational epidemiology and TWH in a hospital setting, particularly for researchers who are intervening to improve health endpoints.

1. **Injury, musculoskeletal pain, and health behaviors share diverse determinants within the work environment and vary by socioeconomic status of workers.** Guided by our conceptual model, we identified many simultaneous pathways to injury and pain outcomes, to social disparities in those outcomes, and to shared determinants of injury, pain, and health behaviors.

Injury: Injury, particularly musculoskeletal injury, was a primary outcome of interest. We found heterogeneity of injury rates by both structural and social factors within units. Structurally, we documented disparities in injury rates between nurses and aides,[5, 11] with aides more likely to have injuries that required days away (RR 1.57, 95% CI: 1.27, 1.95) and no days away (RR 1.74, 95% CI: 1.37, 2.20). We also documented differences in injury rates by unit, with higher rates in the operating room and emergency department, and lower rates in stepdown and pediatric settings.[11] We also found that several dimensions of the psychosocial work environment were associated with injury risk.

Those determinants include workplace harassment (both on an individual and unit level),[10] organizational policies and practices,[5, 13] and supervisor support.[13]

Figure 1: Center conceptual model highlighting our contribution to understanding of pathways between working conditions, health behaviors, and worker health outcomes



Pain: We also identified determinants of musculoskeletal pain. As musculoskeletal pain in general and lower back pain in particular are major health concerns in the health care industry, our work substantially advanced knowledge in this area. *Worker perceptions* of the overall work environment—particularly poor perceptions of organizational practices to reduce ergonomic strain[17] and perceived staffing inadequacy[18]—were associated with increased risk of pain. Cross-domain exposures, such as work-family conflict, were associated with increased musculoskeletal pain.[8] Our findings suggest that although ergonomic factors are most often targeted in interventions to reduce pain, psychosocial and work organizational factors also need to be considered when conducting ergonomic assessments and modifying workplace policies and practices.[3]

Common Pathways to Health Behaviors, Pain, and Injury: We identified several common determinants of health behaviors and musculoskeletal pain and injury. For example, we demonstrated that poor coworker support was associated both with back pain ($p<0.05$) and with inadequate physical activity ($p<0.0001$).[4] In the same study, we found that workplace policies and practices such as people-oriented culture, ergonomic practices, and safety practices jointly predicted lower back pain, sleep deficiency, and to a lesser extent, physical activity. These findings are key indicators of the importance of a Total Worker Health® (TWH) approach and suggest that addressing working

conditions that are common determinants of both pain and behaviors could positively impact both outcomes, improving worker health overall.

2. **The psychosocial work environment shapes safety and health behaviors and health outcomes.** In the last project period, we focused extensively on different dimensions of the psychosocial work environment and their physical and mental health consequences in acute care settings.

Supervisor Support: Supervisor support predicted many health outcomes.[3-7] We found lower injury rates in units where workers reported better supervisor support and more favorable organizational policies and practices.[13] We also found that supervisors who reported being supportive of the meal breaks for workers on their unit were more likely to have nurses on their units actually take meal breaks. In turn, nurses who took frequent meal breaks reported lower psychological distress.[7]

Work-family Conflict and Job Flexibility: Higher levels of work-family conflict were significantly associated with sleep deficiency in the short term and nearly two years later.[9] As discussed above, work-family conflict was associated with multiple types of musculoskeletal pain, even after adjusting for physical and psychosocial work characteristics.[8]

Harassment at Work: Being sworn at, screamed at, and receiving hostile or offensive gestures from patients, coworkers, or supervisors was associated with increased risk of chronic injury; an environment of harassment on the unit was associated with increased injury risk, even if workers themselves were not harassed.[10] Harassed workers were also more likely to be obese and have low levels of physical activity.[4, 19]

Decision Latitude and Job Demands: We studied the contribution of decision latitude, control, and their combination to occupational health endpoints, and found that higher job demands were associated with inadequate physical activity[4] and musculoskeletal pain,[3] that low decision latitude was associated with obesity,[19] and that job strain was associated with sleep deficiency and cardiometabolic risk.[20]

3. **Health behaviors are partially rooted in conditions of work, suggesting that conditions of work should be addressed if health behaviors are to improve.** We found that although patient care work is physically demanding and overall is an active job, physical activity at work in fact contributed little to workers' total weekly amounts of physical activity. When we asked workers to self-report weekly physical activity and compared those self-reports to accelerometers worn during the same period, we observed a stark disparity. Workers reported 206 minutes of moderate activity at work over a seven-day period, but accelerometers recorded only 30 minutes of moderate activity during the same period.[21] This study suggests that patient care workers could benefit from interventions to improve physical activity, but that such interventions need to be tailored to the fatiguing—although not aerobic—nature of the work. We also found that inadequate physical activity and obesity co-vary with adverse psychosocial exposures in the work environment[19]—workers who were harassed or abused at work were more likely to be obese (OR 1.62, 95% CI: 1.20, 2.18), and workers with low decision latitude and low job flexibility were less likely to meet guidelines for adequate physical activity (p=0.001 and p=0.029, respectively).

We found especially strong evidence that sleep and sleep inadequacy were predicted by adverse conditions of work.[4, 9, 19, 20, 22] For example, sleep deficiency was associated with nearly all psychosocial exposures we examined—support from coworkers (p=0.003), support from supervisors (p=0.0002), harassment at work (p=0.0008), demands (p=0.008), and decision latitude (p=0.005). Simultaneously, broader policies and practices within the work environment also predicted sleep deficiency, including people-oriented culture (p=0.02), ergonomic practices (p<0.0001), and safety practices (p=0.0004).[4]

4. **Administrative data, both on its own and in combination with self-report data, can produce robust TWH-relevant conclusions that are not possible with self-report data alone.** We made major headway in establishing an administrative database, in integrating administrative datasets with each other, and in merging database and survey data at the worker and unit levels. In

studies using the administrative data only, with links across the injury dataset and the payroll dataset, we found substantially different injury rates between aides and nurses, highlighting the importance of intervention strategies that take into account structural factors as well as individual risk factors and behaviors in the work environment.[11] We also found gaps in injury-reporting pathways that could lead to underestimates of injury when relying solely on administrative data.[23] In a study linking the human resources dataset, the staffing dataset, and the injury dataset, we found that both consecutive and cumulative shifts were linked with increased injury risk.[24]

For studies combining injury data with self-report data,[10, 13] we were able to overcome the common-method bias that often occurs in occupational studies when exposures and outcomes are both self-reported. Given the promise of the database for understanding core questions about relationships between work environment and worker health, we have opted to develop that portion of the project in the next project period so that we can focus on enhancing and expanding the database for longitudinal analyses.

5. **The workgroup is a key unit of analysis and intervention.** We leveraged the natural clustering of workers within units; the units are both administrative entities and also have different "microclimates" that, we learned, can produce profound differences in worker health and health behavior.

In some studies, we created compositional measures of exposures at the unit level and used them to predict individual-level outcomes. In these studies, we found, for example, that mean perceived staffing adequacy across a unit was associated with an individual worker's risk of musculoskeletal pain, particularly back pain (OR 1.50, 95% CI: 1.06, 2.14), even after adjusting for demographic and occupational confounders.[18] We also found that both mean unit-level harassment and individual experiences of harassment were associated with individual-level injury risk.[10] In a third study, we inverted the above procedure by assessing exposure on an individual level and testing its association with unit-level injuries, finding that individual nurses' positive perceptions of ergonomic practices were associated with lower unit rates of injuries resulting in days away from work (RR 0.57, 95% CI: 0.34, 0.96), but the same was not true for lower-wage workers.[13] These studies provide evidence that not only an individual worker's experience, but also the broader experiences of coworkers in the same unit, are associated with one's own health and the health of coworkers—a powerful indicator that unit-level changes in working conditions may be needed in order to reap individual-level benefits.

We also conducted two studies that tested the impact of coworkers' and supervisors' assessments of the work environment and their impact on workers' own health outcomes. In one study, we found that coworkers' reports of greater schedule control were associated with lower psychological distress among workers (B=-0.10, SE 0.03, $p<0.05$), but that in the same models, workers' own perceptions of schedule control were not associated with distress (B=0.01, SE 0.04, $p>0.05$).[15] In a second study, we found that nurse managers' support for meal breaks predicted whether nurses they supervised would actually take meal breaks.[7] These studies further demonstrated the scientific benefit of moving beyond the individual worker to assess exposure.

Discussion and Conclusion: These intervention research findings have implications for future interventions with direct patient care workers. Interventions to protect and promote worker health must be designed around an understanding of the conditions of work. The pressing demands of patient care, combined with a cultural commitment to putting the interests of the patient before those of the worker, create a high-pressure environment, challenging both emotional resilience and physical stamina. Building a supportive work environment in the face of these demands requires organization-level commitment. System-wide norms and infrastructure supports can then be translated to the unit level. Also, based on our findings, we conclude that unit-based interventions within a supportive infrastructure may need to focus on a few selected outcomes. Targeting multiple health and safety behaviors in this intervention resulted in a somewhat diffuse effect, limiting the depth of exposure around any single intervention target. Given the complexity of the job demands, simple intervention messages that address fewer intervention targets may be needed, and attention to job stress and

building resiliency may be important for policies and practices as well as for programs for individual workers. Finally, unit-level approaches may be suboptimal, especially if only a few units receive the intervention.

Our second intervention study underscored these conclusions. An important part of this program's success was the hospital leadership's commitment. Both upper- and middle-level managers created the appropriate climate, supported workforce development, and provided the resources needed for all aspects of this comprehensive program. Because of the high-level support for the program, communications and efforts across departments were well coordinated. One example was providing workers with the time and support to be off their unit during work time to participate in training. In addition, the management commitment provided the resources to invest in mechanical lifts and slings throughout the hospital, a necessary component of such programs. These mechanical lifts are essential in reducing the physical load on the spine. Training workers different manual lifting techniques without using mechanical devices did little in reducing the physical load of the spine and, hence, reducing injury rates. The program also provided a combination of training formats and tools. These results support the idea that activities and responsibilities for protecting workers' health and safety as well as patient safety must be shared and integrated over all aspects of the organization. Taken together across these two studies, these findings point to the need for embedding unit-level efforts into system-wide initiatives that respond to conditions of work.

These findings were further supported by our observational studies. We conclude from this research that a multifactorial approach is critical to integrated interventions. These findings highlight the importance of intervention strategies that take account of the work context as well as individual risk factors and behaviors in the work environment. By conducting in-depth analyses of a variety of psychosocial exposures, we drew attention to the health impact of exposures such as supervisor support, which has received less attention than more commonly assessed exposures such as job strain.

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PROJECT B: Intervention Research: Integrated Approaches to Health and Safety in Dynamic Construction Work Environment. PI: Jack Dennerlein

SECTION 1

Background and Specific Aims

In 2011, the Harvard T.H. Chan School of Public Health Center for Work Health and Well-being was funded for five years to develop and evaluate an integrated and comprehensive worksite-based program for Total Worker Health ® (TWH) targeting musculoskeletal disorders (MSDs), physical activity, and tobacco use.

Construction workers have a high prevalence of both musculoskeletal disorders and high-risk health behaviors (e.g. tobacco use);[1-5] however, comprehensive worksite musculoskeletal injury prevention, much less integrated health protection and health promotion, do not exist for these workers due to the highly dynamic and variable nature of the construction industry. Our long-term goal is to determine what worksite programs, based within the worksite's lead contractor (i.e. general contractor or construction management company), improve the health and safety of construction workers given the complex organizational structure and dynamic nature of construction.

Our two aims were to:

1) Develop an integrated worksite-based, multi-component musculoskeletal disorder (soft tissue injury) prevention and health promotion intervention for workers in commercial construction.
2) Complete a feasibility study of the developed worksite-based intervention on 10 sites, randomly assigned to either intervention (five sites) or control (five sites).

Significant Findings

The significant findings for the project are illustrated in its major accomplishments, which were:

- Successful *development of a general contractor-based, integrated program* targeting soft tissue injuries, tobacco use, and diet within the context of "energy balance."
  - Its two components included an Ergonomics Program based on the industry's own safety programs and a Health Week, which was based on the industry's practice of safety weeks.
  - We learned that the occupational physical activity of construction workers greatly surpasses the recommended weekly minutes of moderate activity and changed our intervention target from physical activity to diet with a focus on energy balance, balancing diet with physical demands.
- Successful *completion of an evaluation of the program* on 10 construction sites; five received the program activities and the other five served as control sites for comparison.
  - Through analysis of baseline worker surveys, we observed that a *range of worker safety and health outcomes share common factors*, supporting application of the Center's conceptual model to the construction industry.
  - The program successfully *reduced the incidence of new low back pain* in the past 12 months for workers on the treatment/intervention sites compared to workers on the control sights
  - Workers on the intervention sites significantly *improved their intake of fruits and vegetables as well as increased their leisure time physical activity* compared to workers on the control sites
  - No significant changes were observed in the measures of the conditions of work.
- *Expansion of the knowledge-base of work organization in the construction industry* for health and safety research and program implementation.
  - We *further built our successful partnerships* with construction companies.
  - We gained new knowledge on how to navigate construction sites, including the flow of communication and day-to-day activities.

- We *discovered the importance of the subcontractor* in program implementation.
  - We previously hypothesized that the general contractor had more control over the specific physical working conditions; however, many *ergonomic solutions require the trade-specific involvement of the subcontractors*.
  - Subcontractors are the *primary employer for workers*. Core teams based on work tasks at construction sites originate with subcontractors for commercial construction.

Translation of Findings

These findings have informed much of the Center's current work in translation and dissemination. First, the findings have been incorporated into the development of our implementation guidelines. Specifically, the new guidelines currently under development include assessing the needs of a multiemployer site. Second, these finding have been translated into our current research, developing integrated approaches for sub-contractors to complement the worksite based programs. Furthermore, our current work aims to combine the findings from this work with worksite based approaches from the subcontractor companies to come up with recommendations and industry specific guidelines for integrated approaches for construction workers.

Research Outcomes/Impact

Aligned with the Center's overall aim of *expanded scientific evidence* through publications and presentations as well as potential practice resources, we have several outputs from the last project period. These outputs include but are not limited to seven peer-reviewed manuscripts with five more in preparation. 29 presentations at scientific conferences, and a worksite intervention program, ARM, which was tested at five worksites.

The outcomes of this research is increased knowledge of worksite organization of construction companies that influence the health and safety of workers as well as methods to impact the health and safety of these workers through these organizations.

The impact of this knowledge is the development and application of tested and evidence based practices on worker health and safety in the dynamic commercial construction industry.

SECTION 2

Procedures and Methodology

For Aim 1, we developed a worksite based intervention, called All the Right Moves (ARM) through an iterative vetting process the started with a literature search, then key informative interviews, focus groups, and then a dry run of the program. The goal of the program was based on the Center's common conceptual model, which was to change working conditions surrounding work-related MSD risk factors and participation in health promotion activities. ARM's approach was to augment existing programs and practices on worksites to include MSD hazard reduction (ergonomics) and health behaviors surrounding diet and tobacco use. The existing pre-task planning process provided an effective method to reduce hazards before work begins.[4, 5] The program adapted existing practices to include soft tissue injury (MSD) hazard reduction and ergonomic solutions. In addition, the program developed the integrated message of "Fit for work and life" through planning for both work and health, at home as well as at work. The existing practice of safety inspections provided the opportunity to include soft tissue injury risk factors and assess the use of ergonomic solutions. The existing practice of safety weeks among general contractors provided an opportunity to expand existing health and safety messages to include the soft tissue injury (ergonomics) program, tobacco use cessation, and energy balance through diet.

For Aim 2, we completed a cluster randomized controlled trial on 10 construction sites in the Boston Metropolitan Area. Sites were block randomized to intervention or reference by general contractor (GC) pairs (5 pairs). That is after a general contractor agreed to participate, we identified and recruited two concurrent worksites. These two sites were then randomized for either the control or intervention treatments.

The intervention worksites received a program consisting of a six-week ergonomics program followed by a five-day Health Week. The ergonomics program introduced simple ergonomic improvements to construction work practices used in accomplishing daily tasks. The ergonomics program trained both foreman and workers on simple ergonomic solutions for construction and implemented task pre-planning procedure that generated solution for avoiding soft tissue injury hazards. To inform the pre-task planning, program coordinators established and implemented protocols for worksite inspections and communicating hazards and proposed solutions on these worksites. This was followed by a five-day Health Week that included on-site health education and encouraged workers to participate in free health coaching to change health behaviors. Monday's message was about making plans for improving health through health coaching, Tuesday's was about completing task preplans and ergonomic simple solutions. Wednesday's was about diet and energy balance, Thursday's was about tobacco cessation. Friday's messages returned to health coaching. Workers who were interested in health coaching were provided with four free telephone coaching sessions from our collaborators at HealthPartners. The control sites received no program; however, research coordinators were on sites for data collection.

All construction workers at the worksites were deemed eligible for the study. For both intervention and control sites, we collected baseline surveys during concurrent periods for the GC pairs. After the six-week intervention, workers completed follow-up surveys measuring changes in the conditions of work during the program. Six months after that follow-up survey, we fielded another survey to evaluate worker health and health behavioral outcomes.

Hypothesis 1: Workers on intervention sites will report improved changes in ergonomic and safety practices compared to workers on control sites at follow up. Hypothesis 2a: Workers on intervention sites will report less new pain and improved work limitations at follow up compared to workers on the control sites. Hypothesis 2b: Workers on intervention sites will report improved diet and leisure time physical activity behaviors than compared to workers on the control sites. The dependent variables were the changes in variables collected from the surveys. For categorical variables, changes were denoted as either improving, staying the same, or getting worse. Linear regression models tested the differences between the control and reference sites adjusting for race, education, and jobsite correlation.

Results

For Aim 1: A *major product* of the last project period was the integrated worksite-based ergonomics and health promotion program called *All the Right Moves Program (ARM)* (**Table 1**). Based on the Center's common conceptual model,[6] the goal of ARM was to change working conditions surrounding work-related MSD risk factors and participation in health promotion activities.[7, 8] ARM's approach was to augment existing programs and practices on worksites to include MSD hazard reduction (ergonomics) and health behaviors surrounding diet and tobacco use. The existing pre-task planning process provided an effective method to reduce hazards before work begins.[9, 10] The program adapted existing practices to include soft tissue injury (MSD) hazard reduction and ergonomic solutions. In addition, the program developed the integrated message of "Fit for work and life" through planning for both work and health, at home as well as at work. The existing practice of safety inspections provided the opportunity to include soft tissue injury risk factors and assess the use of ergonomic solutions.[11, 12] The existing practice of safety weeks among general contractors provided an opportunity to expand existing health and safety messages to include the soft tissue injury (ergonomics) program, tobacco use cessation, and energy balance through diet.

