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Length of time spent working on a commercial construction site and the associations with worker characteristics

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Abstract

Background—Construction workers move frequently from jobsite to jobsite, yet little is documented about length of stay on-site and associations with worker characteristics.

Method—Using cross-sectional data, we investigated associations between worker characteristics (including trade and musculoskeletal pain) and length of stay on-site (dichotomized as <one month, n=554, and ≥ one month, n=435).

Results—Approximately 56% of workers remained on the worksite for at least one month. Length of stay was significantly associated with workers' race/ethnicity, union status, title, trade, and musculoskeletal pain (p-values<0.05). Trades associated with longer length of stay included pipefitters and plumbers. Trades associated with shorter length of stay included operators and piledrivers. Workers with single-location pain had 2.21 times (95%CI: 1.52, 3.19) the odds of being short-term versus long-term, adjusting for trade, title, and race/ethnicity.

Conclusion—The length of stay and associated characteristics provide important insight into how workers come and go on construction sites and the methodological challenges associated with traditional intervention evaluations.

Introduction

Construction, often termed a "mélange of order and chaos" [Carlan, et al. 2012] is a dynamic work environment in which job demands and related hazards are constantly changing as phases of a project are completed and others begin. The composition of the

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workforce on a construction project also constantly changes with the varying phases of project [Carlan, et al. 2012, Ringen and Stafford 1996]. Some workers may stay for several months on a given construction site, whereas others only stay for a few days or weeks, being reassigned to new construction sites where their specific skills are needed next. This frequent movement of workers from worksite to worksite and constant changing of the composition of workers at a construction site can create a form of “temporariness” for the construction worker. The co-workers, management, and physical space change frequently, causing the worker to constantly need to adapt to new conditions.

The amount of time spent on a worksite is likely related to a number of different factors, including the phase of the project and the type of work needed at a given time, as well as overall project scheduling or budget, and even worker injury. Due to the inherently dynamic nature of construction, workers from different trades and levels of experience are needed at various time points during the building process. In both practice and research, the construction site is frequently described as dynamic [Becker, et al. 2001, Carlan, et al. 2012, Dunlop 1961, Paquet, et al. 2005, Ringen and Stafford 1996, Tak, et al. 2011]. However, the word dynamic is rarely quantified and we did not find any published literature that detail the construction site-employment patterns and associated factors.

In non-construction industries, strong associations between the health and safety of workers and their employment patterns have been demonstrated. Much of the research in this area has focused on contingent work, which is a broad category of employment status that includes temporary contracts or fixed term employment, as well as jobs without an explicit or implicit contract for longer employment [Benach 2000, Quesnel-Vallée, et al. 2010]. Numerous studies have shown that these types of jobs are associated with decreased job satisfaction as well as increased risks of work-related injuries and illnesses, when compared to those with permanent or standard jobs [Benach 2000, Cummings and Kreiss 2008, Kivimäki, et al. 2003, Metcalfe, et al. 2003, Smith, et al. 2010, Wilkin 2013].

Yet it is unclear from the literature what, if any, individual worker characteristics might be associated with patterns of length of stay on a construction site. This is especially relevant to the construction industry, where movement from site to site is inevitable. As a result, it is extremely important for site management to foster workplaces that keep workers safe and healthy. A better understanding of the factors associated with worker movement could help researchers and practitioners design, implement, and evaluate health and safety interventions.

There are two primary goals of this paper. First, we describe patterns surrounding the length of time commercial construction workers spent at eight worksites in the Boston area. Second, we investigate the association of worker characteristics including trade, title, and a measure of health status (self-reported musculoskeletal pain) with the length of time workers spent onsite.

Methods

Study sample and data collection

The sample for this cross-sectional study came from baseline survey data collected in the Building Safety for Everyone study; a cluster randomized controlled trial on the effectiveness of a safety communication and recognition program in construction [Sparer, et al, In press]. The program was implemented at eight sites (four controls, four interventions) in the Boston area for approximately five months per site between August 2011 and December 2013. The sites ranged in size from 8,500-square feet to 495,000-square feet, and all were commercial construction projects that spanned a range of project phases. Three were renovation projects, four were new construction, and one was a mixture of renovation and new construction. In the analysis described in this paper, we used only baseline survey data collected when workers first came on site as part of their on-site safety orientation training. Length of stay was determined if a worker was present or not for the follow up surveys. No other data from follow up surveys were used in these analyses.

All construction workers at the sites were eligible to participate in the study; however, for this paper we are including only those who started after we started baseline data collection at site orientations. To collected baseline surveys, research staff attended every new (to the site) worker safety orientation (site-specific meetings that were required by the site management) at all eight sites. These orientations occurred daily at some sites, and every other day at other sites. Workers were continuously enrolled in the study for the duration of the program (approximately four to five months). The analytical cohort consisted of 989 workers who completed the baseline survey at site orientations and agreed to provide their name for monthly follow up (89% response rate). Workers were also asked to provide company name and mobile phone number, and to give permission for researchers to contact them via SMS text message in order to help locate them at follow up.

