

Relationship between a company's adequate response to near-misses and occupational accidents: a 1-year prospective cohort study

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Abstract

Background: Near-misses in the workplace indicate potential safety hazards, and their adequate management is considered extremely important in preventing occupational accidents. However, the impact of a company's response to near-misses on the occurrence of subsequent accidents remains unclear. This study examined the relationship between the adequacy of a company's responses to near-misses and the occurrence of occupational accidents.

Methods: We conducted a 1-year prospective cohort study using an online self-administered questionnaire, targeting workers in Japan. The study included 2755 participants who had experienced and reported near-misses. We categorized company responses to these near-misses as adequate, inadequate, or no response. The outcome was the incidence of occupational accidents over the past year. We calculated odds ratios (ORs) and 95% CIs using multilevel logistic regression adjusting for covariates.

Results: Among all participants, 59.0% were in the adequate response group, 30.1% were in the inadequate response group, and 10.8% were in the no response group. In the multivariate-adjusted model, the ORs of the inadequate response and the no response groups were 1.53 (95% CI, 1.25-1.88; $P < .001$) and 1.75 (95% CI, 1.32-2.33; $P < .001$), respectively.

Conclusions: Our results suggest that the adequacy of a company's response to near-misses reported by workers can be significantly related to the occurrence of subsequent occupational accidents. Companies need to thoroughly respond to near-misses reported by workers and adequately inform workers about the company's safety activities. This may lead to a reduction in the number of subsequent occupational accidents.

Key points:

- The number of fatalities and injuries caused by occupational accidents remains high worldwide, and the prevention of occupational accidents has become a public health challenge. It is already known that workplace safety measures contribute to the reduction of occupational accidents, but it is unclear whether a company's adequate response to near-misses from the worker's perspective makes a difference in the subsequent occurrence of occupational accidents.
- In this study, we observed that the inadequate response and no response groups were more likely to experience subsequent occupational accidents than the group in which the company responded adequately to the near-misses reported by workers.
- A company's adequate response to near-misses reported by workers and the formation of a safety culture that allows workers themselves to recognize the safety measures taken by the company may contribute to a reduction in the number of occupational accidents.

Keywords: near miss; occupational accident; perception; workplace.

1. Introduction

The occurrence of near-misses indicates the presence of a safety hazard that could result in an occupational accident, and adequate responses to near-misses are crucial for workplace safety. A near-miss is defined as "an incident that could have caused a serious negative outcome but did not."¹ An incident is defined as either an accident or a near-miss, and incidents include adverse events that result in harm and near-misses that could have

resulted in harm, but did not cause harm, either by chance or timely intervention.^{2,3} Therefore, in this context, the term "incident" is used synonymously with near-miss.

Heinrich's classic theory states that for every 1 major accident, there are 29 minor accidents and 300 near-misses.⁴ Reports suggest that numerous minor occupational accidents and near-misses precede major occupational accidents.^{4,5} Additionally, an increase in near-misses is associated with a subsequent increase

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in serious occupational accidents, including fatalities, in the same workplace.⁵ Given that near-misses significantly outnumber actual occupational accidents, adequate responses to near-misses are expected to be very effective in preventing occupational accidents.

Companies need to take adequate actions and measures to reduce the risk of occupational accidents in response to near-misses reported by workers. Cooperation between a company and its workers is essential to respond to near-misses adequately.⁶ Workers are necessarily aware of their daily work environment and accurately report events that can be classified as near-misses. Companies should also establish processes to review near-misses reported by workers and take the necessary risk-reduction actions.

