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Article
Page 2

References
Page 13

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The interaction among life and work stress, and cognitive biases on employees' orientation toward safe courses of action in occupational decisions

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APPLIED RESEARCH

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The interaction among life and work stress, and cognitive biases on employees' orientation toward safe courses of action in occupational decisions

ABSTRACT

Thisstudy explored the effects that life and work stress have on employee safety decision-makingunder three cognitive biases that hinder safety participation. Utilityemployees of municipalities and companies responded to (1) a survey regardingtheir work and global life stress levels and (2) decision simulations-concerning safety orientation. The simulation scenarios were framed tofacilitate conditions highlighting Recency, Melioration, and Free-ride SocialDilemma biases.
Perceived life stress was not a significant predictor of atendency to engage in safety in any of the biases. Work stress was asignificant predictor of reducing engagement in safety in the Recency biasonly. The study was conducted during the peak of COVID-19. COVID-19, primarilythe loss of someone close due to COVID-19, had significant effects under allthree bias conditions. Opposite effects of several variables in differentbiases hint at the need to further research the effects of these biases onsafety participation.

Introduction

BACKGROUND

Stress is commonly viewed as the way the body reacts when perceived demands surpass the person's perceived coping resources, resulting in the development of psychological or physical strain or tension (Selye, 1974; Colman, 2001). Life stress refers to the strain or tension from actual or imagined events that a person feels are unpredictable, uncontrollable, or overloading (Cohen et al., 1983). The individual's appraisal of a situation determines the extent to which the situation is stressful. Repeated exposure to psychosocial stressors can lead to exhaustion and an increased vulnerability to allostatic loads in individuals who display impaired habituation to the stressor (Kudielka et al., 2006). "Impaired habituation" refers to a negative and unbeneficial response, and possibly an aversion, to the stressor. The effects of stress on an individual's health are pervasive and abundant.

Major life stressors such as family illnesses, addictions, or divorce can lead to occasional safety deviations and a drop of job performance (McHugh et al., 2019). Causes of socially related stress and unsafe work behaviors also include exposure to harassment, violence, and substance abuse—all of which inhibit teamwork. Substance abuse was strongly associated with job withdrawal (behaviors such as day-dreaming, chatting with coworkers, and thinking of being absent) (Wayne et al., 1992), leading to deviations from safety and more incidents. These factors are related to perceptions of productivity. Thus, they may be issues of legal liability and safety (Bennett and Lehman, 1999) and concerns about financial difficulties, societal instability, and career advancement opportunities, which are predominant among laborers (Gimaeva et al., 2017).

Occupational demands can be sources of stress. In the occupational group suffering the most strain of all groups, that of Processing, Manufacturing and Utilities, the prevalence of high job strain was 30% and 48% for men and women, respectively (Shields, 2006). Among men and women, 21% and 29% experienced general high day-to-day stress, low coworker support was 30% and 38%, and low supervisor support was 22% and 17%, for men and women, respectively. The youngest population reported the highest job strain while having lower day-to-day stress levels. The oldest population experienced the lowest general stress and job strain. Both male and female managers reported the highest general stress. Besides job strain, other significant causes of work stress include changes to

task procedures, inadequate job control, and excessive workload (Cartwright & Cooper, 1997). Poor performance could be directly related to acute anxiety, although poor performance and chronic stress may be more common in employees who are sensitive to stressors (Starcke & Brand, 2012). This may result from those employees valuing their work performance as a critical factor of their self-worth (Simons et al., 1993).

Work-related stress affects safety behaviors. For example, when job security was adequate, no difference was found between actual and reported workplace incidents; however, job insecurity commonly led to underreporting of incidents (Probst et al., 2013). A mild amount of stress may help motivate goal-directed behaviors. Leung et al. (2012) reported an association between high-level safety behaviors and moderate emotional stress in the construction sector. Participants showed improved safety orientation when they were motivated and were mildly excited to perform tasks. A survey of construction workers suggests that stress hinders safety participation but not compliance (Wang et al., 2018). It was also suggested that positive organizational behavior stemming from an individual's psychological state could mitigate the effect of stress on safety participation. Similarly, Bell and Grushecky (2006) found that programs directed at stress reduction may improve safety measures in that workers' compensation claims did not decline among 67% of the logging companies that participated in a logger safety training program.

Risk aversion is important to both safety orientation and perceived stress. Studies of a wide variety of behaviors, including health precautions and safe driving (Weinstein et al., 2008; Sheeran et al., 2014) as well as self-defense, gun safety, and natural disaster preparedness (Glick et al., 2014), suggest that heightening risk appraisals can change intention and behavior for risk perception and tolerance. Personality traits can affect safety. Henning et al. (2009) found that agreeableness, prevention regulatory focus, and fatalism were significantly related to safety attitudes while conscientiousness and agreeableness can play roles (Drew et al., 2014). However, safety orientation, like prevention regulatory focus, is the most proximal (least direct) predictor of safety performance. This finding may be due to conscientiousness being related to cognitive biases, given that biases are often considered to be fast, intuitive, and automatic ways of thinking (Zohar & Erev, 2007; Kahneman, 2013). Further, extraversion may relate to feeling responsible for others' safety (Henning et al., 2009).

Worker stress may affect safety performance (Lelo et al., 2019). Risk perception abilities can be overwhelmed. When working with complex technical systems, stress may modify an employee's risk assessment by limiting their factor selection within a system, thereby altering the weighting of factors and promoting the adoption of heuristics with contradictory rationales (Cadet, 2003). That is, stress may narrow an operator's focus, limiting attention to sufficient input from the system. The addition of safety measures and factors may lead to conflicting results due to an increase in employee cognitive demand and work stress.