Research staff members returned to the construction sites multiple times per week to administer one month follow-up surveys to workers who remained on the sites, thus, affording the opportunity to determine if workers were still onsite. As workers were enrolled into the study on a rolling basis, follow up surveys were also conducted on a rolling basis, at one-month intervals following baseline survey completion. Prior to visiting the sites, study staff informed the construction workers of the time and location of surveying via text messages. Once at the sites, study staff members were able to confirm whether workers were still working at the sites through communications with site personnel (foremen, union stewards, etc.). Workers who had left the site were not questioned about possible reasons for their departure from the site.

All study participants gave informed consent prior to survey initiation. The Harvard School of Public Health's Office of Regulatory Affairs and Research Compliance and the Northeastern University's Office of Human Subject Research Protection reviewed and approved all procedures and methods for the study.

Worker Characteristics

All sociodemographic and health variables were captured in the baseline survey through self-report. Workers provided their age in years, gender, union membership status, specific trade, job title, tenure in the construction industry in years and highest educational attainment. Although race and ethnicity were collected separately, we combined the two questions to classify workers as Non-Hispanic White, Non-Hispanic Black, Hispanic, and Non-Hispanic Other. Lastly, respondents indicated their weight and height, which were used to calculate their body mass index (BMI).

Only one direct health status measure was recorded in the survey: musculoskeletal pain. The following seven body regions were assessed: head/skull/face; neck; shoulders; hand/wrist/fingers; chest/ribs/sternum; lower back; and, knees. Respondents were asked to indicate if they had experienced pain every day for at least one week in the last month using a version of the Nordic Questionnaire [Kuorinka, et al. 1987], which was previously modified by Cigularov et al (2010) and used with other construction worker populations. We operationalized pain into three categories: no pain (did not indicate pain at any region), single-location pain (indicated pain in at one region only), or multi-location pain (indicated pain in two or more regions).

Length of time on-site

We were able to determine the length of time that all 989 workers remained on the sites using our data on whether workers were still working at the site at the time of each 30 day follow-up survey. All workers were followed up with for at least one month in order to determine their term-length classification. Length of stay was dichotomized to classify workers as either short- or long-term worker. Short-term workers were those who spent less than 30 days on-site and were therefore not present for the first follow-up survey, whereas long-term workers spent 30 days or more on their site of recruitment.

Statistical Analyses

To address the first research goal, which was to characterize the length of stay on a construction site among our 989 construction workers, we determined the length of time each of the workers remained on a study site. These rates were determined by first grouping the workers into separate cohorts, based upon the month in which they started on-site. For example, all workers that started in Month 1 were considered Cohort 1; workers who started in Month 2 were Cohort 2 and so on. Workers were grouped into cohorts based on the months started at the worksite because of the likelihood of similar conditions (e.g. project phase, seasonality) on-site at the time of start. We then determined the number and percent of workers within each cohort who were present for follow ups. We also examined the length of time workers remained on the individual sites by calculating the number of workers who were on-site at each one-month follow up period.

For the second research goal, that of the association of worker characteristics and term-length, we used the Chi-square test of homogeneity for categorical variables and *t*-tests for the continuous variables. Term-length was treated as a dichotomous variable because first and foremost, it is unclear if the relationship between the worker characteristics and length

of stay follows a linear dose-response pathway, which is what a continuous or scaled measure would imply. Additionally, as approximately 50% of our population had a length of stay of less than one-month, the power to detect a linear relationship would be low.

We then completed a multiple logistic regression analysis that included worker characteristics associated with length of stay on-site at $p<0.2$ in bivariate analyses.

The multivariable model was constructed using a backward variable selection process, that eliminated worker characteristics (BMI, gender, union membership status, education level, and construction industry tenure) with $p>0.05$ to reach parsimonious model consisting only of statistically significant covariates of job title, trade and race/ethnicity. This final model was confirmed using forward and stepwise selection methods. None of the eliminated covariates had a significant impact (greater than 10% change) on the magnitude of the final coefficients in the final models, indicating that none of the variables were confounders. The analyses investigated the independent variable, musculoskeletal pain, in three categories: no pain, pain in a single body area or pain in multiple body areas. All data analyses were completed in SAS version 9.3 (SAS Institute, Inc., Cary, NC), with two-sided hypothesis tests considered significant at $p < 0.05$.

Results

The study participants, who were all workers new to one of the eight Building Safety for Everyone jobsites, were primarily male (96.8%), with a mean age of 40.7 and mean body mass index (BMI) of 28.1 (Table 1). The majority of the participants were non-Hispanic white (82.1%). They were largely union members (96.5%) and had an average of 17.5 years of tenure in the construction industry. Participants came from a variety of trades, although the electrical and telecommunications trades (19.0%) and the carpentry trade (17.7%) had the largest number of workers in the sample. The individuals were predominately journeymen (67.3%) (a skilled worker who had completed apprenticeship training but who was not yet in a management position). The distribution of short and long term workers at the control and interventions sites did not differ significantly, thus, we did not account for the site treatment effect from the program in the subsequent analyses. Thirty six percent of workers reported either pain in one location only (18.8%) or pain in multiple areas (17.2%) at baseline.

