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Effectiveness of a no-cost-to-workers, slip-resistant footwear program for reducing slipping-related injuries in food service workers: a cluster randomized trial

by Jennifer L Bell, PhD,¹ James W Collins, PhD,¹ Sharon Chiou, PhD²

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Objective This study evaluated the effectiveness of a no-cost-to-workers, slip-resistant footwear (SRF) program in preventing workers' compensation injury claims caused by slipping on wet or greasy floors.

Methods The study population was a dynamic cohort of food service workers from 226 school districts' kindergarten through 12th grade food service operations. A two-arm cluster randomized controlled study design was implemented, with school districts randomized to the intervention group receiving SRF. Data were analyzed according to the intent-to-treat principle. Logistic regression was used to analyze dichotomous response data (injured based on workers' compensation injury claims data, or not injured, for each month worked). Changes in slipping injury rates from baseline to post-intervention follow-up periods were compared between treatment groups.

Results The probability of a slipping injury was reduced significantly in the intervention group, from a baseline measure of 3.54 slipping injuries per 10 000 worker-months to 1.18 slipping injuries per 10 000 worker-months in the follow-up period [adjusted odds ratio (OR_{adj}) 0.33, 95% confidence interval (CI) 0.17–0.63]. In the control group, slipping injuries were 2.01 per 10 000 worker-months in the baseline, and 2.30 per 10 000 worker-months in the follow-up. The interaction between treatment group and time period (baseline or follow-up) indicated that the decline seen in the intervention group was significantly different than the increase seen in the control group (OR_{adj} 0.29, 95% CI 0.11–0.74, adjusted for age >55 years).

Conclusions This study provides evidence for the effectiveness of a no-cost-to-workers SRF program in reducing slipping-related workers' compensation injury claims in food service workers.

Key terms fall; kitchen; logistic regression; occupational; pretest; posttest; workplace accident; workplace injury.

Slips, trips and falls are the second most common type of both fatal and non-fatal work-related injuries in the United States (1, 2) and are the most expensive category of injuries in direct US workers' compensation costs (3). Although falls from height are more likely to result in a fatality, falls on the same level occur more frequently and cause significant morbidity, with recent US Bureau of Labor Statistics data showing that 50% of all same-level falls resulted in >10 days sick leave (1, 2, 4). Sprains, strains, dislocations and tears to the lower extremities are the most common injuries after a slip, trip or fall (5–8).

Slipping (foot slides out of place away from a person's base of support) is the most common precursor to slip, trip and fall injuries in various diverse worker populations (5, 6, 8–11). Many strategies have been proposed for reducing

work-related slipping injuries, including improvements to floor cleaning and degreasing procedures, prevention of floor contamination, slip-resistant footwear (SRF), slip-resistant flooring, and educating workers about hazards (5, 12–17). One strategy to combat slipping of the foot on the floor surface is the use of SRF, which has been studied in laboratory settings with regard to sole pattern and composition related to the coefficient of friction between the sole and floor surface (18–24). Field studies of the effectiveness of SRF are much less common. In a study done in hospitals that demonstrated effectiveness of an overall slip, trip and fall prevention program that included SRF, the effect of individual components (such as SRF) could not be isolated and evaluated (5). A series of related research papers based on surveys of 475 workers at 36

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limited service restaurants provide evidence supporting the effectiveness of SRF (25–27). Workers wearing SRF had a significantly lower rate (54% lower) of self-reported slipping in comparison to workers not wearing SRF (25, 26). Slip-resistant shoes with ≤ 6 months of reported wear were found to be associated with a lower rate of self-reported slipping than SRF worn for > 6 months (27).

The present study sought to fill gaps in the knowledge base concerning SRF. The aim was to evaluate the effectiveness of a SRF program for reducing the incidence of slipping-related workers' compensation injury claims in food service workers.