Moreover, uncertainty exists as to how stress and job performance may affect safety. Jiang and Probst (2015) found a negative correlation between incident reporting attitudes and safety compliance (Jiang & Probst, 2015), suggesting those who favor production may be less likely to report incidents and engage in non-compliance with safety regulations. However, others suggested a robust positive association between safety performance and job performance (Drew et al., 2014). Likewise, increasing safety leadership and prioritizing safety was found not to incur costs to productivity (Schwarz et al., 2016). Occupational safety and health programs may have a small but significant positive effect on productivity, while stress reduction has an even larger positive effect (Lelo et al., 2019). Nevertheless, while worker stress may affect safety compliance, the extent to which worker stress affects safety-related decision-making remains unclear.

STRESS, SAFETY PARTICIPATION, AND DECISION-MAKING

Investigating the cognitive variables that can shape an individual's safety behavior would be of great value to understanding the leading indicators of safety incidents (Wang et al., 2018). This research builds upon work by Zohar and Erev (2007), who examined the paradox of how external pressures and rewards had a higher influence on workers' safe behaviors than self-preservation. They concluded that safety violations might fall under either the recency bias, the melioration bias, or the free-ride social dilemma bias. These are the three leading cognitive biases that may hinder safety participation.

In the recency bias, people overweight recent events and discount the influence of past events on their current decision. More frequent or more recently occurring events can be easier to recall than rare, past events. Employees who were injured recently may be more likely to take precautionary measures compared to such actions if the injury had not occurred. People also to tend overweight decisions from experience and underweight decisions from description of the context (Hertwig et al., 2004). A recency bias may skew expectations of a work hazard's likelihood, which may cause an employee with a recent injury to exercise more caution if exposed to that hazard in the near future.

The melioration bias occurs when the certainty of short-term negative utility causes a person to underweight delayed outcomes that have much higher importance in the long term (Zohar & Erev, 2007). The melioration is reported to be robust to the extent that it may alter short-term behavior even if the long-term adverse outcomes are certain. For example, an employee may disregard the immediate benefits of wearing PPE, such as hearing protection, and accept the risk of latent, adverse outcomes, such as hearing loss in the coming years.

The free-ride social dilemma is the tendency for people to refrain from contributing to the common good without requiring any personal cost. In occupational safety, this involves the shared responsibility of hazard mitigation or prevention because everyone wants to remain uninjured. However, when any of the individuals in the group can perform the mitigation or prevention efforts, the tendency is to underweight the social externalities and not participate in restoring the safe conditions (Erev et al., 1995). Thus, despite a shared responsibility of hazard mitigation or prevention, the time and effort for mitigation is borne only by the person who takes responsibility to fix the problem.

Understanding the associations among life and work stress and safety participation under conditions portrayed by these three biases may lead to improved safety intervention programs. Thus, the purpose of the present study was to assess the associations between employees' perceived life and work stress and their orientation toward participating in safety. Given the high prevalence of job-related stress and strain, employees in the utility service and maintenance industry were participants in the study. Participants completed surveys assessing life stress and work stress. They then responded to three safety-related decision-making simulations that required balancing trade-offs between job hazard risks and productivity. These simulations were designed to assess for the recency, melioration, and free-ride cognitive biases.

Methods

GENERAL

The participants were frontline municipal utility employees in central Iowa, including public works, power plants, electrical distribution, and water treatment. A letter of consent was distributed at the start of the survey, participation was voluntary and anonymous, and participants were free to end participation at any point. Participants responded online via Qualtrics®™ and received a $5 gift card as a token of appreciation. Program directors further distributed the study to their employees and were asked to encourage participation. Of the 243 responses, 206 were complete; the 37 incomplete responses were not included in the analyses. The study was reviewed by the Iowa State University's Institutional Review Board and was deemed Exempted (Study Number 20-498).

STRESS INSTRUMENTS

A survey questionnaire first gathered each participant's demographic information, job title, and length of employment in their position (see Supplement). Participants then completed the Perceived Stress Scale (PSS) (Cohen et al., 1983) to assess life stress and the Canadian National Population Health Survey (NPHS) (Wang, 2005) to assess work stress.

The PSS is a 10-item Likert scale instrument assessing how unpredictable, uncontrollable, and overloaded a person has felt in the last month. Scores can range from 10 to 50, with higher scores denoting more stress. The PSS is reliable (0.84) and was not skewed by gender (Taylor, 2015). The NPHS (Statistics Canada, 1995) consists of 12 Likert scale questions assessing skill discretion, decision authority, psychological demand, job insecurity, physical exertion, and social support from coworkers and supervisors. Scores can range from 12 to 60; higher scores reflect greater work stress.

AQ1

Data collection occurred in June 2021, during the peak of the COVID-19 pandemic. Consequently, four questions from the Stanford Stress instrument (Adamson, 2020) that address COVID-19-related stress were used. These questions assessed whether the participant had lost someone close to them due to COVID-19 (yes or no), whether work expectations had changed due to COVID-19 (7-item Likert), whether their exercise habits had changed (3-item Likert), and whether the extent to which they were connecting with family and friends had changed due to COVID-19 (3-item Likert).

BIAS DECISION SCENARIOS

A decision-making simulation was introduced after each of the stress questionnaires. Each of the three simulations assessed the extent to which the participant was subject to one of the biases of recency, melioration, and free-ride social dilemma. Each described a generally common work situation relevant to utility production and maintenance environments. For each simulation, there were four initial choices, ranging from "I will not spend time thinking about this issue" to "I will do something about it." If the latter was chosen, multiple options for what to do were given, and one was to be chosen. These options were designed to assess the extent to which the participant was committed to making the situation safe. The scenarios can be found in Appendix A of the Supplement.