Some previous research suggests that safety practices, including near-miss reporting, reduce the incidence of occupational accidents.^{7,8} Near-miss reporting is detailed information about when and where near-misses occurred, reported by workers to companies. Near-miss reports should give answers to the questions of who, where, when, what, why, and how regarding the incident.⁹ One previous study revealed that the implementation of a near-miss reporting system was associated with a subsequent reduction in occupational accidents.⁷ Under this reporting system, employees were asked to report near-misses, and management discussed the reporting in a safety meeting and took any necessary corrective actions. Another study conducted an intervention study of implementing a near-miss reporting system and found that a factory showed a subsequent decrease in the incidence of serious occupational accidents.⁸ These reported incidents were continually analyzed and fed back to workers through supervisors and used by the safety committee to develop preventive measures. However, these studies did not mention how well companies responded to near-misses reported by workers.

Although safety measures are believed to reduce occupational accidents in many workplaces, it has not been proven that a company's adequate response to near-misses has an impact on the subsequent occurrence of occupational accidents. This study aimed to explore the relationship between the adequacy of a company's response to near-misses reported by the workers and subsequent occupational accidents that they suffered in the following year.

2. Subjects and methods

2.1. Study design and participants

This 1-year prospective cohort study was part of the online "Work, Wellbeing and Safety Research for Occupational Health Practices and Management" (W2S-Ohpm Study) survey. Details of the study protocol are described in a separate report.¹⁰ Briefly, the survey targeted workers in Japan aged 20 years and older. Sampling was conducted by age, sex, and region of residence, and was designed to produce a study population equivalent to the proportions in the labor force in Japan. The baseline survey (FY2022) was conducted in March 2022 with 29 997 participants, of whom 27 693 responses were valid after excluding fraudulent responses. A follow-up survey (FY2023) was conducted in March 2023, with a final total of 16 629 individuals responding to both; the follow-up rate after 1 year was 60%.

This study focused on organizations with a clear organizational hierarchy. For this reason, we excluded 3602 self-employed individuals, family employees, executives, participants doing side jobs at home, and others with no clear organizational hierarchy. Our survey targeted full-time, part-time, temporary, and contract

employees as employee status. Additionally, we excluded 907 people working in companies with fewer than 5 employees as they were considered too few to assess organizational responses to near-misses. The survey targeted workers who had experienced near-misses and had properly reported near-misses to the company.

Using the baseline survey results, we assessed whether participants had experienced near-misses by asking the question, "During the past year, have you experienced near-misses at your current workplace that could have led to occupational accidents?" At the baseline survey, 9098 employees who had not experienced near-misses and 807 employees who had experienced near-misses but did not report them to their companies were excluded from the analysis. Ultimately, 2755 employees were included in the analysis (Figure 1).

This study was approved by the Ethics Committee of the University of Occupational and Environmental Health, Japan (approval number: R3-076). Informed consent was obtained from all participants via an online form on the survey website.

2.2. Assessment of companies' responses to near-misses

Companies' responses to near-misses were assessed in the baseline survey question, "Did the company (or your supervisor) respond to your near-misses by investigating the cause or taking action to prevent the accident?" We asked about the company's response over the past year from the baseline survey. Responses were categorized into 3 groups: adequate response group, inadequate response group, and no response group. An adequate response means that the company took adequate action, such as investigating the cause of the problem and improving facilities. An inadequate response means that the company responded, but the actions taken were insufficient. No response means that the company did not respond at all to near-misses.

2.3. Assessment of occupational accidents

Occupational accidents were assessed at the follow-up survey by asking the following question: "Have you been hospitalized for a work-related injury or illness in the past year?" Participants were asked to reflect on events from the baseline survey to the follow-up survey. Respondents were asked to select 1 of the following 5 options: not at all, once, twice, three times, or four or more times.

