Rushing, distraction, walking on contaminated floors and risk of slipping in limited-service restaurants: a case—crossover study

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ABSTRACT

Objectives This nested case—crossover study examined the association between rushing, distraction and walking on a contaminated floor and the rate of slipping, and whether the effects varied according to weekly hours worked, job tenure and use of slip-resistant shoes.

Methods At baseline, workers from 30 limited-service restaurants in the USA reported average work hours, average weekly duration of exposure to each transient risk factor and job tenure at the current location. Use of slip-resistant shoes was determined. During the following 12 weeks, participants reported weekly their slip experience and exposures to the three transient exposures at the time of slipping. The case—crossover design was used to estimate the rate ratios using the Mantel—Haenszel estimator for person-time data.

Results Among 396 participants providing baseline information, 210 reported one or more slips with a total of 989 slips. Rate of slipping was 2.9 times higher when rushing as compared to working at a normal pace (95% CI 2.5 to 3.3). Rate of slipping was also significantly increased by distraction (rate ratio (RR) 1.7, 95% CI 1.5 to 2.0) and walking on a contaminated floor (RR 14.6, 95% CI 12.6 to 17.0). Use of slip-resistant shoes decreased the effects of rushing and walking on a contaminated floor. Rate ratios for all three transient factors decreased monotonically as job tenure increased.

Conclusion The results suggest the importance of these transient risk factors, particularly floor contamination, on rate of slipping in limited-service restaurant workers. Stable characteristics, such as slip-resistant shoes, reduced the effects of transient exposures.

Most published studies of slipping at work have been limited to descriptive epidemiology.7–9 Courtney et al, in a recent cross-sectional study, were the first to report a significant association between coefficient of friction (COF) and self-reported history of slipping.10 Well-designed analytical studies are necessary to examine factors that contribute to risk of slipping and quantify their effects.

The case—crossover study design has been used to identify transient risk factors for sudden onset events.11–12 Many studies have examined the effects of transient risk factors, such as rushing and distraction, on risk of occupational injuries using a case—crossover design.13–15 This design controls for between-subject factors such as industry, occupation, age or other factors that are stable in an individual over a short time period. However, with this approach it is still possible to evaluate whether these stable characteristics alter the effect of transient risk factors on the occurrence of injury.

In an effort to identify modifiable fixed and transient risk factors for slipping, a 12-week prospective cohort study with a nested case—crossover study was conducted in limited-service restaurant workers. The case—crossover study examined the
effects of rushing, distraction and walking on a contaminated floor on the risk of slipping. Effect modification by hours worked per week, job tenure and use of slip-resistent shoes was also explored.

METHODS
The study was conducted in 36 US limited-service restaurants (also known as ‘fast-food restaurants’, North American Industry Classification System Code 722211) located in the states of Connecticut, Massachusetts, New York, Pennsylvania, Tennessee and Wisconsin. These restaurants, in general, had similar main menu items. The study was approved by the Institutional Review Board of the Liberty Mutual Research Institute for Safety and the Office of Human Research Administration at the Harvard School of Public Health.

Enrolment procedure
Several approaches were used to recruit restaurants for this study. These included approaching chains, stores or franchisees that had previously been receptive to research studies by the investigative team members, approaching restaurant trade associations, direct solicitation of stores or franchisees and outreach via the loss control department of a large worker’s compensation insurance company.

Once permission to enrol a restaurant was received, members of the study team met the restaurant manager onsite to explain the purpose of the research study, administer a baseline manager survey, and set up an appointment to enrol and survey the restaurant’s employees. Restaurant managers were given flyers advertising the study with the date of the survey team’s upcoming visit to post in their employee break area. Restaurant workers not scheduled to work on the day of enrolment were encouraged to come to the restaurant sometime during that day, with their work shoes, if they were interested in participating in the study. Participants were enrolled and baseline surveys were conducted in each restaurant on the scheduled date. The survey materials were made available in three languages: English, Spanish and Portuguese. After completing the baseline survey, participants were asked to report their slip experience weekly for the following 12 weeks. A study team member explained the definition of a slip to the study participants by explaining that, “A slip is simply a loss of traction of your foot—you can slip without falling”. Participants were given a choice of reporting their weekly slip experience by telephone using an interactive voice response system, by an internet-based survey, or by filling out written survey forms. Participants who did not complete their weekly survey at the end of the week were given one reminder telephone call. Participants were given 1 week to complete their weekly survey. Enrolment procedures have been previously described. 16 17