Methods

Study design

We conducted a two-arm cluster-randomized controlled study in a population of workers from one company providing contracted food services for school districts. Changes in slipping injury rates from a baseline to a follow-up period were compared between intervention and control groups. A randomized controlled trial (RCT) design was chosen with the goal of balancing known and unknown factors between the treatment groups such that any differences seen between the two could be attributed to the intervention; the two-arm RCT evaluates the effectiveness of a single intervention in comparison to a control (28, 29). Workers were clustered by school district so that all people working together in the same district could be offered the intervention. An additional reason for clustering was that the administrative records used in the study were organized at the school district level, and not further broken out below the school district level.

Study timeline

The duration of the study was 1 August 2009–31 December 2013. The baseline pre-intervention period was 1 August 2009–31 July 2011. School districts were randomized to the treatment group in May of 2011, with study enrollment and shoe ordering for the intervention taking place May–July 2011, and a start date of 1 August 2011 for use of the SRF by workers. The post intervention follow-up period was 1 August 2011–31 December 2013. These dates were held constant for all school districts in the study, regardless of the exact date when each school district opened for the school year and began serving food.

Cluster eligibility and study participants

An Institutional Review Board approved the study before commencement. The study population comprised workers

employed by a partnering company who provided contracted food services at kindergarten through 12th (K-12) grade schools in the US. Each cluster in this study was the food services operations at one school district. The eligibility criteria for a school district to participate were that it must (i) be located within three of the partnering company's geographic business units (Northeast, South Central, and Great Lakes West) and (ii) have both management and frontline food service workers working at the school district.

Intervention

Prior to the start of the study, the partnering company had a pre-existing slip, trip and fall prevention program in place, which included a SRF payroll deduction program. The company's program remained in place for the entire duration of the study, for both intervention and control sites. As part of the company's slip, trip and fall prevention program, the use of SRF was strongly recommended to workers (in 2012, partway through the follow-up period, the company issued a requirement that all workers wear SRF); however, workers generally were required to purchase their own SRF. A voluntary payroll deduction program was available where onsite managers helped facilitate workers' purchase of shoes through an approved SRF vendor. Workers could also purchase SRF from other sources of their own choosing.

The intervention, overlaid on the pre-existing program and offered only to school districts randomized to the intervention group, was commercially-available SRF offered at no cost to workers, paid for by study research funds. To minimize variation from multiple sole patterns, one SRF brand was chosen based on highly ranked performance in wet, greasy conditions (19–22) and availability of a variety of sizes and styles of the upper portion of the shoe. The shoe brand chosen for the intervention ended up being the same brand that was available to workers through the payroll deduction program. For the intervention, the food service workers could order seven styles of SRF (including a slip-resistant shoe cover) directly from the vendor through a process facilitated by their onsite manager. New hires could also receive SRF. Onsite managers were to assist workers in monitoring for sole wear and re-ordering as needed, with the knowledge that the vendor recommended re-ordering after six months of full-time wear.

Data on shoe purchases (both worker- and research funds-purchased) made by the school districts in this study, during the entire duration of the study, were obtained from the SRF vendor. No information was available on shoe purchases that may have been made outside the payroll deduction or intervention program.

A measure of SRF participation was calculated for each school district as the total number of SRF ordered

by each school district each school year from the SRF vendor in the numerator, and a count of unique number of workers employed each school year as the denominator. The participation measure is descriptive only and was not intended to be an outcome measure in the study.

Study data and injury case definition

The company shared electronic data (administrative records already collected and maintained by the company for non-research purposes) with study researchers, between 1 August 2009–31 December 2013. Workers were identified in the datasets using unique, anonymous numbers. Data records from all workers were used in the study; there were no exclusions at the worker level. Workers hired at any time during the study duration were included in the study. Information on workers' hire and termination dates, age, and gender were obtained. Data were not available on race or ethnicity.

