Moving Research to Practice through Partnership: A Case Study in Asphalt Paving

Charlotte Chang, DrPH MPH,[1]* Laura Nixon, MPH,[1] and Robin Baker, MPH[2,3]

Background *Multi-stakeholder partnerships play a critical role in dissemination and implementation in health and safety. To better document and understand construction partnerships that have successfully scaled up effective interventions to protect workers, this case study focused on the collaborative processes of the Asphalt Paving Partnership. In the 1990s, this partnership developed, evaluated, disseminated, and achieved near universal, voluntary adoption of paver engineering controls to reduce exposure to asphalt fumes.*

Methods *We used in-depth interviews (n = 15) and document review in the case study.*

Results *We describe contextual factors that both facilitated and challenged the formation of the collaboration, central themes and group processes, and research to practice (r2p) outcomes.*

Conclusions *The Asphalt Paving Partnership offers insight into how multi-stakeholder partnerships in construction can draw upon the strengths of diverse members to improve the dissemination and adoption of health and safety innovations and build a collaborative infrastructure to sustain momentum over time.* Am. J. Ind. Med. 58:824–837, 2015. © 2015 Wiley Periodicals, Inc.

KEY WORDS: partnerships; research to practice; construction; engineering controls; asphalt

INTRODUCTION

As attention in occupational health and safety increasingly moves toward issues of "research to practice," or ensuring that existing solutions actually make it into the real world to protect workers [Glasgow and Emmons, 2007; National Research Council and Institute of Medicine, 2009; Gillen, 2010], so does interest in better understanding and promoting efforts to disseminate and implement effective interventions. Partnerships have long been considered critical to addressing the need for better research translation and dissemination in public health [Schurman, 1996; Weinstein et al., 2007; Kreuter and Bernhardt, 2009; Chen et al., 2010]. These collaborative entities allow "independent individuals and organizations to combine their human and material resources and accomplish objectives they are unable to bring about alone" [Lasker et al., 2001].

Partnerships that bridge disciplines and constituencies can help make research questions and instruments more relevant in the field; build relationships and trust with key stakeholders, in turn increasing response rates and participation in research; develop interventions more likely to succeed in the real world; and facilitate the translation, dissemination, implementation, and sustainability of interventions in the field [O'Fallon and Dearry, 2002; Best et al., 2003; Cargo and Mercer, 2008; Gillen, 2010]. Ongoing partnerships that continue their collaboration beyond an initial research project are often able to more effectively respond to

[1]Labor Occupational Health Program, University of California, Berkeley, California
[2]CPWR—Center for Construction Research and Training, Silver Spring, Maryland
[3]Center for Occupational and Environmental Health, University of California, Berkeley, California

Contract grant sponsor: CPWR; Contract grant number: U60-OH009762; Contract grant sponsor: NIOSH.

Correspondence to: Charlotte Chang, DrPH, MPH, Labor Occupational Health Program, University of California, 2223 Fulton Street, 4th Floor, Berkeley, California.
E-mail: cychang@berkeley.edu

Accepted 23 April 2015
DOI 10.1002/ajim.22475. Published online 15 June 2015 in Wiley Online Library (wileyonlinelibrary.com).

emerging issues and changes in the system [Best et al., 2003]. Collaborative inquiry, involving collective conceptualization of the research problem, development of mutual understanding on common issues, and engagement in change interventions, allows for opportunities for "early and continued involvement of relevant decision makers," which may be the best predictor of research utilization [Kramer et al., 2010].

Because of the important role that partnerships play in the uptake of safety and health interventions, and also because the challenges of collaborating across diverse interests have been widely acknowledged [Israel et al., 1998], the partnership process is considered a critical mediating factor in successful dissemination and implementation efforts [Weinstein et al., 2007; Wallerstein et al., 2008; Kreuter and Bernhardt, 2009; Chen et al., 2010]. Partnerships and their role in dissemination and implementation have been discussed extensively in public health [Best et al., 2003; Cargo and Mercer, 2008; Kreuter and Bernhardt, 2009; Minkler and Salvatore, 2012; Minkler et al., 2014]. Commonly recommended practices for facilitating the development of these partnerships include: the participation of key stakeholders; building mutual trust and respect; maintaining open and consistent communication; sharing decision-making power; ensuring equitable participation; developing common missions, goals, and objectives for the partnership; creating partnership agreements and other structures to facilitate collaboration; involving partnership facilitators and other formal and informal leaders; ensuring dissemination to all partners and to populations most affected; and evaluating the partnership and its activities [Israel et al., 1998; Connors and Seifer, 2000; Weiss et al., 2002; Wallerstein et al., 2008; Kramer et al., 2010].

Little is known, however, about how such partnerships function and play out in occupational health and safety [Chang et al., 2013; Kramer et al., 2010], and particularly in the construction industry. Collaboration between stakeholders such as building trades unions, construction contractors, government agencies, equipment manufacturers and others, and the mechanics of how they operate successfully have been largely unexplored. As part of its multi-year research to practice (r2p) initiative to study and promote dissemination efforts in construction health and safety, CPWR – The Center for Construction Research and Training undertook research and evaluation efforts to better document and understand partnerships in construction that have successfully scaled up effective interventions to protect workers.

This article details CPWR's in-depth qualitative case study of the Asphalt Paving Partnership, an effective multi-stakeholder collaboration in construction. We describe the processes that enabled the group to come together and work across diverse stakeholders and interests and identify elements contributing to the partnership's success, focusing in particular on its original efforts to design and disseminate engineering controls for asphalt fumes (Engineering Controls Partnership). The collaboration's experiences offer lessons for future partnership efforts to explore and promote promising safety practices that are much needed in the high hazard construction industry.

Asphalt Paving Industry and Fumes

Asphalt, a product of crude oil in petroleum refining, is a cement-like substance used most commonly in paving and roofing. More than 92% of the roads in the United States are paved with asphalt [National Asphalt Pavement Association and European Asphalt Pavement Association, 2011], and the asphalt paving industry employs an estimated 300,000 people [National Institute for Occupational Safety and Health (NIOSH), 2001; Mickelsen et al., 2006].

Symptoms and conditions associated with exposure to asphalt fumes include eye, nose, and throat irritation, drowsiness, loss of appetite, changes in lung function, headaches, skin rash, cough, breathing problems, asthma, and bronchitis [Norseth et al., 1991; Randem et al., 2004; Tepper et al., 2006]. At the time the original Engineering Controls Partnership formed, there was substantial concern about the health effects and potential carcinogenicity of asphalt fumes, yet information was limited and the link between exposure and long-term health effects was controversial. Evidence focusing specifically on occupational asphalt exposure and cancer risk included three Danish cohort studies of asphalt workers which found excess cancer incidence and mortality among asphalt workers, and NIOSH animal studies that found tumors resulting from dermal exposure to condensed asphalt fume [Kojola, 1994]. The epidemiological studies did not control for potential confounders such as smoking or exposure to coal tar, and the animal studies tested roofing asphalt, rather than paving asphalt, which has a slightly different composition [Kojola, 1994]. Industry critiques of the animal studies also focused on testing asphalt heated to temperatures much higher than those used in paving, up to 600°F [Macro International, 1998].