STATISTICAL PROCEDURES

Multiple logistic regression likelihood ratio tests were used to examine whether perceived life stress and perceived work stress are significant predictors of employee decision-making to participate in safety under the cognitive biases. The regression modeling included traditional demographic variables, work history factors, and potential COVID-19 stressors. Multiple logistic regression was applied to understand the extent of safety engagement in each of the cognitive bias scenarios. Here, significant predictors were first screened among the demographic, injury history, and COVID-19-related variables, and then based on these screening results, multiple logistic regression was applied for life stress, work stress, age, and gender.

To control for Type I errors, false discovery rates were calculated on the results from the three simulations, and Benjamini-Hochberg (B-H) (Benjamini & Hochberg, 1995) p-values were adjusted ($q^* = 0.05$). Only variables that survived the B-H procedure are presented in the discussions below. Data are presented as mean $\pm$ SD, and statistical significance was considered to be $p < 0.05$.

Results

PARTICIPANT CHARACTERISTICS

Participants were predominantly male, with most being between the ages of 25 and 54 years, and employed full-time (Table 1). Work-related injuries to either the participant or a team member were relatively common, as was safety-related training.

STRESS

Responses to the PSS and NPHS were 27.8 ± 4.5 and 36.2 ± 5.3, respectively. About a third of participants (32%) reported they had lost someone close to them due to COVID-19. The majority (69.4%) reported they had experienced an increase in work expectations due to the disease. Most had experienced no change in exercise (33.5%) or were exercising less (44.7%). Slightly more (37.4%) were connecting more with family and friends than were experiencing either less (31.6%) or no change (31.0%).

DECISION BIASES

Recency bias scenario—Predictors for engaging in safety. Multiple logistic regression was applied to understand the tendency to get engaged in safety in the recency bias for screening for significant predictors among the demographic, injury history, and COVID-19-related variables. Effect likelihood ratio tests demonstrated changes in expectations due to COVID-19 [$\chi^2(5,\ N = 182) = 13.899$, $p = 0.0163$], losing someone close due to COVID-19 [$\chi^2(1,\ N = 182) = 5.450$, $p = 0.0196$], whether the participant was injured in the last 5 years [$\chi^2(1,\ N = 182) = 4.200$, $p = 0.0404$], whether disciplinary action was applied to the participant [$\chi^2(2,\ N = 182) = 7.084$, $p = 0.0290$], and whether training changes were introduced to the safety program in the last 5 years [$\chi^2(3,\ N = 182) = 10.710$, $p = 0.0134$] were significant predictors for engaging in safety.

AQ1

Table 1.
Participant demographics and work history

Variable	Percent
Gender	
Male	67
Female	32
Unspecified	1
Age (y)*	
18–24	3.9
25–34	33.4
35–44	35.0
45–54	20.4
55–64	6.4
65+	1.0
Employment Status	
Full-time	86.3
Part-time	10.7
Unemployed	1.0
Laid off/disabled	1.0
Incurred a work-related injury within past 5 years?	
Yes	44
No	56
Team members incurred a work-related injury within past 5 years?	
Yes	57
No	43
Any disciplinary actions applied to your or team member due to an incident?	
Yes	42

No	46
Not applicable	12
Training provided due to changes in the company safety program within past 5 years?	
Yes	72
No	21
Not sure	4

*Age ranges were adjusted in Table 1 to ensure more robust data. We started with 18–24 to capture early career phases, followed by 10-year increments like 25–34. The 20–29 range covers a full 10 years, considering year-end dates. This modification provides a stable and representative dataset, particularly in the context of COVID-19.

Multiple logistic regression was then applied for life stress, work stress, and the significant predictors above. Parameter estimates for the model are provided in Table 2.

The parameter estimates demonstrate the following: that the relative odds ratio of an increase in work stress decreases the likelihood of deciding to engage in safety by approximately 10%; that life stress was not a significant predictor of the tendency to engage in safety; that experiencing a disciplinary action in the last 5 years was roughly 2.5 times more likely to result in a decision to engage in safety in the scenario in comparison to not experiencing an incident; that an increase in work stress decreases the likelihood of deciding to engage in safety by approximately 10%; that experiencing the same level of expectations during COVID-19 was 65% less likely to result in a decision to engage in safety in comparison to when the expectations were much higher; that experiencing much lower expectations during COVID-19 was 2.5 times more likely to result in a decision to engage in safety in comparison to when the expectations were much higher; that implementing training due to changes in the company was roughly 39% less likely to result in a decision to engage in safety in comparison to cases where new training was not introduced; that losing someone close due to COVID-19 was 56% more likely to result in a decision to engage in safety in comparison to when loss was not experienced; that experiencing an injury in the last 5 years was 43% more likely to result in a decision to engage in safety in comparison to not experiencing injury; and that not experiencing a disciplinary action (either to the participant or to any member of the team) was 70% more likely to result in a decision to engage in safety in comparison to cases where an incident was not experienced.

Recency bias scenario—Predictors for the extent of safety engagement. When assessing the extent of engagement in the safety behaviors in the recency bias scenario, only changes in expectations due to COVID-19 [$\chi^2(5,\ N = 59) = 11.902,\ p = 0.0362$] was a significant predictor of engagement strength. Multiple logistic regression was then applied for life stress, work stress, and changes in expectations due to COVID-19. Table 3 consists of parameter estimates for the model.

Melioration bias scenario—Predictors for engaging in safety. Significant predictors of the tendency to get engaged in safety in the melioration bias scenario were the loss of someone close during COVID-19 [$\chi^2(1, N = 182) = 4.011, p = 0.0452$] and participant injury in the last 5 years [$\chi^2(1, N = 182) = 6.047, p = 0.0114$].