Table 1: All the Right Moves (ARM), construction worksite-based program components

Ergonomics Program	Health Week	Worker Follow Up	Training
Pre Task-planning • Checklist for the Ergo 4, Ergo Simple Solutions • Database of solutions Inspections • Soft Tissue Injury Hazards & Ergonomic Solutions • Weekly reports to foremen and workers • Web-based hazard and solutions inspection tool	Monday What is health coaching Tuesday Ergonomics Program Wednesday Tobacco cessation CO measurements Thursday Food and Activity Friday Health Coaching sign up	Health Coaching • 4 sessions • No cost to worker • Diet, Tobacco Tobacco cessation referral • Nicotine Replacement Therapy • Online Resources • 1-800 QUIT NOW	Supervisor Training • Ergonomic simple solutions, Adding Ergo to pre-task planning • Weekly meeting with foreman Worker training • Toolbox talk on ergo and health (and Health Week)

For Aim 2: There were no statistically significant differences in workers surveyed on the control and intervention sites in terms of age, BMI, race, education, and job title. No differences between intervention and reference sites were observed in the conditions of work between baseline and follow up 1 (Table 1).[13]

Table 1: Effects of intervention on changes in working conditions from baseline to follow-up 1

Outcome Measure (units)	N	B-Coefficient (95% CI)	P-Value
3 item ergonomics scale	215	0.09 (-0.05, 0.23)	0.1782
Physically demanding work	200	0.11 (-0.12, 0.33)	0.3080

In contrast, changes in 12-month pain, physical activity, and diet improved significantly on the intervention sites compared to reference sites at the 6 month follow up (Table 2). The number of tobacco users who completed follow up surveys was small, with only two workers, meeting the definition for smoking cessation, one on an intervention worksite and one on a control site.

Table 2: Effects of intervention on changes in worker health from baseline to follow-up 2			
Outcome Measure (units)	N	B-Coefficient (95% CI)	P-Value
Recreational physical activity (minutes/day)	**93**	**39.24 (16.46, 62.02)**	**0.0036**
Healthy diet	**114**	**0.92 (0.02, 1.80)**	**0.0459**
Unhealthy diet	113	-0.25 (-0.78, 0.27)	0.3649
Dietary balance	**113**	**1.20 (0.04, 2.36)**	**0.0440**
:			
Categorical outcome variables	N	OR (95% CI)	P-Value
12-month pain (increase compared to no change)	**111**	**0.33 (0.15, 0.72)**	**0.0113**
12-month pain (decrease compared to no change)	111	0.78 (0.27, 2.23)	0.6052

The qualitative data collection indicated that while health week was successful in engaging workers and foremen, the implementation of the ergonomics program did not change work practices. Two key barriers identified: the subcontractors' capability to implement ergonomic solutions and the site supervisors' and project managers' buy-in and management support.[14]

Discussion and Conclusions

We successfully built and tested an effective general contractor-based, integrated program targeting soft tissue injuries, tobacco use, and diet within the context of energy balance. Its two components included an Ergonomics Program based on the industry's own safety programs and a Health Week, which was based on the industry's practice of safety weeks. Through the cluster randomized controlled trial, program successfully reduced the incidence of new low back pain in the past 12 months for workers on the treatment/intervention sites compared to workers on the control sights. In addition, workers on the intervention sites significantly improved their intake of fruits and vegetables as well as increased their leisure time physical activity compared to workers on the control sites. We observed no changes in the conditions of work that were measured indicating these effects had other causal pathways.

Additionally, we gained new knowledge on the flow of communication within and between work units, which enhanced our ability to navigate the worksite. For example, we learned that despite the different project phases, sizes, and scopes, there is a core set of practices that occur almost daily on most sites, and therefore can be easily incorporated into a program such as ARM and/or into the program evaluation. These include new worker safety orientations, safety stand- downs,[15] stretch-and-flex, and pre-task planning. We also learned about the intricacies of the construction site hierarchy, which helped us to communicate efficiently and effectively with all personnel on-site. The amount of communication and the structure varied from site to site, with emphasis on different factors.

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PROJECT C: Knowledge Transfer Project: SafeWell: Education and Dissemination to Promote Integrated Approaches to Worker Health in Small- to Medium-sized Businesses. PI: Deborah McLellan

SECTION 1

Background and Specific Aims

Translating evidence-based interventions into practice is critical to achieving NIOSH's goals of improving and protecting worker health and quality of life. Research demonstrates that an integrated approach to keeping workers healthy, by implementing policies, programs and practices focusing on working conditions, results in both improved worker health outcomes, as well as improved employer outcomes, including overall market performance.[1-5]

Based on a synthesis of existing evidence, the Institute of Medicine, NIOSH and others have recommended this integrated approach to worker health.[6-9] Dissemination of this approach is complicated by the paucity of practical tools for implementation and assessment—particularly for small and medium-sized businesses (SMB). While some planning guides exist, they are heavily weighted toward *either* worksite health promotion (WHP) or occupational safety and health (OSH), and largely targeted at large employers. As a result, there is a need for new tools to facilitate use of these approaches with particular attention to the needs of SMBs. In addition, successful dissemination efforts will require an in-depth understanding of how and why organizations adopt integrated worker health initiatives, and of their capacity to deliver and sustain such programs. In the absence of tools, these innovations will likely not become standard-of-practice.

In pursuit of this goal, we developed provisional practice guidelines that describe an approach for reaching across the traditional departmental silos of WHP, OSH and human resources (HR).[10] These guidelines provide a recommended sequence of processes, practices, and programs that employers can implement to optimize worker health. *The purpose of this research-to translation project was to test the dissemination of an integrated WHP/OSH approach by understanding the needs and resources of small to medium-sized businesses.* This focus is particularly important because organizations in this size range represent more than 99% of U.S. businesses and employ more than 52% of U.S. workers.[11] Yet most interventions have been developed for and evaluated in large organizations. A focus on SMBs is needed because they face different barriers and generally have fewer resources compared with larger organizations.[12, 13] In particular, SMBs are less likely to offer health programs to their employees; when they do, they are more likely to hire an external provider ("vendor") to deliver these services.[14]

The overall objective of this project was to develop the knowledge, products and processes needed to broadly disseminate the practice guidelines to SMBs through readily accessible channels. Our specific aims were to:

Aim 1-- Identify facilitators and barriers to adoption of integrated approaches among SMBs.

Aim 2--Develop a business case and implementation package to promote adoption of the integrated approach among SMBs.

Aim 3--Assess the feasibility, acceptability, degree of implementation, and preliminary impact of integrated approach delivered by a vendor (HP) among three SMBs.

We successfully completed these aims.

Significant Findings

We assessed facilitators and barriers to implementing TWH approaches. Factors influencing adoption and implementation of TWH approaches included having an organization that was open to making changes to improve worker health, leadership support and organizational capacity (i.e., having resources allocated by leadership including dedicated staff, budgets, and committees).[15, 16] Key barriers to implementation included having little knowledge about TWH approaches and limited staffing and financial resources.[16]

The investigator team used the *SafeWell Practice Guidelines*, to create and adapt marketing and intervention tools for the business case and intervention package. We worked with HealthPartners to develop and present the business case for TWH approaches, which successfully engaged three employers in the pilot program. The intervention approach was adapted from the Center's evidence-based conceptual model and was built upon HealthPartners well-being program. The intervention used four major components: (1) *worksite-wide events* promoting changes in working conditions such as providing environmental supports for ergonomic practices; (2) a *worksite-level intervention including consultation with mid-level and upper management* based on outcomes from assessments conducted, and resulting in forming TWH health and safety teams; (3) a *learning collaborative* that engaged company leaders, including the CEOs from the pilot sites, to share their TWH-related experiences with other executives;[17] and (4) *additional programs* supporting individual changes in targeted health and safety behaviors, including individual health coaching and web-based resources.

As a result of testing this intervention with HealthPartners, we identified factors associated with successful implementation of TWH approaches at the pilot sites including: openness to change and innovation; multi-level management support; allocation of dedicated staff, budgets, and committees; collaborative organizational cultures that prioritize employee health and safety; existing organizational processes that could be leveraged for new approaches; and realistic implementation timelines to account for organizational changes.[18, 19] Vendor staff also clearly pointed to the need for capacity-building supports for employers and vendors, including tactical guidance for changing organizational structures. Main findings from the pilot include that the approach was feasible, acceptable, and meaningful to the pilot companies. While there was variation in the level of implementation among the three sites, all were able to take action on recommendations and document changes in the corporate environment that supported safety, health, and well-being.[20]

Translation of Findings

We found that health and safety vendors can be a successful dissemination channel for TWH approaches. Such vendors are a major resource for providing health and safety services to many organizations and companies. Since this project worked solely with SMBs, who often lack in-house resources to provide these types of programs on their own, the successful adoption and implementation of TWH approaches by the three sites is notable.

We found that a TWH approach utilizing the *SafeWell Guidelines* could successfully be embedded into existing policies, programs, and practices of health and safety vendors, as well as for SMBs. Rather than having to create an entire new process or program, organizations can use their existing ones as a basis for implementing TWH approaches.

Research Outcomes / Impact:

Outputs
The outputs of this project include peer-reviewed scientific papers and presentations at scientific conferences, validated assessment tools for organizations to use, and career development in TWH approaches.

- The project published 9 peer-reviewed papers (listed in the Publications table).
- We conducted 15 presentations at scientific conferences (listed in the Outputs table).
- We validated and tested assessment tools
  - This project validated the Indicators of Integration measure,[21] developed as a Center-wide effort, and adapted it for use as a practice tool: Using the survey of SMBs, we *validated the Indicators of Integration measure*.[22] We further validated the measure in collaboration with the Veterans' Health Administration (VHA).[23]
  - We translated the Center's Indicators of Integration measure into a *scorecard*, making this a useable planning tool for organizations implementing TWH. We found that this measure was easily implemented, and could be customized, priming it for widespread dissemination and use.[23]
  - We also incorporated the Indicators of Integration scorecard into a *set of practical TWH assessment and feedback tools called the Dimensions of Corporate Integration*. It includes assessment of the physical work environment; organizational policies, programs, and practices; and individual health and perceptions of health and safety. With the pilot companies, we demonstrated that these integrated measurement tools were feasible, acceptable, and meaningful to the pilot companies.[20] (Available on the Center's website.[24])
- We used information gathered from this study to develop implementation guidelines that will be available on our website shortly. http://centerforworkhealth.sph.harvard.edu/
- We have provided career development to three post-doctoral fellows, Drs. Alberto Cabán-Martinez, Candace Nelson and Jessica Williams, who had the opportunity to be mentored by the Project C Investigators and collaborate on multiple papers and presentations. The Indicators of Integration Tool has the potential to be used in other companies.

Outcomes
The very essence of this project is based in Research to Practice (R2P), as a key motive was to translate the SafeWell Integrated Practice Guidelines for the vendor community. The fact that HP engaged in this effort is an example of R2P. Through knowledge transfer about integrated approaches, collaboration has blossomed with HP. Practical tools were developed and validated for measuring integrated approaches. The vendor also adapted its programs and is adopting integrated approaches on a pilot basis. Depending on additional outcomes, HP is interested in turning this project into a scalable model for the marketplace.

SECTION 2

Procedures and Methodology

This project had three overall phases that reflected our objective and aims. In the first phase, we collaborated with a not-for-profit health/well-being vendor, HealthPartners Inc (HP), to conduct in-depth qualitative interviews among 20 SMBs to understand factors that influence their decision to adopt an integrated approach. While there are varied definitions of SMBs, we defined them as having fewer than 750 employees.[11, 25-27] In the second phase, we collaborated with HP to develop a business case and implementation plan for our provisional practice guidelines specifically

targeted at SMBs. In the third phase, we worked with Journey Well to conduct a preliminary test of the approach among three SMBs, evaluating the feasibility, acceptability, implementation process, and preliminary impact.

The objective of the first aim was to understand organizational characteristics and factors that might influence organizational decision-making about adopting and implementing an integrated approach. We accomplished this objective by conducting 1) in-depth interviews with representatives from SMBs, and 2) through on-line quantitative surveys designed to understand employers' priorities, concerns, and challenges related to worker health and safety.

To address the second aim, investigators from Harvard and HP created and adapted marketing and intervention tools for the business case and implementation package. We were able to adapt some of HP's marketing tools and overlay integrated concepts onto them. We used the *SafeWell Guidelines* and some of HP's intervention tools to develop an implementation package that HP staff delivered and tested in pilot sites. To build HP capacity to deliver integrated programs, HP staff was trained in an integrated approach. The intervention used four major components: (1) *worksite-wide events* promoting changes in working conditions such as providing environmental supports for ergonomic practices; (2) a *worksite-level intervention including consultation with mid-level and upper management* based on outcomes from assessments conducted, and resulting in forming TWH health and safety teams; (3) a *learning collaborative* that engaged company leaders, including the CEOs from the pilot sites, to share their TWH-related experiences with other executives;[17] and (4) *additional programs* supporting individual changes in targeted health and safety behaviors, including individual health coaching and web-based resources.

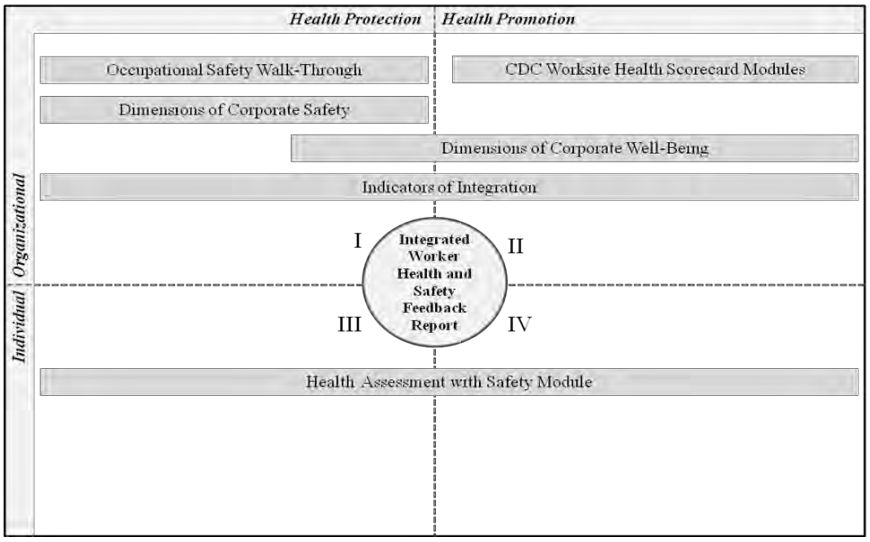
For the third aim, to assess feasibility and acceptability of a vendor-delivered integrated approach at three SMBs, we conducted: six key informant interviews conducted with the vendor and pilot companies; one focus group conducted at each of the three companies with health, safety and wellness staff; and interviews and process tracking data were collected weekly for feasibility, and monthly for acceptability from three pilot site contacts (n=5) over 11 months, and three vendor staff over nine months. This also included tracking the process of implementation and obtaining feedback from staff during the implementation phase and immediately after.

Since this was a dissemination project, we developed a highly practical measurement approach based on a clear conceptual model (see Figure 1 below)[20] that included 1) an organizational-level assessment of health protection/safety, 2) organizational level assessment of health promotion, 3) organizational-level assessment of level of integration, 4) individual-level assessment of health protection/safety, and 5) individual-level assessment of health promotion. Individual-level assessments were derived from worker survey data and include their perceptions and practices related to safety, health, and well-being. These data also include workers' perceptions of organizational-level safety programs, practices, and commitment at the workplace. The organizational assessments are derived from both measurements of safety hazards at the workplace through direct observation, as well as the level of agreement on safety, health, and well-being factors from the informed opinions of a representative group of organizational leaders gathered in a group process. We conducted six different assessments before the project started and after the intervention ended, which are summarized in one of our pulications.[20] Summaries of results were synthesized into integrated worker health and safety feedback reports, and were provided to and discussed with company management

For tracking the implementation process we developed tools and collected information weekly to assess feasibility, and monthly for acceptability from contacts at the 3 pilot sites, and 3 staff from the vendor (HP). We analyzed this information using Excel and a computer program that analyzes

written data. Additionally we conducted six key informant interviews with staff at the vendor and pilot companies, and one focus group at each company with health, safety and wellness staff. These qualitative data were recorded, transcribed and analyzed using a standard qualitative content analysis methods.

Figure 1. Assessments for Total Worker Health™–A Conceptual Model



Results

Understanding factors related to adopting integrated approaches among SMBs: In collaboration with our partners HP, we conducted, transcribed, and analyzed interviews with fifteen informants from SMBs. We found that there was a wide range of knowledge and practice about integrated approaches.[16] Most participants had never heard of these approaches, would need more resources to undertake them, and were interested in learning more about how such approaches might improve employee health and company finances. Most respondents indicated that their company was open to making changes in their approach to worker health; however, cost and staffing considerations were frequently perceived as barriers to action.

The web-based survey was distributed to 400 Human Resource Directors of SMBs (<750 employees). Of these 117 responded (response rate = 29%). With this survey we were able to corroborate some of findings of the interviews discussed above. For instance, respondents reported relatively low implementation levels of integrated approaches. This suggests that SMBs are in the preliminary phases of implementing integrated approaches and that additional dissemination efforts are necessary with SMBs to inform them about the benefits of such approaches for their organizations and workers.

Survey respondents reported that a higher percentage of organizations had leaders who supported occupational safety and health efforts (80%) than for those supporting worker well-being (64%).[15] Notably, those organizations who had leaders who supported worker well-being implemented higher levels of integrated approaches than those that did not. OSH leadership support was not significantly associated with higher levels of implementing integrated approaches.[15] This may be because as most worksites in this study were mandated to have certain OSH activities as a requirement of federal and state regulations, they needed to conduct some level of implementation already. Having

a top leader supportive of worker well-being, however, might indicate interest in implementing integrated approaches and that they have the resources and will to do so.

We also found that organizations that had occupational safety and health committees also had higher levels of implementing integrated approaches compared to those that did not. Such committees can indicate that there is the infrastructure and commitment to assist in implementation efforts of integrated approaches. While top leadership support is important, having the capacity through infrastructure to implement is also critical.