Eventually, in 2011, the International Agency for Research on Cancer (IARC) classified exposure to asphalt fumes in paving operations as "possibly carcinogenic to humans (Group 2B), " finding inadequate evidence for the carcinogenicity of occupational exposures from human or animal studies [International Agency for Research on Cancer (IARC), 2011]. While some data were suggestive, with mechanistic evidence of mutagenic and genotoxic/cytogenetic effects in workers exposed to emissions during paving, as well as those observed in experimental systems under controlled conditions, the IARC classification reflected the conclusion that overall, asphalt fume is not a human carcinogen.

The Partnership

The Asphalt Paving Partnership began in the mid-1990s with a focus on developing engineering controls to reduce worker exposure to asphalt fumes. Using a model that integrated scientific research and practice, the partnership was able to achieve broad adoption of evidence-based worker protections against asphalt fumes. The collaboration continues today, and has expanded its efforts to address other industry hazards including silica and dermal exposures as well as work zone safety. Participants in the original Engineering Controls Partnership included representatives from industry, labor, and government: the National Asphalt Pavement Association (NAPA), which represents asphalt paving contractors and equipment manufacturers, the Laborers' International Union of North America (LIUNA), the Laborers' Health and Safety Fund of North America (LHSFNA), the International Union of Operating Engineers (IUOE), the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the Federal Highway Administration (FHWA).

Liquid asphalt producers and the Asphalt Institute, a trade group that represents asphalt producers, were also involved in providing technical expertise in the early stages of the partnership. In subsequent efforts, the partnership engaged additional partners, including academic researchers, the Association of Equipment Manufacturers (AEM), milling machine manufacturers, the American Association of State Highway and Transportation Officials (AASHTO), state departments of transportation (DOTs), and the American Road and Transportation Builders Association (ARTBA).

METHODS

We used a case study research approach [Yin, 2003] to conduct document review and 15 in-depth interviews with industry, labor, and government stakeholders who had been involved in the Asphalt Paving Partnership. According to the case study research method as described by Yin [2003], we developed a study protocol to guide the project that included detailed research questions of interest, methods, study propositions to focus the inquiry, and theories and frameworks relevant to understanding the partnership [see Tables I and II].

For the document review, we examined industry association publications, partner presentations, trade and academic journal articles, and award application materials provided by partnership facilitators, as well as reports and correspondence gathered from other research participants. Drawing from this review, we created a detailed timeline of key events over the history of the partnership, identified significant stakeholders and organizations, and extracted major themes relating to research to practice principles and the partnership's approach. The background information from the document both informed the in-depth interview process and provided data for addressing research questions.

We developed a semi-structured in-depth interview guide based on the document review and exploratory interviews with partnership facilitators. Potential participants were identified by partnership facilitators, as well as through the document review and recommendations solicited from other participants during interviews. All participants were current or former members of the partnership, and to obtain a diversity of perspectives from labor ($n = 3$), contractor ($n = 4$), manufacturer ($n = 2$), and government representatives ($n = 5$) in the sample, we aimed to recruit three to five participants in each category.

Telephone interviews lasting 60–90 min were conducted by two-person research teams. Interview question topics focused on partnership development and processes that contributed to success, including the participant's background and history of involvement with the partnership, motivations, concerns, roles, interpretations of partnership success, facilitation, leadership, partnership structures, resources, and the transferability of the partnership's experience to other areas of construction. The interviews were audio-recorded, transcribed, and checked by research team members for accuracy.

Two researchers conducted textual analysis on all 15 interview transcripts using both pre-defined codes as well as open-codes using ATLAS.ti qualitative data analysis software. The research team members defined an initial set of codes related to partnership success based on case study research questions, document review findings, and the literature on public health partnerships and diffusion and dissemination. Researchers developed new codes during the

TABLE I. Asphalt Paving Partnership Case Study Research Questions

Research questions
How successful was the Asphalt partnership in obtaining widespread adoption of worker health and safety solutions and potentially reducing worker injuries and illnesses?
How successful was the partnership in collaborating across stakeholder groups and creating a sustainable, replicable model for industry r2p partnerships?
What elements contributed to the partnership's successes and challenges?

analysis process based on themes emerging from the data. During the analysis process, researchers exchanged memos and met regularly to reconcile interpretations of codes and themes. Quotes were member-checked with research participants.

This study was approved by UC Berkeley's Office for the Protection of Human Subjects.

RESULTS

The Asphalt Paving Partnership achieved considerable success in controlling asphalt fumes through their initial engineering controls effort as well as in their later follow-up efforts on warm mix asphalt. Partners attributed much of their success to aspects of partnership development and processes. In this section, we describe contextual and background factors that both facilitated and challenged the formation of the collaboration, the central principles and group processes participants identified as helping the partnership function, and the r2p outcomes and accomplishments of the partnership resulting from effective collaborative work.

Contexts of Partnership Formation

Several developments coincided to create momentum for the partnership in the mid- to late- 1990s. Concern about and investigation into the health effects of asphalt fumes by a range of stakeholders including government, labor, and community groups was increasing amidst a climate of heightened awareness about toxic hazards in occupational health. Along with related policy initiatives and concerns about liability, these events compelled industry stakeholders to act and presented them with a choice between pursuing an adversarial or a collaborative approach.

Developments in research and government policies

As mentioned above, animal research and European studies conducted to study the health effects of asphalt fumes drew the attention of labor groups concerned about the potential impact on workers. In 1994, the Laborer's Health and Safety Fund issued a report summarizing available health effects evidence, suggesting that asphalt fumes be considered a suspect human carcinogen, and calling for further research, field testing, and a new permissible exposure limit (PEL) [Kojola and Moran, 1993; Moran and Kojola, 1994]. Regulatory and legislative action was also underway, including OSHA proposals for asphalt fume health standards in 1988 and 1992 as part of efforts to update PELs in construction, and a 1991 Congressional act requiring the use of scrap tires in asphalt to encourage recycling of rubber tires. The proposed addition of crumb rubber (from scrap tires) to asphalt mix prompted pushback from both industry and labor groups concerned about worker health. In response, the Federal Highway Administration was instructed to investigate the potential health effects of the requirement [Moran and Kojola, 1994; Moran et al., 1997; Macro International, 1998].

Adding to the scrutiny were communities and activists who, responding to the strong odor of asphalt in communities, began to focus on possible consequences for the health of the public and the physical environment. One NAPA partner described the challenges of having "such a visible industry. We've got to work in neighborhoods, we've got asphalt plants. There's probably close to 3,500 plants all over the country. We just wanted to solve the issue."