2.4. Covariates

We selected age, sex, education level, annual household income, marital status, employment status, and number of employees in the company as covariates, and input industry in the multilevel model. Previous studies have shown the influence of workplace hazards (physical, psychosocial, and work organization) and individual factors (gender, age, and health status) on occupational accidents.¹¹ For instance, a previous study on the relationship between risk self-perception and occupational accidents considered individual and job-related characteristics as variables, such as age, education level, family, working hours, company size, length of service, occupation, sector, contract type, and other job-related factors.¹² In addition, another previous study describing occupational accidents and their contributing factors examined economic factors (age, residence, marital status, economic status, educational level, medical condition, pattern of employment, income), occupational factors [working section/job category, total work hours/day, availability of safe tools, availability of safe machinery, occupational safety training, availability of personal protective equipment (PPE)], and behavioral factors (use

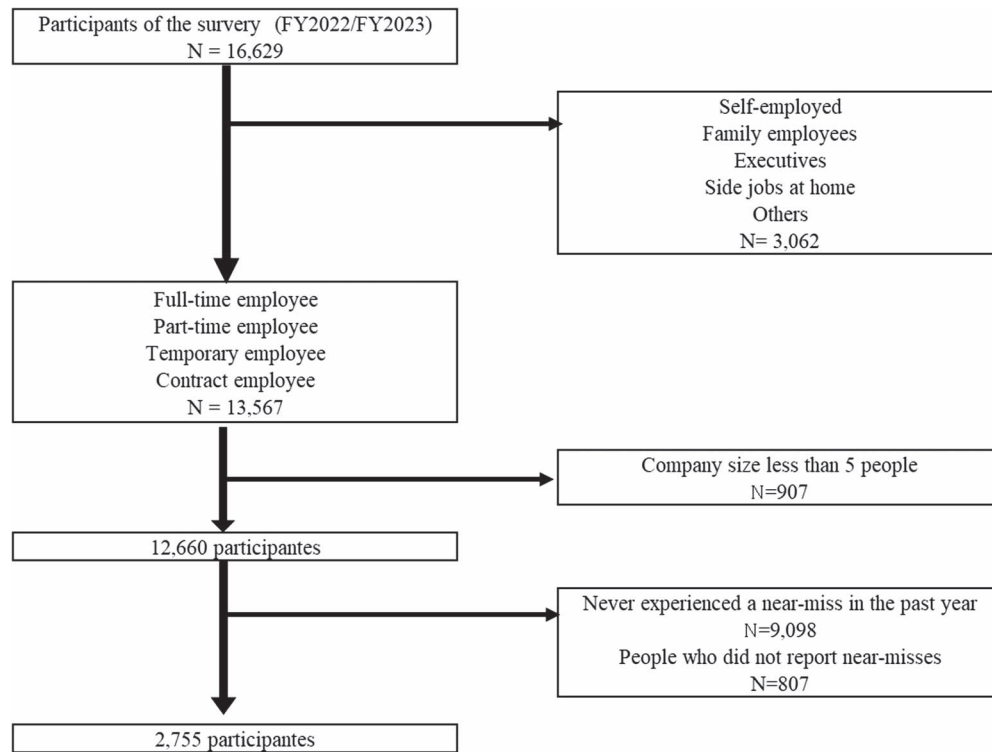


Figure 1. Study flowchart.

of PPE, job satisfaction, sleep disturbance problems, substance use) as variables.¹³ Based on the covariates from previous studies and our survey items, we selected age, sex, education level, annual household income, marital status, employment status, and number of employees in the company as covariates. Age was expressed as a continuous variable. Sex was divided into 2 categories based on biological sex. Educational level was divided into 3 categories: junior high school or high school; vocational school, junior college or technical college; and university or graduate school. Annual household income was categorized into 6 groups: <4.00 million, 4.00-5.99 million, 6.00-7.99 million, 8.00-9.99 million, 10.00-11.99 million, and ≥ 12.00 million Japanese yen. Marital status was classified into 3 categories: married, never married, and divorced or widowed. Employment status was divided into 4 categories: full-time, part-time, temporary, and contract employment. Number of employees in the company was classified into 5 groups: 5-9, 10-49, 50-99, 100-999, and ≥ 1000 . Industries were categorized into the following 20 categories based on Japan's standard industrial classification¹⁴: agriculture and forestry; fisheries; mining and quarrying of stone; construction; manufacturing; electricity, gas, heat supply, and water; information and communications; transportation and postal services; wholesale and retail trade; finance and insurance; real estate and goods rental and leasing; scientific research, professional and technical services; accommodations, eating and drinking services; living-related and personal services and amusement services; education, and learning support; medical, healthcare and welfare; compound services; services, not elsewhere classified; government, except elsewhere classified; and others.