Developing a business case and integrated implementation package: The research collaborator, HP, had existing sales and marketing materials for making the business case to potential clients and to use during its annual contract negotiation process with existing clients. We used these existing processes and materials, and embedded information about integrated approaches into them. Jointly, we approached three clients to participate and all three were recruited to the pilot study; this was a 100% recruitment rate.

To build HP and pilot site capacity to implement integrated approaches, three major trainings occurred. Two of the trainings targeted HP staff that deliver or administer the intervention. The third training brought together the main HP and pilot site staff involved in adopting, administering, and implementing integrated approaches.

The implementation package followed the model laid out in the SafeWell Integrated Practice Guidelines: leadership commitment and employee engagement, planning, implementation, and evaluation. While we used many of HP's existing intervention tools, new ones utilizing the integrated approach had to be developed.

The intervention was delivered over 12 months in three pilot manufacturing sites, and began in January 2014. The intervention used a theme-based approach with four components: (1) site-wide events to promote individual changes in targeted health and safety behaviors and promote co-worker/supervisor support for those behaviors; (2) a site-level intervention with mid-level and upper management based on outcomes from the physical, organizational, and individual assessments; (3) the formation of a health and safety team, consisting of those from occupational safety and health, worksite health promotion, and human resources to work together in an integrated fashion to address site chosen priorities and (4) additional programs supporting individual changes in targeted health and safety behaviors, including telephone health coaching and web-based resource

Feasibility, acceptability, degree of implementation, and preliminary impact of integrated approach delivered by a vendor (HP) among three SMBs. As noted above, we conducted a series of assessments and a year-long intervention described above to assess the feasibility, acceptability, degree of implementation, and preliminary impact of integrated approach delivered by a vendor (HP) among three SMBs.

Some of the *major findings for feasibility and acceptability* include:[18, 19]

- The overall approach and amount of time was feasible for and acceptable to worksites. The companies could incorporate and adapt the program for their worksites and could add it into existing programs and their organization's culture.
- Companies range in their ability to implement integrated approaches, with some needing more guidance and technical assistance than others.
- Thirteen months was too short of a time frame to make organizational level changes. Implementation staff requested more technical assistance and tools for consulting with management on organizational change.

- Sustained leadership support, and dedicated staff time and budgets for implementing integrated approaches may increase feasibility & acceptability.
- Staff turnover and competing priorities can impact feasibility and acceptability.
- Both the vendor and the pilot sites requested that toolkits be developed for them to adapt and use.

Degree of implementation: All three pilot companies conducted an integrated approach at their worksites. Two of the companies were able to implement nearly all of the scheduled activities, as well as some additional ones focusing on management. One of the companies needed more technical support and guidance than the others. This third company conducted about 80% of the individual level activities, but was unable to conduct management level activities.[18] The third company had project staff turnover, underwent a company merger, and lost its original CFO who supported the project. These factors likely contributed to implementation efforts.

Preliminary impact: The assessment and intervention approach outlined in the methodology section above generated documented changes in the physical and psychosocial work environments between baseline and follow-up.[20] All three of the companies experienced positive improvements in the safety environment, and each shifted the distribution of higher level risks to lower level ones between baseline and follow-up.

The assessment of integration showed maintenance of an initially high score over time in one worksite, a large improvement in one company, and a large decline in another due to organizational changes. These changes in organizational assessment scores qualitatively reflect the degree of change achieved in the three companies from baseline to follow-up.

The worksite health scorecard showed an increase over time in environmental resources available for health and well-being. This may suggest that the three companies acted upon baseline assessment results and improved or maintained organizational support systems, resources for physical activity, and nutrition services. Indeed, we found in the employee survey that employees reported health and well-being culture increased across all worksites between baseline and follow-up. Also, tobacco use decreased among employees.

Discussion and Conclusion

Integrated approaches may be successfully embedded into existing policies, programs, and practices at worksites, including SMBs. Vendors are able to deliver integrated approaches that results in meaningful change to worksites. Tools and resources that assist with delivering the business case for, and measurement and implementation of, integrated approaches are important adjuncts for vendors and organizations to use. Providing training and technical assistance for vendors and interested worksites aid in implementation and dissemination efforts.

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Pilot Projects

Pilot Project Abstract Listing:

1. **National Worker Health Survey: Organizational Characteristics Associated with Integrated Worker Health Initiatives**. PI and Lead Investigators: Jennifer Allen and Nico Pronk

2. **Physical Activity among Commercial Construction Workers**. PI: Jack Dennerlein, Lead Investigator: Oscar Arias

3. **Determining Effective Strategies for Integrated Health Promotion and Health Protection Programs in Small- to Medium-Sized Subcontractors.** PI: Jack Dennerlein, Lead Investigators: Emily Sparer, Michael Grant

4. **Feasibility of Integrating Worker Health Insurance (Med/Truven) and Occupational Health Data**. PI: Dean Hashimoto, Lead Investigator: Karen Hopcia

5. **Integration of Healthcare Worker Health Insurance Information (Medstat) with Occupational Health data (iVos).** PI: Dean Hashimoto, Lead Investigator: Karen Hopcia

6. **Standing Up Against Sedentary Behavior.** PI: Jack Dennerlein, Lead Investigator: Dinesh John

7. **Simulation Modeling of Construction Workers.** PI: Jack Dennerlein, Lead Investigator: Justin Manjourides

8. **Establishing relationships between work organization, worker behaviors, and productivity indicators in smaller manufacturing companies.** PI: Nico Pronk/Deborah McLellan, Lead Investigator I: Nico Pronk/Abigail Katz

9. **Enhancing an Integrated Intervention for Patient Care Workers: Program Implementation and Evaluation.** PI and Lead Investigator: Glorian Sorensen

10. **SafeWell Implementation Package: Designing Tools and Training for Dissemination**. PI and Lead Investigator: Glorian Sorensen

11. **Employee Wellness in Nursing Homes**. PI: Glorian Sorensen, Lead Investigator: Cassandra Okechukwu

12. **Epidemiologic Investigation of Mental Health among Construction Workers**. PI: Jack Dennerlein, Lead Investigator: Silje Reme

Organizational Characteristics Associated with Integrated Worker Health Initiatives
Co-PI's: Jennifer Allen and Nico Pronk

Background and Specific Aims

Successful dissemination of worker health programs, including those that address both health promotion (HP) and occupational health and safety (OSH), will require an in-depth understanding of how and why organizations adopt these initiatives, and whether they have the capacity to deliver and sustain them. This study was designed in collaboration with other work in Project C, which was gathering formative data on organizational readiness to adopt integrated approaches among small-to-medium sized businesses (SMBs) through key informant interviews. This study was designed to inform plans for a workplace survey, which was expected to include additional items to assess the existence of integrated HP and OSH programs, as well as organizational factors that are associated with HP/OSH program adoption and/or readiness to adopt these initiatives. The aim of this study was to conduct a systematic review of the literature that would inform the development of a survey, to be conducted as part of Project C. This survey would be designed to document:(1) prevalence of comprehensive and/or 'integrated' HP/OSH initiatives; and (2) organizational characteristics associated with adoption (or readiness to adopt) this innovative approach.

Significant Findings

Nico Pronk and Jennifer Allen initiated a review of the literature, following the stated aims. The aims of the paper were expanded, such that the work was expanded to be placed in the context of implementation science. This pilot resulted in a publication of a paper identifying and describing measures of constructs relevant to the adoption or implementation of innovations (i.e., new policies, programs or practices) at the organizational-level.[1] Jennifer Allen coordinated with investigators in the Cancer Prevention and Control Research Network on this literature review. The author team searched for published studies (1973–2013) in 11 bibliographic databases for quantitative, empirical studies that presented outcome data related to adoption and/or implementation of an innovation. Included studies had to assess latent constructs related to the "inner setting" of the organization, as defined by the Consolidated Framework for Implementation Research.

Of the 76 studies included, most (86%) were cross sectional and nearly half (49%) were conducted in health care settings. Nearly half (46%) involved implementation of evidence-based or "best practice" strategies; roughly a quarter (26%) examined use of new technologies. Primary outcomes most often assessed were innovation implementation (57%) and adoption (34%); while 4% of included studies assessed both outcomes. There was wide variability in conceptual and operational definitions of organizational constructs. The two most frequently assessed constructs included "organizational climate" and "readiness for implementation." More than half (55%) of the studies did not articulate an organizational theory or conceptual framework guiding the inquiry; about a third (34%) referenced Diffusion of Innovations theory. Overall, only 46% of articles reported psychometric properties of measures assessing latent organizational characteristics. Of these, 94% (33/35) described reliability and 71% (25/35) reported on validity.

Translation of Findings

This paper highlighted important gaps and limitations in the existing literature, including the lack of clarity associated with construct definitions, inconsistent use of theory, absence of standardized reporting criteria for implementation research, and the fact that few measures have demonstrated reliability or validity. Given these findings, the authors recommend that increased attention be devoted toward the development or refinement of measures using common psychometric standards. In addition, they identified a need for measure development and testing across diverse settings, among

diverse population samples, and for a variety of types of innovations. This work was intended to advance the field of dissemination and implementation research by aiding scientists in the identification of existing measures and highlighting methodological issues that require additional attention.

Research Outcomes/Impact

This literature search provided a foundation for the development of the Center's Indicators of integration, which was validated in two separate samples, following recommendations from this literature review.[2-4] As a follow up, as the Center's work has increasingly moved beyond the integration of HP and OSH and toward increased focus on improvements in working conditions, the Center investigators have developed a new questionnaire to assess best practices related to systems approaches to worker safety, health and wellbeing. A manuscript describing this questionnaire is currently under review.

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PACES: Physical Activity Among Commercial Construction Workers
PI: Jack Dennerlein, Lead Investigator: Oscar Arias

Background and Specific Aims

The overall goal for this proposed pilot study is to measure and characterize the physical load and physical activity levels of construction workers in order to develop key messages for physical activity and ergonomic interventions. These results will give a better understanding of the interaction of these factors and will inform strategies for the implementation of a preventive program focusing on increasing physical activity in general and reduce the physical load at work.

- **Specific Aim #1**: Measure and characterize the physical activity levels at work and outside of work among a convenience sample of 50 commercial construction workers for seven days.

- **Specific Aim #2:** With the data collected we will test the hypotheses that measured levels of workplace physical activity are positively associated to levels of perceived workplace physical exertion.

Significant or Key Findings

From the directly measured physical activity, the average number per participant of moderate minutes of occupational physical activity and physical activity outside of work obtained in short bouts (>1 minutes) were 243 minutes (65%) and 130 minutes (35%), respectively. Directly measured minutes of vigorous occupational physical activity were significant and positively correlated with self-reported fatigue (rs = 0.4).

Translation of findings

- Direct measurements of the exposure to physical activity while at work and outside work is an economical and very feasible method for occupational exposure assessment.
- Our direct measures for physical activity performed in short bouts indicate that levels of moderate occupational physical activity exceeded the American College of Sports Medicine and the American Heart Association's recommended number of minutes of physical activity per week.
- These study results indicate that construction workers are getting plenty on physical activity; however, US construction workers similar to our sample in terms of BMI still have poor health.

Outputs and outcomes associated with the core/program

- Outputs:
    - Publication in a peer-reviewed journal (Arias OE, Caban-Martinez AJ, Umukoro PE, Okechukwu CA, Dennerlein JT. Physical activity levels at work and outside of work among commercial construction workers. Journal of occupational and environmental medicine/American College of Occupational and Environmental Medicine. 2015 Jan;57 (1):73.)

- Outcomes:
    - We recommend a tailored intervention aimed to reduce physical loads at work, increase physical fitness in order to reduce the gap between physical job demands and workers' fitness, and the promotion of healthy lifestyles such as healthy diet, tobacco cessation and alcohol abuse prevention.

- Impact:
    - The results of our study suggest that interventions addressing health status in these workers should not rely on increasing PA alone. We recommend a tailored intervention aimed to reduce physical loads at work, increase physical fitness to reduce the gap between physical job demands and workers' fitness, and promote healthy lifestyles such as healthy diet, tobacco cessation, and alcohol abuse prevention.

Determining Effective Strategies for Integrated Health Promotion and Health Protection Programs in Small-to Medium-Sized Subcontractors
PI: Jack Dennerlein, Lead Investigators: Emily Sparer, Michael Grant

Background and Specific Aims

We were successful in completing Aim 1: to conduct key informant interviews with health and safety representatives from small to medium sized subcontracting companies as well as from trade specific unions to investigate employment patterns and determine effective strategies for development and evaluation of integrated health promotion and health protection programs. We completed three key informant interviews with unions representing laborers, operating engineers, and iron workers. We also completed seven key informant interviews with subcontracting companies representing concrete, scaffolding, erectors, the mechanical trades, drywall, and geotechnical engineering.

Significant Findings

We discovered that these small to medium sized companies have anywhere from 50 to 300 workers, depending on the season and the number of projects that the company is working on at a given time. We learned that most subcontractor companies have core groups of workers that travel from worksite to worksite and that those core groups are supplemented by additional workers as necessary. The subcontractors' project managers assign workers to the different jobs, and decide when they move from job to job. We learned that most of these companies are concerned about soft-tissue injuries but they do not have ergonomics programs. There were periodic initiatives brought up in the interviews but none of the companies or unions we interviewed had any long-term, strategic initiatives to combat soft tissue injuries beyond stretch and flex programs and an occasional toolbox talk. The biggest health and safety concern related to soft-tissue injury prevention was manual materials handling. We also learned that past health promotion efforts were either nonexistent or not well attended, likely because they were not offered during work hours. The aging workforce and tobacco cessation were the major concerns related to health promotion. Virtually all of the interviews revealed that these subcontractors rely on their own safety managers and foremen and not on the general contractors to manage safety on the worksite. The subcontractors indicated that the reason they do not rely on the general contractors to manage safety is that there is too much variability between general contractors. They also expressed that even within the same general contracting company there is a lot of variability between worksites as to how safety is managed.

Translation of Findings

These findings can be used to prevent workplace injuries and modify safety programs by enhancing the implementation of the Total Worker Health approach of ARM to implementing an integrated health and safety program on commercial construction sites. We now have a better understanding of subcontractor employment patterns and opportunities for successful implementation of an integrated health promotion and health protection program.

Research Outcomes / Impact

This pilot project advanced the methodology of integrated health and safety programs by examining a different part of the work organization (the subcontractor) and identified opportunities for successful implementation and employee engagement. The findings of this pilot were used to inform the design of

SubARM, the Center's construction project for the renewal period. SubARM contains elements related to following teams of workers from worksite to worksite, which allows for longer follow-up and sustained intervention delivery. This pilot also showed that the focus of ARM was appropriate and that subcontracting companies, at least in the Boston Area, are interested in these kinds of programs and that they could have a large impact on the industry. With concerns about aging workforces and high rates of smokers and soft-tissue injuries, this information shows how valuable the ARM intervention can be for these companies. This information showed that foremen and safety managers are responsible for on-site safety so any intervention activities will heavily involve the foremen and safety managers of these companies. We also decided to shift focus away from the general contractors implementing intervention activities since the subcontractors do not rely on them to manage safety on the worksites. Webelieve that this shift will allow better penetration and fidelity in the next phase of the intervention.

Without this information, we would not have had the knowledge required to understand how to best approach implementing an intervention within the dynamic and complex work environment of subcontracting companies.

Feasibility of Integrating Worker Health Insurance (Medstat/Truven) and Occupational Health Data. PI: Dean Hashimoto, Lead Investigator: Karen Hopcia

Background and Specific Aims

The specific aim of this study is to determine the feasibility of integrating two databases, the healthcare worker health insurance information (Truven, formerly Medstat,) with Occupational Health data (iVos). Linking objective health data (Medstat/Truven) to the Be Well Work Well (BWWW) study data including objective Occupational Health injury data (iVos database), subjective survey data, and intervention data would provide a more complete accounting of injury rates, musculoskeletal injuries (MSDs) and health expenditures related to current hospital policies and BWWW interventions. However, the health data is currently not available in the BWWW database. Integrating these two databases would allow further integration with the entire BWWW database.

Significant Findings

There are several areas that were explored in this pilot study to understand the feasibility of integrating Truven with iVos data. The first is to evaluate the benefits of using the Occupational Health (OH) software package available from Truven to integrate medical and injury data or whether it is more efficient to download the data from their respective databases into the BWWW database.

The second area explored in this pilot was to evaluate the resources necessary for linking the databases via a unique identifier and integrating the variables found in each of the two databases. The BWWW grant programmer/analyst, the iVos analyst and the Truven analyst worked with the grant consultant on this aspect of the project. For linking the databases, there are two main linking areas necessary for integration of the data, the worker identification and the medical claim. For the worker, the variable Social Security Number (SSN) can be found in both databases is the preferred linkage. For medical claims, both databases use similar nomenclature for claims which are ICD-9 diagnosis codes, CPT procedural codes and NDC drug codes. The next step was to identify individual variables for name, data type and space needed for integration. A list of variables in areas of demographics, medical claim and medical costs have been identified.

The last part of this project was to evaluate the Truven OH software for identification of variable fields that can be used to import a grant identification (ID) for the purposes of later de-identification during downloads and to filter appropriate worker data for the BWWW database download. In discussions with Truven company representatives, there are blank variables that can be modified and converted to the necessary variables for de-identification and filtering prior to download. Preliminary fields needed include the BWWW unique id and the iVos claim number.

Translation of Findings

This pilot complements current work in the Center BWWW study by exploring the expansion of measures collected to include an objective measure of health via medical utilization and further evaluate the relationships among the mediating mechanisms, modifying conditions, proximal outcomes, and self-reported worker health outcomes.

Research Outcomes/Impact

The objectives for this pilot have been completed and following the pilot grant we continued to explore the necessary algorithms to map Truven and iVOS fields. Once integrated, the data can be linked to the Center Be Well Work Well data from four other sources: (1) a Human Resources database (Peoplesoft), information on number of jobs, job role, worker overtime, absences and demographic information; (2) the staffing database (OneStaff), which includes all scheduled and shifts worked for all workers; (3) the workload database (Medicus) which includes numbers of patients and patient acuity; and (4) the Occupational Health Services database (iVos) consisting of

all incident reports and worker's compensation claims. Additionally, through individual and unit coded IDs, the database data can be linked to the subjective survey data and intervention survey data.

This final database allows us to generate work and health outcomes, especially Musculoskeletal Disorders sensitive to policy and practice changes on the hospital and unit level, and to allow further exploration of extramural grants related to these objectives.