Potential liability and avoiding "another asbestos"

Partners described the role that the construction industry's experience with asbestos played in elevating the priority of addressing concerns about asphalt fumes. Asbestos exposure, which increased the risk for mesothelioma and other cancers, led to the longest mass tort in history and would eventually be called "the worst occupational health disaster in U.S. history" [Carroll et al., 2002]. Construction workers were one of the groups which had been at significant risk. By the early 2000s, $54 billion had been spent on asbestos litigation [Carroll et al., 2002]. One partner recalled:

The contractors, NAPA and its members, were obviously very concerned that asphalt not become another asbestos. Because if it turned out that they had a problem like asbestos, no one would be in business… And so they were quite interested in what could you do to limit your liability.

From the perspective of the labor partners, the potential toxicity of fumes to their members as well as the impact on jobs were also serious concerns:

The building trades were never totally happy about the asbestos litigation exposure. They did not want to see another one of those in their memberships, but they also saw that this was 300,000 or 400,000 jobs, and they need those jobs. So anything that could be done to both protect the workers and keep the jobs was a win–win.

The accumulation of research, the prospect of regulation, and the potential for negative public opinion with the possible classification of asphalt fumes as an occupational carcinogen were recognized by the asphalt industry as serious threats that required action. However, NAPA disagreed with conclusions drawn from existing research

linking asphalt fumes to cancer and initially responded to government and labor's concerns by contesting the science, investing substantial sums in their own studies to counter government and labor's research to address the increasingly pressing issue.

Opting for an alternative approach

As NAPA and industry partners were sponsoring more and more research to challenge government studies, an alternative to what partners termed "the adversarial approach" began to take form. A prominent paving contractor and then chairperson of NAPA wondered if there was a way to sidestep the controversy altogether, explaining "I said, we're crazy to fight this. Why don't we just get away from exposing our people to these fumes and then the issue goes away whether they're bad or good."

This contractor, whom partners widely credited as being an important early champion of the proactive, collaborative approach, leveraged his relationships within the industry to convince a core group of contractors and manufacturers to begin to investigate how to reduce worker exposures. Initial exploration of the issue pointed to a variety of potentially viable engineering controls. The manufacturers developed prototype control packages based on these ideas, and early tests suggested that fairly simple ventilation systems could significantly reduce the level of fumes near workers. One partner described the initial trials:

[I]t was literally plastic sheeting and duct tape. That was kind of how basic it was at that time. You know, fans. It was pretty rudimentary. And it was really just to see if the concept worked. Once it looked like things were really moving, then the manufacturers came in in a formal manner.

Supporting this perspective was the concern among contractors and manufacturers that if a health standard to limit worker exposure to asphalt fumes was put in place, it might require changes to equipment or work practices that they would find challenging or expensive to implement. Several partners referred to the threat of regulation as an important driver that initially motivated the formation of the partnership. One government-based partner commented, "you can't underestimate the role of the initial threat, the regulatory threat. And maybe that's the generating spark. It isn't just goodwill that will make this go."

Partners also noted that for paving contractors and equipment manufacturers, the threat of regulatory action made the decision to invest in proactive measures easier to justify. In describing the manufacturers' initial reaction to the engineering controls initiative, one manufacturer partner referenced a number of concerns, including added cost. However, according to this partner, taking a proactive approach allowed each manufacturer to design controls tailored to its own machines and allowed them to shape the process. "The good thing was we had a group of manufacturers that all believed to a man that we're far better to be ahead of this thing and be part of the solution than wait for an edict from OSHA."

Reaching out to stakeholders

With promising preliminary tests of engineering controls, NAPA began reaching out to other stakeholder groups. They knew that they needed the collaboration of key government agencies and of labor unions to move forward with developing, testing, and implementing the engineering controls. To make the case for collaborating on the controls, rather than continuing to dispute research findings on the possible health effects of asphalt fumes, the NAPA contractor who originated the idea of getting ahead of the issue observed to the then-director of NIOSH, "this is going to be our mice against your mice. We're going to be testing mice forever. Why don't we just get rid of the fume?"

Although NAPA members included both union and non-union contractors, there was recognition about the importance of the role of unions in making meaningful change. One facilitator noted that:

[Even non-union contractors in NAPA] were very vocal and adamant that if they went forward to do this kind of health protection that they had to do it with the union involvement because they felt that they would never get what they wanted from the government. They'd never get it right if they didn't have the workers representatives agreeing. That was the only way to success. And so they encouraged union participation.

Proceeding cautiously within their own organization, one NAPA partner explained how union involvement was a central part of their commitment to trying out a collaborative approach:

If we don't engage [labor] as partners, then the outcome can be very, very different, and we'll continue to do business as we've always done business. We were looking and searching for a different [way] to get out of this adversarial model.

Challenges

While the idea for partnership was appealing, challenges remained in bringing together diverse groups. Foremost among these was the lack of established trust and a history of adversarial or competitive relationships between some partners. Labor and government representatives were wary of partnering with industry around the controversial worker health issue, and on the industry side, there was distrust of

both labor and government among NAPA members. Equipment manufacturers were more accustomed to competing with each other for market share than cooperating and had concerns about collaborating in ways that could spark anti-trust concerns. The partnership found it needed to address issues of adapting controls to variations in machinery between manufacturers while also neutralizing the threat that any one manufacturer choosing to participate might develop a competitive advantage over another.

In spite of the reservations partners recall having about joining the partnership, they recognized the difficulties associated with pursuing other options, including the complexity and time horizons of the regulatory process. Each partner group described a growing recognition of the potential for genuine and fruitful collaboration. As one labor partner recalled the opportunity presented. "It was sort of an offer, you know: can we work together in some way to address your concerns about potential health problems from asphalt?"

Themes in Building and Sustaining a Multi-Stakeholder Collaboration

In this section we discuss common themes that emerged from the interviews as factors contributing to the partnership's success.

Common vision, common goals, and compartmentalization

Establishing a common, "win–win" vision that would benefit all partners and protect worker health was cited as particularly important for gaining buy-in from the diverse stakeholders. A former chairperson and co-facilitator of the partnership described what a common vision brought to the development of the partnership. "Therein lies a common ingredient, a bond, a mutually supportable goal that becomes the glue for each of these partnerships. It's that kind of issue: protecting, preserving, promoting the protection of workers."

One partner from the equipment manufacturers' perspective emphasized the importance of a common vision that was collectively defined by all the members of the partnership and used to ground the work:

You have to start with having a target, having a goal. I give [the partnership chairperson] credit for defining it initially, getting buy-in from everybody. He didn't just say, "This is what we're going to do." He got good input. But then every meeting he started off reminding everybody what the goals were, keeping them focused.