Study population
Figure 1 shows the selection of the study population. A total of 475 workers were recruited from 36 restaurants. Questions about transient exposures were added after 79 participants had already been recruited into the study and initial concerns about the length of the questionnaire had been resolved. The 30 restaurants included in the case–crossover arm of the study employed 950 employees, 396 of whom participated in the study (42%). Information about transient exposures was collected from these participants. Of the 396 participants who reported baseline information about transient exposures, 45 did not report any follow-up data and 141 did not report any slips during follow-up. A total of 210 participants reported one or more slips during the follow-up period. Since a case–crossover study design includes only cases, the study population consisted of 210 participants who reported one or more slips.

Exposures
Information about three transient exposures at the time of each slip was collected including rushing, distraction and walking on a contaminated floor. Rushing was defined as working faster than the normal or comfortable pace. Distraction was defined as doing multiple tasks at once, such as taking orders for drive-through while also working on something else. Walking on a contaminated floor was defined as walking on a floor that was not clean and dry (a surface that was wet, oily or had other contaminants on the floor).

Exposure information during the control time
A usual frequency approach was taken to estimate exposure information during the control time. 18 At baseline, each participant was asked to estimate their average frequency and duration of rushing, distraction and walking on a contaminated floor at work during a 1-week period. The average frequency was multiplied by average duration to estimate the number of exposed hours per week. 14 19 Participants also reported average weekly work hours at baseline. For each transient exposure, the proportion of exposed time was calculated at the baseline by dividing the exposed time by average amount of time each worker reported working in 1 week ($P_b$).

$$P_b = \frac{\text{Average frequency of weekly exposure} \times \text{Average duration of exposure}}{\text{Average weekly work hours}}$$
During follow-up, participants reported their weekly work hours each week for up to 12 weeks following the baseline survey. Total work time (time at risk, $T_i$) during follow-up was calculated by summing all of their weekly hours. Total exposed time ($T^e_i$) was determined by multiplying total work time during follow-up period ($T_i$) by the proportion of exposed time from baseline ($P_i$). Total unexposed time ($T^u_i$) was calculated by subtracting total exposed time from the sum of all weekly hours.

$$T^u_i = \text{Sum of weekly work hours reported during follow-up} \times P_i - T^e_i$$

For example, if a participant reported rushing three times a week for 2 h on average each time, and reported working 40 h per week, the proportion of exposed time ($P_i$) for this participant would be $3 \times 2/40 = 0.15$. If this participant reported follow-up data for 3 weeks and reported working 35, 40 and 40 h in weeks 1, 2 and 3, respectively, then the total exposed time ($T^e_i$) for rushing for this participant would be $(35 + 40 + 40) \times 0.15 = 17.25$ h, and total unexposed time ($T^u_i$) would be $(35 + 40 + 40 - 17.25) = 97.25$ h.

**Exposure information at time of slipping**

Every week participants reported the number of slips they experienced in the previous week. If participants reported one or more slips, questions were asked about the three transient exposures at the time of the slip. Exposure status at the time of the slip was collected for up to four slips each week for each participant, as it was believed that very few participants would report more than four slips in a week. On average, participants reported slip information within 3.6 days of slipping (median 3.0, range 0–13).

**Stable characteristics**

**Weekly work hours and job tenure**

At baseline, participants reported weekly work hours and job tenure at the restaurant. Participants were divided into four groups based on weekly work hours: (1) 25 h or less, (2) 26–55 h, (3) 36–40 h and (4) 41 h or more. In the USA, the Fair Labor Standards Act establishes a standard workweek of 40 h for overtime pay for certain kinds of workers and, therefore, a category of 41 or more hours was created to indicate workers working more than full-time.\(^{(20)}\) Full-time work is not defined in the USA. However, 36–40 h per week is generally considered full time in the USA and some European countries. Less than 36 h was divided into two equal categories (according to number of participants), as there was not justification for choosing one cut-off over the other. Job tenure was divided into three groups: (1) <1 year, (2) 1–5 years and (3) more than 5 years.\(^{(14)}\)

**Slip-resistant shoes**

At the time of completing the baseline survey, participants were asked to remove their right shoe and the sole of the shoe was examined. Since clear classification criteria for slip-resistant shoes could not be found in the literature, shoes were classified as slip-resistant if the manufacturer claimed them to be such by writing ‘slip resistant’ on the sole.\(^{(17)}\) ‘Non-slip-resistant’ was the default category and participants who were not wearing their usual work shoes on the day of the survey were categorised as non-slip-resistant shoe users as the slip-resistant status of their shoes could not be confirmed (n=5). A total of 199 participants reported wearing the same shoes every day at work (95%).