Integration of Healthcare Worker Health Insurance Information (Truven) with Occupational Health data (iVos)

PI: Dean Hashimoto, Lead Investigator: Karen Hopcia

Background and Specific Aims

In this pilot project, we proposed to integrate objective measures of health care utilization through employee group health insurance data (Truven) to objective measures of occupational health illness and injury data (iVos). With the integration of these data sources, we are able to link this data to the current Center Be Well Work Well database. This is a follow up study of the pilot grant entitled the "Feasibility of Integrating Worker Health Insurance (Medstat/Truven) and Occupational Health Data" which was completed last year. The recommendation from that grant was to link the two databases using the Truven OHS module which was proposed in this pilot grant.

Significant Findings

We linked medical group health data with injury data using the Truven OHS module after integrating the two databases using Social Security Number, and reconciling various fields related to the variables identified and field type. This pilot work builds upon and complements current work in the Center Be Well Work Well study by expanding the measures collected to include an objective measure of health. This pilot will also expand one of the existing specific aims to evaluate the relationships among the mediating mechanisms, modifying conditions, proximal outcomes, and self-reported worker health outcomes to include an objective measure of worker health outcomes via medical utilization.

Translation of Findings

Currently, the database for the current Be Well Work Well links objective data collected from several database sources to various Be Well Work Well subjective measures (pilot and intervention survey data) and objective measures from the pilot intervention (e.g., biomarker and actigraphy sub-studies). The database includes data from four other sources: (1) a Human Resources database (Peoplesoft), information on number of jobs, job role, worker overtime, absences and demographic information; (2) the staffing database (OneStaff), which includes all scheduled and shifts worked for all workers; (3) the workload database (Medicus) which includes numbers of patients and patient acuity; and (4) the Occupational Health Services database (iVos) consisting of all incident reports and worker's compensation claims and now (5) Truven group health insurance data. The combination of objective and subjective measures of health and work can be a valid and reliable way to link workplace related exposures to self-reported health outcomes, access to objective clinical measures of health can further augment subjective perceptions of health and are a critical element to understanding the overall health of the population being studied.

Research Outcomes/Impact

This final robust longitudinal database allows us to generate work and health outcomes in a number of ways that are sensitive to policy and practice changes on the hospital and unit level, and to allow further exploration of extramural grants related to these objectives. Additionally, these objective health measures will improve empirical outcome measures for future workplace interventions designed to decrease workplace exposures and promote general health and well-being of employees.

Currently, one paper has been published and another submitted that explored the integrated database. Further studies are underway. The citations for the published paper is below.

Williams, J.A.R., Sorensen, G., Hashimoto, D., Hopcia, K., Wagner, G.R., ,Boden, L.I., (2017).Impact of Occupational Injuries on Nonworkers' Compensation Medical Costs of Patient-Care Workers. Journal of Occupational and Environmental Medicine 59 (6): e119-e124

Significant Findings

Behavior change: Using sit-to-stand workstations allowed sedentary office workers (N= 10) to significantly reduce sitting and increase the proportion of standing time during the workday. However, there was no significant increase in the proportion of time spent in physical activity while at work. During the intervention, participants did not significantly alter the proportion of sitting (baseline= 75%; 8 month= 74%) and standing behavior (baseline= 17%; 8 month= 20%) outside the workplace. However, the proportion of time spent each day in physical activity outside the workplace declined significantly during follow-up (baseline= 7%; 8 month= 5%). **Table 1** contains mean and standard deviations for daily standing accrued in bouts lasting greater than 5 and 10 minutes at baseline and after 8 months. Level of significance: $p<0.05$.

	Bouts > 5min			Bouts >10min		
	Average count/day	Average min/day	Mean bout (min)	Average count/day	Average min/day	Mean bout (min)
Baseline	5.5 (7.3)	57.3 (80.4)	9.7 (2.3)	1.2 (3.6)	33.7 (56.5)	14.3 (3.7)
8 month	7.8 (4.2)	89.4 (71.7)	10.7 (3.7)	3.1 (2.7)	64.5 (78.9)	18.5 (5.3)

Health Outcomes: No statistically significant ($p<0.05$) differences observed in measured cardiometabolic health variables (Table 2).

	Baseline	8-month
Weight (kg)	89.4 ± 22.8	89.5 ± 21.7
BMI (kg/m^2)	30.2 ± 6.1	30.2 ± 5.5
Waist circ. (cm)	92.9 ± 20.4	92.3 ± 16.3
Hip circ. (cm)	111.0 ± 13.8	113.3 ± 11.9
% Body Fat	41.1 ± 8.7	40.3 ± 8.3
% Fat Free Mass	58.9 ± 8.7	59.7 ± 8.3
Total Cholesterol (mg/dl)	192.6 ± 67.3	194.7 ± 65.2
LDL (mg/dl)	108.8 ± 50.4	111.9 ± 51.3
Insulin (µIU/ml)	5.9 ± 2.9	7.3 ± 3.2
Plasma Glucose (mg/dl)	100.4 ± 43.9	105.2 ± 43.8
HbA1C (%)	5.8 ± 1.1	5.9 ± 1.0
Fibrinogen (mg/dl)	313.6 ± 63.7	301.8 ± 74.8
Resting HR (bpm)	70.1 ± 11.3	69.1 ± 9.2
Resting SBP (mmhg)	113.4 ± 10.1	112.4 ± 5.1
Resting DBP (mmhg)	77.4 ± 7.9	71.4 ± 6.3
Popliteal IMT (mm)	0.65 ± 0.17	0.64 ± 0.11
Popliteal PSV (cm/s)	25.1 ± 5.8	34.4 ± 6.5*
Carotid IMT (mm)	0.55 ± 0.17	0.64 ± 0.17
Carotid PSV (cm/s)	79.3 ± 15.1	75.9 ± 11.5

Translational findings

Providing sit-stand desks to office workers may help to reduce sedentary time among office workers. Uses must be caution in preventing compensating for increased standing time at work with increased sedentary behavior outside the workplace. Further evidence is required to examine the effect of such workstations on cardiometabolic variables.

Research output

The following outputs can be associated with the pilot project.

Publications:
John D., Lyden K., Bassett D. Treadmill and sit-to-stand workstations: A physiological perspective. *Ergonomics in Design.* 2015; 23(3), 14-19.
John D. The active desk. Fitting in fitness, *ACSM - Fit Society Page.* 2015; 1(15), 4-5

Funded grant proposals:
1. Modifying the workplace to decrease sedentary behavior and improve health (1R21OH010564-01). Sponsored by the National Institute for Occupational Safety and Health. **John PI,** Direct Costs: $274,249, Project period: 5/1/2014 to 4/31/2018

Presentations:
1. John D. Physiology of sitting, standing, and walking - Integration of treadmills to improve workstations, *Ergonomics and Human Factors: Strategic Solutions for Workplace Safety and Health*, Harvard School of Public Health, Boston, MA. October 5-9, 2015.
2. John D. Chronic Health Conditions and Sedentary Work. *NIOSH Total Worker Health Webinar Series- Sedentary Work: Implications and Interventions for Worker Safety and Health,* https://www.cdc.gov/niosh/twh/webinar.html. July 23, 2015.
3. John D. Changing the way we work: workstation alternatives to seated desks. *Annual Meeting of the American College of Sports Medicine,* San Diego, CA. May 26-30, 2015.
4. John D. Physical activity, sedentary behavior and the workplace, *Advancing Wellness Seminar Series*, Massachusetts Institute of Technology, Boston, MA. November 19, 2014.
5. John D. Reduction in BMI using treadmill workstations. *Office Ergonomics Research Committee Conference*. Austin, TX. Jan 24-26, 2014
6. Arguello D., Morton A., Cloutier G., John D. Associations between Incidental Physical Activity and Cardiometabolic Health in Sedentary Overweight and Obese Adults. *Annual Meeting of the American College of Sports Medicine*, Boston, MA. May 31-June 4, 2016.

Simulation modeling of construction workers to estimate and mitigate the effects of individual mobility patterns on worksite-level interventions.
PI: Jack Dennerlein, Lead Investigator: Justin Manjourides

Significant Findings

Little is known about how mobile populations of workers may influence the ability to implement, measure, and evaluate health and safety interventions delivered at worksites. We use a simulation study to objectively measure both precision and relative bias of six different analytic methods as a function of the amount of mobility observed in the workforce. Our study indicates that as workforce's mobility increases, relative bias in treatment effects derived from standard models to analyze cluster-randomized trials also increases. Controlling for amount of time exposed to the intervention can greatly reduce this bias. Analyzing only subsets of workers who exhibit the least amount of mobility can result in decreased precision of treatment effect estimates.

Translation of findings

A manuscript titled "The effect of workforce mobility on intervention effectiveness estimates" was submitted to the *Annals of Work Exposure and Health* (formerly *Annals of Occupational Hygiene*) and has received a revise and resubmit that we are currently drafting a response. Findings of this work also helped inform the design and implementation of the *Integrated approaches to health & safety in dynamic construction work environments* project.

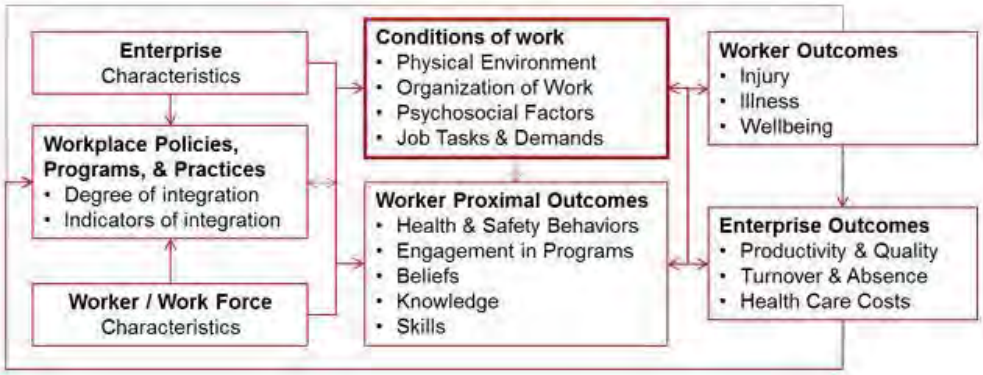
Research outcomes

Studies evaluating worksite based interventions need to consider the mobility of the workforce when estimating treatment effects. The choice of analytic method can greatly affect both precision and accuracy of estimates.

Relationships between workplace climates of safety and well-being, and worker behaviors and productivity indicators among employees in small-to-medium sized manufacturing companies
PI: Deborah McLellan, Lead Investigators: Nico Pronk and Abigail Katz

Background: Within the field of employee health, there is a growing understanding that multiple work factors affect the safety, health and well-being of employees. A recently published conceptual model[1] developed at the Harvard T.H. Chan School of Public Health's Center for Work Health and Well-being (CWHW), provides an innovative approach to thinking about the complex interplay between organizational, environmental and individual factors within workplaces. The model, found in figure 1 below, acknowledges that work factors are important contributors to individual health, related knowledge and behaviors. Moreover, they also have an impact on enterprise outcomes such as employee productivity.

Figure 1



Specific Aims: The principal aim of the investigation was to examine associations among variables specified as part of the conceptual model. Three specific aims were identified:

- Specific aim #1: Test the association between worker perception of organizational safety and health & well-being (HWB) climate and worker health behaviors (including physical activity, diet, sleep, tobacco and alcohol use).
- Specific aim #2: Test the association between worker perception of organizational safety and HWB climate and worker outcomes (such as verbal and emotional abuse, back pain, job and life satisfaction and self-perceived health status).
- Specific aim #3: Test the association between worker perception of organizational safety and HWB climate and employee productivity indicators as measured by the Work Limitations Questionnaire (WLQ[2]) and the Work Productivity and Activity Impairment scale (WPAI[3]).

Cross-sectional data used for the analyses were collected as part of an employee health risk assessment (HA) offered at 3 small-to-medium sized Midwestern manufacturing companies in 2014 (n=959; 53% response rate).

Significant findings

Workplace safety, and health and well-being climates are associated with both worker health behaviors and worker outcomes. Of the five worker health behaviors considered, physical activity and healthy sleep were the only variables for which significant relationships were found with workplace safety climate. Healthy sleep was found to relate marginally to workplace HWB climate. Of the eight worker outcome variables considered, nearly all were associated with the two climate variables (safety climate and health and well-being climate). Climate variables were related to less depression, higher job satisfaction, higher life satisfaction, less frequency of back pain, less daily impact of back pain, and higher self-perceived general health.

Strong cultures of worksite safety and HWB may be associated with employee productivity.
Two different indicators of productivity were considered, the WLQ and the WPAI. Using the WPAI we found that the odds that an employee will experience productivity loss are lower for those who report a strong culture of worksite safety and culture of HWB. The short form WLQ was not associated with either climate variable.

Translation of Findings

Our work adds evidence supporting links between workplace safety, health and well-being climates to

- worker health behaviors, such as sleep and physical activity
- worker health outcomes, such as depression, job and life satisfaction, back pain, and perceived general health
- and enterprise productivity outcomes.

We also observed that the WPAI and WLQ appear to operate differently with respect to workplace climate; in the present work, only the WPAI was associated with the climate variables studied, potentially indicating a difference in what aspects of productivity each of these tools actually measure.

Research Outcomes and Impact

While much of the existing scholarship has focused on the impact of workplace safety climate, the present study provides additional evidence that a workplace climate of HWB impacts worker outcomes, health behaviors and enterprise outcomes too. We realized that we need a better understanding of what existing productivity tools actually measure regarding their association with safety, health, and well-being climates. This has led to current cross-project and interdisciplinary examination within our Center to determine the most appropriate tool(s) for use when measuring productivity as part of research on worksite safety, health, and well-being.

References

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Enhancing an Integrated Intervention for Patient Care Workers: Program Implementation and Evaluation. **PI and Lead Investigator: Glorian Sorensen**

Background and Specific Aims

Improving and protecting the health and well-being of healthcare workers requires addressing key risks in the work environment as well as promoting safe and healthy behaviors. Patient care workers are at risk for a variety of musculoskeletal disorders (MSDs) related to their high workload and job factors such as long hours, shift work, and lifting patients. Health behaviors, including level of physical activity, inadequate sleep, and dietary patterns, are also influenced by the work environment, and are associated with MSDs. Project A aimed to estimate the feasibility and efficacy of integrated policies, programs, and practices that reduce these risks through the *Be Well Work Well* intervention, which was tested in a proof-of-concept study in eight patient care units randomly assigned to intervention and control. We encountered several key challenges to designing this intervention in the demanding work environments of these units, including competing priorities, limited time for patient care staff to participate in programs during the work day, and little space on the units to offer programs. We learned that to the extent possible, it is important that the intervention messages be closely aligned with patient care priorities. In response to these challenges, the *objective of this pilot project* was to enhance the potential impact of this intervention by implementing and evaluating two program enhancements. The specific aims were to:

1. Develop and implement strategies to incorporate a safe patient handling intervention for individual patient care workers into the *Be Well Work Well* intervention. We proposed to contract with an experienced vendor who provides safe patient mobilization training incorporating ceiling lifts and other assistive devices in order to reduce MSD risk.
2. Develop and implement strategies to incorporate a telephone coaching intervention for individual workers into the *Be Well Work Well* intervention. We offered the option of health coaching to the patient care staff; a health coach will be available by phone outside work to facilitate the behavior change process following a standard protocol.
3. Assess the feasibility of these program enhancements by tracking workers' participation in each component.

Significant Findings

We conducted this proof-of-concept trial in 8 in-patient care units on one hospital over 12 months. The intervention followed a theme-based approach, with two main components: (1) monthly unit-wide events, including support from peer educators; and (2) a unit-level intervention with nurse directors and other leadership on each unit. These intervention components aimed to provide a means of building a presence on the unit, in order to take advantage of small amounts of time during the work day that staff might have to participate in the programs. This pilot proposal was aimed at filling an important gap in this intervention plan by adding programs for individual workers, either outside the normal work day through telephone coaching, or during the work day through a program aimed a safe patient handling.

Process tracking results showed ongoing challenges in implementing the intervention.[1] For example, across the four intervention units, only seven patient- care workers signed up for the BWWW telephone health coaching calls, each receiving on average two 10-minute phone coaching calls. Participation in the safe patient handling activity was 25%; this one-on-one activity had the highest average number of minutes participants spent at an activity (47 minutes). For all other intervention activities, participants consistently spent under 10 minutes at each activity. While 73% of workers attended the kickoff event, average time spent at the event was six minutes. Most events were attended by approximately 50% of workers. This was attributed to challenges of providing

around-the-clock care, physically demanding work, and a dominant culture of putting patients first. Through focus groups, we learned that while both managers and patient care workers were aware of safety and health risks within their work environments and health behaviors, patient care work took precedence; nurse managers restricted their units' intervention activities to one per shift per month. This limited workers' exposure to the intervention.

Using survey data, we found no significant differences in the outcomes between intervention and control units for pain (p=0.271), fruit/vegetable servings per day (p=0.456), sugary drinks per day (p=0.254), total weekly physical activity (p=0.364), or sleep deficiency (p=0.734). We also did not find differences in the proximal outcomes of ergonomic practices (p=0.237), supervisor support (p=0.584), or meal break frequency (p=0.358). Given workers' limited exposure to the intervention, this was not surprising.[1]

Translation of Findings

These findings have implications for future interventions with direct patient care workers. Interventions to protect and promote worker health must be designed around an understanding of the conditions of work. The pressing demands of patient care, combined with a cultural commitment to putting the interests of the patient before those of the worker, create a high-pressure environment, challenging both emotional resilience and physical stamina. Building a supportive work environment in the face of these demands requires organization-level commitment. System-wide norms and infrastructure supports can then be translated to the unit level.

Also, based on our findings, we concluded that unit-based interventions within a supportive infrastructure may need to focus on a few selected outcomes. Targeting multiple health and safety behaviors in this intervention resulted in a somewhat diffuse effect, limiting the depth of exposure around any single intervention target. Given the complexity of the job demands, simple intervention messages that address fewer intervention targets may be needed, and attention to job stress and building resiliency may be important for policies and practices as well as for programs for individual workers.

Finally, unit-level approaches may be suboptimal, especially if only a few units receive the intervention. Because the intervention was not hospital-wide, it may have missed opportunities for broader support.