Partners also noted the importance of clearly defining the issue of focus and translating the vision into concrete deliverables. As one of the partnership facilitators suggested:

If all you want to do is convene a coffee klatch that will meet every three months forever, it'll be fun, but you really don't have anything to move forward. . ..No matter how long it takes, you've got a deliverable, which is just different than an ongoing 'let's break bread together' dialogue.

However, developing a common vision and actionable goals and objectives did not eliminate differences between partners, particularly those that occurred outside of the issue of reducing exposure to asphalt paving fumes. Partners found they had to "agree to disagree" about certain issues and suggested that identifying and compartmentalizing areas of tension outside of the partnership allowed individuals to focus on collective action in the areas where they shared a common interest. Such issues ranged from beliefs about the long term health effects of asphalt fumes to contract negotiations between local unions and their employers. As one partner from NIOSH reflected, "The state of mind was [that] you could be proactive, you could be positive, you could be worker-protective and still have disagreements."

One partner from the labor perspective used the term "maturity" to describe the group's ability to compromise and commented:

I think we've actually made a commitment to each other. . .that any of my locals – any issues they may be having with any of the employers that are a part of the association – I think we've made an unwritten commitment that we're not going to bring that into the mix.

Key stakeholders

Partners described actively including all key stakeholders as an essential ingredient for success. They noted that each partner organization made critical contributions to the effort. All collaborators helped to promote and create buy-in for partnership activities within their respective constituencies, made themselves fully available to other partners when needed, and contributed some level of time and financial resources. As a partner from the labor perspective recounted, "we represented different constituencies, but if someone had to sort of pull their constituency in, they would do it. They would just do it."

Partners also took on specific roles. NAPA was often credited with providing leadership in initiating the collaboration and in the administration and facilitation of the partnership. They actively invested in the functioning of the group, retaining the partnership's facilitator and contributing funding for research. NAPA's member contractors, engineers, and other professionals provided practical and technical paving expertise. Labor unions contributed technical and practical expertise on health and safety issues as well as critical worker perspectives. Labor's guidance and

participation also lent credibility to the group's, and especially industry's, role in worker protection efforts.

Manufacturers designed, developed, and tested controls for their machines, committed to implementation of the changes, and invested substantial resources in the research, development, and testing efforts. Respondents described government partners as providing a range of resources and skills. NIOSH contributed scientific research and evaluation expertise, and helped to shepherd the partnership's work through the agency's processes for hazard review and issuing engineering control guidelines. OSHA took on a pivotal role in drafting the voluntary agreement that would eventually commit the group to implementing the engineering controls and allow them to achieve universal adoption. They used their weight as a regulatory agency to bring partners together to sign it, and provided critical legal cover against anti-trust claims that might otherwise have been filed against manufacturers. FHWA was credited with providing essential resources for the group's early work, and convened partners early on regarding crumb rubber health effects research, which helped lay the foundation for the formal partnership.

In addition to the organizational roles detailed above, those interviewed also stressed the importance of having the right individuals at the table and the dedication of each individual to the partnership. One labor partner emphasized the importance of these factors. "You have to have individuals that are open to working with other partners in ways that they may not have even thought of in the past."

Facilitators

An essential component of managing group dynamics included the presence of skilled and trusted facilitators. Individuals who could bridge the gap between stakeholders who had not previously worked together, or who were accustomed to dealing with each other on a more adversarial basis, were noted as critical by respondents. An official facilitator was hired by NAPA to help foster relationships within the fledgling partnership. He was a veteran labor lawyer with years of experience at high levels of government and respected across the construction industry, particularly among labor and government agency stakeholders. A NAPA partner explained the rationale for inviting this individual to facilitate.

Although [the facilitator] was hired by [NAPA] as a consultant, he was never going to do anything that would get NIOSH or the unions into trouble. He was seen as an honest broker of this partnership. And I don't think we would have got this done without [him].

The facilitator described being tasked with initiating and maintaining the overall relationship between labor, government, and industry, and establishing buy-in around a "win-win" proposition for all groups. His role also extended to convener and "translator," bringing together the different groups and helping them to minimize conflict and misunderstandings. NAPA also assigned a co-facilitator from their own organization, and the two worked closely together. The NAPA facilitator described the pivotal role of the independent facilitator, particularly in the early stages of the collaboration.

What [he] did in the early days we don't have to do so much of today. He was the guy who helped us 'tiptoe through the tulips,' so to speak. Consider that the trust is not there when you walk in the room with a bunch of people you don't know and you have questions maybe as to whether they really share in the mission that you share. . . .I didn't pick up the phone in those days and call [partners from the unions]. I'd call [the facilitator] and say, "I'm not sure how this will be perceived. Can you help?" And he would get the answer to the question. And we would act accordingly and that kept us out of what I would call sensitive territory.

The NAPA facilitator took a leading role in organizing meetings and conference calls and along with NAPA as an organization, was also often credited with keeping the group focused, cohesive, and adhering to its principles. According to a labor partner, "NAPA has been the lead. Their openness and commitment and [their facilitator's] openness and commitment matched. And I think that permeated itself throughout the partnership and everything that the partnership has actually taken on."

For manufacturers participating in the partnership, NAPA's leadership was noted as particularly important:

NAPA being sort of the organizing body who represents both the manufacturers and the customer, their role was critical because they had to be the moderator and make sure that we stay away from antitrust issues and manufacturers bickering with each other.

Champions

In addition to the role of the facilitators, respondents also referred to the part played by champions, or "individuals who informally emerge to actively and enthusiastically promote innovations through the crucial organizational stages and are pivotal to the successful implementation of an innovation" [Howell and Boies, 2004]. As mentioned above, a prominent paving contractor and member of NAPA served as an important early champion of the partnership and of a proactive, precautionary approach to controlling asphalt fumes. This contractor described what he believed was necessary to help champion a new concept forward:

When I had the idea, we were a major player on the industry side and I certainly built friends over the years and was a major purchaser of lots of equipment. So we leaned on our friends. . .. You always have to have a champion in any of these ventures that says, "I know you don't believe in it, but let's make it work. . .." You had to put your personal self on the line.

In subsequent partnerships, some respondents described the chairperson, who was usually a contractor member of NAPA, as an ongoing champion for the partnership, particularly within NAPA's membership. Characteristics of these champions included that they were well respected by both contractors and manufacturers and that they were able to communicate effectively with NAPA leadership.

Investment in positive group dynamics

Partners across the board noted that one of the defining features of the partnership was its high level of attention to group dynamics and relationship building. As the initial convener, NAPA made it a high priority to demonstrate its own commitment to the collaboration and proactive approach as well as the functioning of the partnership, and made active investments in developing positive partnership dynamics. One of the partnership facilitators noted how critical such efforts were to success: "[T]he important thing is that you've got to really work on what I call the chemistry of these relationships to make sure that there are sufficiently joint interests in making something work."