Multiple logistic regression was then applied for life stress, work stress, participant injury in the last 5 years, and the loss of someone close due to COVID-19. Table 4 presents the parameter estimate for the model.

The parameter estimates demonstrate that losing someone close due to COVID-19 was roughly 38% less likely to result in a decision to engage in safety in the scenario in comparison to not losing someone close due to COVID-19, and experiencing an injury in the last 5 years was roughly 32% less likely to result in a decision to engage in safety in the scenario in comparison to not experiencing an injury. Neither life stress nor work stress were significant predictors.

Table 2.
Parameter estimates for the tendency to engage in safety in the recency bias scenario

Variable	β	SE β	χ^2	*p*
Disciplinary action applied to you or team [Yes]	0.8531	0.26156	10.64	0.0172*
COVID-19-related changes in expectations [About the same]	−1.0511	0.3468	9.19	0.0226*
Work stress	−0.1062	0.0345	9.51	0.0235*
Training changes applied in the last 5 years [Yes]	−0.9717	0.3333	8.30	0.0235*
COVID-19-related loss of someone close [Yes]	0.4441	0.1543	8.28	0.0235*
Disciplinary action applied to you or team [No]	0.5274	0.2252	5.48	0.0752
Recent injury [Yes]	0.3572	0.1502	5.66	0.0818
COVID-19-related changes in expectations [Much less]	0.9161	0.4574	4.01	0.1416
Training changes applied in the last 5 years [No]	0.4624	0.3569	1.68	0.4369
COVID-19-related changes in expectations [Slightly less]	−0.3198	0.2712	1.39	0.5093
Life stress	−0.0228	0.0357	0.41	1.000
Training changes applied in the last 5 years [Unsure]	−0.1497	0.5316	0.08	1.000
COVID-19-related changes in expectations [Moderately less]	−0.0230	0.2877	0.01	1.000
COVID-19-related changes in expectations [Slightly more]	0.2519	0.5228	0.23	1.000

Pseudo $R^2 = 0.1292$.
Values with * and in red are significant.

Table 3.
Parameter estimates for the extent of engagement in the recency bias

Variable	β	SE β	χ^2	*p*
Life stress	0.133	0.080	2.81	0.2197
Work stress	0.114	0.066	2.98	0.2199
COVID-19 expectation changes	0.153	0.084	0.00	0.5263

Note: Pseudo $R^2 = 0.076$.
None of the variables were a significant predictor for the extent of engagement in safety in the recency bias.

Melioration bias scenario—Predictors for the extent of safety engagement. When assessing the extent of engagement in the safety behaviors in the melioration bias scenario, only changes in work expectations due to COVID-19 [$\chi^2(5, N = 59) = 11.902$, $p = 0.0362$] was a significant predictor of the

Table 4.
Parameter estimates for the tendency to engage in safety in the melioration bias

Variable	β	SE β	χ^2	*p*
COVID-19-related loss of someone close [Yes]	−0.480	0.143	11.22	0.0188*
Recent injury [Yes]	−0.373	0.132	7.93	0.0256*
Life stress	−0.066	0.034	3.86	0.1448
Work stress	0.071	0.030	5.64	0.0752

Note: Pseudo $R^2 = 0.0474$.
Values with * and in red are significant.

Table 5.
Parameter estimates for the extent of engagement in the melioration bias

Variable	β	SE β	χ^2	*p*
Life stress	0.036	0.071	0.26	1.0000
Work stress	−0.011	0.065	0.03	1.0000
COVID-19-related changes in expectations [Slightly less]	3.522	318.483	0.00	1.0000
COVID-19-related changes in expectations [Slightly more]	2.494	318.483	0.00	1.0000
COVID-19-related changes in expectations [Moderately less]	1.974	318.483	0.00	1.0000

Note: Pseudo $R^2 = 0.1120$.
None of the variables were significant predictors of the extent of engagement in the melioration bias.

engagement strength. Multiple logistic regression was then applied for life stress, work stress, and changes in expectations due to COVID-19. Table 5 presents parameter estimates for the model.

Free-ride social dilemma scenario—Predictors for engaging in safety. Participant injury in the last 5 years [$\chi^2(1, N = 182) = 15.278$, $p < 0.0001$], changes in job expectations due to COVID-19 [$\chi^2(5, N = 182) = 16.204$, $p = 0.0063$], and team member injury in the last 5 years [$\chi^2(1, N = 182) = 5.951$, $p = 0.0147$] were significant predictors of the tendency to engage in safety in the free-ride scenario.

Multiple logistic regression was then applied for life stress, work stress, participant injury history, changes to job expectations due to COVID-19, and team member injury history. Table 6 presents parameter estimates for the model.

The parameter estimates demonstrate that experiencing an injury in the last 5 years was roughly 50% less likely to result in a decision to engage in safety in the scenario in comparison to not experiencing an injury.

All other variables were not significant predictors of a tendency to engage in safety in the free-ride social dilemma.