**Data analysis**

The data were stratified by individual participant. Rate ratios and 95% CIs for these stratified data were calculated using the Mantel–Haenszel estimator for person-time data.\(^{(11,18,21)}\) A participant could experience multiple slips during follow-up. However, data were stratified by individual participant and not slips. Appendix 1 details rate ratio calculations for five participants using the usual frequency analysis approach. $\chi^2$ Tests of homogeneity were used to evaluate differences in the rate ratio estimates across levels of the stable characteristics.\(^{(21)}\)

**RESULTS**

Table 1 shows the characteristics of the 210 participants. The mean age of participants was 27 years (SD 11.2). A majority of participants were female (71%) and white, not Hispanic (59%). Average weekly work hours was 34.2 (median 35, SD 11.0) and average job tenure was 27 months (median 14, SD 33.7). Slip-resistant shoes were being worn by 136 participants (65%).

### Table 1: Participants reporting at least one slip (n=210) and no slip (n=141) during the 12-week follow-up period and p values for the differences in their demographic characteristics

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Participants with at least one slip during the follow-up period</th>
<th>Participants with no slip during the follow-up period</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15–19</td>
<td>67 31.9 21 15.9</td>
<td>18 8.6 14 9.9</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>20–29</td>
<td>76 36.2 37 26.2</td>
<td>35 16.6 24 17.4</td>
<td>0.93</td>
</tr>
<tr>
<td>30–39</td>
<td>29 13.8 27 19.2</td>
<td>17 8.1 13 9.3</td>
<td>1.00</td>
</tr>
<tr>
<td>40–49</td>
<td>27 12.9 30 21.3</td>
<td>25 11.9 20 13.8</td>
<td>0.18</td>
</tr>
<tr>
<td>50 or more</td>
<td>11 5.2 26 18.4</td>
<td>10 4.7 24 16.9</td>
<td>1.00</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>148 70.5 88 62.4</td>
<td>103 67.1 74 53.4</td>
<td>0.11</td>
</tr>
<tr>
<td>Male</td>
<td>62 29.5 53 37.6</td>
<td>95 32.9 80 47.6</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, not Hispanic</td>
<td>123 58.6 78 55.3</td>
<td>79 47.3 70 49.9</td>
<td>0.93</td>
</tr>
<tr>
<td>Black, not Hispanic</td>
<td>47 22.4 34 24.1</td>
<td>32 20.4 23 16.8</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>22 10.5 15 10.6</td>
<td>20 13.2 15 10.8</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>18 8.6 14 9.9</td>
<td>11 5.2 8 5.3</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never attended school</td>
<td>3 1.4 2 1.4</td>
<td>4 2.2 3 1.8</td>
<td>0.47</td>
</tr>
<tr>
<td>Grades 1–11</td>
<td>64 30.5 37 26.2</td>
<td>60 41.2 56 43.5</td>
<td></td>
</tr>
<tr>
<td>Finished high school</td>
<td>79 37.6 65 46.1</td>
<td>72 47.9 51 39.8</td>
<td></td>
</tr>
<tr>
<td>Some college or above</td>
<td>64 30.5 37 26.2</td>
<td>64 41.2 53 42.9</td>
<td></td>
</tr>
<tr>
<td>Weekly work hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 or less</td>
<td>54 25.7 32 22.7</td>
<td>26 20.7 20 15.4</td>
<td>0.18</td>
</tr>
<tr>
<td>26–35</td>
<td>53 25.2 46 32.6</td>
<td>39 27.5 31 21.7</td>
<td></td>
</tr>
<tr>
<td>36–40</td>
<td>70 33.3 35 24.6</td>
<td>38 26.1 31 23.3</td>
<td></td>
</tr>
<tr>
<td>41 or more</td>
<td>33 15.7 28 19.9</td>
<td>34 21.9 27 20.7</td>
<td></td>
</tr>
</tbody>
</table>

Job tenure

| Less than 1 year | 94 44.8 56 39.7 | 0.25 |
| 1–3 years        | 66 31.4 40 28.3 |     |
| More than 3 years| 50 23.8 45 31.9 |     |

Slip-resistant shoes

| No         | 74 35.2 46 32.6 | 0.61 |
| Yes        | 136 64.8 95 67.4 |     |

Slips reported

| 1          | 57 27.1         |     |
| 2          | 31 14.8         |     |
| 3          | 26 12.4         |     |
| 4–9        | 68 32.4         |     |
| 10+        | 28 13.4         |     |
On average, 9.4 weeks of data were collected for each worker (median 11, range 1–12). Eighty-nine participants completed the entire 12 weeks of follow-up.