Partners appreciated and ultimately attributed much of the group's effectiveness to these efforts, with one NAPA partner observing:

If all that we do is focus on tasks and objectives, you might eventually get there, but you won't get there as fast and you won't get there as effectively. . ..How they work together, how they listen to each other, how they collaborate. Is there a healthy oxygen in that room when people get together?

While the group instituted administrative structures and processes that supported their work together such as formal meetings, agendas, and minutes, partners tended to believe that interpersonal relationships formed the true backbone of the partnership and were a natural departure point from which to make decisions and work through conflict. One NAPA partner explained, "you can have these formal systems and structures and processes and that's fine. And we have some of that. But I think that what's distinctive about this is that strong, strong relational component." When asked how relationships were built, partners mentioned breaking bread over "really good crab dinners" and frequent communication as essential components. Regular communication occurred during formal meetings and conference calls as well as individual phone calls and other less formal channels.

Inclusiveness and respect

The partnership made efforts to ensure all members were respected, valued, and had a voice. As one labor partner observed, "I think for the partnership to be effective, everyone in the process has to have a voice. And all of the entities in the partnership have to feel comfortable that their voice can be heard." A partner from NIOSH described an environment that encouraged the contributions of all members. "[There was] a real willingness to have people bring to the table whatever expertise they had and then have that expertise be respected and used."

Respect was conveyed in different ways including taking all partners' concerns and ideas seriously. One partner recalled:

For instance, one of the partners may put an issue on the table that may mean literally nothing to me, but because that partner put that issue on the table, I don't have a problem addressing it to the extent I can to keep the partner involved. And I think we've consistently done that.

Another partner commented on the role of the chairperson in creating a climate of respect by "[making] sure that all the principals [felt] like they were important, integral parts of making this whole process work." Of particular note, the influence of partners was, as the NAPA facilitator put it, "never grounded on the basis of resource participation." While the engineering controls and subsequent projects required significant levels of resources, partners did not mention funding as a challenging issue for the collaboration, nor did they indicate any difference in influence based on financial contributions made to the effort.

Transparency and trust

Establishing trust between partners who had often seen themselves as far apart on issues of health and safety was a major hurdle facing the group. Trust and transparency were themes to which partners repeatedly returned. A partner from the FHWA explained:

[We] agreed to the fact that we would be open, that there would be no secrets, that we would share our results. We committed to transparency. . .. There was no such thing as, "Well, we can't tell you that till we're done."

A NIOSH partner also commented:

One of the reasons we were able to accomplish what we did was that we had great trust in the parties. I think we had good faith going in and knew from the outset that this wasn't just lip service about multi-sectoral collaboration. . ..

Consistency and care with trust was recognized as paramount, particularly between industry and labor partners. While the entire group held regularly scheduled meetings three times a year with occasional ad-hoc meetings in between, the two facilitators met separately with the union partners on a monthly basis at the beginning to acknowledge the special attention that fostering such ties required. The NAPA facilitator described the mindset when reaching out to partners from labor:

If one time we had violated that relationship, we might not ever get back on top of the relationship. So that was the principle. Openness and transparency, that's the rule.

Reliance on evidence

Also among the partnership's established principles was an interest in "practical research and technology and best practices implementation." When developing engineering controls for pavers, partners agreed that they did not need to wait for conclusive evidence on the health effects of asphalt fumes in order to take preventive action to protect worker health. However, partners described how science remained at the center of the partnership's work as they committed themselves to conducting rigorous, high-quality research and evaluation throughout their effort. In addition to the initial evaluation of the engineering controls, the partnership also later conducted follow-up field testing which indicated that the controls were effective at keeping worker exposure to asphalt fumes below target levels [Mickelsen et al., 2006]. One partner explained:

From everybody's point of view, the only way we were really going to do this is to have the research effort that allows the researchers to do lab work and then field work to test these [engineering control] systems out and see if they work. . .. And I think it was just self-evident that, if we're going to move this project forward, if this is our objective, the research is the lynchpin for making this happen.

R2p Outcomes and Accomplishments – Use of Research and Moving Into Practice

The result of the partnership's efforts to build an effective multi-stakeholder partnership and conduct sound research resulted in the eventual universal adoption of the engineering controls for fumes over a relatively short time period. In 1997, all six manufacturers signed a voluntary agreement with OSHA, FHWA, NAPA, and labor groups agreeing to equip all new highway class pavers with engineering controls to reduce worker exposure to asphalt fumes.

The controls were exhaust systems that captured fumes and channeled them away from worker breathing areas. While each manufacturer was able to tailor the systems for their own paver designs, all kept exposures to total particulate matter and benzene soluble matter below levels recommended by NIOSH and the American Conference of Government Industrial Hygienists, respectively (for more on the development and testing of the engineering controls, see Mickelsen et al., 2006).

Because the working life of the equipment ranges from 5-10 years, effectively all such pavers in the United States included the fume controls by the mid-2000s. Partners highlighted the efficiency of the change process and contrasted it with typical timelines for OSHA rulemaking which can take years to initiate, and then up to ten years more to complete the process of establishing a new health standard, if at all [National Advisory Committee on Occupational Safety and Health (NACOSH), 2000; Skryzcki, 2004; Public Citizen, 2011]. As one NIOSH partner observed:

If we had started at that same time and tried to get a new permissible exposure limit for asphalt fume through OSHA, we'd still be working on it. And yet we have added engineering controls to highway-class pavers that reduced emissions by around 80% in the breathing zone of workers. Subsequently with the warm mix asphalt [partnership that followed], it's probably even more so. And so we have achieved through partnership just on the fume side of it. . .reducing the exposure and potential risk to workers almost, probably, to the level that we would have achieved if we had had a standard.

One partner observed how each partner was able to build upon the assets of the other and provide insight into creating an effective control that both worked and could be implemented in the real world.

You want to talk about r2p, you cannot have a better example. How do we take NIOSH's ability to do this research and link it to what you do with a field test?. . .[T]hen the manufacturers have already agreed that they're going to install this stuff on their equipment and away we go. All of the pieces were linked.