Free-ride social dilemma scenario—Predictors for the extent of safety engagement. When assessing the extent of engagement in the safety behaviors in the free-ride scenario, losing

Table 6.
Parameter estimates for the tendency to engage in safety in the free-ride social dilemma

Variable	β	SE β	χ^2	*p*
Recent injury [Yes]	−0.677	0.146	21.38	0.0047*
Life stress	−0.086	0.038	5.20	0.0759
Work stress	0.061	0.035	3.09	0.0789
Team member injured? [Yes]	−0.250	0.149	2.84	0.2268
COVID-19-related changes in expectations [Moderately less]	2.121	205.460	0.00	1.0000
COVID-19-related changes in expectations [Slightly less]	2.505	205.460	0.00	1.0000
COVID-19-related changes in expectations [About the same]	3.095	205.460	0.00	1.0000
COVID-19-related changes in expectations [Slightly more]	2.985	205.460	0.00	1.0000
COVID-19-related changes in expectations [Moderately more]	−12.453	1232.758	0.00	1.0000
COVID-19-related changes in expectations [Moderately more]	1.103	205.460	0.00	1.0000

Note: Pseudo $R^2 = 0.1218$.
Values with * and in red are significant.

Table 7.
Parameter estimates for the extent of engagement in the free-ride social dilemma

Variable	β	SE β	χ^2	*p*
COVID-19-related loss of someone close [Yes]	−0.812	0.272	8.91	0.0219*
COVID-19-related connecting with family and friends [As much]	−0.723	0.313	5.35	0.0752*
COVID-19-related connecting with family and friends [Less than Before]	−0.259	0.350	0.55	0.9365
Work stress	−0.026	0.049	0.28	1.000
Life stress	−0.004	0.07	0.00	1.000

Note: $R^2 = 0.0941$.
Values with * and in red are significant.

someone close due to COVID-19 [$\chi^2(1, N = 75) = 5.887$, $p = 0.0153$] and connecting with family and friends during COVID-19 [$\chi^2(2, N = 75) = 7.449$, $p = 0.0241$] were significant predictors. Multiple logistic regression was applied for life stress, work stress, losing someone close due to COVID-19, and connecting with family and friends during COVID-19. Table 7 presents parameter estimates for the model.

The parameter estimates demonstrate the following: the relative odds ratio of losing someone close due to COVID-19 decreases the likelihood of strong engagement in safety by 56%, and connecting with family and friends during COVID-19 as much as before COVID-19 decreases the likelihood of strong engagement in safety by 51%. Neither life stress nor work stress were significant predictors of the extent of engagement in safety.

Discussion

LIFE STRESS

McHugh et al. (2019) reported that living in communities with a poor health environment was a significant distractor, leading to safety deviations. Hammer et al. (2015) showed that workplace intervention targeting work-life stress had no significant impact on safety participation and safety compliance. Murphy et al. (1986) reported that crew members and pilots involved in accidents experienced higher life stress changes than those who did not have accidents. Murphy and his colleagues then presented a model that suggests that work and non-work stressors increase anxiety, unhealthy behavior, and motivation decline, resulting in reduced accuracy, reaction time, attention, reasoning, judgment, and memory, leading to non-safety-compliance behavior and improper use of equipment.

In the present study, life stress was not a significant factor in any of the biases. However, a larger cohort study may yet consider revisiting life stress in the framework of the free-ride bias as it trended toward significance ($p = 0.759$) in the tendency to reduce engagement in safety.

WORK STRESS

A significant body of literature has documented the effect of work stress on safety behavior. Özer et al. (2022) reported that the perception of occupational safety level attributed to only 4.1% of the total work stress variance in healthcare employees. Further research should investigate whether this safety-stress variation has an interaction similar to that of the pattern of safety-related stress hindering safety participation (Wang et al., 2018). Ghasemi et al. (2018) developed a path analysis model for work pressure on unsafe behavior in the workplace. Their results suggest that work pressure combined with group and personal attitude negatively affected safe behavior. Soori et al. (2008) reported that work stress may have led to 12% of the reported injuries in the automotive manufacturing industry. Backhordari et al. (2019) found that work stress significantly affected accident proneness in an Iranian steel company. Alkan and Gültekin (2021) reported that work incidents increase as work stress increases across the working population in Turkey. Wang et al. (2018) further delved into the concept of work stress and examined the effect of safety-related stress on safety behavior. Their results demonstrated that high-level safety-related stress impaired participation in safety but did not affect safety compliance. Wang et al. (2022) found that team safety stressors inversely predicted safety citizenship behavior.

Clarke (2012) conducted a meta-analysis to examine the relationships among occupational stressors, safety behaviors, and safety outcomes (injuries and near-misses). She distinguished between challenge and hindrance occupational stressors (challenge stressors contribute to performance, and hindrance stressors interfere with performance and goal achievements). Her results demonstrated that safety behaviors fully mediated the relationship between hindrance stressors and occupational injuries. Challenge stressors' associations with compliance and occupational injuries were insignificant and near-zero. Hindrance stressors had a significant effect on reduction in safety compliance and safety participation, and they had a significant association with high levels of injuries and near-misses.

The results from the recency bias are in line with those reported in the literature, where the increase in work stress had a downward effect on the tendency to engage in safety. However, work stress was not a significant predictor of the tendency to engage in safety in the melioration and free-ride social dilemma biases. In the construct of the free-ride social dilemma, Zohar and Erev (2007) concluded as follows: "All of the above suggest that the tendency to choose *un*safe behavior in many routine work situations remains unaltered even when such decisions entail negative externalities. This behavioral bias thus provides additional explanation for the prevalence of unsafe behavior in routine work" (p. 128). While work stress failed to pass the cut for melioration following the FDR B-H adjustment, its significance prior to the adjustment may justify pursuing work stress in a larger cohort study. Finally, work stress was not a significant predictor of the extent of engagement in any of the three biases.