2.5. Statistical analysis

Participant characteristics were summarized using means and SDs for continuous variables and numbers and percentages for categorical variables. We calculated odds ratios (ORs) and 95%

CI using a multilevel logistic regression analysis nested by the industry for associations between company responses to near-misses and occupational accidents. We set a company's response to near-misses as the explanatory variable and occupational accidents as the outcome. Age, sex, education, household income, marital status, employment status, and number of employees were adjusted for as covariates. ORs and 95% CIs were calculated for age-sex- and multivariate-adjusted models. Statistical significance was set at $P < .05$. Two-sided significance tests were performed. All analyses were performed using Stata Statistical Software (release 18; StataCorp LLC, College Station, TX, USA).

3. Results

A total of 2755 participants were included in this study. Table 1 presents the characteristics of the participants. Among all participants, 1627 (59.0%) were in the adequate response group, 830 (30.1%) were in the inadequate response group, and 298 (10.8%) were in the no response group. The average age of the participants in this study was 43.3 years, and 60.4% were male. About half (51.7%) of the participants in this survey had graduated from university or graduate school. Regarding the number of employees in the workplace, 864 (31.4%) of the participants worked for companies with between 100 and 999 employees, and 861 (31.3%) worked for companies with between 10 and 49 employees. Regarding the type of industry to which the participants belonged, medical, health care, and welfare had the largest number of participants with 754 (27.4%), followed by manufacturing with 499 (18.1%). After 1 year, 600 participants reported at least 1 hospital visit for a work-related accident or illness in the past year, whereas 2155 reported no hospital visits for such reasons.

Table 2 presents the relationship between a company's response to near-misses and occupational accidents. In the model adjusted for age and sex, compared with the adequate response

Table 1. Characteristics of participants.