Information about injuries to workers in the study were obtained from claims that had been accepted into the company's workers compensation injury claims database. Researchers extracted all claims that were pre-coded during the company's insurance process as slip-, trip- and fall-related in cause, and these were subset and coded for case status using text from three cause and narrative fields present in the claims dataset. Injury cases in this study were defined using criteria from the SRF vendor's warranty for the types of incidents their shoes are designed to prevent, specifically, injury cases were incidents caused by slipping (with or without a fall) on liquid or grease contaminants (such as water, fluids, condensation, oil, or grease) indoors. For the rest of the claims coded by the company's insurance process as something other than slip-, trip- or fall-related, the incident description narrative field was first computer-searched for iterations of the words "slip", "skid" and "slid." Any narrative with those key words was subset and coded using the same case status determination. Coding for injury case status was done blinded to information such as intervention or control assignment, date of claim, and school district name, using SAS table editor to hide these data columns prior to coding (SAS Institute, Cary, NC, USA). A second researcher also coded the claims using the same blinded method and any discrepancies were compared and resolved. The same injury case criteria and methods were used for the entire study duration, for all school districts in the study.

Sample size calculation

Initial sample size calculations were performed prior to the start of the study using EpiInfo software (EpiInfo Version 3.3.2., US Centers for Disease Control and Prevention, USA), and designed so that this study would have 80% power to detect statistical significance ($P < 0.05$) with

a reduction of 50% in injury. Detailed data from the study population were not available at the time the sample size was calculated, therefore pre-existing rate estimates provided from the collaborating company were used. From an estimated baseline slip, trip and fall injury rate of 2 per 100 workers per year, a 50% reduction would result in a rate of 1 claim per 100 workers year, and would require a total study population of 5028 full-time equivalents (FTE). The 50% reduction was selected based on results reported in a previous study (5) on food service workers' reduction in slip, trip and fall workers' compensation claims rates following implementation of a comprehensive prevention program including SRF.

Part-time work is common in food services, and it was estimated that 1.7 workers would be needed to work the hours of 1 FTE. Therefore, the goal was to obtain data on a population of 8548 workers over the entire study period. The initial sample size calculation did not include any additional adjustments for clustering.

Randomization

The company developed a master list of eligible school districts, and the research team used a simple random number generator using SAS software to randomly reorder the list of eligible school districts and assign them to intervention or control group. School districts were not assigned to intervention or control group in a 1:1 ratio. As each school district was added to the intervention group, its number of workers was considered to ensure there were enough resources to supply all workers with SRF before adding the next school district in random order to the intervention group. Additionally, more school districts were added during initial randomization to the intervention group than to the control group to maximize the use of pre-existing resources (research grant funds earmarked for the purchase of SRF).

Statistical analysis

Data were analyzed according to the intention-to-treat principle, whereby subjects were analyzed according to the group to which they were originally randomized, regardless of whether they participated in the intervention or not. Each individual worker-month was a unit of analysis. A response of 0 was a non-event (worked during that month, but did not have a slip injury), a response of 1 was an event (worked during a month and also had a slip injury). There were no worker-months with >1 injury. Logistic regression was used for analyzing dichotomous response data. The analysis was performed using the GENMOD procedure in SAS/STAT version 9.3 software.

Generalized estimating equations (GEE) using the REPEATED statement and an exchangeable correlation structure were used to account for potential within-

cluster correlation of the workers at the school district (cluster) level, as well as to account for repeated measurements on the same workers over time (30).

Two models were tested, the first to determine if there was a significant decline in the probability of an injury from baseline to follow-up in the intervention group, and a second to determine whether the trend seen in the intervention group was significantly different than any trend in the control group over the same time period. The second model included an interaction term between a dichotomous time period variable (24-month baseline period versus 29-month follow-up period) and treatment group (intervention or control).

Two potential covariates were examined based on previous slip, trip, and fall research findings. Age and gender were found in previous studies to be risk factors for work-related slips, trips, and falls as a combined outcome (5, 31, 32). Therefore, age and gender were examined as potential risk factors for slipping-related injuries in data from the baseline period.

Results

Recruitment and participation

There were 226 school districts that met the eligibility criteria for the study. A dynamic cohort of 16 949 unique workers were employed over the entire study duration (figure 1). Ten school districts were lost from the study because the company did not renew its contracts with the school districts; therefore, they contributed data during the baseline period only.