Table 2 presents the distribution of weekly work hours and weekly hours exposed to rushing, distraction and walking on a contaminated floor. Exposure information on rushing and walking on a contaminated floor were missing for eight participants. Distraction and walking on a contaminated floor had a positively skewed distribution with a mean and median of 9 and 5 h for distraction, and 12 and 5 h for walking on a contaminated floor, respectively. After taking into account the number of hours worked by each participant individually, the percentage of total person-time exposed varied from 25% for distraction and 36% for walking on a contaminated floor to 45% for rushing (figure 2).

A total of 1080 slips were reported by 210 participants during the follow-up. Information about the circumstances of only four slips was collected from participants who reported more than four slips in the prior week, which should have led to 1011 slips with transient exposure information. However, this information was missing for 22 slips (2.2%) and results are based on the 989 slips with exposure information. The total number of hours worked by these 210 participants was 50,260.

The rate of slipping increased 2.9 times when rushing as compared to when working at a normal pace (95% CI 2.5 to 3.5). The rate of slipping was also significantly increased by distraction (rate ratio (RR) 1.7, 95% CI 1.5 to 2.0) and walking on a contaminated floor (RR 14.6, 95% CI 12.6 to 17.0) (table 3). Effects of the risk factors were significantly modified by all three effect modifiers. Those working 36–40 h per week were at a lower risk of slipping due to rushing and walking on contaminated floors than were workers who reported working 35 h or less per week. Rate ratios for all three transient factors decreased as job tenure increased; workers with a job tenure of 1 year or less had the highest rate ratios. Among those who wore slip-resistant shoes, rate ratios for the three risk factors were lower compared to those who did not wear slip-resistant shoes and this effect was significant for rushing and walking on a contaminated floor.

**DISCUSSION**

A significant burden of injuries results from slips and falls in the workplace. Few studies, however, have systematically examined and quantified the effects of risk factors and protective factors for slipping at work. Results from this study suggest there is an increased rate of slipping due to rushing, distraction and walking on a contaminated floor in limited-service restaurant workers. The effects of these transient factors were modified by hours worked per week, job tenure and use of slip-resistant shoes.

In this study, walking on a contaminated floor was associated with the highest rate ratio of slipping (RR 14.6, 95% CI 12.6 to 17.0). Floor contamination leads to reduced available COF at the floor surface/shoe sole interface and a slip is more likely to occur if the available COF at this interface is less than the COF required to walk safely.22 23 In the current study, participants on average reported walking on a contaminated floor for 36% of their work time, which was associated with a 14.6 times increase in the rate of slipping. High prevalence of exposure and high rate ratio may lead to high attributable fraction of slipping associated with walking on a contaminated floor. This finding reflects that a large proportion of slips and subsequent falls and the injuries resulting from them in limited-service restaurants could be prevented by measures to better control floor surface contamination. Filiaggi et al suggested that common sources of floor contamination could be dishwashing overspray or runoff, leaking equipment or pipes, food debris and spillage from transport of open containers.24 In an earlier study, we identified work processes that could be improved to reduce floor contamination and thus slipping hazards, particularly in the sink and fryer areas.16

Rushing was a common transient risk factor in this study with a prevalence of about 45% of the total time at work, and it was associated with an approximately threefold increased rate of slipping. Walking faster than normal may lead to an increased required COF25 26 As stated previously, a slip is more likely to occur when the COF required to walk safely exceeds the COF available at the floor/shoe interface.22 23 Rushing may also lead to decreased attention to the surrounding work environment and work processes and, thus, may lead to an increased risk of slipping. Many studies have reported rushing to be associated with an increased risk of injury at work.14 15 RR of 2.4 for hand injuries14 and 3.3 for sharps-related injuries15 have been reported in association with rushing. These estimates of relative risks are similar to those found in the current study (RR 2.9, 95% CI 2.5 to 3.5).