| | Adequate response ^a | Inadequate response ^b | No response ^c |
|--|--------------------------------|----------------------------------|--------------------------|
| Number of participants | 1627 | 830 | 298 |
| Age, mean (SD) | 43.1 (13.0) | 44.0 (12.3) | 42.8 (12.2) |
| Sex, male | 942 (57.9%) | 523 (63.0%) | 199 (66.8%) |
| Education level | | | |
| Junior high or high school | 400 (24.6%) | 179 (21.6%) | 86 (28.9%) |
| Vocational school, junior college, or technical college | 416 (25.6%) | 190 (22.9%) | 61 (20.5%) |
| University or graduate school | 811 (49.8%) | 461 (55.5%) | 151 (50.7%) |
| Annual household income (JPY) | | | |
| <4.00 million | 410 (25.2%) | 183 (22.0%) | 86 (28.9%) |
| 4.00-5.99 million | 415 (25.5%) | 227 (27.3%) | 84 (28.2%) |
| 6.00-7.99 million | 360 (22.1%) | 193 (23.3%) | 49 (16.4%) |
| 8.00-9.99 million | 227 (14.0%) | 106 (12.8%) | 44 (14.8%) |
| 10.00-11.99 million | 88 (5.4%) | 50 (6.0%) | 15 (5.0%) |
| ≥12.00 million | 127 (7.8%) | 71 (8.6%) | 20 (6.7%) |
| Marital status | | | |
| Married | 855 (52.6%) | 450 (54.2%) | 151 (50.7%) |
| Never married | 554 (34.1%) | 252 (30.4%) | 102 (34.2%) |
| Divorced or widowed | 218 (13.4%) | 128 (15.4%) | 45 (15.1%) |
| Employment status | | | |
| Full-time employment | 1200 (73.8%) | 633 (76.3%) | 229 (76.8%) |
| Part-time employee | 292 (17.9%) | 130 (15.7%) | 47 (15.8%) |
| Temporary employee | 35 (2.2%) | 18 (2.2%) | 3 (1.0%) |
| Contract employee | 100 (6.1%) | 49 (5.9%) | 19 (6.4%) |
| Number of employees | | | |
| 5-9 | 149 (9.2%) | 60 (7.2%) | 33 (11.1%) |
| 10-49 | 512 (31.5%) | 252 (30.4%) | 97 (32.6%) |
| 50-99 | 207 (12.7%) | 131 (15.8%) | 38 (12.8%) |
| 100-999 | 517 (31.8%) | 259 (31.2%) | 88 (29.5%) |
| 1000+ | 242 (14.9%) | 128 (15.4%) | 42 (14.1%) |
| Industry | | | |
| Agriculture and forestry | 9 (0.6%) | 3 (0.4%) | 2 (0.7%) |
| Fisheries | 0 (0.0%) | 1 (0.1%) | 0 (0.0%) |
| Mining and quarrying of stone | 1 (0.1%) | 4 (0.5%) | 1 (0.3%) |
| Construction | 73 (4.5%) | 36 (4.3%) | 11 (3.7%) |
| Manufacturing | 293 (18.0%) | 140 (16.9%) | 66 (22.1%) |
| Electricity, gas, heat supply, and water | 19 (1.2%) | 11 (1.3%) | 7 (2.3%) |
| Information and communications | 48 (3.0%) | 25 (3.0%) | 7 (2.3%) |
| Transportation and postal services | 102 (6.3%) | 53 (6.4%) | 20 (6.7%) |
| Wholesale and retail trade | 101 (6.2%) | 72 (8.7%) | 29 (9.7%) |
| Finance and insurance | 48 (3.0%) | 23 (2.8%) | 19 (6.4%) |
| Real estate and goods retail and leasing | 19 (1.2%) | 12 (1.4%) | 5 (1.7%) |
| Scientific research, professional and technical services | 22 (1.4%) | 20 (2.4%) | 8 (2.7%) |
| Accommodations, eating and drinking services | 42 (2.6%) | 19 (2.3%) | 3 (0.1%) |
| Living-related and personal services and amusement services | 25 (1.5%) | 15 (1.8%) | 8 (2.7%) |
| Education, and learning support | 93 (5.7%) | 44 (5.3%) | 7 (2.3%) |
| Medical, health care and welfare | 488 (30.0%) | 217 (26.1%) | 49 (16.4%) |
| Compound services | 13 (0.8%) | 8 (1.8%) | 2 (0.7%) |
| Services, not elsewhere classified | 119 (7.3%) | 63 (7.6%) | 31 (10.4%) |
| Government, except elsewhere classified | 93 (5.7%) | 44 (5.3%) | 17 (5.7%) |
| Others | 19 (1.2%) | 20 (2.4%) | 6 (2.0%) |
| Occupational accidents from the baseline to the follow-up survey | | | |
| Not at all | 1325 (81.4%) | 619 (74.6%) | 211 (70.8%) |
| Once | 200 (12.3%) | 134 (16.1%) | 51 (17.1%) |
| Twice | 50 (3.1%) | 43 (5.2%) | 15 (5.0%) |
| Three times | 12 (0.7%) | 12 (1.4%) | 4 (1.3%) |
| Four or more times | 40 (2.5%) | 22 (2.7%) | 17 (5.7%) |

Abbreviation: JPY, Japanese yen. ^aCompany responded adequately by investigating the cause and improving facilities. ^bCompany responded, but not sufficiently. ^cCompany did not respond at all.

group, the OR of the inadequate response group was 1.52 (95% CI, 1.24-1.86; $P < .001$), and the OR of the no response group was 1.78 (95% CI, 1.35-2.36; $P < .001$). In the multivariate-adjusted model,

the ORs of the inadequate response group and the no response group were 1.53 (95% CI, 1.25-1.88; $P < .001$) and 1.75 (95% CI, 1.32-2.33; $P < .001$), respectively.