Research Outcomes / Impact

Partners Healthcare has used findings from this study to inform other TWH initiatives. For example, the sister hospital involved in Project A implemented a safe patient handling and mobilization program, incorporating the need for system-wide efforts to ensure success. The intervention produced statistically significant increases in workers' self-reported safe patient handling practices (mean difference=0.35, 95% CI: 0.27, 0.43), decreases in unsafe patient handling (mean difference=-0.11, 95% CI: -0.18, -0.04), and improvements in ergonomic practices (mean difference=0.08, 95% CI: 0.00, 0.15).[2] We have published the results of the *Be Well Work Well* intervention[1] and have incorporated implications for a system-wide approach in our new Implementation Guidelines.[3]

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patient handling and mobilisation programme. Occup Environ Med. 2017;74:336-43.
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SafeWell Implementation Package: Designing Tools and Training for Dissemination
Glorian Sorensen, PI; Lead investigator: Eve Nagler

Background and Specific Aims

Our Center has developed a broad array of TWH resources and tools that provide a solid foundation for development of evidence-based tools for dissemination and communication around Total Worker Health. We previously developed the *SafeWell Practice Guidelines: An Integrated Approach to Worker Health:*[1] The goal of these guidelines was to provide organizations with a framework for using TWH approaches, specific strategies, organizational processes, concrete tools, and links to other resources. The Guidelines have been disseminated widely through the Center and TWH websites,[2] our annual Executive and Continuing Professional Education (ECPE) courses,[3] international and national symposia, and the literature.[4] These guidelines were used in the Project C, our knowledge transfer project, focusing on leadership commitment and employee engagement, planning, implementation, and evaluation, and incorporated this model into services and supports provided by HealthPartners to their clients. The guidelines also informed interventions tested in Projects A and B.

In collaboration with Health Partners, the Center's Worksite Advisory Board, and investigators in Projects A, B and C, we identified the need for extending the resources the Center provides, building on the SafeWell Guidelines. The aim of this pilot was to enhance our existing intervention tools and processes to create a new set of Implementation Guidelines. These new guidelines were prioritized in order to better align with the Center's conceptual model that places working conditions as central determinants of worker safety and health. This pilot also aimed to build a collaboration with the Veterans Health Administration (VHA) as a location for pilot testing the guidelines.

Significant Findings

The resources from this pilot directly contributed to the development of the Center's new Implementation Guidelines, to be posted on the Center's website by October 2017 (http://centerforworkhealth.sph.harvard.edu/). Recommendations from these guidelines focus on the following core themes:

- Inspire key worksite stakeholders to support and participate in an integrated approach
- Identify goals and objectives for an integrated initiative
- Target efforts on working conditions
- Implement policies and practices that create and sustain positive working conditions
- Evaluate and continually improve efforts to enhance worker safety, health, and well-being

This pilot also contributed to fostering a long-term partnership with the VHA. This relationship was initiated in 2014, when the national VHA sent eight staff members to participate in the Center's Work, Health, and Well-being Executive Continuing Professional Education course. We have since established an effective collaboration, including agreement on a Memorandum of Understanding to sustain this partnership. We have established a close collaboration with one Boston facility, where we have pilot tested training and worker engagement processes. In addition, we have completed an extensive qualitative data collection effort with VHA employees. These data are currently being analyzed, will be the basis for a joint publication, and will inform next steps in pilot testing the Implementation Manual.

Translation of Findings

The Center has created a communication plan for launching these Implementation Guidelines, to ensure that they are broadly disseminated. They will be posted free-of-cost on our website, and also

made available in hard copy through Amazon. The guidelines provide a foundation for the Center's capacity building suite, including detailed plans for training and technical assistance using the recommended processes outlined in the manual. The manual will be further tested in collaboration with the VHA, Health Partners, and other partners.

Research Outcomes / Impact

We expect the Implementation Guidelines to contribute to improved uptake of integrated TWH policies, programs, and practices by a broad range of worksites. In addition, we expect that the collaboration with the VHA can help to inform policies, programs and practices influencing worker health across VHA facilities.

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Employee Wellness in Nursing Homes
PI: Glorian Sorensen, Lead Investigator: Cassandra Okechukwu

Background and Aims

The health and wellbeing of the 3.5 million workers in the United States nursing home industry is greatly challenged by the lack of a comprehensive plan for addressing the overwhelming cluster of risk factors for chronic disease and occupational injury faced by these workers. Another issue, with pertinent implications for the 1.4 million disabled and elderly individuals who receive care from these workers, is persistent findings of poor quality of care, leading to avoidable negative patient outcomes, such as pressure ulcers. One key gap in comprehensively addressing these issues is the lack of coordination and sharing of data among researchers and practitioners concerned about the health of workers and patients in nursing homes.

The long-term goal of this pilot project was to improve the health of workers and patients in nursing homes by bridging knowledge from different disciplines regarding key determinants of health and potential avenues for interventions. This pilot project was particularly designed to lay the groundwork for a larger study included in the Center's competing renewal. Towards that goal, the aims of this pilot proposal were to:

1) Understand past and current availability of nursing home facility-level data pertaining to occupational injuries, organizational characteristics, and performance on quality of care (i.e. patient outcomes) and determine methods of merging available administrative datasets.
2) Determine key confounders of the associations between the extent of Total Worker Health adoption and nursing homes' performance on occupational injuries and quality of care (i.e. patient outcomes) and conduct preliminary analyses necessary to facilitate submission of grant proposal evaluating these associations.
3) Investigate variability in responses to the indicators of integration survey tool among a sample of Directors of Nursing at different nursing homes.

Significant Findings

Assessing availability of nursing home data and methods to merge datasets: This pilot project provided a foundation for building our capacity to merge data from six available databases on nursing homes and their patients. We conducted literature reviews and analysis of data from the Work-Family Network survey and the nursing home databases. We linked occupational injuries with several enterprise outcomes, including worker turnover.[1] We also linked support of the health and well-being of workers by supervisors and organizations with improvements in enterprise outcomes (i.e., improvements in patient outcomes in nursing homes).[2]

Metrics development: Results of quantitative and qualitative studies in nursing homes demonstrated that directors of nursing are the best choice for responding to Indicators of Integration tool, confirmed item clarity on the tool, and also indicated wide variation in attitudes towards integrated approaches. In the Center's use of the Indicators of Integration in Project C in the Midwest and in collaboration with the VHA, we sent the Indicators of Integration tool to a person at each enterprise whose job description indicated they would be most knowledgeable about workplace health, safety, and well-being policies, programs, and practices. In preparation for our work in nursing homes, it was important to determine who might be best able to respond to the survey. Findings from the following three qualitative interview studies in nursing homes conducted through this pilot study informed our choice of directors of nursing as respondents in the enterprise outcomes project: (1) Pilot of integration tool with 12 nursing home directors of nursing; (2) Pilot project with 30 nursing home administrators: (3) Work-Family Network's interview of 152 nursing home managers.

Supporting the minor change made by the VHA to have “employee wellness” in the Indicators of Integration tool instead of “worksite wellness,” the directors of nursing reported that “worksite wellness” is understood to pertain to patients, while “employee wellness” pertained to employees.[3] We supplemented data from interviewing 30 nursing home administrators in the Work-Family Network study about their daily involvement with policies, programs and practices at their enterprises with qualitative data from 152 nursing home managers, including 31 directors of nursing, in the Work-Family Network study. Directors of nursing provided richer information on both workers and patients.

Variability in responses: Preliminary data on the Indicators of Integration tool demonstrates variability in Integration scores, and attitudes to TWH approaches in nursing homes. A study of 890 employers in Massachusetts that used one question to assess integration found that 28% of worksites (33% for health care facilities) reported use of integrated approaches.[4] Another study used a 43-item tool to assess readiness for integration in six nursing homes owned by a single for-profit chain owner, and found low variability in scores, which is unsurprising because chain ownership necessitates uniformity in programs, policies, and practices.[5] To improve comparisons using empirical data, we field-tested the integration tool with 12 nursing home directors of nursing. The sample included seven for-profit facilities owned by three chains and two families, and five non-profit religious facilities. We found that health care facilities have higher levels of and wider variation in scores on integration. The wide variability and higher levels of integration scores in nursing homes are unsurprising given that the prevailing characteristics of these enterprises include inbuilt integration resources. The pilot study included qualitative interviews of the directors of nursing. Analysis of the qualitative data indicated that the directors understood the questions on the Integration tool, and agreed with the basic precepts of integrated approaches; however, they framed the pursuit of TWH approaches as arising out of personal empathy for workers’ health and unrelated enterprise outcomes.

Translation of Findings

This pilot study showed that gaining buy-in for TWH approaches from executive and line managers in nursing homes will be difficult without evidence of how integrated approaches may influence patient care**.** The results of this pilot study underscored the need to empirically ascertain whether TWH approaches relate to enterprise outcomes. Empirically demonstrating the value of TWH can strengthen the business case for this approach.

Research Outcomes / Impact

This pilot study provided an important study for our *Enterprise Outcomes* study included in our competing renewal submitted in late 2015. This study is significant because positive findings will support the *research-to-practice* dissemination of TWH approaches as a strategy for attenuating high levels of adverse health risks among nursing home workers. We expect this study will provide key insights on aspects of TWH that have been most frequently implemented by nursing homes. If most nursing homes have already implemented some aspects of TWH, then small-scale adoption starting with those aspects may be encouraged among nursing home facilities that are completely new to TWH approaches. We also expect this study to address the fundamental question of whether a TWH approach is associated with better worker injury outcomes and patient medical outcomes. The findings of this Aim are critical to any future plan to scale up TWH adoption in the nursing home industry and other industries that employ disproportionate numbers of low-wage workers. Ultimately, the concern of nursing home leadership contemplating TWH is whether adoption would improve worker health and patient outcomes. This study will address these concerns.

References

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Environ Med. Submitted:Paper presented at Work, Stress and Health Annual Conference, Atlanta, GA.
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3. Williams JAR, Schult TM, Nelson CC, Cabán-Martinez AJ, Katz JN, Wagner GR, Pronk NP, Sorensen G, McLellan DL. Validation and Dimensionality of the Integration Score in a Sample of Small and Medium Size Employer Groups and VA Medical CentersIn submission.
4. Tremblay PA, Nobrega S, Davis L, Erck E, Punnett L. Healthy workplaces? A survey of Massachusetts employers. American journal of health promotion : AJHP. 2013;27(6):390-400. doi: 10.4278/ajhp.110216-QUAN-72. PubMed PMID: 23470184.
5. Faghri PD, Kotejoshyer R, Cherniack M, Reeves D, Punnett L. Assessment of a Worksite Health Promotion Readiness Checklist. Journal of occupational and environmental medicine / American College of Occupational and Environmental Medicine. 2010;52(9):893-9. doi: 10.1097/JOM.0b013e3181efb84d. PubMed PMID: 20798646.

Epidemiologic Investigation of Mental Health among Construction Workers: A pilot study. PI: Jack Dennerlein, Lead Investigator: Silje Reme

Significant Findings

The goal of this pilot study was threefold: 1) to document the prevalence of substantial mental distress in a sample of construction workers, 2) describe the prevalence of mental disorders in a subsample by using a diagnostic interview, and 3) investigate whether self-reported musculoskeletal pain and injuries were associated with mental distress. The sample comprised 172 construction workers from 4 different construction sites. They were predominantly male (n=158), the majority were white (n=150), and the mean age was 41 years.

The results showed that the prevalence of substantial mental distress was 16%. Of the workers who reported substantial mental distress on the rapid mental health screening, 10 workers were followed up for a psychiatric interview by phone. Nine of 10 met the criteria for one or several psychiatric diagnoses, which indicates that the rapid mental health screening used in this study is able to identify construction workers with mental disorders. Furthermore, having substantial mental distress was associated with low back pain, multiple pain sites, and higher frequency and range of work-related injuries. Finally, 41% of those with substantial mental distress had felt the need to seek professional help without doing so.

Translation of Findings

The high prevalence of substantial mental distress and lack of treatment in this population is of concern. The high prevalence might indicate a lack of social support and coping strategies when it comes to dealing with substantial mental distress. The results further showed an association between substantial mental distress, low back pain, and number of pain sites, which is in accordance with numerous other studies on chronic and multisite pain. In cases where the pain is accompanied by mental distress, there is a severe exacerbating of function and disability.

The findings in this study support earlier statements regarding a pressing need for effective interventions, and these interventions need to target and increase knowledge of psychological factors in chronic pain, particularly in construction workers. Construction workers are generally considered to be a low-income group with a high frequency of temporary work status, both of which have been independently associated with a higher risk of mental distress. The high rate of musculoskeletal pain and occupational injuries might, in part, be explained by mental distress, but more knowledge about mental distress and disorders, and how it relates to work-related pain and injuries in the construction industry is needed.

Research Outcomes / Impact

This is the first comprehensive investigation of mental distress among construction workers. By using a rapid self-administered mental health screening, we were able to document substantial mental distress in 16% of the workers, a much higher prevalence than in the general male population. This was supported by follow-up clinical interviews where 9 of 10 workers fulfilled the criteria for a mental disorder. The results also indicate that substantial mental distress is associated with both injury rate and self-reported pain.

This pilot study strongly suggests the need for additional rigorous studies on construction worker mental health and how this affects their work and well-being. It is most likely an underreporting population, struggling with a high prevalence of substantial mental distress, and they are unwilling or afraid to seek professional help for their mental problems. This study also suggests the need for increased treatment options, literacy, and acceptance of mental disorders in this high-risk worker population.

View Burden Statement

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

***Study Title (must be unique):** Project A: Integrated approaches to improving the health and safety of health care workers

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type	☐ Planned	☒ Cumulative (Actual)		
Using an Existing Dataset or Resource	☒ Yes	☐ No		
Enrollment Location	☒ Domestic	☐ Foreign		
Clinical Trial	☐ Yes	☒ No	**NIH-Defined Phase III Clinical Trial**	☐ Yes ☒ No

Comments:

Racial Categories	Ethnic Categories									Total
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	5	3	0	0	0	0	0	0	0	9
Asian	264	45	0	0	0	0	0	0	0	309
Native Hawaiian or Other Pacific Islander	7	0	0	0	0	0	0	0	0	7
Black or African American	1,300	68	0	0	0	0	0	0	0	1,368
White	6,612	733	0	0	0	0	0	0	0	7,275
More than One Race	0	0	0	0	0	0	0	0	0	0
Unknown or Not Reported	0	0	0	334	79	0	0	0	0	413
Total	8,151	817	0	334	79	0	0	0	0	9,381

Report 1 of 1

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To ensure proper performance, please save frequently.

View Burden Statement

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

*Study Title (must be unique): Integrated Approaches to Health and Safety in Dynamic Construction Work Environment

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type	☐ Planned	☒ Cumulative (Actual)		
Using an Existing Dataset or Resource	☒ Yes	☐ No		
Enrollment Location	☒ Domestic	☐ Foreign		
Clinical Trial	☐ Yes	☒ No	NIH-Defined Phase III Clinical Trial	☐ Yes ☒ No

Comments: Data on all individuals surveyed

Racial Categories	Ethnic Categories									Total
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	1	10	0	0	1	0	0	1	0	13
Asian	0	6	0	0	0	0	0	1	0	7
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	0
Black or African American	5	30	0	0	3	0	1	8	0	47
White	11	441	1	0	18	0	0	43	0	513
More than One Race	2	16	0	0	14	1	0	2	0	35
Unknown or Not Reported	0	5	0	0	15	0	1	4	17	42
Total	19	508	1	0	51	1	2	58	17	657

Report 1 of 1

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View Burden Statement

PHS Inclusion Enrollment Report

This report format should NOT be used for collecting data from study participants.

OMB Number: 0925-0001 and 0925-0002
Expiration Date: 10/31/2018

*Study Title (must be unique): Project Ci Dissemination of integrated worker health programs among small/medium employers

* Delayed Onset Study? ☐ Yes ☒ No

If study is not delayed onset, the following selections are required:

Enrollment Type	☐ Planned	☒ Cumulative (Actual)
Using an Existing Dataset or Resource	☒ Yes	☐ No
Enrollment Location	☒ Domestic	☐ Foreign
Clinical Trial	☐ Yes	☒ No

NIH-Defined Phase III Clinical Trial ☐ Yes ☐ No

Comments:

Racial Categories	Ethnic Categories									
	Not Hispanic or Latino			Hispanic or Latino			Unknown/Not Reported Ethnicity			Total
	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	Female	Male	Unknown/ Not Reported	
American Indian/ Alaska Native	0	0	0	0	0	0	0	0	0	0
Asian	0	0	0	0	0	0	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0	0	0	0	0	0	0
Black or African American	0	0	0	0	0	0	0	0	0	0
White	0	0	0	0	0	0	0	0	0	0
More than One Race	0	0	0	0	0	0	0	0	0	0
Unknown or Not Reported	0	0	0	0	0	0	90	19	1,541	1,650
Total	0	0	0	0	0	0	90	19	1,541	1,650

Report 1 of 1

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To ensure proper performance, please save frequently.

Inclusion of Children

Project A: Intervention Research and Observational Studies: Integrated Approaches to Improving the Health and Safety of Health Care Workers
PI: Glorian Sorensen, PhD
n/a

Project B: Intervention Research: Integrated approaches to health and safety in dynamic construction work environments
PI: Jack Dennerlein, PhD

n/a

Project C: Knowledge Transfer Project: SafeWell: Education and Dissemination to Promote Integrated Approaches to Worker Health in Small-to-Medium-sized businesses
PI: Deborah McLellan, PhD

n/a

Materials Available for Other Investigators

1. SafeWell: Integrated Approaches to Worker Health in Small- to Medium-sized Businesses. McLellan D, Pronk N, Sorensen G. Successful implementation plan of an integrated approach in small to medium-sized businesses, delivered by a vendor. 2012.