Participants reported being distracted for about 25% of their work time. In the current study, the rate of slipping increased by

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**Table 2** Distribution of weekly work hours, and hours exposed to rushing, distraction and walking on contaminated floors

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly work hours</td>
<td>210</td>
<td>34.0</td>
<td>11.0</td>
<td>35.0</td>
<td>8–65</td>
</tr>
<tr>
<td>Rushing (h/week)*</td>
<td>202</td>
<td>15.5</td>
<td>13.9</td>
<td>11.3</td>
<td>0–60</td>
</tr>
<tr>
<td>Distraction (h/week)†</td>
<td>203</td>
<td>9.0</td>
<td>12.8</td>
<td>2.7</td>
<td>0–50</td>
</tr>
<tr>
<td>Walking on a contaminated floor (h/week)*</td>
<td>202</td>
<td>12.3</td>
<td>14.0</td>
<td>5.0</td>
<td>0–55</td>
</tr>
</tbody>
</table>

*Exposure information missing for eight participants. †Exposure information missing for seven participants.
69% during distraction. Few studies have systematically examined the effect of distraction on the risk of slipping or falling. Studies examining the effects of distraction on the risk of work-related injuries have generally reported higher estimates of rate ratios than was found in the current study.14 15

Rate ratios due to rushing and walking on a contaminated floor were lowest among those who worked 36–40 h. Compared to the participants working fewer hours, these lower rate ratios may be due to an increased familiarity with the work environment, and better gait and work process adjustments in the presence of slipping hazards. However, the rate ratio for slipping due to rushing was higher among participants working 41 h or more per week than was found in the current study.14 15

Some studies have examined how fatigue is associated with increased slip propensity.29 A study has suggested that quadriceps fatigue could be associated with increased slip propensity.29 Only a few studies have examined the effect of distraction on the risk of slipping or falling. Several studies have reported an association between long work hours, fatigue and the risk of injury.27 28

With respect to job tenure, the group with the highest rate ratio was that with less than 1 year’s experience. Employers may want to focus more on these employees as well as part-time employees by way of training and other methods to increase their familiarity with the work environment. Employers might also implement policies to reduce turnover rate and increase average job tenure. Similar to the effects of weekly work hours, longer job tenure may lead to increased familiarity with the work environment and gait adaptations and, thus, reduced rate ratios due to the transient risk factors.

There is limited evidence in the existing literature regarding the effects of ‘slip-resistant’ shoes on the risk of slipping in the workplace or in the general population. In the current study, use of slip-resistant shoes reduced the effects of rushing and walking on a contaminated floor. Slip-resistant shoes may increase the available COF at the floor surface/shoe sole interface and, thus, counter some of the effects of the transient factors studied.30 One intervention study reported an effective slip, trip and fall prevention program in hospital employees where slip-resistant shoes were a part of the comprehensive approach.31 However, the study design did not allow for the independent examination of individual components of the intervention. Courtney et al did not find a significant association between slip-resistant shoes and risk of slipping in limited-service restaurant workers.10 They classified shoes as slip-resistant based on tread pattern, which they suggested might have led to misclassification. In the prospective cohort arm of the current study, we compared the rate of slipping among those who wore slip-resistant shoes and those who did not and found that use of slip-resistant shoes was associated with a 54% reduction in the reported rate of slipping (95% CI 37% to 64%).17 However, one of the limitations of the study was that participants knew about their slip-resistant shoe use and that knowledge might have affected their detection threshold for reporting slips. The case–crossover study design controls for subject-specific characteristics. Modification of the effects of these transient factors may be one of the mechanisms through which slip-resistant shoes reduce the risk of slipping. In the light of these findings, slip-resistant shoes could be an effective intervention to reduce slipping in limited-service restaurants.

Walking on a contaminated floor was associated with a significantly higher rate of slipping as compared to walking on a dry and clean floor surface. Moreover, participants reported walking on a contaminated floor for more than one third of their work time. An effect modifier that will reduce the effect of a contaminated floor is likely to also significantly reduce slipping in limited-service restaurant workers. Slip-resistant shoes reduced the effects of floor contamination by about 26%, and can be a relatively easy intervention to implement. Effect of floor contamination was about one fifth in those with job tenure greater than 3 years as compared to workers with less than 1 year of job tenure. Employers may want to adopt policies to encourage low turnover and increase average job tenure. Similarly, employees working less than 25 h were more affected by floor contamination than those working 35–40 h per week. Moreover, the effects of rushing were higher among employees with job tenure less than 1 year, those working less than 25 h per week and among non-slip-resistant shoe users. A focused effort on reducing floor contamination, training part-time and new employees, and ensuring their use of slip-resistant shoes may provide high dividends.