After randomization to treatment group, some managers declined to have their school district participate. If managers chose to have the school district participate, then workers were given the offer to participate. Participation by workers was voluntary, and workers choosing to receive shoes gave informed consent. Of the school districts randomized to receive the intervention (excludes those lost to follow-up due to contract nonrenewal), 80% (94 out of 118) ordered shoes during the follow-up period through the research study, and 20% (24 out of 118) did not. Of the 24 school districts not ordering through the research study, 15 of them had ordered shoes outside of the research study through payroll deduction, while 9 of the 24 showed no record of ordering. Therefore, 92% (109 out of 118) of the school districts in the intervention group were found to have ordered SRF through the shoe vendor during the follow-up period. There was no formal follow-back survey done to managers or workers to determine why they did not participate. Of the 98 school districts in

the control group, 47% (46 out of 98) had record of ordering from the shoe vendor in the follow-up period.

Examination of potential covariates

Comparisons performed in the baseline period showed that workers ≥ 55 years had a significantly higher probability of a slipping injury in comparison to workers < 55 years (table 1). No significant difference was found for the rate of slipping injuries between males and females (table 1). After randomization, no differences were found in the proportion of months worked by workers

Figure 1. Chart showing flow of school districts, and number of workers, for the pre-intervention baseline (1 August 2009–31 July 2011) and post-intervention follow-up (1 August 2011–31 December 2013) time periods.

Table 1. Statistical examination of potential risk factors gender and age for slip injuries in the pre-intervention baseline period (1 August 2009–31 July 2011), intervention and control groups combined. [OR=odds ratio; CI=confidence interval.] **Bold indicates significance at P<0.05.**

Treatment group	Number of injuries	Worker-months ^a	Injuries per 10 000 worker-months ^b	OR	95% CI
Gender					
Male	5	12 890	3.88	0.72	0.28–1.82
Female	42	149 975	2.80		
Age group (years)					
<55	26	115 626	2.34	1.82	1.00–3.28
≥ 55	21	47 239	4.23		

^a Count of months where workers worked any number of hours for pay; dynamic cohort where workers contributed differing amounts of working-months.

^b Calculated as (number of injuries / number of working-months) $\times$ 10 000.

^c Lower confidence interval = 1.004.

aged ≥ 55 years, or the proportion of months worked by female workers between the intervention and control groups (table 2). Because no significant difference was found between males and females in the rate of slipping injuries, and because the proportion of females did not differ significantly between intervention and control groups, gender was not retained as a covariate in further statistical analyses. Although the proportion of older workers was not significantly different between the intervention and control groups at baseline, it was retained as a covariate, given the significantly greater risk for older workers found in baseline, and the potential for ageing of the workforce over the study duration.

Slipping injuries

No adverse outcomes were reported during this study. The first model tested was to determine if there was a significant decline in the probability of an injury from baseline to follow-up in the intervention group. This model was confirmed, with the intervention group showing a significant decline in the odds of a slipping injury, from 3.54 injuries per 10 000 worker-months in the baseline to 1.18 injuries per 10 000 worker-months in the follow-up [adjusted odds ratio (OR_{adj}) 0.33, 95% confidence interval (CI) 0.17–0.63, descriptive statistics shown in table 3]. Age ≥ 55 years was not found to be

significant in the model (OR 1.55, 95% CI 0.84–2.85). For the control group, slipping injuries were 2.01 per 10 000 worker-months in the baseline, and 2.30 per 10 000 worker-months in the follow-up. The second model was to determine whether the trend seen in the intervention group was significantly different from any trend in the control group over the same time period. The interaction between treatment group (intervention or control) and time period (baseline or follow-up) indicated that the decline seen in the intervention group was significantly different than the change seen in the control group (OR_{adj} 0.29, 95% CI 0.11–0.74, adjusted for age >55 years). The analysis done to check for within-cluster correlation found little evidence of significant correlation, either within clusters, or within repeated measurements on the same worker, with the exchangeable working correlation being $P < 0.001$ in both models.

Discussion

To our knowledge, this is the first RCT evaluating the effectiveness of a no cost to workers SRF program for reducing slipping-related workers' compensation injury claims in food service workers in the field. The results showed a significant 67% decline in the probability of

Table 2. Statistical comparison of age and gender between intervention group and control group in the baseline period (1 August 2009–31 July 2011). [OR=odds ratio; CI=confidence interval; SD=standard deviation.]