The distribution of pain between short and long term workers among the various demographic categories was fairly consistent, with similar proportions in each category (Table 2). For example, of the long-term carpenters, approximately 65% did not report pain, with approximately the same percentage of short-term carpenters reporting no pain (67%). However, some categories, including sheet metal workers and foremen, did have distributions of pain that varied between long and short-term workers.

Pattern of length of time on-site

For the eight worksites, the composition of workers on-site changed by approximately half each month (Figure 1). On average, in any given month, half of workers had been on that site for less than one month. For example, during the first month of data collection, 227 new

workers started at one of the eight sites (Cohort 1). By the second month, 119 of these workers had left the site, leaving 108, while another 224 workers started (Cohort 2). By the third month, 318 workers had started on-site, while another 38 from cohort 1 left and another 96 from cohort 2 left. This pattern continued throughout the remainder of our data collection.

Of the 989 workers who completed the baseline survey, 554 (56%) were still on a study worksite after one month, 288 (29%) were still on-site after two months, and 133 (13%) were still on-site after three months (Figure 2). On an individual site level, the percent of workers who stayed on-site for one month or longer ranged from 41% to 68%, depending on the site. While the duration of time spent on-site varied from person to person, with some individuals staying for the duration of the project and others coming on for only a few days, the average and median length of time spent on-site was 0.93 months and 1 month, respectively.

The percent of workers who remained on-site for at least one month did vary from site to site (Figure 2), which may be related to differences in site characteristics, such as size, number of workers, and phase of the project. While these characteristics might be related to the worker leaving the jobsite, it is apparent from this raw data that despite the overall differences at the site level, the same patterns persist. We accounted for these possible differences in site characteristics by adjusting for various individual-level factors such as trade and title that may be associated with phase of project.

Associations between worker characteristics and length of time on-site

There were significant bivariate associations between some worker characteristics and length of stay on-site at the sites. Musculoskeletal pain had significant bivariate associations with length of stay on-site, as did workers' race/ethnicity, union status, job title, and trade (p-values of 0.004, 0.011, 0.046, 0.0002, and <0.0001, respectively) (Table 1). For example, a greater proportion of non-Hispanic white workers were long-term workers (57.1%) whereas a lower proportion of Hispanic workers were long-term (43.1%). Trades varied as well, with longer length of stay on-site including pipefitters, plumbers, and sprinklerfitters (70.1% long-term) as well as sheetmetal (62.7% long-term), and trades with shorter term-lengths including operators, operating engineers, elevators, and piledrivers (with only 39.5% long-term).

The association of musculoskeletal pain at baseline and length of stay on-site was maintained in the multivariable analysis. The multiple logistic regression model indicated that reporting pain in one body area only was associated with more than double the odds of having short-term length of stay (OR: 2.21; 95% CI 1.52, 3.19), controlling for trade, job title, and race/ethnicity (Table 3). Reporting of pain in multiple body areas, while not statistically significant, was also associated with short-term length of stay (OR: 1.27; 95% CI 0.86, 1.86).

Discussion

This paper aimed to (1) describe the patterns surrounding the length of time commercial construction workers spend at one of eight worksites in the Boston area and to (2) investigate the association of worker characteristics including trade, title, and a measure of health status (self-reported musculoskeletal pain) with the length of time workers spent on-site based on cross-sectional data. The results indicated that approximately 56% of workers remained on-site for at least one month. This is for the first time, a quantification of the dynamic nature of commercial construction. In addition, there were certain worker characteristics measured when coming onto a site including musculoskeletal pain and trade that were associated with length of stay on a construction site.

The fact that approximately 56% of workers remained on-site for at least one month has important implications for researchers in terms of evaluating worksite programs and interventions. It highlights the need for researchers to consider worksite mobility patterns when analyzing and interpreting data collected from construction sites and other workplaces with contingent or temporary workers, which are becoming more common for workers in the United States and abroad [Alterman, et al. 2013, Quesnel-Vallée, et al. 2010, Wilkin 2013]. With individuals coming on and off worksites so frequently, the ability to accurately measure a worksite intervention or phenomena may be hindered, as the changing site population may mask the potential impact. As a result, traditional cohort analysis methodology for evaluating interventions may lead to biased results. For example, if the goal of an intervention is to reduce musculoskeletal disorders, but the workers who stay on a worksite for longer periods of time (and have more exposure to the intervention) are the workers with a lower prevalence of musculoskeletal disorders, the intervention might miss the high risk and arguably more important group for the intervention. The effect measurements of the intervention may thus be a form of survivor bias or length-biased sampling, and may underestimate the true intervention impact. On the other hand a quick messaging campaign may have great short-term effects but the sustainability of such messaging may be lost as soon as a worker moves onto another site overestimating the effect.