2. Indicators of Integration. Williams, J, Schultz T, Nelson C, Caban-Martinez A, Katz J, Wagner G, Pronk N, Sorensen G, McLellan D. A validated metric for an integrated approach. 2015-2016. http://www.ncbi.nlm.nih.gov/pubmed/26340291. http://journals.lww.com/joem/Abstract/2016/05000/Validation_and_Dimensionality_of_the_Integration.12.aspx

3. Dimensions of Corporate Integration. Pronk N, McLellan D, Sorensen G. Assessment and feedback tool for an integrated approach. 2016. http://centerforworkhealth.sph.harvard.edu/dimensions-corporate-integration

PARTNERSHIPS				
Partner	**Type**	**Role**	**Location**	**New/Existing?**
HealthPartners, Inc.	Multiple: Non-profit, integrated healthcare organization	Researcher, Recruiter, Educator, Outreach	Minnesota	Existing
TURCK, Inc.	Industry	Research participant, Recruiter, Outreach	Minnesota	New
Quality Bicycle Products	Industry	Research participant, Recruiter, Outreach	Minnesota	New
Bühler	Industry	Research participant, Recruiter, Outreach	Minnesota	New
Gallagher Benefit Services, Inc.	Industry	Recruiter	Minnesota	New
Minnesota Chamber of Commerce	Trade Association	Recruiter	Minnesota	New
American Society of Safety Engineers, Health & Wellness Branch	Trade Association	Outreach	National	New
Massachusetts Department of Public Health (MDPH)	Local/state govt.	Research participant, Outreach	Massachusetts	New
Veterans Health Administration (VHA), Brockton facility	Healthcare Org	Research participant	Massachusetts	New
Laborers International Union of NA			Massachusetts	Existing
New England International Association of Ironworkers Local 7				New
International Association of Operating Engineers Local 4				

Fishing Partnership Support Services	Trade Association	Representative for Workers, Outreach	Massachusetts	New
Boston Fire Department	Multiple: Local/State government, Non-Profit	Recruiter, Research participant	Massachusetts	New
Boston Fire Fighters Local 718	Union	Representative of Workers	Massachusetts	New
Sodexo, LLC	Industry	Recruiter, Research participant	Maryland Massachusetts	New
Veterans Health Administration (VHA) – National offices	Health Care Organ.		National	New
NIOSH TWH Outreach and Communication Committee	Federal Gov't.	Technology producer, researcher, representative for workers, outreach, training/educator	National	New
National Association of Health Care Journalists	Trade Association	Outreach	Missouri	New
Transportation Learning Center			Maryland	New
Serviço Social da Industria, Brazil	Multiple: International; non-profit,	Outreach, Representative for Workers	Brazil	New
Mutual de Seguridad, Chile	Multiple: international; non-profit	Outreach, representative for workers,	Chile	New
Skanska of North America				New
Harvard University Construction Services			Massachusetts	New
Shawmut Design and Construction			Massachusetts	New
Suffolk Construction			Massachusetts	New
John Moriarty and Associates			Massachusetts	New
Gilbane			Massachusetts	New

Partners Healthcare	Health Care Organ.	Research participant, Recruiter, Outreach	Massachusetts	New
Center for Construction Research and Training			Maryland	New
Dartmouth-Hitchcock Medical Center	HealthCare Organ	Research participant	New Hampshire	New

Outputs and Outcomes

	PEER REVIEWED JOURNALS			
Citation	Title	Authors	Type of Publication	URL
	Project A, Glorian Sorensen			
An Inspection Tool and Process to Identify Modifiable Aspects of Acute Care Hospital Patient Care Units to Prevent Work-Related Musculoskeletal Disorders. Grant MP, Okechukwu CA, Hopcia K, Sorensen G, Dennerlein JT Workplace Health Saf 2017, Aug 1; doi: 10.1177/2165079917718852	An Inspection Tool and Process to Identify Modifiable Aspects of Acute Care Hospital Patient Care Units to Prevent Work-Related Musculoskeletal Disorders.	Grant MP, Okechukwu CA, Hopcia K, Sorensen G, Dennerlein JT	Journal [2017]	
Associations between trunk flexion and physical activity of patient care workers for a single shift: A pilot study. Arias OE, Umukoro PE, Stoffel SD, Hopcia K, Sorensen G, Dennerlein JT. *Work* 2017 56 (2), 247-255. DOI: 10.3233/WOR-72481.	Associations between trunk flexion and physical activity of patient care workers for a single shift: A pilot study.	Arias OE, Umukoro PE, Stoffel SD, Hopcia K, Sorensen G, Dennerlein JT.	Journal [2017]	Abstract: www.ncbi.nlm.nih.gov/pubmed/28211832
Nurses' but not managers' safety practices are linked with job satisfaction. Hurtado D, Kim S-S, Subramanian SV, Dennerlein JT, Christiani DC, Hashimoto DM, Sorensen G. J Nurs Manag 2017 May 25. doi: 10.1111/jonm.12484.	Nurses' but not managers' safety practices are linked with job satisfaction.	Hurtado D, Kim S-S, Subramanian SV, Dennerlein JT, Christiani DC, Hashimoto DM, Sorensen G.	Journal [2017]	
Impact of occupational injuries on nonworkers' compensation medical costs of patient-care workers. Williams JA, Sorensen G, Hashimoto D, Hopcia K, Wagner GR, Boden LI. J Occup Environ Med. 2017; 59(6):e119-24.	Impact of occupational injuries on nonworkers' compensation medical costs of patient-care workers.	Williams JA, Sorensen G, Hashimoto D, Hopcia K, Wagner GR, Boden LI.	Journal [2017]	Abstract: https://www.ncbi.nlm.nih.gov/pubmed/28598939

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Racial disparities in occupational injury: Obscured by administrative data? Sabbath EL, Boden LI, Williams JAR, Hashimoto D, Hopcia K, Sorensen G. Scan J Work Environ Health 2017 Mar 1;43(2):155-162. doi: 10.5271/sjweh.3611	Racial disparities in occupational injury: Obscured by administrative data?	Sabbath EL, Boden LI, Williams JAR, Hashimoto D, Hopcia K, Sorensen G.	Journal [2017]	Abstract: www.ncbi.nlm.nih.gov/pubmed/27942733
The feasibility, safety, and efficacy of using a wireless pedometer to improve the activity level in a cohort of nurses. Flanagan J, McCord A, Cheney M, and Lundquist D. J Holistic Nurs 2016. [Epub ahead of print]. doi:10.1177/0898010116632919	The feasibility, safety, and efficacy of using a wireless pedometer to improve the activity level in a cohort of nurses.	Flanagan J, McCord A, Cheney M, and Lundquist D.	Journal [2016]	
Exploring the experience and impact of therapeutic touch treatments for nurse colleagues. Coakley AB, Barron A-M, and Annese CD. Visions: J Rogerian Nurs Sci 2016, 22(1), Manuscript 1, 13 pp. Retrieved from http://www.societyofrogerianscholars.org	Exploring the experience and impact of therapeutic touch treatments for nurse colleagues.	Coakley AB, Barron A-M, and Annese CD.	Journal [2016]	http://www.societyofrogerianscholars.org

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Implementing an integrated health protection/health promotion intervention in the hospital setting: Lessons learned from the Be Well, Work Well Study. Sorensen G, Nagler EM, Hashimoto D, Dennerlein JT, Theron J, Stoddard AM, Buxton OM, Wallace L, Kenwood C, Nelson CC, Tamers SL, Grant MP, Wagner GR. J Occup Environ Med 2016 Feb;58(2):185-94.	Implementing an integrated health protection/health promotion intervention in the hospital setting: Lessons learned from the Be Well, Work Well Study.	Sorensen G, Nagler EM, Hashimoto D, Dennerlein JT, Theron J, Stoddard AM, Buxton OM, Wallace L, Kenwood C, Nelson CC, Tamers SL, Grant MP, Wagner GR.	Journal [2016]	Abstract: www.ncbi.nlm.nih.gov/pubmed/26849263
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Work-family conflict, psychological distress, and sleep deficiency among patient care workers. Jacobsen H, Reme SE, Sembajwe G, Hopcia K, Stoddard A, Kenwood C, Stiles T, Sorensen G, Buxton O. Workplace Health Saf 2014 Jul;62(7):282-91. doi: 10.3928/21650799-20140617-04.	Work-family conflict, psychological distress, and sleep deficiency among patient care workers.	Jacobsen H, Reme SE, Sembajwe G, Hopcia K, Stoddard A, Kenwood C, Stiles T, Sorensen G, Buxton O.	Journal [2014]	Full article (free): www.ncbi.nlm.nih.gov/pmc/articles/PMC4430726/
Results of a pilot intervention to improve health and safety for healthcare workers. Caspi CE, Dennerlein J, Kenwood C, Stoddard A, Hopcia K, Hashimoto D, Sorensen G. J Occup Environ Med 2013; 55:1449–1455.	Results of a pilot intervention to improve health and safety for healthcare workers.	Results of a pilot intervention to improve health and safety for healthcare workers.	Journal [2013]	Abstract: journals.lww.com/joem/Abstract/2013/12000/Results_of_a_Pilot_Intervention_to_Improve_Health.13.aspx
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Occupational injuries among nurses and aides in a hospital setting. Boden, L. I., Sembajwe, G., Tveito, T. H., Hashimoto, D., Hopcia, K., Kenwood, C., Stoddard, A. M. and Sorensen, G. Am. J. Ind. Med., 55: 117–126. doi: 10.1002/ajim.21018	Occupational injuries among nurses and aides in a hospital setting.	Boden, L. I., Sembajwe, G., Tveito, T. H., Hashimoto, D., Hopcia, K., Kenwood, C., Stoddard, A. M. and Sorensen, G.	Journal [2012]	Abstract: onlinelibrary.wiley.com/doi/10.1002/ajim.21018/abstract
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	Project B, Jack Dennerlein			
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Key organizational characteristics for integrated approaches to protect and promote worker health in smaller enterprises. McLellan D, Williams JA, Katz, JN, Pronk NP, Wagner GR, Cabán-Martinez AJ, Nelson CC, Sorensen G. J Occup Environ Med. March 2017; 59(3):289–294. doi: 10.1097/JOM.0000000000000949.	Key organizational characteristics for integrated approaches to protect and promote worker health in smaller enterprises.	McLellan D, Williams JA, Katz, JN, Pronk NP, Wagner GR, Cabán-Martinez AJ, Nelson CC, Sorensen G.	Journal [2017]	Abstract: www.ncbi.nlm.nih.gov/pubmed/28267100

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Supporting employees' work-family needs improves health care quality: Longitudinal evidence from long-term care. Okechukwu CA, Kelly EL, Bacic J, DePasquale N, Hurtado D, Kossek E, Sembajwe G. Soc Sci Med. 2016 May;157:111-9. doi: 10.1016/j.socscimed.2016.03.031. Epub 2016 Mar 24.	Supporting employees' work-family needs improves health care quality: Longitudinal evidence from long-term care.	Okechukwu CA, Kelly EL, Bacic J, DePasquale N, Hurtado D, Kossek E, Sembajwe G.	Journal [2016]	Abstract: www.ncbi.nlm.nih.gov/pubmed/27082022
"Well-Being in All Policies": Promoting Cross-Sectoral Collaboration to Improve People's Lives. Kottke TE, Stiefel M, Pronk NP. Prev Chronic Dis 2016;13:160155.	"Well-Being in All Policies": Promoting Cross-Sectoral Collaboration to Improve People's Lives.	Kottke TE, Stiefel M, Pronk NP.	Journal [2016]	
Bicycling to work at Quality Bicycle Products: A case example for active transportation in the business and industry sector. Pronk NP, Simon BC, Gaikowski J. ACSM's Health and Fitness Journal 2014; 18(5):49-52.	Bicycling to work at Quality Bicycle Products: A case example for active transportation in the business and industry sector.	Pronk NP, Simon BC, Gaikowski J.	Journal [2014]	

NON-PEER REVIEWED JOURNALS PUBLICATIONS			
Title	**Authors**	**Type of Publication**	**URL (if applicable)**
SafeWell: Integrated Approaches to Worker Health in Small- to Medium-sized Businesses	McLellan D, Pronk N, Sorensen G	Book [2012]	http://centerforworkhealth.sph.harvard.edu/resources/safewell-resources
A Conceptual Model for Guiding Integrated Interventions and Research: Pathways through the Conditions of Work	Sorensen G, McLellan D, Dennerlein J, Nagler E, Sabbath E, Pronk N, Wagner G	Book Chapter [in press]	
Total Worker Health – A Holistic Perspective on Employee Wellbeing, Sodexo Workplace Trends Report, 2014	Hurtado, D	Report [2014]	http://viewer.zmags.com/publication/17fda3ad#/17fda3ad/1
Wellness 3.0, contribution in Sodexo Workplace Trends Report, 2017	Sorensen, G	Contribution to report chapter [2017]	http://pages.sodexo.com/rs/199-HVB-296/images/Sodexo-2017-workplace-trends-report.pdf?mkt_tok=eyJpIjoiWTJGbU9HTmlZMkZqTkRkbCIsInQiOiJoWUhPQjd4bEdETjJcL3BmMmlaamFLazFqdnlcL1wvSzJSOTZnNlZSSGIzeXBSR2xxRm9aMWdKemJPS3QwaU12WmxGK1B6NVwvU1JcL3ZiMVIzaGQ3NVJEcXBkT1FmUkcwSHBlRU85ZW1cL3g3Y25ydHZ2UDhVaFQ4TFhzRkxFd3Y5anZsMCJ9
Emerging Efforts to Measure Total Worker Health in Action, Volume 2, Number 4, November 2013	McLellan, D	Newsletter [2013]	https://www.cdc.gov/niosh/twh/newsletter/twhnewsv2n4.html
Workplace wellness: What's it worth to you American Society of Safety Engineers 2012	McLellan, D	Webinar [2012]	N/A
Moving into the Future: Promoting safe patient handling for worker and patient safety in Massachusetts hospitals: Report of the Massachusetts Hospital Ergonomics Task Force	Dennerlein, J	Report [2014]	http://www.mass.gov/eohhs/docs/dph/occupational-health/ergo-sph-hospitals-2014.pdf

Outputs and Outcomes

TRAINEES			
Name	**Project Focus**	**Outputs**	**Current Placement**
Current Trainees			
Maria Andree Lopez-Gomez	Mutual de Seguridad Project A		Post-doctoral trainee
Susan Peters	Sodexo, Mutual de Seguridad		Post-doctoral trainee
Emily Sparer (post-doc and prior pre-doc)	Project B and Affiliated	Sparer EH, Okechukwu CA, Manjourides J, Herrick RF, Katz JN, Dennerlein JT. Length of time spent working on a commercial construction site and the associations with worker characteristics. Am J Ind Med. 2015 Jun 29. [Epub ahead of print] (Affiliated project) Sparer EH, Herrick R, Dennerlein JT. Development of a Safety Communication and Recognition Program for Construction. New Solutions 2015 May;25(1):42-58.	Post-doctoral trainee
Former Trainees			
Nicholas Andreou (pre-doc)	Project A	In progress	Doctoral Candidate, Centre for Organizational Health and Development Systems Officer, European Academy of Occupational Health Psychology Nottingham, UK
Oscar Arias (pre-doc)	Project A	Arias OE, Umukoro PE, Stoffel S, Dennerlein JT, Sorensen G. Associations between physical load as measured through bending and physical activity of patient care workers for a given shift (in progress). Arias OE, Cabán-Martinez AJ, Umukoro PE, Okechukwu CA, Dennerlein JT. Physical activity	Assistant Director, Southern California NIOSH – ERC University of California, Los Angeles

		levels at work and outside of work among Commercial Construction Workers. J Occup Environ Med. 2015 Jan;57(1):73-8.	
Alberto Caban-Martinez (pre- and post-doc)	Project B	Caban-Martinez AJ, Lowe K, Herrick R, Kenwood C, Gagne JJ, Becker JF, Schneider S, Dennerlein JT, Sorensen G. Construction workers working in musculoskeletal pain and engaging in leisure-time physical activity: Findings from a mixed-methods pilot study. Am J Ind Med 2014 Jul;57(7):819-25. Zhang M, Sparer EH, Murphy LA, Dennerlein JT, Fang D, Katz JN, Caban-Martinez AJ. Development and validation of a fatigue assessment scale for U.S. construction workers. Am J Ind Med. 2015 Feb;58(2):220-8. (Affiliated project).	Assistant Professor University of Miami Miller School of Medicine
Caitlin Eicher Caspi (pre-doc)	Project A	Caspi CE, Dennerlein J, Kenwood C, Stoddard A, Hopcia K, Hashimoto D, Sorensen G. Results of a pilot intervention to improve health and safety for healthcare workers. J Occup Environ Med 2013;55:1449-1455.	Assistant Professor Department of Family Medicine & Community Health, University of Minnesota, Minneapolis
Michael Grant (pre-doc)	Project B	An Inspection Tool and Process to Identify Modifiable Aspects of Acute Care Hospital Patient Care Units to Prevent Work-Related Musculoskeletal Disorders. Grant MP, Okechukwu CA, Hopcia K, Sorensen G, Dennerlein JT Workplace Health Saf 2017, Aug 1; 2165079917718852. doi: 10.1177/2165079917718852	Industrial Hygienist, National Institute for Occupational Safety and Health
Karen Hopcia (pre-doc)	Project A	Hopcia K, Dennerlein J, Hashimoto D, Stoddard A, Orechia T, Sorensen G. A case-control study of occupational injuries for consecutive and cumulative shifts in hospital registered nurses and patient care associates. Workplace Health Saf 2012;60(10):437-44.	Associate Director for Shared Services, Budget and Data Analysis Partners Healthcare Occupational Health Services

David Hurtado (post-doc/ HSPH Yerby Fellow)	Project A Overall Center	Hurtado DA. Disparities in subjective well-being by socioeconomic status in Colombia. In Rojas M. (Ed). Handbook of Happiness Research in Latin America. Houten, Netherlands: Springer (In press). ISBN 978-94-017-7203-7.(Affiliated project). Hurtado DA, Glymour MM, Berkman LG, Reme S, Hashimoto D, Sorensen, G. Schedule control and mental health: the relevance of coworkers' reports. Community, Work & Family 2015;18(4):416-434. Hurtado DA, Nelson CC, Hashimoto, D, Sorensen, G. Supervisors' support for nurses' meal breaks and mental health. Workplace Health Saf 2015, 63(3), 107-115. Hurtado DA, Kim SS, Subramanian SV, Dennerlein J, Hashimoto D, Sorensen G. Nurses but not managers' reports of safety diligence and ergonomic practices were linked with job satisfaction: a multilevel study among hospital patient-care workers. (under review) Contributed to Sodexo, LLC; Workplace Trends Report 2014. Section titled "Total Worker Health: A Holistic Perspective on Employee Well-Being"	Assistant Scientist Oregon Institute of Occupational Health Sciences Oregon Health and Science University
Henrik Jacobsen (pre-doc)	Project A	Jacobsen HB, Reme SE, Sembajwe G, Hopcia K, Stoddard A, Kenwood, Stiles T , Sorensen G, Buxton OM. Work-Family conflict, Psychological Distress and Sleep Deficiency Among Patient are Workers. Workplace Health Saf 2014;62 (7), 282-291. Jacobsen HB, Reme SE, Sembajwe G, Hopcia K, Stiles T, Sorensen G, Porter J, Marino M, & Buxton OM. Work stress, sleep deficiency,	Department of Psychology The Norwegian University of Science and Technology