Table 2. Relationship between the adequacy of companies' responses to near-misses and occupational accidents.^a

| | Model 1 ^b | | | | Model 2 ^c | | | |
|----------------------------------|----------------------|--------|------|---------|----------------------|--------|------|---------|
| | OR | 95% CI | | P value | OR | 95% CI | | P value |
| Adequate response ^d | Reference | | | | Reference | | | |
| Inadequate response ^e | 1.52 | 1.24 | 1.86 | <.001 | 1.53 | 1.25 | 1.88 | <.001 |
| No response ^f | 1.78 | 1.35 | 2.36 | <.001 | 1.75 | 1.32 | 2.33 | <.001 |

^aMultilevel logistic regression analyses were performed nested for industries. ^bModel 1 is adjusted for age and sex. ^cModel 2 is adjusted for age, sex, education level, annual household income, marital status, employment status, and number of employees. ^dCompany responded adequately by investigating the cause and improving facilities. ^eCompany responded, but not sufficiently. ^fCompany did not respond at all.

4. Discussion

This study clarified the relationship between the adequacy of a company's response to near-misses reported by the workers and subsequent occupational accidents. The results indicate that the inadequate response group and no response group were more likely to experience subsequent occupational accidents than the adequate response group.

Workers' perceptions of their own workplace safety management can serve as indicators of the company's adequacy of safety measures. An observational study conducted in a concrete manufacturing plant is an example of research that uses worker perceptions of their own workplace safety management.¹⁵ The study suggested that workers' perceptions of safety management processes were related to fewer occupational accidents.

Several mechanisms exist by which the adequacy of a company's response to near-misses is related to the occurrence of occupational accidents. First, failure to adequately respond to near-misses by investigating the causes and improving equipment can result in unacceptable safety risks. Unsafe mechanical conditions and unsafe worker behavior are due to inadequate management on the part of employers.¹⁶ This suggests that simply correcting unsafe worker behavior is not enough; it is essential to look for root causes and to improve and manage the organization. An occupational health and safety management system (OHSMS) is a system that voluntarily and continuously implements organizational safety and health management through the Plan-Do-Check-Act (PDCA) cycle.^{17,18} An OHSMS provides a systematic methodology to identify hazards, analyze and evaluate risk, and apply risk-control methods.¹⁶ In the Korean construction industry, the introduction of OHSMSs has been shown to significantly reduce both the occupational accident rate and the fatal accident rate.¹⁹ Safety activities using near-miss reporting are part of the OHSMS continual improvement process in Japan. If the process of using near-miss reporting to investigate the causes and background of occupational accidents and take preventive measures is adequate, it will lead to elimination of the causes of workplace accidents. Furthermore, if the near-miss reports are shared, other employees will be able to simulate the incident and learn from it. Sharing lessons learned from near-misses is key to preventing similar events from recurring.²⁰ In this way, a company's adequate response to near-misses is effective in preventing occupational accidents.

Second, if the company's response to near-misses is inadequate, workers may perceive the company's attitude toward safety to be not serious, which can lead to a deterioration in the safety climate. Previous studies suggest that management's attitudes toward safety, as assessed from the workers' perspective, significantly impact workers' perceptions and behaviors, as well as the safety climate of the organization.²¹ Additionally, a relationship exists between management's safety awareness and workers' willingness to follow safety rules.²² A poor safety

climate discourages employees from following safety rules and procedures, resulting in occupational accidents. Also, the safety climate of the workplace influences a worker's ability to report near-misses. An environment where workers feel comfortable reporting is characterized by their perception of management's commitment to their safety and their supervisor's support. A study identified factors that discourage workers from reporting near-misses, including fear of disciplinary action, fear or embarrassment of being ridiculed by peers, and lack of management commitment.²³ Third, an inadequate company response to near-misses can decrease employee job satisfaction because their opinions may not be fully reflected in the company's actions. Previous studies have shown that high job satisfaction is associated with a more positive workplace safety climate, proactive safety management, and full compliance with policies.^{24,25} A decrease in workers' job satisfaction is believed to hinder the creation of a safe workplace climate, resulting in an increased incidence of occupational accidents.