COVID-19 STRESS

We collected data during spring 2021 when the concern and the impact of COVID-19 peaked. Losing someone close due to COVID-19 significantly predicted the tendency to engage in safety in all three biases. In the recency bias, losing someone close due to COVID-19 was 56% more likely to result in a decision to engage in safety than not experiencing such loss. Also, those who reported experiencing much lower expectations during COVID-19 were 2.5 times more likely to decide to engage in safety in comparison to when the expectations were much higher, although experiencing the same level of expectations during COVID-19 was 65% less likely to result in a decision to engage in safety in comparison to when the expectations were much higher. In contrast, the effect of losing someone close due to COVID-19 led to a roughly 38% decrease in the likelihood of engaging in safety under the melioration condition. The novelty of the COVID-19 circumstances limits our ability to draw major conclusions, especially when observing the counter effect of losing someone to COVID-19 under the recency or the melioration conditions.

WORK HISTORY

The introduction of training due to changes to the company safety program significantly hindered the tendency to engage in safety only in the recency bias. This factor was not a significant predictor of either tendency to engage or the extent of engagement in the other two biases. The lack of significance in the other biases is in line with the work reported by Bell and Grushecky (2006). Their evaluation of workers' compensation claims showed that introducing a logger safety training program (as part of a Logger Safety Initiative in West Virginia) did not lead to a decline in claims rates in 67% of the logging companies that participated in this initiative. Furthermore, these companies' claim rates differed from those of other companies that did not participate in the initiative. Huang et al. (2012) examined the association between perceived management commitment to safety and employee-perceived safety training with future injury among restaurant workers. Their results showed that future injury had no significant relationship with the shared perception of management commitment to safety. Their results also suggest that perceived safety training potentially could be a proximal predictor of future injury, which in turn may mediate the relationship between injury outcome and the perception of management commitment to safety.

A recent work-related injury to the participant or a team member was a significant predictor of a decrease in the tendency to engage in safety in the melioration and the free-ride biases. The negative consequences of unsafe engagement, even if certain, lead to a discount of proper reasoning (melioration effect). As such, employee or coworker injury is not expected to inform a decision to engage in safety under these conditions. As presented earlier, the free-ride social dilemma is a robust bias. Consequently, the tendency to choose unsafe behavior in many situations will not alter even when others carry the cost of the consequence. Thus, the negative trend reported herein could be expected.

Finally, either experiencing or not experiencing disciplinary action(s) in the last 5 years was a strong predictor of the tendency to engage in safety in the recency bias only, in comparison to not experiencing an incident. Atwater et al. (2001) examined the reaction of recipients and observers to disciplinary action in the workplace. Their results showed that both the recipients and the observers identified positive elements associated with disciplinary actions. However, both groups may lose respect for the discipliner and may develop a negative attitude toward the organization. They further reported that both groups would likely perceive the disciplinary action as unfair when it is applied to informal expectations than when it applies to formal rule violations. Rollinson et al. (1997) conducted an exploratory study on the effect of experiencing disciplinary actions and behavior. They reported that only about half of those disciplined internalized and observed the rules, while the other half retained their tendency to break the rules. In the workplace scenario where a previously injured employee is confronted with a decision regarding a loose guard on a machine, their reluctance to take proactive safety measures might indeed stem from disillusionment with collective action (Praslova, 2022). This disillusionment is shaped by a belief that individual efforts, such as the proper response in a free-ride scenario, might be ineffective in an environment where shared responsibility and teamwork are paramount for ensuring safety. The experience of a past injury, which did not lead to significant improvements in safety practices,

further compounds this feeling. Consequently, this might result in a passive attitude toward addressing safety issues, evidenced by a tendency to wait for others to take action or to simply continue working without intervening.

This behavior, potentially reflecting a diminished faith in the impact of their actions (Moore, 2023), whether it is about repairing the guard or initiating safety discussions with the team, may also suggest a relationship between recency and free-ride biases. Interestingly, the effect of a past injury in scenarios emphasizing recent experiences (recency scenarios) was found to be opposite to that in social dilemmas. In recency scenarios, past experiences might have a more immediate and potent influence on behavior, while in social dilemmas, the collective nature of the problem and the perceived ineffectiveness of individual action take precedence.

This dichotomy between the impacts of past injuries in different scenarios highlights the complex interplay of psychological biases in decision-making. This apparent contradiction calls for further research into the interaction among these biases, particularly how recency and social dilemma (free-ride) biases interact and influence employee behavior in safety-critical situations. Understanding these nuances may benefit developing more effective strategies to enhance workplace safety, especially in environments where past experiences and collective action significantly impact individual decision-making.

Generally, lack of disciplinary action can be attributed to the following three scenarios (1) proper safety behavior, (2) unsafe behavior that has not been observed, and (3) deficient safety culture/climate where unsafe behavior is tolerated, consequently signaling acceptance of such behavior. The research efforts herein were not designed to account for these three scenarios. Yet the positive, significant relationship between the tendency to engage in safety in the recency bias situation is expected since recency informs choice, and it will inform choice in all three scenarios described above. The discount effect of the melioration bias may compete with the impact of recent disciplinary action. As such, it might mediate the expected negative association of melioration bias and free-ride social dilemma with the tendency to participate in safety.

Summary

Zohar and Erev (2007) presented the recency, melioration, and free-ride social dilemma as safety-participation-hindering biases. The effects of life stress and work stress on the tendency to engage in safety and the extent of the engagement under the recency, melioration, and free-ride social dilemma biases were examined herein. The relationships with work history, COVID-19, and gender were examined, too. No significant relationships were detected between life stress and any of the biases. Work stress significantly impacted the tendency to engage in safety only in the recency bias. It did not affect the other biases. COVID-19 stress variables had significant effects in all three bias scenarios. The counter effects of certain variables inform the challenge associated with delivering one-size-fits-all safety programs encouraging participation. The results also hint that the perspective of Zohar and Erev (2007) on safety-participation-hindering biases warrants further attention from the research community. Moreover, the sensitivity of the model of engaging in safety to a larger set of variables under recency conditions calls for considering developing recency-based interventions and examining their potential to improve safety participation.