These results also highlight differences in worker characteristics between short- and long-term workers. Certain trades, such as electrical and telecommunications, and pipefitters, plumbers, and sprinklerfitters had more workers who were on site for more than 30 days than workers who were on site for less than 30 days. The duration a worker stays on a single site is likely related, at least in part, to the inherent nature of the construction jobs. Workers are contracted for specific times, when their skill set and trade are needed for a given project. It is also possible that different job titles and trades are associated with different exposures to risk factors, which in turn may lead to variations in prevalence of musculoskeletal pain. Therefore, it is possible that job title and/or trade may be confounding the relationship between musculoskeletal pain and length of time on-site. In the multivariable model, when we control for items such as trade and title, we still see that there is an increased prevalence of musculoskeletal pain among short-term workers indicating that there is likely something else driving the relationship. For example, the categories of trade and title may not accurately describe the workers experience on a construction site, leading

to misclassification of the independent variables in this analysis, which could underestimate the effect estimate (Pearce et al. 2006). A more refined classification system to distinguish experiences may be needed (Punnett and Wegman, 2004). Finally, it should also be noted that the data used in this analysis are cross sectional in nature and cannot be used to draw causal inferences between independent and dependent variables, in particular as they relate to musculoskeletal pain and duration of employment. It is plausible that construction workers who have to adjust to new working environments as part of frequent, short-term contracts are exposed to working conditions that increase the risk for musculoskeletal injuries. Short-term contracts may also result in missed opportunities to participate in prevention programs that reduce the risk of work-related injury and pain. Conversely, workers who start work with musculoskeletal pain may not be able to sustain long-term employment patterns.

We also observed differences in the associations between musculoskeletal pain and term-length in single-location and multi-location pain. Both were in the same direction, but larger in magnitude for single-location pain. The lower odds ratio for multi-location pain may be indicative of chronic rather than acute pain [Carnes et al 2007].

The practical implications for safety and health professionals includes the need for more reliance on systems of safety that recognize and adapt to the changing human element on a construction site. A system of safety should include all the elements of successful programs including clear hazard recognition and control that is embedded in the project management and day-to-day on-site activities [OSHA 2012, OSHA 1990]. Because of the higher risk for injury during the first 30 days, some construction managers and general contractors have implemented policies and practices to address the high level of transience among workers. We have observed policies and practices addressing this concern on different worksites, including new worker safety orientations and special hardhat stickers and/or t-shirts to indicate workers who are within their first month on the job. These programs help acknowledge the high risk period that a new worker experiences during the first 30-days on a new jobsite [Breslin and Smith 2006].

The results describing these workers' time on site are of course within the context of how the data were collected and limited to the eight construction sites we observed; however, we expect these patterns to extend to the other similar construction sites. In conversations with workers, they frequently noted that they move around from jobsite to jobsite quite often, spending a similar amount of time on each jobsite. The results of our bivariate analyses indicate that trade, job title, and race/ethnicity are significantly associated with term-length. As these characteristics are likely to remain constant while a worker moves from site to site, we assume that any bias resulting from a misclassification of length of stay on-site would be minimal. While the findings might not be generalizable to other forms of construction, such as residential or industrial, the discrepancy points to an important area of injury prevention research and practice. The assumptions regarding length of stay on the worksite would likely impact equally both groups of the independent variables. The potential impact of this limitation on the interpretation of the results would be non-differential and would likely bias these results towards the null.

Another limitation relates to the reporting of musculoskeletal pain. It is possible that workers who anticipate spending longer periods of time on the worksite might underreport pain in the baseline survey due to concerns of management viewing the response, despite our strictly enforced confidential handling of the surveys. Thus, it is possible that the results presented here are actually an underestimate of the true association of the relationship between musculoskeletal pain and length of stay.

A large driver behind this study's high follow up response rate was the novel use of text messaging to connect with study participants. Addressing occupational health issues faced by construction workers and other frequently mobile or contingent workers has been hindered by issues of recruitment in previous studies [Atrostic, et al. 2001, Kidd, et al. 2004]. National studies show that though there are still disparities based on race/ethnicity and socioeconomic position in access to broadband internet at home, no such disparities exist in access to mobile phones and smartphones [Smith 2012, Viswanath, et al. 2012]. The high follow up response rate in our study indicates that the use of text messages is a potential medium through which occupational health researchers and practitioners can reach contingent workers and other frequently mobile populations.

In conclusion, approximately 56% of workers remained on-site for at least one month. Length of stay on-site was associated with several worker characteristics, notably trade and musculoskeletal pain. Workers who reported pain had almost twice the odds of being a short-term worker, compared to a long-term worker, controlling for trade, title, and race/ethnicity. Given these findings, researchers and practitioners should consider mobility patterns when implementing and evaluating worksite-based interventions and programs aimed at improving construction worker health and safety. The observed length of stay on a construction site and associated characteristics provide important insight into how workers come and go on commercial construction sites and the methodological challenges associated with traditional intervention evaluation protocols.

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References

Alterman T, Luckhaupt SE, Dahlhamer JM, Ward BW, Calvert GM. Prevalence rates of work organization characteristics among workers in the U.S.: Data from the 2010 National Health Interview Survey. American Journal of Industrial Medicine. 2013; 56:647–659. [PubMed: 22911666]

Atrostic BK, Bates N, Burt G, Silberstein A. Nonresponse in US government household surveys: consistent measures, recent trends, and new insights. Joural of Official Statistics-Stockholm. 2001; 17:209–226.