Treatment group	Proportion of >55 -year-olds' working hours ^a	OR	95% CI	Proportion of female working-hours ^b	OR	95% CI
Control	29.3% (20 443 / 69 676)	–		92.4% (64 346 / 69 676)	–	
Intervention	28.8% (26 796 / 93 189)	0.99	0.91–1.08	91.9% (85 629 / 93 189)	0.95	0.84–1.08

^a Number of >55 -year-olds' working-months / total number of <55 - and >55 -year-olds' working-months.

^b Number of female working-months / total number of male and female working-months.

Table 3. Descriptive statistics for intervention and control group by time period, pre-intervention baseline (1 August 2009–31 July 2011) and post-intervention follow-up (1 August 2011–31 December 2013). [SRF=slip-resistant footwear.]

Treatment group	Number of workers ^a	Working-months ^b	Number of Injuries ^c	Injuries per 10 000 working-months ^d	SRF participation rate ^e	School districts with slip injuries	Schools ordering SRF ^f
Control							
Baseline (N=101 school districts) ^g	4800	69 676	14	2.01	0.14	11%	28%(28 / 101)
Post-intervention (N=98 school districts)	6647	82 573	19	2.30	0.20	15%	47%(46 / 98)
Intervention							
Baseline (N=125 school districts) ^g	5384	93 189	33	3.54	0.18	22%	46%(46 / 125)
Post-intervention (N=118 school districts)	7490	110 417	13	1.18	0.94	9%	92%(109 / 118)

^a Number of workers working at least one month during each time period.

^b Count of months where workers worked any number of hours for pay; dynamic cohort where workers contributed differing amounts of working-months.

^c All injuries were from different workers with the exception of two workers that had two injuries over the course of the study duration.

^d Calculated as (number of injuries / number of working-months) $\times$ 10,000

^e Participation rate calculated by (total pairs SRF ordered by the school district / total number of workers each year of the study combined)

^f At least one pair of SRF ordered by the school district.

^g Ten school districts were lost to follow-up and contributed data to the baseline period only.

an injury in the intervention group receiving no cost SRF from baseline to follow-up, and this trend was significantly different from the trend seen during the same time period in the control group (a 14% increase in injury probability). Prevention trials undertaken in the field, providing evidence for effectiveness of measures such as SRF, are needed for overall reductions in same level falls (10). This current study helps to bridge the gap between understanding the performance of SRF in laboratory settings to understanding the effectiveness of SRF at preventing injuries in a functional work environment. Additionally, this study attempted to isolate the effect of a single intervention as much as possible through the study design.

Another finding from this research was that prior to the no cost SRF intervention, workers age ≥ 55 years had a higher probability of a slipping-related workers' compensation injury claim than workers < 55 years. This is of public health significance, as the United States is showing continual increases in the proportion of workers aged ≥ 55 years in the active workforce, and without intervention, slipping injuries may be an increasing injury problem (33).

The findings from this study, providing evidence of the effectiveness of SRF, may assist employers, managers, and workers in their decision on whether to invest time and resources in a SRF program. The use of workers' compensation injury claims as an outcome measure may be a particularly useful source of information given that most businesses in the US use the worker's compensation injury system and a company's worker injury burden can play a role in its profitability (34–38). Information is becoming increasingly available to help employers and workers select SRF with a high degree of slip resistance in a variety of conditions (22–24, 37). While it is not currently known what percentage of the workforce needs to be wearing SRF before a company-wide reduction in injuries would occur, in this study, 94% of the workers participated in the SRF program. Although not directly comparable numbers, this figure is close to the 91% participation reported from a previous study in workplaces where employers provided SRF at no cost to employees (39). Future research looking for a correlation between percent SRF use in the workforce and corresponding slipping injury rates would be useful, particularly if workers' use of SRF was documented. Barriers to the use of SRF by workers is warranted. Future research evaluating the cost-effectiveness of SRF programs could prove useful as employers may be more willing to support SRF programs if the cost-benefit could be clearly demonstrated in addition to the injury reduction component.