Precautionary approach

Part of the r2p accomplishments of the Asphalt Paving Partnership included adopting a precautionary approach, which was, at the time, a novel response to a potential occupational health hazard in the face of scientific uncertainty. The new model required an investment of resources, but ensured that workers and the industry were protected if asphalt did cause long-term health effects. Respondents from industry, labor, and government suggested

TABLE II. Case Study Propositions Guiding the Research Design

Study propositions
Participation by key stakeholders from manufacturers, employer organizations, labor, government made success possible
The partnership operates on the precautionary principle in its approach to research. It draws on scientific research, but does not wait for the science to be conclusive before it takes action.
To what extent was the evidence base in place?
What role did the strength of evidence play?
Collaborative research that engaged researchers, users, and stakeholders in developing and testing interventions was an important part of facilitating the adoption of the solutions.
The partnership approach was critical to developing and instituting engineering controls and other efforts.
Having champions of the control/innovation from labor, management, and government was important to the success of the adoption of engineering controls and other efforts.
What role did champions play in the diffusion process? In the partnership as a whole?
Were there factors in the asphalt industry that helped to develop or support those champions or leaders? E.g., History of joint labor-management collaboration? NAPA leadership with driving principles of quality improvement and worker & environmental safety (a learning organization?)
The partnership's effectiveness was facilitated by characteristics of the partnership
Key organizational or group processes
Group characteristics and climate, e.g., common principles of mutual trust, respect, and openness to innovation
Open communication, leadership, collaborative structures & agreements
Stage of group dynamics (e.g., forming, storming, norming, performing)
In addition to partnership efforts, contextual and industry factors also contributed to the partnerships' successes in critical ways.
Regulatory environment with engineering controls
Small number of manufacturers (6)
History of industry/gov't collaboration, strong industry-labor relations.
Rival explanations – contextual factors:
Type of interventions and level of controversy/contention made it uniquely amenable to implementing change and is not necessarily replicable
The change was driven by environmental concerns rather than worker protection
The existing fleet of highway paving equipment was aging & ready for replacement
The partnership's chosen intervention of engineering controls on the pavers had key characteristics that facilitated the uptake and the voluntary agreement, such as adaptability, and similarly for other partnerships/silica milling.
The partnership was successful in:
Ensuring widespread adoption of worker H&S innovations
Creating a sustainable partnership throughout the course of the engineering controls effort;
Sustaining the effort through:
Continuation and expansion of partnership effort into new areas,
Increasing the capacity of participating individuals and organizations, and
Inspiring other similar partnerships in construction and other industries.

that it provided them with a way forward, getting past the acrimony and finding common ground. One NAPA partner recalled:

[If] the science were to have proven that we had a really terrible material, we wouldn't be then starting from the very beginning. We had already changed the industry or converted the industry to what it would have had to have done anyway. So it seemed like a win-win for us.

One partner shared the perspectives from members of the group from labor:

It would be a much more proactive approach, which I think was the key from the union perspective – that we weren't standing back and letting our members be potentially harmed and not do anything about controlling exposures.

A model for collaboration and sustainability

The partnership's experience collaborating on engineering controls for asphalt fumes created a foundation for future

TABLE III. Asphalt Paving Partnerships

Partnership	Description
Warm-mix	Development of a lower-temperature warm-mix asphalt that releases fewer asphalt fumes. This new form of asphalt also requires less energy to prepare, providing environmental and economic benefits.
Silica/Milling	Testing and development of engineering controls to suppress silica dust on asphalt milling machines.
Work-zone safety	Trainings and the development of information materials to improve roadway work-zone safety.
Dermal exposures	Research to assess and characterize workers' dermal exposures to asphalt in the paving industry.

efforts in two main ways. First, it provided evidence that a cooperative approach could work. The group's efforts garnered recognition including awards for partnership and innovation from the National Occupational Research Agenda and Harvard University's Kennedy School of Government. Second, the partnership developed lasting infrastructure for future collaboration. This included the establishment of cooperative, trusting relationships between the diverse partners, shared norms and principles for working together, and a collective identity as an open, innovative, and forward-looking group actively seeking to protect the health and safety of workers and the vitality of the asphalt paving industry. One manufacturer partner reflected on the value of the effort regardless of the ultimate classification of asphalt fumes:

I think we all said, "Hey, down the road we still have a product that's better to work around, safer to work around regardless of government edict and so we did a good thing and we're sticking with it."

Building on this infrastructure and the momentum of the engineering controls outcomes, the partnership spun off additional collaborations and projects (see Table III), including a "warm mix" effort that reduced fumes further by lowering the temperature of the asphalt paving mix. One NAPA partner commented on this evolution. "That [engineering controls effort] was great, but for us the gold standard was to reduce or eliminate fumes at the source completely. And so we continued our quest to improve workplace conditions."

Transferability

Partners suggested that a number of the contextual factors that facilitated the success of the engineering controls effort were unique to their particular situation. These included the possibility of asphalt fumes being labeled a human carcinogen; having a small, clearly defined universe of manufacturers to work with in coordinating universal adoption of the controls; a unique and proactive trade association; the presence of organized labor; a champion with strong industry buying power; and the visible nature of asphalt paving fumes and overlap with broader environmental concerns. At the same time, respondents from across the partner perspectives – industry, labor, and government – strongly believed that their model was transferrable to other areas of construction, as long as key principles and processes to build and manage group dynamics are preserved:

One ought not to look at a model like this as a prescriptive solution. What you would do is you would look at the ingredients which are the gears that make it go.

I don't know that effective partnerships are unique, but I think effective partnerships are complex. . .I think they have to have an organization that has a very open mind to lead the partnership and make the partnership work. . .[that] all of the entities in the partnership have to feel comfortable that they have a voice and their voice can be heard, and that the partnership is doing something.

It's highly transferrable in the sense that people can appreciate a model that includes identifying areas of disagreement, compartmentalizing them to some extent, if you can deal with the underlying concern for the workforce. . .You could find a lot of situations where people from all stakeholder groups would resonate with that kind of approach because it's a sensible approach.

DISCUSSION

Our findings detail in depth how a successful multi-stakeholder health and safety partnership in construction came together, decided to pursue a collaborative course of action, and achieved broad implementation of an effective safety solution. The Asphalt Paving Partnership's success in the voluntary, universal adoption of engineering controls to reduce exposures to asphalt paving fumes involved a commitment to a collaborative process that included identifying the right stakeholders, establishing a common

vision, investing in group dynamics, relying on strong science, and opting for a proactive approach. The partnership ultimately also built the collaborative infrastructure that allowed it to sustain and expand its efforts over time through new health and safety initiatives.

Partnerships that can forge links between researchers and industry and government practitioners can serve as critical components of research to practice efforts. Systematic study of how such partnerships begin and function can yield lessons to help encourage and support new collaborative efforts. This case study from the high hazard construction industry corroborates the substantial literature on public health partnerships and coalitions. The Asphalt Paving Partnership's experience illustrates the process of generating relevant research that is designed for dissemination, tested in real-world conditions, and draws on the expertise of diverse stakeholders [Israel et al., 1998; Lasker et al., 2001; Best et al., 2003; Stokols, 2006; Minkler et al., 2010]. The effort to identify interventions to reduce asphalt fume exposure was initiated by industry players. Manufacturers, having agreed to meet criteria established by the partnership, were able to develop and tailor the engineering controls to their particular models. Asphalt paving workers and contractors subsequently tested the controls along with NIOSH researchers, integrating practical field experience and technical scientific capabilities. The partnership's efforts that followed in work zone safety, silica, dermal exposures, and warm-mix allowed the partnership to sustain its efforts in health and safety over the course of two decades, reflecting the benefit of ongoing collaboration which encourages the pursuit of new research questions and the building of health and safety infrastructure and capacity [O'Fallon and Dearry, 2002].