Becker P, Fullen M, Akladios M, Hobbs G. Prevention of construction falls by organizational intervention. Injury Prevention. 2001; 7(Suppl 1):i64–i67. [PubMed: 11565975]

Benach JFGPS-RAC. The Health-Damaging Potential of New Types of Flexible Employment: A Challenge for Public Health Researchers. American Journal of Public Health. 2000; 90:1316–1317. [PubMed: 10937019]

Breslin FC, Smith P. Trial by fire: a multivariate examination of the relation between job tenure and work injuries. Occupational and Environmental Medicine. 2006; 63:27–32. [PubMed: 16361402]

Carlan NA, Kramer DM, Bigelow P, Wells R, Garritano E, Vi P. Digging into construction: Social networks and their potential impact on knowledge transfer. Work: A Journal of Prevention, Assessment and Rehabilitation. 2012; 42:223–232.

Carnes D, Parsons S, Ashby D, Breen A, Foster NE, Pincus T, Vogel S, Underwood M. Chronic musculoskeletal pain rarely presents in a single body site:results from a UK population study. Rheumatology. 2007; 46:1168–1170. [PubMed: 17488750]

Cigularov KP, Chen PY, Rosecrance J. The effects of error management climate and safety communication on safety: a multi-level study. Accid Anal Prev. 2010; 42:1498–1506. [PubMed: 20538106]

Cummings KJ, Kreiss K. Contingent workers and contingent health: Risks of a modern economy. JAMA. 2008; 299:448–450. [PubMed: 18230783]

Dunlop, JT. The structure of collective bargaining. 1961. The industrial relations system in construction; p. 255-277.

Kidd P, Parshall M, Wojcik S, Struttmann T. Overcoming recruitment challenges in construction safety intervention research. American Journal of Industrial Medicine. 2004; 45:297–304. [PubMed: 14991857]

Kivimäki M, Vahtera J, Virtanen M, Elovainio M, Pentti J, Ferrie JE. Temporary Employment and Risk of Overall and Cause-specific Mortality. American Journal of Epidemiology. 2003; 158:663–668. [PubMed: 14507602]

Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, Jørgensen K. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Applied Ergonomics. 1987; 18:233–237. [PubMed: 15676628]

Metcalfe C, Davey Smith G, Sterne JAC, Heslop P, Macleod J, Hart C. Frequent job change and associated health. Social Science & Medicine. 2003; 56:1–15. [PubMed: 12435547]

Occupational Safety and Health Administration (OSHA). Draft Proposed Safeyt and Health Program Rule. 1999 29 CFR 1900.1, Docket No. S&H-0027.

Occupational Safety and Health Administration (OSHA). Injury and Illness Prevention Programs: White Paper. United States Department of Labor; 2012.

Paquet V, Punnett L, Woskie S, Buchholz B. Reliable exposure assessment strategies for physical ergonomics stressors in construction and other non-routinized work. Ergonomics. 2005; 48:1200–1219. [PubMed: 16251156]

Pearce N, Checkoway H, Kriebel D. Bias in occupational epidemiology studies. Occupational and Environmental Medicine. 2007; 64(8):562–568. [PubMed: 17053019]

Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. Journal of Electromyography and Kinesiology. 2004; 14(1):13–23. [PubMed: 14759746]

Quesnel-Vallée A, DeHaney S, Ciampi A. Temporary work and depressive symptoms: A propensity score analysis. Social Science & Medicine. 2010; 70:1982–1987. [PubMed: 20371142]

Ringen K, Stafford EJ. Intervention research in occupational safety and health: Examples from construction. American Journal of Industrial Medicine. 1996; 29:314–320. [PubMed: 8728131]

Smith, A. Nearly half of American adults are smartphone owners. Pew Research Center; 2012. http://www.pewinternet.org/files/old-media//Files/Reports/2012/Smartphone%20ownership%202012.pdf [Accessed 5/8/14]

Smith CK, Silverstein BA, Bonauto DK, Adams D, Fan ZJ. Temporary workers in Washington State. American Journal of Industrial Medicine. 2010; 53:135–145. [PubMed: 19618410]

Sparer EH, Herrick RF, Dennerlein JT. Development of a safety communication and recogition program for construction. New Solutions. In press.

Tak S, Buchholz B, Punnett L, Moir S, Paquet V, Fulmer S, Marucci-Wellman H, Wegman D. Physical ergonomic hazards in highway tunnel construction: Overview from the Construction Occupational Health Program. Applied Ergonomics. 2011; 42:665–671. [PubMed: 21112043]

Viswanath K, Nagler RH, Bigman-Galimore CA, McCauley MP, Jung M, Ramanadhan S. The Communications Revolution and Health Inequalities in the 21st Century: Implications for Cancer Control. Cancer Epidemiology, Biomarkers & Prevention. 2012; 21:1701–1708.