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References

Adamson, M. (2020). Psychological stress associated with the COVID-19 crisis. *NIH BSSR research tools. Disaster research response (DR2) resources portal*.

Alkan, Ö., & Gültekin, S. (2021). Modeling the factors that affect work accidents with binary logistic regression: Evidence from Turkey. In K. Palaniappan & P. McCauley (Eds.), *Occupational wellbeing*. IntechOpen. https://doi.org/10.5772/intechopen.93872

Atwater, L. E., Waldman, D. A., Carey, J. A., & Cartier, P. (2001). Recipient and observer reactions to discipline: Are managers experiencing wishful thinking? *Journal of Organizational Behavior*, *22*, 249–270. https://doi.org/10.1002/job.67

Backhordari, A., Malmir, B., & Malakoutikhah, M. (2019). An analysis of individual and social factors affecting occupational accidents. *Safety and Health at Work*, *10*(2), 205–212. https://doi.org/10.1016/j.shaw.2019.01.002

Bell, J. L., & Grushecky, S. T. (2006). Evaluating the effectiveness of a logger safety training program. *Journal of Safety Research*, *37*(1), 53–61. https://doi.org/10.1016/j.jsr.2005.10.019

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B*, *57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Bennett, J., & Lehman, W. (1999). The relationship between problem co-workers and quality work practices: A case study of exposure to sexual harassment, substance abuse, violence and job stress. *Work & Stress*, *13*(4), 299–311. https://doi.org/10.1080/02678379950019761

Cadet, B. (2003). Stress and risk assessment in the workplace. *Archives des Maladies Professionnelles et de Medecine du Travail*, *64*(3), 148–156.

Cartwright, S., & Cooper, C. (1997). *Managing workplace stress*. Sage Publications.

Clarke, S. (2012). The effect of challenge and hindrance stressors on safety behavior and safety outcomes: A meta-analysis. *Journal of Occupational Health Psychology*, *17*(4), 387–397. https://doi.org/10.1037/a0029817

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 386–396. https://www.jstor.org/stable/2136404

Colman, A. M. (2001). *Oxford dictionary of psychology*. Oxford University Press.

Drew, E. (2014). Personnel selection, safety performance, and job performance: Are safe workers better workers? (Publication No. 1231) [Doctoral dissertation, Florida International University]. FIU Electronic Theses and Dissertations. https://digitalcommons.fiu.edu/etd/1231

Erev, I., Gopher, D., Itkin, R., & Greeshpan, Y. (1995). Toward a generalization of signal detection theory to in-person games: The example of two person safety problem. *Journal of Mathematical Psychology*, *39*(4).

Ghasemi, F., Kalatpour, O., Moghimbeigi, A., Mohhamadfam, I. (2018). A path analysis model for explaining unsafe behavior in workplaces: The effect of perceived work pressure. *International Journal of Occupational Safety and Ergonomics*, *24*(2), 303–310. https://doi.org/10.1080/10803548.2017.1313494

Gimaeva, Z. F., Karimova L. K., Bakirov A. B., Kaptsov V. A., & Kalimullina D. K. (2017). Risks of cardiovascular diseases evolvement and occupational stress. *Health Risk Analysis*, *1*, 106–115. https://doi.org/10.21668/health.risk/2017.1.12.eng

Glick, D., Eisenman, D., Zhou, Q., Chi-Hong, & Asch, S. (2014). Using the Precaution Adoption Process model to describe a disaster preparedness intervention among low-income Latinos. *Health Education Research*, *29*(2), 272–283. https://doi.org/10.1093/her/cyt109

Hammer, L. B., Truxillo, D. M., Bodner, T., Rineer, J., Pytlovany, A. C., & Richman, A. (2015). Effects of a workplace intervention targeting psychosocial risk factors on safety and health outcome. *BioMed Research International, 2015*, ID 836967. https://doi.org/10.1155/2015/836967

Henning, J., Stufft, C., Payne, S., Bergman, M., Mannan, S., & Keren, N. (2009). The influence of individual differences on organizational safety attitudes. *Safety Science*, *47*(3), 337–345. https://doi.org/10.1016/j.ssci.2008.05.003

Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from experience and the effect of rare events in risky choice. *Psychological Science*, *15*(8), 534–539. https://doi.org/10.1111/j.0956-7976.2004.00715.x

Huang, Y. H., Verma, S. K., Chang, W. R., Courtney, T. K., Lombardi, D. A., Brennan, M. J., & Perry, M. J. (2012). Management commitment to safety vs. employee perceived safety training and association with future injury. *Accident Analysis & Prevention*, *47*, 94–101. https://doi.org/10.1016/j.aap.2011.12.001

Jiang, L., & Probst, T. (2015). The relationship between safety–production conflict and employee safety outcomes: Testing the impact of multiple organizational climates. *Work & Stress*, *29*(2), 171–189. https://doi.org/10.1080/02678373.2015.1032384.

Kahneman, D. (2013). *Thinking fast and slow*. Farrar, Straus & Giroux.

Kudielka, B. M., von Känel, R., Preckel, D., Zgraggen, L., Mischler, K., & Fischer, J. E. (2006). Exhaustion is associated with reduced habituation of free cortisol responses to repeated acute psychosocial stress. *Biological Psychology*, *72*(2), 147–153. https://doi.org/10.1016/j.biopsycho.2005.09.001

Lelo, D., Yusof, S., & Purba, J. (2019). *Influence of work safety and work stress on productivity*. Proceedings of the International Conference on Industrial Engineering and Operations Management, March 5–7, Bangkok, Thailand.