	Project B	psychological distress and 10-year cardiometabolic risk among female patient are workers. Am J Ind Med 2014;57:940-949 Jacobsen HB, Caban-Martinez A, Onyebeke L , Sorensen G, Dennerlein J, Reme SE. Construction workers struggle with a high prevalence of mental distress and this is associated with their pain and injuries. J Occup Environ Med 2013; 55(10):1197-1204.	
Jin Lee (pre-doc)	Publications	Lee J, Huang YH, Murphy, LA, Robertson, MM, Garabet A. Measurement equivalence of safety climate scale for mobile lone workers using truck drivers as exemplar, J Occup Org Psychol (in press). (Affiliated project). Lee, J, Huang, Y H, Robertson, M. M., Murphy, L. A., Garabet, A, Chang W R. External validity of a generic safety climate scale for lone workers across different industries and companies. Accident Anal Prev 2014; 67:138-145. (Affiliated project).	Postdoctoral Fellow Liberty Mutual-Harvard Program in Occupational Safety and Health Hopkinton, Massachusetts
Seung-Sup Kim (pre-doc)	Project A	Kim SS, Okechukwu CA, Buxton OM, Dennerlein JT, Boden LI, Hashimoto DM, Sorensen G. Association between work-family conflict and musculoskeletal pain among hospital patient care workers. Am J Ind Med. 2013 Apr;56(4):488-95 Kim SS, Okechukwu CA, Dennerlein JT, Boden LI, Hopcia K, Hashimoto DM, Sorensen G. Association between perceived inadequate staffing and musculoskeletal pain among hospital patient care workers. Int Arch Occup Environ Health. 2014 Apr;87(3):323-30 Kim SS, Dutra LM, Okechukwu CA. Contractor-, steward-, and coworker-safety practice:	

		associations with musculoskeletal pain and injury-related absence among construction apprentices. Int Arch Occup Environ Health. 2014;87(5):493-500. (Affiliated project). Kim SS, Perry MJ, Okechukwu CA. Association between perceived union connection and upper body musculoskeletal pains among unionized construction apprentices. Am J Ind Med. 2013;56(2):189-96. (Affiliated project).	
Lauren Murphy (post-doc)	Project B	Sparer, EH, Murphy, LA, Taylor, KM, Dennerlein, JT. Correlation between safety climate and contractor safety assessment programs in construction. Am J Ind Med 2013; 56(12), 1463-1472. (Affiliated project). 1 presentation	Occupational Health Research Psychologist Washington Department of Labor and Industries; SHARP (Safety & Health Assessment & Research for Prevention), Olympia, WA
Candace Nelson (post-doc)	Project A Project C	Nelson CC, Wagner GR, Caban-Martinez AJ, Buxton OM, Kenwood CT, Sabbath EL, Hashimoto DM, Hopcia K, Allen J, Sorensen G. Physical activity and body mass index: The contribution of age and workplace characteristics. Am J Prev Med 2014; March;46(Suppl1): S42-S51. Nelson C, Allen J, Sabbath E, Caban-Martinez A, Buxton O, Wagner G, Sorensen G. Cancer Risk-Related Behaviors – comparing older workers to younger workers (in progress). Nelson, CC, Allen, JD, McLellan, D, Pronk, N, Davis, K L. Integrating health promotion and occupational safety and health in manufacturing worksites: Perspectives of leaders in small-to-medium sized businesses. Work 2015; *52*(1):169-176.	Information Access and Dissemination Manager Massachusetts Department of Public Health
Silje Reme (post-doc)	Project B	Reme, S. E., Dennerlein, J. T., Hashimoto, D., & Sorensen, G. Musculoskeletal pain and	Associate Professor Health Psychology University of Oslo

		psychological distress in hospital patient care workers. J Occup Rehabil 2012;*22*(4), 503-510. Reme SE, Shaw WS, Boden LI, Tveito TH, O'Day ET, Dennerlein JT, Sorensen G. Worker assessments of organizational practices and psychosocial work environment are associated with musculoskeletal injuries in hospital patient care workers. Am J Ind Med 2014;57(7):810-818. 2 presentations	
Erika Sabbath (post-doc)	Project A	Sabbath E, Hurtado D, Okechukwu C, Tamers SL, Nelson C, Kim S-S, Wagner G, Sorensen G. Occupational injury among hospital patient-care workers: what is the association with workplace verbal abuse? Am J Ind Med 2014. Feb;57(2):222-232	Assistant Professor Boston College School of Social Work Chestnut Hill, MA
Grace Sembajwe (post-doc)	Project A	Sembajwe G, Tveito TH, Hopcia K, Kenwood C, O'Day, ET, Stoddard A, Dennerlein J, Hashimoto D, Sorensen G. Psychosocial stress and multi-site musculoskeletal pain: a cross-sectional survey of patient care workers. Workplace Health Saf 2013; 61(3):117-125.	Associate Professor, Environmental & Occupational Health Sciences at Hunter College, Doctoral Programs at CUNY Graduate Center
Sonja Doris Stoffel (post-doc)	Project B	Sorensen G, Stoddard AM, Stoffel S, Buxton O, Sembajwe G, Hashimoto D, Dennerlein JT, Hopcia K. The role of the work context in multiple wellness outcomes for hospital patient care workers. J Occup Environ Med 2011; Aug;53(8):899-910. Umukoro PE, Arias OE, Stoffel SD, Hopcia K, Sorensen G, Dennerlein JT. Physical activity at work contributes little to patient care workers' weekly totals. J Occup Environ Med. 2013 Dec;55(12 Suppl):S63-8.	Faculty Centre for Sport & Exercise Education Camosun College Interurban, Pacific Institute for Sport Excellence Victoria, BC, Canada
Sara Tamers (post-doc)	Project A and B	5 presentations	Office for Total Worker Health®, Coordination and Research Support, NIOSH

Torill Helene Tveito (post-doc)	Project A	Tveito TH, Sembajwe G, Boden LI, Dennerlein JT, Wagner GR, Kenwood C, Stoddard AM, Reme SE, Hopcia K, Hashimoto D, Shaw WS, and Sorensen G. Impact of Organizational Policies and Practices on Workplace Injuries in a Hospital Setting. J Occup Environ Med 2014; 56(8):802-8. How do job strain and job satisfaction in supervisors influence health, job strain, and job satisfaction in workers (in progress).	Research Group Leader Uni Research Health Bergen, Norway Professor of Health Promotion Buskerud and Vestfold University College, Horten, Norway
Peter Umukoro (pre-doc)	Project A	Umukoro PE, Arias O, Stoffel SD, Hopcia K, Sorenson G, Dennerlein J. Physical activity at work contributes little to patient care workers' weekly totals. J Occup Environ Med 2013. Dec;55(12);Suppl:S63-S68.	Training Registrar for EPIC Medical Software Mass General Hospital
Jessica Williams (post-doc)	Project C	Williams JA, Nelson CC, Caban-Martinez AJ, Katz JN, Wagner GR, Pronk NP, Sorensen G, McLellan DL. Validation of a New Metric for Assessing the Integration of Health Protection and Health Promotion in a Sample of Small- and Medium-Sized Employer Groups. J Occup Environ Med 2015. Sep:57(9):1017-1021. Williams J, Schult T, Nelson C, Cabán-Martinez JA, Katz JN, Wagner GR, Pronk NP, Sorensen G, McLellan DL. Dimensionality and Adaptation of a New Metric for Assessing Approaches Integrating Health Protection and Health Promotion. J Occup Environ Med (under review). Williams J, Schult T, Nelson C, Cabán-Martinez A, Katz J, Wagner G, Pronk N, Sorensen G, McLellan D. Validation and Dimensionality of the Integration Score: Evidence from the PULSE small business and VA Medical Center Surveys. J Occup Environ Med 2016 May;58(5)499-504.	Assistant Professor University of Kansas Medical Center Kansas City, MO

*For trainees, see Trainee table, p. 101.

OTHER OUTPUTS			
Title	**Authors**	**Type of Output**	**URL(if applicable)**
SafeWell: Integrated Approaches to Worker Health in Small- to Medium-sized Businesses	McLellan D, Pronk N, Sorensen G	Successful implementation plan of an integrated approach in small to medium-sized businesses, delivered by a vendor	n/a
Indicators of Integration	Williams J, Schultz T, Nelson C, Caban-Martinez A, Katz J, Wagner G, Pronk N, Sorensen G, McLellan D.	Validated metric for an integrated approach [2015,2016]	http://www.ncbi.nlm.nih.gov/pubmed/26340291 http://journals.lww.com/joem/Abstract/2016/05000/Validation_and_Dimensionality_of_the_Integration.12.aspx
Indicators of Integration	Williams J, Nelson C, Caban-Martinez A, Katz J, Wagner G, Pronk N, Sorensen G, McLellan D.	Assessment tool for an integrated approach	http://centerforworkhealth.sph.harvard.edu/resources/indicators-integration
Dimensions of Corporate Integration	Pronk N, McLellan D Sorensen G	Assessment and feedback tool for an integrated approach [2016]	http://centerforworkhealth.sph.harvard.edu/dimensions-corporate-integration

"Work, Health, and Wellbeing: Strategic Solutions for Integrating Wellness and Occupational Safety and Health in the Workplace" Executive and Continuing Professional Education, Harvard Chan School of Public Health	Sorensen G Pronk, N	Training [2012]	(https://ccpe.sph.harvard.edu/Workplace-Health).
"Work, Health, and Wellbeing: Integrating Wellness and Occupational Safety and Health in the Workplace" Executive and Continuing Professional Education, Harvard Chan School of Public Health	Sorensen G Pronk, N	Training [2014, 2015, 2016]	(https://ccpe.sph.harvard.edu/Workplace-Health).
"Ergonomics and Human Factors, Strategic Solutions for the prevention of work-related MSDs". Executive and Continuing Professional Education, Harvard Chan School of Public Health	Dennerlein, J, Pronk N	Training [2011, 2012, 2013, 2014, 2015]	n/a
"Intervention Research Methods" Dept of Social and Behavioral Sciences, Harvard Chan School of Public Health,	Sorensen, G	Academic Coursework/Training [annual]	n/a
"Ergonomics and Human Factors" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J	Academic Coursework/ Training [annual]	n/a
"The Epidemiology of Occupational and Environmental Health Standards" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J	Academic Coursework/ Training [annual]	n/a
"Occupational Safety and Injury Prevention" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J	Academic Coursework/ Training [annual]	n/a
"Environmental and Occupational Epidemiology" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/ Training [annual]	n/a
"Exposure Assessment for Epidemiology" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/ Training [annual]	n/a
"Analytical Methods and Exposure" Assessment Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/ Training [annual]	n/a
"Field Methods of Environmental Health" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/ Training [annual]	n/a
"Occupational Health Standards" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/	n/a

		Training [annual]	
"Practice of Occupational Health"Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/ Training [annual]	n/a
"Injury Epidemiology and Prevention" Department of Environmental Health, Harvard Chan School of Public Health	Dennerlein, J.	Academic Coursework/ Training [annual]	n/a
"Intervening upon Management Practices for Improving Worker Health: One Promising New Approach" HSPH Education Research Center, 2013	Nelson, C	Seminar [2013]	n/a
"Job flexibility and psychological distress among hospital nurses – Contrasting, multilevel associations" December 9, 2013. HSPH Education Research Center	Hurtado, D	Seminar [2013]	n/a
"Supervisory Messages as Leverage for Safety Climate Improvement," December 16, 2013. HSPH Education Research Center	Zohar, D	Seminar [2013]	n/a
"Evaluation of a Comprehensive Ergonomics Program on Construction Sites: Preliminary Results". HSPH Poster Day, Harvard School of Public Health, Boston, MA. November 7, 2014.	Grant MP, Ironside K, Dennerlein JT	Presentation [2014]	n/a
"Adopting Total Worker Health Approaches in Small- to Medium- sized businesses" 1st International Symposium to Advance Total Worker Health. Bethesda, MD. October 8, 2014	McLellan D, Nelson C, Sorensen G, Pronk N	Post conference workshop [2014]	n/a
"Developing and implementing Total Worker Health™ approaches in small- to medium-sized businesses" 1st International Symposium to Advance Total Worker Health. Bethesda, MD. October 7 2014	McLellan D, Pronk N	Presentation [2014]	n/a
"Practical Tools for Assessing and Reporting Total Worker HealthTM in Small- to Medium-Sized Businesses" 1st International Symposium to Advance Total Worker Health. Bethesda, MD. October 7 2014	Pronk N, McLellan D, McGrail M, Olson S.	Presentation [2014]	n/a
"Organizational Factors Related to Implementation of Safety and Wellness Activities in Smaller Organizations" 1st International Symposium to Advance Total Worker Health. Bethesda, MD. October 7,2014	McLellan D, Caban-Martinez A, Katz J, Pronk N, Wagner G, Sorensen G.	Presentation [2014]	n/a
"The Validation of a New Metric for Assessing Approaches Integrating Health Protection and Health Promotion" 1st International	Williams J	Presentation [2014]	n/a

Symposium to Advance Total Worker Health. Bethesda, MD. October 7, 2014			
"Putting Guidelines into Practice: Integrating a health promotion vendor's product in small- to medium-sized businesses" 1st International Symposium to Advance Total Worker Health. Bethesda, MD. October 6, 2014	Pronk N	Preconference workshop [2014]	n/a
"Translating Integrated Health and Safety Research into Practice: Exploring and Implementing Harvard's SafeWell Practice Guidelines". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Dennerlein J, McLellan D, Pronk, N	Pre-symposium workshop [2014]	n/a
"A Framework for developing and implementing Total Worker Health interventions across industries". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Sorensen G, Dennerlein J, McLellan D	Pre-symposium workshop [2014]	n/a
"Design and implementation of an integrated intervention targeting work organization in hospital patient care units". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Nagler E	Pre-symposium workshop [2014]	n/a
"A framework for developing and implementing Total Worker Health interventions in Construction". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Dennerlein J	Pre-symposium workshop [2014]	n/a
"Total Worker Health Surveillance in the US workforce". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Caban-Martinez AJ	Pre-symposium workshop [2014]	n/a
"Multi-Survey Linkage for the Calculation of Occupation-Specific Quality-Adjusted Life Years (QALYs) in the US workforce". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Caban-Martinez AJ	Pre-symposium workshop [2014]	n/a
"Integrated approaches for mobile and contingent workforces, using construction as an exemplar". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Dennerlein J, Sparer E, Murphy L	Pre-symposium workshop [2014]	n/a
"Patterns of Site-Employment of Commercial Construction Workers and the Relationship with Musculoskeletal Pain". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Sparer E	Pre-symposium workshop [2014]	n/a
"Safety climate and the organizational complexity of commercial construction worksites". 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Murphy L	Pre-symposium workshop [2014]	n/a

“Meal Breaks and Mental Health: A Total Worker Health Approach among Hospital Nurses”. 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Hurtado D	Pre-symposium workshop [2014]	n/a
“Development and Validation of an Ergonomic Survey Instrument for Construction Workers”. 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Caban-Martinez AJ	Pre-symposium workshop [2014]	n/a
“Working with Multi-site Pain: Preliminary Findings from the (MUSCLE) Musculoskeletal Study of Construction workers’ Longitudinal Exposures”. 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Caban-Martinez AJ	Pre-symposium workshop [2014]	n/a
“Development of a TWH Intervention for Patient Care Staff”. 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Nagler E	Pre-symposium workshop [2014]	n/a
“Developing work organization measures for patient care staff under the TWH framework”. 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Hurtado D	Pre-symposium workshop [2014]	n/a
“Lessons learned in an acute care hospital to inform future TWH interventions” 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	Tamers S	Pre-symposium workshop [2014]	n/a
“Adoption, Implementation, and Dissemination of Worksite-based Interventions: Lessons Learned and Applications for Improving Worker and Workplace Health”. 1st International Symposium to Advance Total Worker Health. Oct 6-8 2014.	McLellan D	Pre-symposium workshop [2014]	n/a
"Sleep as a source of resilience and restoration", Workshop on Positive Psychobiology, sponsored by the Princeton Center for Research on Experience and Well-Being (funded by the National Institute on Aging), Miami, FL, March 13, 2013	Buxton, O.	Presentation [2013]	n/a
“Causes and Adverse Consequences of Sleep Deficiency and Circadian Disruption: Clinical and Workforce Impacts”, Preceptors Introductory Sleep Course, T-32 Program, Brigham and Women’s Hospital, Boston MA, January 14, 2013	Buxton, O.	Presentation [2013]	n/a
“Causes and Consequences of Sleep Deficiency”, Center for Research on Occupational & Environmental Toxicology, Oregon Health Sciences University, Portland OR Dec 6, 2012 and Department of Biobehavioral Health, Pennsylvania State University, State College PA Feb 28, 2013	Buxton, O.	Presentation [2012, 2013]	n/a

“Workplace wellness: What’s it worth to you” American Society of Safety Engineers 2012	McLellan, D	Webinar [2012]	n/a
"The Harvard School of Public Health Center for Work Health and Well-Being: Integrated approaches to worker health through research and practice”, April 18, 2012, HealthPartners, Inc. in Bloomington, MN	McLellan, D	Presentation [2012]	n/a
“Workplace Wellness—What’s it Worth to You?” Webinar panelist at the American Society of Safety Engineers’ Wellness Symposium. Aired on April 25, 2012.	McLellan, D	Presentation [2012]	n/a
"Insomnia, sleep, and pain" Dental Sleep Medicine Mini-Residency Program, Tufts School of Dental Medicine, Boston MA, 2012	Buxton, O	Presentation [2012]	n/a
“Worklife and effects on sleep health” National Heart Lung and Blood Institute Workshop entitled “Reducing Health Disparities: The Role of Sleep Deficiency and Sleep Disorders”, National Institutes of Health, Bethesda MD.	Buxton, O	Presentation [2012]	n/a
“Causes and Consequences of Sleep Deficiency: Clinical and Workforce Impacts”Oregon Healthy WorkForce Center, Oregon Health & Science University, Portland, OR , 2012	Buxton, O	Presentation [2012]	n/a
“SafeWell: Integrated Practice Guidelines for Workplace Health” at Harvard T.H. Chan School of Public Health Executive and Continuing Professional Education Course. Boston, MA Sept 2012	McLellan, D	Course lecture [2012]	n/a
“Making the Case for an Integrated Approach to Workplace Mental Health”,. HSPH Education Research Center, August 29, 2012	Lamontagne, A.	Presentation [2012]	n/a
“Total Worker Health: Innovative Approaches to Promoting and Protecting Worker Health”,TWH symposium: Safe, Healthy and Cost-effective solutions Symposium, November 29-30, 2012, Iowa City, Iowa	Sorensen, G.	Presentation [2012]	n/a
“Physically Demanding Work and Physical Activity in Health Care Workers: Developing Key Messages for Integrated Interventions”, Total Worker Health Symposium: Safe, Health and Cost-effective Solutions. November 29-30, 2012 Iowa City, IA	Dennerlein, J.	Presentation [2012]	n/a
“Causes and Consequences of Sleep Deficiency”, Epidemiology Seminar Series, Department of Epidemiology, Harvard School of Public Health, Boston MA, November 14, 2012	Buxton, O.	Presentation [2012]	n/a