Wilkin CL. I can't get no job satisfaction: Meta-analysis comparing permanent and contingent workers. Journal of Organizational Behavior. 2013; 34:47–64.

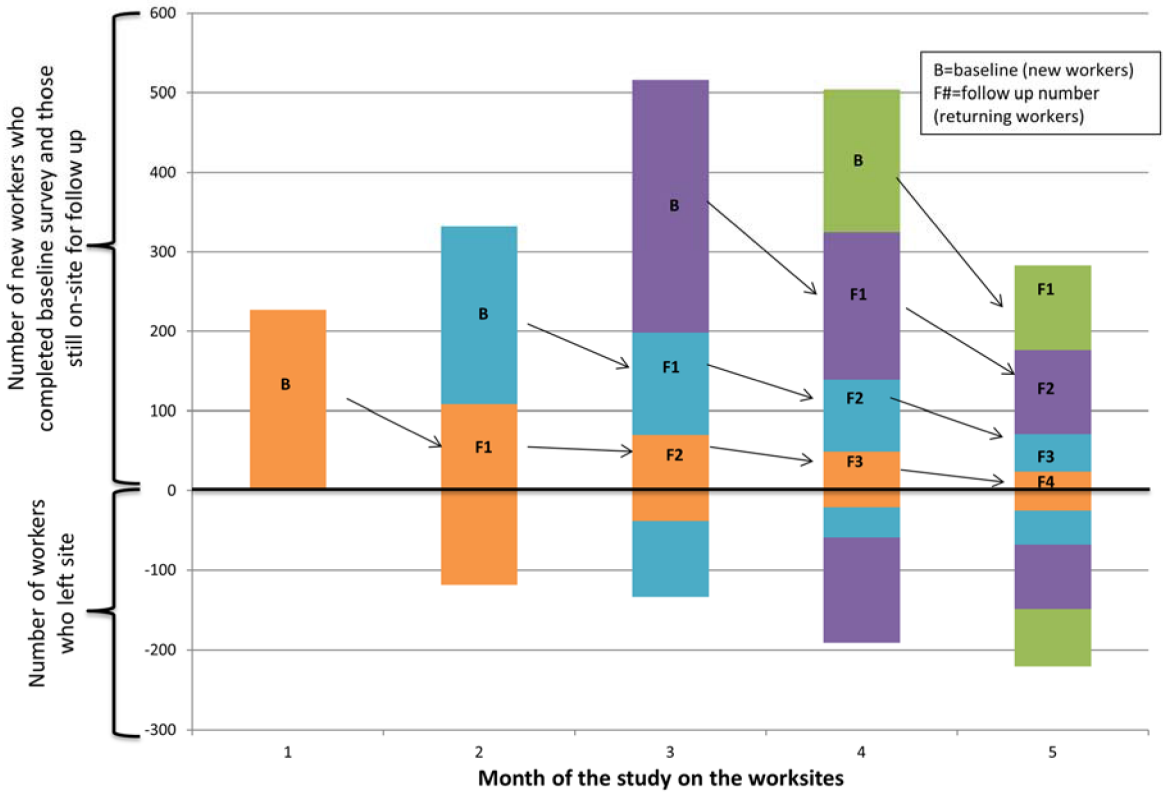

Figure 1.

Workers completed a baseline (B) survey when they started on the worksite, and were followed up (F) with monthly until they left the site, with each color representing a new cohort of workers.