In this study, workers' perceptions of the adequacy of a company's response to near-misses reported by themselves may not accurately reflect the true state of the company's safety practices. For example, even if the company's response to near-misses is adequate, it is possible that workers may perceive the company's response to be insufficient. However, even if the company's response to near-misses is adequately implemented, if workers are not aware of the company's safety actions, it can become a barrier to safety behavior through safety awareness and a safety climate. This can also be attributed to the lack of 2-way communication between the company and its workers. If workers are not involved in the process of responding to near-misses, or if progress is not shared or feedback is not provided, they may not accurately perceive the company's response. Previous research has shown that active, 2-way communication between employees and managers about safety significantly improves employee safety behavior.²⁶

In order to prevent occupational accidents, the basic premise for companies is to investigate the causes and background of occupational accidents based on near-miss reports, and to take preventive measures. In addition, to increase the effectiveness of safety activities, including near-miss reporting, it is considered effective for workers to be aware that the company is taking adequate measures for occupational safety. In the process, companies need to provide adequate feedback on near-misses by analyzing the causes and discussing corrective actions with workers.

This study had several limitations. First, it used workers' perceptions as an indicator of the adequacy of the company's response to near-misses. This survey did not provide examples of specific adequate or inadequate responses, nor did it ask questions about the speed or frequency of responses. Therefore, there may be differences among respondents in the extent to which they judge that the company responded adequately

to the near-misses. Therefore, future research should include specific definitions of companies' adequate responses with some examples, and ask related questions such as speed or frequency of responses. In addition, as previously mentioned, this may not accurately represent the true adequacy of the company's response and may differ from the actual situation. Therefore, future research should distinguish between the actual situation of a company's response to near-misses and workers' perceptions of it. However, it would be very difficult to accurately distinguish between the 2 realities. Second, the survey asked participants to recall events from the past year during the baseline survey and follow-up survey, so there is a possibility that responses regarding the company's handling of near-miss reports and occupational accidents were affected by recall bias. However, given that occupational accidents are typically memorable, the impact of recall bias is expected to be minimal. Third, the generalizability of the survey is limited because it only included workers with internet access. However, considering the widespread use of internet devices in Japan today and the deliberate sample selection mirroring the age, sex, and area of residence of the Japanese workforce, it is reasonable to assume that the survey represents a standard Japanese workforce.

5. Conclusion

This study suggests that the adequacy of a company's response to near-misses reported by their workers can be significantly related to the occurrence of subsequent occupational accidents. It is significant for companies to thoroughly investigate near-misses to determine root causes and corrective actions in order to reduce occupational accidents. In this process, companies should work closely with their workers in safety activities. Reviewing corrective actions based on near-miss reporting with workers and providing feedback will also help workers themselves recognize that the company is taking adequate steps to ensure workplace safety. In this study, a company's response to near-misses was evaluated using workers' perceptions. In future research, it would be desirable to make a clear distinction between the actual state of company responses and workers' perceptions.

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The study was approved by the Ethics Committee of the University of Occupational and Environmental Health, Japan (No. R3-076). Only those who gave their consent completed the questionnaire. Informed consent was obtained via the survey form on the web-site.

Author contributions

T.N., K.O., and K.M. conceived the study idea; T.N., K.O., N.P.A., and K.M. collected the data; M.I. designed the analysis, analyzed

the data, and wrote the draft of the manuscript. All authors have advised on the data interpretation and have reviewed, edited, and approved the final manuscript.

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Conflicts of interest

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Data availability

The data are not publicly available due to privacy or ethical restrictions.

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