The Health Consequences of Sleep Deficiency for Cardiometabolic Risk and Other Outcomes/ invited lecture, Dental Sleep Medicine Mini-Residency Program, Tufts School of Dental Medicine, Boston MA, October 18, 2012	Buxton, O.	Presentation [2012]	n/a
"Causes and Consequences of Sleep Deficiency", Center for Family Resilience, Department of Human Development & Family Science, Oklahoma State University, Tulsa OK. October 25, 2012	Buxton, O.	Presentation [2012]	n/a
"Strategies and challenges by size and sector for implementing integrated approaches to worker health", Annual meeting of the American Public Health Association, San Francisco, CA October 30, 2012	McLellan, D.	Presentation [2012]	n/a
"A mixed methods approach to understanding leisure-time physical activity and musculoskeletal pain among construction workers: Findings from a pilot study", 1.) American Public Health Association, San Francisco, CA October 30, 2012; 2)TWH Safe, Healthy and Cost-effective solutions Symposium, November 29-30, 2012, Coralville, Iowa	Caban-Martinez, A.	Presentation [2012]	n/a
"Epidemiologic Pilot Investigating Mental Health among Construction Workers", National Institute of Occupational Health and Safety, Construction Sector Council Meeting, Washington, DC, November 12, 2012	Caban-Martinez, A.	Presentation [2012]	n/a
"Association between Trunk Flexion and Physical Activity in Patient Care Unit Workers", Human Factors and Ergonomics Society, 56th Annual Meeting, November 25, 2012	Arias, O.	Presentation [2012]	n/a
TWH symposium: Safe, Healthy and Cost-effective solutions Symposium, November 29-30, 2012, Iowa City, Iowa	Sorensen, G	Presentation [2012]	n/a
"In Pursuit of Total Worker Health (TM)" HSPH Education Research Center, November 7th, 2011	Schill, A	Presentation [2011]	n/a
"Using Work Outcomes in Comparative Effectiveness Research: Health-Related Work Role Functioning vs. Work Ability," HSPH Education Research Center, April 3rd, 2012	Amick, C.B	Presentation [2012]	n/a
"Emerging efforts to measure Total Worker Health" TWH™ in Action. Volume 2 Number 4 November 2013	McLellan D, Hudson H, Sorensen G	NIOSH e-newsletter article [2013]	https://www.cdc.gov/niosh/TWH/newsletter/TWHne

			wsv2n4.html
"Highlights from the Harvard Center for Work, Health and Well-being. Total Worker Health webinar entitled Charting the Path to Total Worker Health™: A Practitioner's Guide to Getting Started", August 22, 2014.	Dennerlein, J	Presentation [2014]	n/a
"Safer Healthier Workers: Work-family conflict, sleep and the heart" NIOSH science blog, November 19, 2014	Buxton, O, Jacobsen, H	Blog [2014]	http://blogs.cdc.gov/niosh-science-blog/2014/11/19/work_sleep_heart/).
"The Impact of Workplace Policies In the Safety, Health, and Well-Being of Hospital Workers, Advancing Research and Scholarship" Boston College, Boston College, Yawkey Center, Boston, MA. Dec. 11, 2014.	Hashimoto D, Sabbath E.	Presentation [2014]	n/a
"The Affordable Care Act's Impact on the Practice of Occupational Medicine and the Implications for Public Health Surveillance", Northeast Regional Occupational Disease and Injury Surveillance Conference, Chester, CT, May 14, 2014.	Hashimoto, D	Presentation [2014]	n/a
"Who will care for us: Addressing health, productivity and turnover in long-term care". National Institute on Aging Intramural Research Program. Baltimore, MD. November 2014	Okechukwu, C.	Presentation [2014]	n/a
"Total Worker Health: Promising and Best Practices in the Integration of Occupational Safety and Health Protection with Health Promotion in the Workplace," Institute of Medicine presentation, Washington DC, May 2014.	Sorensen, G.	Presentation [2014]	
"Reaction to presentation of the Total Worker Health™: Promising and Best Practices in the Integration of Occupational Safety and Health Protection with health Promotion in the Workplace" A workshop meeting at the Institute of Medicine. Washington, DC, May, 2014.	Pronk, N.P	Presentation [2014]	n/a
"Addressing Prolonged Sitting Time at Work: Connecting Practice and Research". Faculty and Staff Scientific Lecture. Oregon Institute of Occupational Health Science at the Oregon Health Sciences University, Portland, OR, June, 2014.	Pronk, N.P.	Presentation [2014]	n/a

“Sit Less, Move Often, Move More: Addressing Prolonged Sitting Time at Work as Part of a Total Worker Health Agenda. Symposium on Sedentary, Stationary and Physically Demanding Work” Oregon Institute of Occupational Health Science, Portland, OR, June, 2014.	Pronk, N.P.	Presentation [2014]	n/a
“Innovative approaches and opportunities for promoting and protecting worker health”, Washington University at St. Louis, St. Louis, MO, March 20, 2014	Sorensen G.	Presentation [2014]	n/a
“The application of comparative effectiveness research to test worksite interventions”. Comparative Effectiveness Research Institute, Boston, MA, May 15, 2014.	Sorensen G.	Presentation [2014]	n/a
“Potential Impacts of the Affordable Care Act On the Colorado Workers’ Compensation System”, 2014 Colorado Workers’ Compensation Educational Conference, Colorado Springs, CO, July 24, 2014	Hashimoto D, Keynote speaker	Presentation [2014]	n/a
“The Psychology of Chronic Pain Invited speaker for the Department of Occupational Health in Partners health care (Brigham and Womens Hospital & Mass General Hospital), September 1st, 2011,	Reme, S	Presentation [2011]	n/a
Active Twitter account	Center staff	Social Media [ongoing]	n/a

OUTCOMES			
Title	**Authors/Organization /Institution**	**Type of Outcome**	**URL (if available)**
Integrated approach to worker health	HSPH, Dana-Farber Cancer Institute, HealthPartners	HealthPartners, a vendor of safety, health, and well-being services is adopting integrated approaches for its organization, and adapting its programs for clients on a pilot basis. –Movement toward TWH practices by employers	n/a
Indicators of Integration	Williams J, Schultz T, Nelson C, Caban-Martinez A, Katz J, Wagner G, Pronk N, Sorensen G, McLellan D.	Validated metric for an integrated	http://www.ncbi.nlm.nih.gov/pubmed/26340291 http://journals.lww.com/joem/Abstract/2016/05000/Validation_and_Dimensionality_of_the_Integration.12.aspx
Dimensions of Corporate Integration	McLellan D Sorensen G	Assessment and feedback tool for an integrated approach [2016]	http://centerforworkhealth.sph.harvard.edu/dimensions-corporate-integration
Partners HealthCare	Sorensen G, Hashimoto D	Findings from this research project have been used by Partners to integrate traditional occupational health services with employee health promotion within Partners Healthcare. This provides a model	n/a

		approach for other organizations.	
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	Vermont Department of Health has utilized the Guidelines in materials it produced for worksites.	http://www.healthvermont.gov/sites/default/files/documents/2016/12/HPDP_PA%26N%20Worksite%20Creating%20a%20Healthier%20Worksite%20Resource.pdf
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	The Transit Bus Operator's Health, Wellness and Retention project used the Guidelines as a framework for its Practitioner's Guide.	https://www.nap.edu/catalog/22322/developing-best-practice-guidelines-for-improving-bus-operator-health-and-retention https://www.nap.edu/login.php?action=guest&record_id=22322
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	Listed as a planning, assessment, and evaluation tool on NIOSH website	https://www.cdc.gov/niosh/twh/tools.html
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	Executive Summary from Guidelines were forwarded by an Australian attendee to the ECPE course to legislators in that country to encourage investment in health and safety.	n/a
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	North Shore LIJ Health System. Manhasset, NY November 6, 2012	n/a
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	Executive Summary from Guidelines were forwarded by an Australian attendee to the ECPE course to legislators in that	n/a

		country to encourage investment in health and safety.	
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	Johnson Matthey, Inc, For applying guidelines into health and safety program. October 1, 2012	n/a
SafeWell Practice Guidelines	McLellan D, Harden E, Markkanen P, Sorensen G	Massachusetts Department of Public Health, Boston, MA For considering integrated approaches to worker health in consideration of regulations to provide tax incentives for small businesses that adopt wellness programs. December 3, 2012	n/a
SafeWell in Small-to medium sized businesses delivered by a vendor	McLellan D, Pronk N, Sorensen G	Movement toward TWH practices by employers, including vendors and their clients	www.ncbi.nlm.nih.gov/pubmed/27206128
SafeWell in Small-to medium sized businesses delivered by a vendor	McLellan D, Pronk N, Sorensen G	Changes in TWH by employers	www.ncbi.nlm.nih.gov/pubmed/27206128
Fishing Partnership Support Services (FPSS)	Dennerlein J, McLellan D	Provided seed funding and Partnered in planning and implementing a strategic planning	n/a

		session on the issue of mental and behavioral health in the NE commercial fishing community	
Boston Fire Fighters	Sorensen G, Wagner G, Sparer E	Pilot project work around exposures to workplace hazard	https://www.reuters.com/article/us-health-cancer-firefighters/fire-station-air-quality-puts-firefighters-at-risk-idUSKBN1AR297
Servico Social da Industria (SESI)	Sorensen G, Dennerlein J, McLellan D	Memo of Understanding signed for pilot work and training around TWH approaches. Training conducted in 5/2017	n/a
Mutual de Secuduridad, Santiago, Chile	Dennerlein J, Sorensen G	Memo of Understanding signed for Center consultation in adapting Safewell Guidelines	n/a
Sodexo, LLC	Sorensen G, Permuth R	NIOSH Funded R01 "Organizational Approaches to Total Worker Health for Low-Income Workers"	n/a
VHA, Brockton	Sorensen G, McPhaul K	TWH approaches training and technical assistance for implementation of a TWH pilot project at the Brockton facility	n/a
Massachusetts Department of Public Health	Dennerlein J	Member of the Hospital Ergonomics Task Force for reviewing data and making recommendations for musculoskeletal	http://www.mass.gov/eohhs/docs/dph/occupational-health/ergo-sph-hospitals-2014.pdf

		injuries and safe patient handling programs	
“Healthcare and Commercial Construction: The Role of Inspections Within Health and Safety Interventions in Dynamic Workplaces and Associations With Safety Climate”	Grant M	Harvard TH Chan School of Public Health, Doctoral Dissertation, 2016	https://dash.harvard.edu/handle/1/27201742
“Flexible work arrangements and the health of direct-care workers.”	Hurtado, D	Harvard TH Chan School of Public Health, Doctoral Dissertation, 2013	
“Social Determinants of Workers' Health and Well-being”	Seung-Sup K	Harvard TH Chan School of Public Health, Doctoral Dissertation, 2011	
“The effects of work, stress, and work-family conflict on health behavior,"	Nelson C	Harvard TH Chan School of Public Health, Doctoral Dissertation, 2011	

Acknowledgments

In addition to our Center Investigator team and our partners and collaborators, we would also like to acknowledge our multi-disciplinary External and Worksite Advisory Boards. We are extremely grateful for their ongoing commitment and contributions to our scientific and outreach efforts.

References

Please see individual components for references.

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FEDERAL FINANCIAL REPORT

FINAL

1. Federal Agency and Organizational Element to Which Report is Submitted NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH		**2. Federal Grant or Other Identifying Number Assigned by Federal Agency** 5U19OH008861-09		
3.Recipient Organization (Name and complete address, including Zip code) HARVARD SCHOOL OF PUBLIC HEALTH 677 HUNTINGTON AVENUE BOSTON MA 021156028				
4a. DUNS Number 149617367	**4b. EIN** 1042103580A6	**5. Recipient Account Number or Identifying Number** 275-23600-114897	**6. Report Type** ☐ Quarterly ☐ Semi-Annual ☐ Annual ☒ Final	**7. Basis of Accounting** ☒ Cash ☐ Accrual
8. Project/Grant Period **From:** 09/01/2007		**To:** 02/28/2017	**9. Reporting Period End Date** 02/28/2017	
10. Transactions			**Cumulative**	
(Use lines a-c for single or multiple grant reporting)				
Federal Cash (To report multiple grants, also use FFR Attachment):				
a. Cash Receipts			0.00	
b. Cash Disbursements			0.00	
c. Cash on Hand (line a minus b)			0.00	
(Use lines d-o for single grant reporting)				
Federal Expenditures and Unobligated Balance:				
d. Total Federal funds authorized			2,545,102.00	
e. Federal share of expenditures			2,545,101.79	
f. Federal share of unliquidated obligations			0.00	
g. Total Federal share (sum of lines e and f)			2,545,101.79	
h. Unobligated balance of Federal funds (line d minus g)			0.21	
Recipient Share:				
i. Total recipient share required			0.00	
j. Recipient share of expenditures			0.00	
k. Remaining recipient share to be provided (line i minus j)			0.00	
Program Income:				
l. Total Federal program income earned			0.00	
m. Program income expended in accordance with the deduction alternative			0.00	
n. Program income expended in accordance with the addition alternative			0.00	
o. Unexpended program income (line l minus line m or line n)			0.00	

11. Indirect Expense	**a. Type**	**b. Rate**	**c. Period From**	**Period To**	**d. Base**	**e. Amount Charged**	**f. Federal Share**
	Predetermined	61.5	09/01/2015	08/31/2016	87,136.92	53,589.21	53,589.21
				g. Totals:	87,136.92	53,589.21	53,589.21

12. Remarks: Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation:

13. Certification: By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and intent set forth in the award documents. I am aware that any false, fictitious, or fraudulent information may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 18, Section 1001)

a. Typed or Printed Name and Title of Authorized Certifying Official Brian Cody	**c. Telephone (Area code, number and extension)** **d. Email address** brian_cody@harvard.edu
b. Signature of Authorized Certifying Official Submitted directly to eRA Commons.	**e. Date Report Submitted (Month, Day, Year)** 03/28/2017 **14. Agency use only:**

Standard Form 425
OMB Approval Number: 0348-0061 Expiration Date: 10/31/2011

TANGIBLE PERSONAL PROPERTY REPORT
Final Report SF-428- B

Federal Grant or Other Identifying Number Assigned by Federal Agency (Block 2 on SF-428).

5U190H008861-09

1. **Report** (Select all that apply)

a._ Federally-owned Property (List on Supplemental Sheet SF-428S or recipient equivalent and complete Section 2a below.)

b. _ Acquired Equipment with acquisition cost of $5,000 or more for which the awarding agency has reserved the right to transfer title (List on Supplemental Sheet SF-428S or recipient equivalent and complete Section 2b below.)

c. _ Residual Unused Supplies with total aggregate fair market value exceeding $5,000 not needed for any other Federally sponsored programs or projects. *(Complete Section 2c below)*

d. X None of the above

2. Complete relevant section(s)

ForAge11cy.-UtieC>nly

2a. **Federally-owned Property**
(Select one or more.)

(i) _ Request transfer to Award______________
(ii) _ Request Federal Agency disposition instructions
(iii) _ Other *(Provide detail in Block* ***3*** *or attach request)*

Agency response to requested disposition of Federally owned property:

(i)··Reclpient request pprqv d_,_---aenied _

(ii) Dispose in accordance with attached instructions ___.

2b. **Acquired Equipment** *(Select one or more.)*

(i) _ Request unconditional transfer of title with no further obligation to the Federal Government.

(ii) _ Request Federal Agency disposition instructions

Note: If the awarding agency does not provide disposition instructions within 120 days the recipient may continue to use the equipment for Federally supported projects or dispose in accordance with the applicable property standards.

Agency response to requested disposition of acquired equipment:

0) [redacted] '/ -.
(ii) Dispq iin tcorancewit iji fff;din foctiohs _.

Authorized Awarding Agency Official

Signature:	Date:
Name:	Phone:
Title	Email

2c. **Reportable Residual Unused Supplies**

(i) _ Sale proceeds or_ Estimate of current fair market value•••••••••••••••••••••••• $__________
(ii) Percentage of Federal participation •• __________%
(iii) Federal share•• $__________
(iv) Selling and handling allowance•••••••••••••••••• ••••••••••••••••••• ••••••• •••••• $__________
(v) **Amount remitted to the Federal Government**... $__________

4. Comments

Agency use only

FINAL REPORT ATTACHMENT TO SF-428

SF- Final Report Form -Attachment to
SF-428 0MB Approval Number:

Form Approved Through 10/31/2018
0MB No. 0925-0002

Department of Health and Human Services

Final Invention Statement and Certification

(For Grant or Award)

DHHS Grant or Award No.

SU190H0088691-09

A. We hereby certify that, to the best of our knowledge and belief, all inventions are listed below which were conceived and/or first actually reduced to practice during the course of work under the above-referenced DHHS grant or award for the period

9/1/2011 *original effective date* through 2/28/17 *date of termination*

B. **Inventions** (Note: If no inventions have been made under the grant or award, insert the word *"NONE"* under

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO DHHS
NONE		
(Use continuation sheet if necessary)		

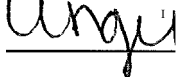
C. Signature - This block ***must*** be signed by an official authorized to sign on behalf of the institution.

Title
Assistant Director, Research Administration

Typed Name
Angie Suriel

Name and Mailing Address of Institution
President and Fellows of Harvard College
677 Huntington Avenue
Boston, MA 02115-6028

Signature



Date