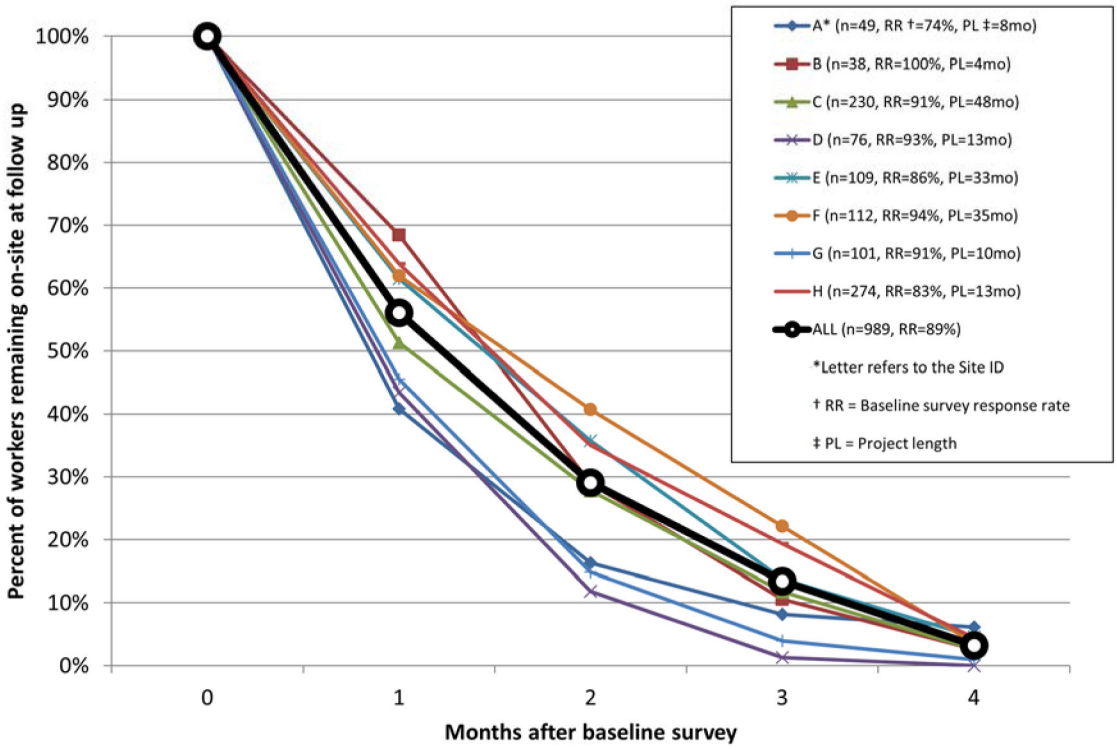

Figure 2.

Percent of the workers who completed the baseline (B) survey and remained onsite at the various monthly follow-ups (F).

Table 1

Bivariate analysis comparing characteristics of those who are long-term workers compared to those that are short-term workers (n=989)

Individual characteristics	Total n	Long-term N (%)	Short-term N (%)	p-value
Gender				0.35
Male	940	526 (56%)	414 (44%)	
Female	31	20 (65%)	11 (35%)	
Race/Ethnicity				**0.011**
White, Non-Hispanic	720	411 (57%)	309 (43%)	
Black/African-American, Non-Hispanic Black	39	28 (72%)	11 (28.2%)	
Other, Non-Hispanic	54	24 (44%)	30 (55.6%)	
Hispanic	58	25 (43%)	33 (56.9%)	
Union member				**0.046**
No	33	13 (39%)	20 (60.6%)	
Yes	909	517 (57%)	392 (43.1%)	
Education				*0.078*
Some High school/High School or GED	405	216 (53%)	189 (46.7%)	
Some College/ Vocational/ trade school/ Associate's degree	451	272 (60%)	178 (39.6%)	
Bachelor's degree/Post graduate degree	75	39 (52%)	36 (48.0%)	
Job Title				**0.0002**
General Foreman	22	13 (59%)	9 (41%)	
Foreman	108	62 (57%)	46 (43%)	
Journeyman	642	356 (56%)	286 (44%)	
Apprentice	153	101 (66%)	52 (34%)	
Other	30	6 (20%)	24 (80%)	
Trade[†]				**<0.0001**
Bricklayer/mason/plasterer/tiler/floorlayer	101	45 (45%)	56 (55%)	
Carpenter	174	92 (53%)	82 (47%)	
Electrical/Telecommunication	187	116 (62%)	71 (38%)	
Finisher/taper/drywall/glazier/ insulator/painter	106	65 (61%)	41 (39%)	
Ironworker	84	48 (57%)	36 (43%)	
Laborer	57	32 (56%)	25 (44%)	
Operator/Operating Engineer/Elevator/Piledriver	38	15 (39%)	23 (61%)	
Pipefitter/Plumber/ Sprinklerfitter	117	82 (70%)	35 (30%)	
Sheetmetal	59	37 (63%)	22 (37%)	
Waterproofer/roofer	16	2 (13%)	14 (87%)	
Unknown/Other	50	20 (40%)	30 (60%)	
Reporting of Pain by Number of Locations				**0.0006**
No pain	634	377 (59%)	257 (41%)	
Single site pain	186	81 (44%)	105 (56%)	

Individual characteristics	**Total n**	**Long-term N (%)**	**Short-term N (%)**	**p-value**
Multi-site pain	169	96 (57%)	73 (43%)	
Treatment status				0.20
Control	324	172 (53%)	152 (479%)	
Intervention	665	382 (57%)	283 (43%)	
	Total n	**Long term Mean (standard deviation)**	**Short term Mean (standard deviation)**	**p- value**
Age (years)	973	40.3 (10.8)	41.1 (10.3)	0.27
BMI (kg/m^2)	906	28.1 (4.4)	28.1 (4.6)	0.83
Tenure (years)	938	17.2 (10.3)	17.8 (10.4)	0.39