Promising practices for partnerships identified in this case study echo themes from the partnership literature, including bringing together key stakeholders and establishing a common vision, trust, transparency, respect, and open communication [Israel et al., 1998; Seifer, 2006; Cargo and Mercer, 2008; Wallerstein et al., 2008; Minkler and Salvatore, 2012]. The pivotal role of facilitators and champions and the active investment in creating positive group dynamics are additionally often cited as partnership best practices [Israel et al., 1998; Kramer et al., 2010; Wallerstein and Duran, 2010; Chang et al., 2012; Hacker et al., 2012]. The emphasis from Asphalt Paving partners on the development of personal relationships as a vehicle for encouraging positive group dynamics and building trust has also been emphasized in the literature, yet many have also tended to underscore the importance of formal partnership structures in working toward these objectives, such as agreements and decision-making rules [Israel et al., 1998; Becker et al., 2005; Seifer, 2006; Cargo and Mercer, 2008; Kramer et al., 2010]. Themes and lessons from this case study notably also substantially overlap with the Asphalt Paving Partnership's own stated principles of: *1) protecting the health and safety of workers and the environment, 2) involvement of all key stakeholders, 3) openness, transparency, and trust, 4) practical research and technology,* and *5) best practices implementation* [Acott, 2007].

Few published studies have explicitly focused on partnership processes and dynamics in occupational health and safety [Kramer et al., 2010; Chang et al., 2013], though as part of CPWR's r2p initiative, partnership evaluation and additional case research on collaborations in masonry, floor finishing, electrical transmission and distribution, and on safety culture have been undertaken and findings applied in the development of its recent *Construction Research to Practice (r2p) Partnership Toolkit* (http://www.cpwr.com/whats-new/construction-research-practice-r2p-partnership-toolkit). Principles, facilitating factors, and barriers identified from the broader partnership literature are largely confirmed by these construction and occupational health and safety examples. It is worth noting, however, that important differences may exist that uniquely characterize and affect collaborations in this field.

While also emphasized in the broader literature [Greene-Moton et al., 2006; Horowitz et al., 2009], the need for compartmentalization of outside issues may be particularly pronounced. Health and safety partnerships that involve worker and employer representatives in particular are likely to bring complex and challenging histories and relationships that require special attention. Interactions outside the partnership, such as labor-management contract negotiations and power differentials between employers and employees, may impact the ability to achieve equitable and open participation within the partnership. The ability to "agree to disagree" in such cases as well as clearly defining roles within the partnership, may be especially salient practices. Partnerships focused on worker health and safety may also be more likely to come with certain advantages, such as the potential to be self-funded. As with the Asphalt Paving Partnership, this may allow groups to better avoid common tensions around seeking and allocating funding from outside sources [Israel et al., 1998; Wallerstein et al., 2008].

Limitations of this case study research include that the original partnership studied came together almost 20 years ago and the group in the intervening years has involved numerous players and focused on several other issues in addition to asphalt fumes. Many of the original partners have retired and precise recall of events may have been an issue. The long tenure of the group additionally presented challenges around defining the original Engineering Controls Partnership as the unit of analysis. A number of partners had also been involved in the later efforts and would sometimes refer to actions of these subsequent partnerships in interviews, yet systematically examining all subsequent partnerships was beyond the scope of this study.

CONCLUSION

The Asphalt Paving Partnership offers insight into how multi-stakeholder partnerships in construction can draw upon the strengths of diverse members to attain significant success in wide dissemination and adoption of health and safety innovations and build collaborative infrastructure to sustain momentum over time. While this case example offers possible models and strategies to continue to explore and encourage, further prospective evaluation and study of r2p partnerships in health and safety will be needed to develop more targeted and refined guidance for future efforts in the field.

ACKNOWLEDGMENTS

The authors wish to acknowledge all those who participated in the research and shared their own histories and perspectives, in particular Don Elisburg and Gary Fore, and to Mellissa Bixler, Jessica Bunting, and Eileen Betit for support on the manuscript development.

The research was made possible by CPWR – The Center for Construction Research and Training through cooperative agreement U60-OH009762 from the National Institute of Occupational Safety and Health (NIOSH). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CPWR or NIOSH.

Additional findings from this research are available in *Case Study: The Asphalt Partnership Summary Report* available at http://www.cpwr.com/sites/default/files/research/AsphaltCaseStudy.pdf.

REFERENCES

Acott M. 2007. Bold initiatives in the asphalt industry to safeguard health, safety, and the environment lantham. MD: National Asphalt Pavement Association.

Becker AB,Israel BA, Allen AJ. 2005. Strategies and techniques for effective group process in cbpr partnerships. In: Israel BA Eng E Schulz AJ Parker EA, editors. Methods in community-based participatory research for health. San Francisco: Jossey-Bass. p. 52–72.

Best A, Stokols D, Green LW, Leischow S, Holmes B, Buchholz K. 2003. An integrative framework for community partnering to translate theory into effective health promotion strategy. Am J Health Promot 18:168–176.

Cargo M, Mercer SL. 2008. The value and challenges of participatory research: strengthening its practice. Annu Rev Publ Health 29:325–350.

Carroll SJ, Hensler DR, Abrahamse A, Gross J, Ashwood JS, Sloss EM, White M. 2002. Asbestos litigation costs and compensation: An interim report. Santa Monica, CA: RAND Institute for Civil Justice.

Chang C, Salvatore A, Lee PT, Liu SS, Minkler M. 2012. Popular education, participatory research, and community organizing with immigrant restaurant workers in san francisco's chinatown: A case study. In: Minkler M, editor. Community organizing and community building for health and welfare. 3rd ed. NJ: Rutgers University Press: Piscataway.

Chang C, Salvatore A, Lee P, Liu S, Tom A, Morales A, Baker R, Minkler M. 2013. Adapting to context in community-based participatory research: "Participatory starting points" in a chinese immigrant worker community. Am J Community Psychol 51:1–12.

Chen PG, Diaz N, Lucas G, Rosenthal MS. 2010. Dissemination of results in community-based participatory research. Am J Prev Med 39:372–378.

Connors K, Seifer SD. editors. 2000. San Francisco, CA: Community-Campus Partnerships for Health.

Gillen M. 2010. The niosh construction program: Research to practice, impact, and developing a national construction agenda. J Safety Res 41:289–299.

Glasgow RE, Emmons KM. 2007. How can we increase translation of research into practice? types of evidence needed. Annu Rev Publ Health 28:413–433.

Greene-Moton E, Palermo A-G, Flicker S, Travers R. 2006. Unit 4: trust and communication in a cbpr partnership - spreading the "glue" and having it stick. in: The examining community-institutional partnerships for prevention research group. developing and sustaining community-based participatory research partnerships: A skill-building curriculum. www.cbprcurriculum.info.