### Limitations and strengths

Recall bias is a major limitation of retrospective studies. Underestimation of the usual frequency of exposures and/or overestimation of exposure frequency at the time of slipping will lead to overestimation of the rate ratio. In the current...
study, participants reported a higher prevalence of rushing and distraction during the control time compared to other studies.\textsuperscript{14,15} Participants also reported walking on contaminated floors for more than one third of their work time. It is less likely, therefore, that all of the effects could be explained by underestimation of usual frequency of exposures.

On average, participants reported slip information within 3.6 days of slipping. Since participants knew in advance the information they would have to provide the following week, this may have led to improved accuracy of recall of exposure status at the time of each slip during the multiple weeks of reporting.

Another potential limitation is co-occurrence of the transient risk factors during the control time and at the time of slipping. For example, a participant may be rushing, distracted and walking on a contaminated floor when the slip occurred. It is difficult to evaluate interaction effects of simultaneous transient risk factors.

This is one of the first studies to systematically examine the effect of transient risk factors on the rate of slipping and quantify the rate ratios associated with them. One of the major strengths of a case--crossover study design is the ability to control for participant-specific characteristics such as age, gender and detection threshold for reporting a slip.

CONCLUSIONS

These results suggest that employees in limited-service restaurants spend a significant amount of their work time rushing, being distracted and walking on a contaminated floor. These three transient risk factors, particularly floor contamination, significantly increase the rate of slipping. The effects of these risk factors are modified by the use of slip-resistant shoes, hours worked per week and years of job experience. Employers may want to encourage the use of slip-resistant shoes and focus more on the new as well as part-time employees by way of training and other methods to increase their familiarisation with the work environment in addition to implementing policies to reduce turnover rate and increase average job tenure.

Funding The Liberty Mutual Research Institute for Safety funded this study.

Competing interests None.

Ethics approval This study was conducted with the approval of the Institutional Review Board of Liberty Mutual Research Institute for Safety and the Office of Human Research Administration at the Harvard School of Public Health.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES


APPENDIX 1
Usual frequency analysis for five subjects using the Mantel–Haenszel incidence rate ratio (IRRMH): example of exposure to rushing

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Slips while rushing (exposed, $A_{1i}$)</th>
<th>Slips not while rushing (not exposed, $A_{0i}$)</th>
<th>Hours exposed to rushing ($T_{1i}$)</th>
<th>Hours not exposed to rushing ($T_{0i}$)</th>
<th>Total hours ($T_i$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>108.0</td>
<td>162.0</td>
<td>270</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0</td>
<td>12.5</td>
<td>187.5</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0</td>
<td>64.0</td>
<td>176.0</td>
<td>240</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0</td>
<td>5.4</td>
<td>254.6</td>
<td>260</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
<td>57.4</td>
<td>197.6</td>
<td>255</td>
</tr>
</tbody>
</table>

\[
\text{IRRMH} = \frac{\sum A_{1i} T_{0i} / T_i}{\sum A_{0i} T_{1i} / T_i}
\]

where:
- $A_{1i}$ is exposure at the time of the slip
- $A_{0i}$ is non-exposure at the time of the slip
- $T_{1i}$ is amount of person-time in hours exposed during the follow-up period
- $T_{0i}$ is amount of person-time in hours unexposed during the follow-up period
- $T_i$ is total amount of time in hours at work during the follow-up period.

\[
\text{IRRMH} = 6.9
\]

The interpretation of the rate ratio is that the rate of slipping is 6.9 times higher during rushing than when not rushing.

The variance estimator for the logarithm of the Mantel–Haenszel incidence rate ratio can be found by using the formula on page 270 of Rothman and Greenland.\textsuperscript{21} The 95% CI for the above IRR estimate is 2.3 to 20.1.

\[
\text{Var} \left( \ln \left( \text{IRRMH} \right) \right) = \frac{\sum M_{ii} T_{0i} T_{1i} / T_i^2}{\left( \sum A_{1i} T_{0i} / T_i \right) \left( \sum A_{0i} T_{1i} / T_i \right)}
\]

where: $M_{ii} = A_{1i} + A_{0i}$ is the total number of cases in stratum $i$. 

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