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Table 2

Distribution of reported pain among long- and short-term workers

	Long term			Short term		
	No pain (% of long term)	**Single- Location Pain (% of long term)**	**Multi-Location Pain (% of long term)**	**No pain (% of short term)**	**Single-Location Pain (% of short term)**	**Multi-Location Pain (% of short term)**
Trade						
Bricklayer/mason/plasterer/tiler/floorlayer	26 (58%)	9 (20%)	10 (22%)	37 (66%)	13 (23%)	6 (11%)
Carpenter	60 (65%)	10 (11%)	22 (24%)	55 (67%)	17 (21%)	10 (12%)
Electrician/Telecommunication	82 (71%)	21 (18%)	13 (11%)	40 (56%)	18 (25%)	13 (18%)
Finisher/taper/drywall/glazier/insulator/painter	54 (83%)	5 (8%)	6 (9%)	28 (68%)	8 (20%)	5 (12%)
Ironworker	33 (69%)	8 (17%)	7 (15%)	17 (47%)	9 (25%)	10 (28%)
Laborer	21 (66%)	4 (13%)	7 (22%)	14 (56%)	8 (32%)	3 (12%)
Operator/Operating Engineer/Elevator/Piledriver	11 (73%)	1 (7%)	3 (20%)	16 (70%)	3 (13%)	4 (17%)
Pipefitter/Plumber/Sprinklerfitter	51 (62%)	10 (12%)	21 (26%)	16 (46%)	10 (29%)	9 (26%)
Sheetmetal	22 (59%)	11 (30%)	4 (11%)	8 (36%)	8 (36%)	6 (27%)
Waterproofer/roofer	1 (50%)	0 (0%)	1 (50%)	8 (57%)	4 (29%)	2 (14%)
Unknown/Other (e.g. architect, security, asbestos)	17 (85%)	1 (5%)	2 (10%)	18 (60%)	7 (23%)	5 (17%)
Gender						
Male	357 (65%)	80 (15%)	89 (16%)	239 (58%)	103 (25%)	72 (17%)
Female	15 (75%)	0 (0%)	5 (25%)	9 (82%)	1 (9%)	1 (9%)
Race/Ethnicity						
White, Non-Hispanic	278 (68%)	62 (15%)	71 (17%)	173 (56%)	82 (27%)	54 (17%)
Black/African-American, Non-Hispanic Black	18 (64%)	3 (11%)	7 (25%)	7 (64%)	4 (36%)	0 (0%)
Hispanic	17 (71%)	4 (17%)	3 (13%)	24 (80%)	5 (17%)	1 (3%)
Non-Hispanic, Other	18 (72%)	3 (12%)	4 (16%)	16 (48%)	5 (15%)	12 (36%)
Union member						
No	12 (92%)	1 (8%)	0	13 (65%)	2 (10%)	5 (25%)
Yes	344 (66.5%)	79 (15%)	94 (18%)	223 (57%)	101 (26%)	68 (17%)
Education						
Some High school/High School or GED	162 (75%)	24 (11%)	30 (14%)	105 (56%)	52 (28%)	32 (17%)

	Long term			Short term		
	No pain (% of long term)	**Single- Location Pain (% of long term)**	**Multi-Location Pain (% of long term)**	**No pain (% of short term)**	**Single-Location Pain (% of short term)**	**Multi-Location Pain (% of short term)**
Some College/ Vocational/ trade school/ Associate's degree	167 (61%)	49 (18%)	56 (21%)	107 (60%)	41 (23%)	30 (17%)
Bachelor's degree/Post graduate degree	26 (67%)	6 (15%)	7 (18%)	20 (56%)	8 (22%)	8 (22%)
Job Title						
General Foreman	11 (85%)	0 (0%)	2 (15%)	3 (33%)	2 (22%)	4 (44%)
Foreman	45 (73%)	10 (16%)	17 (11%)	18 (39%)	16 (35%)	12 (26%)
Journeyman	231 (65%)	55 (15%)	70 (20%)	172 (60%)	68 (24%)	46 (16%)
Apprentice	71 (70%)	15 (15%)	15 (15%)	30 (58%)	14 (27%)	8 (15%)
Other	5 (83%)	1 (17%)	0 (0%)	17 (71%)	5 (21%)	2 (8%)

Table 3

Worker characteristics as a predictor of short-term length of stay on-site

	Odds ratio (95% CI)
Pain	
No pain	1.00
Single-site pain	2.21 (1.52, 3.19)
Multi-site pain	1.27 (0.86, 1.86)
Trade	
Laborer	1.00
Bricklayer/mason/plasterer/tiler/floorlayer	1.35 (0.67, 2.71)
Carpenter	1.12 (0.59, 2.13)
Electrical/Telecommunication	0.74 (0.39, 1.42)
Finisher/taper/drywall/glazier/ insulator/painter	0.75 (0.37, 1.49)
Ironworker	0.68 (0.33, 1.43)
Operator/Operating Engineer/Elevator/Piledriver	1.38 (0.54, 3.52)
Pipefitter/Plumber/ Sprinklerfitter	0.55 (0.27, 1.11)
Sheetmetal	0.44 (0.19, 1.03)
Waterproofer/roofer	1.78 (0.61, 5.15)
Unknown/Other	11.65 (1.38, 98.69)
Race/ethnicity	
White, Non-Hispanic	1.00
Black/African-American, Non-Hispanic Black	0.60 (0.28, 1.28)
Other, Non-Hispanic	1.24 (0.66, 2.32)
Hispanic	1.92 (1.08, 3.42)
Job Title	
Journeyman	1.00
General Foreman	0.99 (0.37, 2.65)
Foreman	0.87 (0.55, 1.37)
Apprentice	0.63 (0.42, 0.95)
Other	4.02 (1.39, 11.64)