Hacker K, Tendulkar SA, Rideout C, Bhuiya N, Trinh-Shevrin C, Savage CP, Grullon M, Strelnick H, Leung C, DiGirolamo A. 2012. Community capacity building and sustainability: Outcomes of community-based participatory research. Prog Community Health Partnersh: Res Edu Action 6:349–360.

Horowitz CR, Mimsie Robinson R, Seifer S. 2009. Community-based participatory research from the margin to the mainstream: Are researchers prepared? Circulation 119:2633–2642.

Howell JM, Boies K. 2004. Champions of technological innovation: The influence of contextual knowledge, role orientation, idea generation, and idea promotion on champion emergence. Leadership Quart 15:123–143.

International Agency for Research on Cancer (IARC) 2011. Occupational exposures to bitumens and their emissions. Lyon: International Agency for Research on Cancer.

Israel BA, Schulz AJ, Parker EA, Becker AB. 1998. Review of community-based research: Assessing partnership approaches to improve public health. Annu Rev Publ Health 19:173–202.

Kojola B. 1994. An emerging issue: Asphalt fumes applied occupational and environmental hygiene. 9:323–329.

Kojola WH, Moran JB. 1993. Crumb rubber modifier in asphalt pavement: A critical review of the dot/epa human health and environmental assessment. Washington, D.C.: Laborers' Health & Safety Fund of North America.

Kramer DM, Wells RP, Bigelow PL, Carlan NA, Cole DC, Hepburn CG. 2010. Dancing the two-step: Collaborating with intermediary organizations as research partners to help implement workplace health and safety interventions. Work: J Prev Assess Rehabil 36:321–332.

Kreuter MW, Bernhardt JM. 2009. Reframing the dissemination challenge: A marketing and distribution perspective. Am J Publ Health 99:2123–2127.

Lasker RD, Weiss ES, Miller R. 2001. Partnership synergy: A practical framework for studying and strengthening the collaborative advantage. Milbank Quart 79:179–205.

Macro International 1998. Effective health and safety promotion: Evaluation of NIOSH small business interventions: Prepared for NIOSH, CDC.

Mickelsen RL, Shulman SA, Kriech AJ, Osborn LV, Redman AP. 2006. Status of Worker Exposure to Asphalt Paving Fumes with the Use of Engineering Controls. Environ Sci Technol 40:5661–5667.

Minkler M, Lee PT, Tom A, Chang C, Morales A, Liu SS, Salvatore A, Baker R, Chen F, Bhatia R, Krause N. 2010. Using community-based participatory research to design and initiate a study on immigrant worker health and safety in San Francisco's Chinatown restaurants. Am J Industr Med 53:361–371.

Minkler M, Salvatore A. 2012. Participatory approaches for study design and analysis in dissemination and implementation research. In: Brownson RC Colditz GA Proctor EK, editors. Dissemination and implementation research in health. New York: Oxford University Press. pp. 192–212.

Minkler M, Salvatore AL, Chang C, Gaydos M, San Liu S, Lee PT, Tom A, Bhatia R, Krause N. 2014. Wage theft as a neglected public health problem: An overview and case study from San Francisco's chinatown district. Am J Public Health e1–e11.

Moran J, Kojola B, Melius J. 1997. Asphalt paving exposure controls: A model for the future?. Applied Occup Environ Hyg 12:407–409.

Moran JB, Kojola B. 1994. Construction - An emerging issue: Asphalt fumes. Applied Occup Environ Hyg 9:323–330.

National Advisory Committee on Occupational Safety and Health (NACOSH) 2000. Report and recommendations related to osha's standards development process.

National Asphalt Pavement Association and European Asphalt Pavement Association 2011. The asphalt paving industry: A global perspective, Third edition: National asphalt pavement association, European asphalt pavement association.

National Institute for Occupational Safety and Health (NIOSH) 2001. Hazard review: Health effects of occupational exposure to asphalt. In: Department of Health and Human Services editor.

NIOSH 2015. Best practice engineering control guidelines to control worker exposure to respirable crystalline silica during asphalt pavement milling. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH). Publication No. 2015–2105.

National Research Council and Institute of Medicine 2009. Construction research at NIOSH. In: Program CtRtNCR editor. Report No 8, Reviews of research programs of the national institute for occupational safety and health. Washington, D.C.: The National Academies Press.

Norseth T, Waage J, Dale I, . 1991. Acute effects and exposure to organic compounds in road maintenance workers exposed to asphalt. Am J Industr Med 20:737–744.

O'Fallon LR, Dearry A. 2002. Community-based participatory research as a tool to advance environmental health sciences. Environ Health Perspect 110:155–159.

Public Citizen 2011. OSHA inaction: Onerous requirements imposed on OSHA prevent the agency from issuing lifesaving rules. Washington, DC: Public Citizen's Congress Watch.

Randem BG, Ulvestad B, Burstyn I, Kongerud J. 2004. Respiratory symptoms and airflow limitation in asphalt workers. Occup Environ Med 61:367–369.

Schurman SJ. 1996. Making the "new American workplace" safe and healthy: A joint labor-management-researcher approach. Am J Industr Med 29:373–377.

Seifer SD. 2006. Building and sustaining community-institutional partnerships for prevention research: Findings from a national collaborative. J Urban Health-Bullet New York Acad Med 83:989–1003.

Skryzcki C. 2004. OSHA Withdraws More Rules than it Makes, Reviews Find. Washington Post Washington, DC. p1.

Stokols D. 2006. Toward a Science of Transdisciplinary Action Research. Am J Commun Psychol 38:63–77.

Tepper AL, Burr GA, Feng HA, Singal M, Miller AK, Hanley KW, Olsen LD. 2006. Acute symptoms associated with asphalt fume exposure among road pavers. Am J Industr Med 49:728–739.

Wallerstein N, Duran B. 2010. Community-based participatory research contributions to intervention research: The intersection of science and practice to improve health equity. Am J Public Health 100:S40–S46.

Wallerstein N, Oetzel J, Duran B, Tafoya G, Belone L, Rae R. 2008. What predicts outcomes in community-based participatory research? In: Minkler M Wallerstein N, editors. Community-based participatory research for health: from process to outcomes. San Francisco: Jossey-Bass. pp. 371–392.

Weinstein MG, Hecker SF, Hess JA, Kincl L. 2007. A roadmap to diffuse ergonomic innovations in the construction industry: There is nothing so practical as a good theory. Int J Occup Environ Health 13: 46–55.

Weiss ES, Anderson RM, Lasker RD. 2002. Making the most of collaboration: Exploring the relationship between partnership synergy and partnership functioning. Health Educ Behav 29:683–698.

Yin RK. 2003. Case study research: Design and methods, 3rd ed. Thousand Oaks: Sage.

Institutions at which work was performed: Labor Occupational Health Program and Center for Occupational and Environmental Health, University of California Berkeley.

Disclosure Statement: The authors report no conflicts of interests.