Methodologic considerations

Strengths of this study include the randomized controlled design, the large number of participants, and geographic

breadth of study sites (school districts from 25 states were included in the analysis). An additional strength is that the school districts were followed for 53 months (24 months pre-intervention baseline, and 29 months post-intervention follow-up), making it less likely that findings were due to a Hawthorne or other unintended effect.

The findings from this study should be generalizable to other populations of food service workers with similar demographics and working conditions. The workforce in this current study was mostly female (~90%) with an average age of 47 years. It is not known how generalizable these findings would be to other food services segments, such as quick-service restaurants described in Verma et al (39) that had a younger average age (31 years) and were more equally balanced by gender (66% female).

An additional methodologic consideration was the use of workers' compensation injury claims as an injury outcome measure. Workers' compensation, as a social insurance program, covers the majority of workplaces with employees in the US; most recently in 2015, workers' compensation coverage extended to an estimated 86.5 percent of all jobs held in the employed workforce (34, 38). Workers' compensation injury claims data, despite some limitations, are a widely-accepted and useful tool to monitor injuries and evaluate safety and health programs in the workplace (35–37, 40). The cost and severity of claims were not examined as separate outcomes in the current study, however a workers' compensation injury claim of any kind can be considered to incur costs because the worker, employer, claims administrators, and safety and health, medical, and legal professionals all contribute to the processing and evaluation of a claim, regardless of outcome (41–43). A reduction in the number of slipping-related injury events should bring down the rate of those events with both major and minor consequences. The most notable limitation on the use of workers' compensation injury claims databases is that they may undercount injuries due to non-reporting of injuries, with workers seeking medical treatment outside of the workers' compensation claims system (40, 44, 45). Therefore, there may have been a number of unreported injuries present in this population not present in the claims-based rates reported in this study. Given the RCT study design, it was assumed that if underreporting were present, it would be balanced between intervention and control groups.

There are several limitations to be considered when assessing the conclusions from these research findings. First, data were not collected on whether or not injured workers were wearing their SRF at the time of the injury. The research team did not quantify workers' jobsite use of SRF, SRF purchases by a school district were not linked to individual workers, and workers could have ordered SRF but decided not to wear them. It was assumed that onsite managers would monitor SRF usage by workers,

in accordance with company policy. Assumptions were made about workers' SRF usage in that if workers made the effort to enroll in the no cost SRF program, most workers would wear the shoes. This assumption is based on data from a previous research study done in food services by Verma et al (46), where workers' visually verified use of SRF was highest (with 91% of workers wearing them) in restaurants where footwear was provided by and paid for by the employer. We assumed our study would have a similar usage rate because the intervention was no cost. Additionally, the no cost SRF intervention was added into a pre-existing framework where the company recommended, then required all workers to use SRF; however, workers were free to choose whatever brand of shoe they wanted, as long as it was labeled as slip-resistant.

Another potential limitation is that data were not available on use of other brands of SRF that may have been purchased and used by workers outside of the onsite payroll deduction program or research funded program. In this study, one specific scenario was tested, whereby sites with highly ranked SRF of one brand with the same sole pattern was provided at no cost to participating workers were compared to sites where workers had the same SRF administrative requirement, but were generally purchasing a variety of brands at their own expense. Because one scenario was tested as the intervention, it remains possible that other types of SRF tested in the same manner could have a similar impact.

Finally, the generalizability of these study findings may be affected by what could have been a reduced level of floor contamination in K-12 school kitchens in comparison to other food service industry environments. Deep-fat fryers have been phased out of many school kitchens in recent years due to dietary health concerns prompted by the USDA (47–49). Deep-fat fryers tend to create the most slippery areas in a working kitchen (50), and increased levels of contamination on the floor may lead to reduced coefficient of friction between a shoe sole and the floor (51, 52). Given the potential loss of deep fat frying as a cooking process, these K-12 school kitchen floors may be less slippery than floors found in other food services still using open fryers for cooking, and potentially have a lower slipping-related injury rate than other food service environments.

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Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

Conflicts of interest

The authors report no conflicts of interest.

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