Leung, M., Chan, I. Y. S., & Yu, J. (2012). Preventing construction worker injury incidents through the management of personal stress and organizational stressors. *Accident Analysis & Prevention*, *48*, 156–166. https://doi.org/10.1016/j.aap.2011.03.017

McHugh, M., French, D. D., Farley, D., Maechling, C. R, Dunlop, D. D., & Holl, J. L. (2019). Community health and employee work performance in the American manufacturing environment. *Journal of Community Health*, *44*(1), 178–184. doi: 10.1007/s10900-018-0570-5.

Moore, A. (2023, August 28). *The relation between worker morale and workplace safety*. Safeopedia. Retrieved from https://www.safeopedia.com/the-relation-between-worker-morale-and-workplace-safety/2/9732

Murphy, L. R., DuBois, D., & Hurrell, J. J. (1986). Accident reduction through stress management. *Journal of Business and Psychology*, *1*(1), 5–18. https://doi.org/10.1007/BF01014163.

Özer, Ö., Özkan, O., Özmen, S., & Çirakli, Ü. (2022). Investigation of the perception of occupational safety, work stress and happiness in healthcare workers. *Journal of Health Management*, *25*(4), 813–819 https://doi.org/10.1177/09720634221078413

Praslova, L. N. (2022, April 11). *How to identify and address moral injury at work*. Psychology Today. Retrieved from https://www.psychologytoday.com/us/blog/positively-different/202204/how-identify-and-address-moral-injury-work

Probst, T., Barbaranelli, C., & Petitta, L. (2013). The relationship between job insecurity and accident under-reporting: A test in two countries. *Work & Stress*, *27*(4), 383–402.

Rollinson, D., Handley, J., Hook, C., & Foot, M. (1997). The disciplinary experience and its effects on behavior: An exploratory study. *Work, Employment and Society*, *11*(2), 283–311. https://doi.org/10.1177/0950017097112005

Selye, H. (1974). *Stress without distress*. J.B. Lippincott Company, 171.

Schwarz, U., Hasson, H., & Tafvelin, S. (2016). Leadership training as an occupational health intervention: Improved safety and sustained productivity. *Safety Science*, *81*, 35–45. https://doi.org/10.1016/j.ssci.2015.07.020

Sheeran, P., Harris, P. R., & Epton, T. (2014). Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychological Bulletin*, *140*(2), 511–543. https://doi.org/10.1037/a0033065

Shields, M. (2006). Stress and depression in the employed population. *Health Reports*, *17*(4), 11–29.

Simons, A. D., Angell, K. L., Monroe, S. M., & Thase, M. E. (1993). Cognition and life stress in depression: Cognitive factors and the definition, rating, and generation of negative life events. *Journal of Abnormal Psychology*, *102*(4), 584–591. https://doi.org/10.1037/0021-843X.102.4.584

Soori, H., Rahimi, M., & Mohseni, H. (2008). Occupational stress and work-related unintentional injuries among Iranian car manufacturing workers. *Eastern Mediterranean Health Journal*, *14*(3), 697–703.

Statistics Canada. (1995). *National Population Health Survey overview*. Ottawa, Ontario, Canada: Minister of Industry, Catalog No. 821567.

Starcke, K., & Brand, M. (2012). Decision making under stress: A selective review. *Neuroscience & Biobehavioral Reviews*, *36*(4), 1228–1248. https://doi.org/10.1016/j.neubiorev.2012.02.003

Taylor, J. M. (2015). Psychometric analysis of the Ten-Item Perceived Stress Scale. *Psychological Assessment*, *27*(1), 90–101. https://doi.org/10.1037/a0038100

Wang, J. (2005). Work stress as a risk factor for major depressive episode(s). *Psychological Medicine*, *35*, 865–871. https://doi.org/10.1017/S0033291704003241

Wang, J., & Patten, S. (2001). Perceived work stress and major depression in the Canadian employed population, 20–49 years old. *Journal of Occupational Health Psychology*, *6*(4), 283–289. DOI: 10.1037//1076-8998.6.4.283.

Wang, D., Wang, X., & Xia, N. (2018). How safety-related stress affects workers' safety behavior: The moderating role of psychology capitol. *Safety Science*, *103*, 247–259. https://doi.org/10.1016/j.ssci.2017.11.020

Wang, D., Sheng, Z., Wang, X., Griffin, M. A., Zhang, Y., & Wang, Z. (2022). How team safety stressors affect proactive and prosocial safety behaviors: Felt safety responsibility and affective commitment as mediators. *Safety Science*, *147*, 105625. https://doi.org/10.1016/j.ssci.2021.105625

Wayne, K., Lehman D., & Simpson, D. (1992). *Employee substance use and on-the job behaviors*. Institute of Behavioral Research Texas Christian University.

Weinstein, N., Sandman, P., & Blalock, S. (2008). The precaution adoption process model. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education* (4th edition, pp. 123–147). Jossey-Bass.

Zohar, D., & Erev, I. (2007). On the difficulty of promoting workers safety behavior: Overcoming the underweighting of routine risks. *International Journal of Risk Assessment and Management*, *7*(2), 122–136.

Appendix A. Work History and Demographic questionnaires

Work History

Have you suffered a work-related injury within the last 5 years?

- Yes
- No

Have any of the members of your team suffered a work-related injury within the last 5 years?

- Yes
- No

Were any disciplinary actions was applied to you are to a member of your team as a result from any incident?

- Yes
- No
- N/A

Have you been provided training due to changes to the company safety program within the last 5 years?

- Yes
- No
- Unsure
- I am not aware of changes to the company safety program within the last 5 years

Demographic Questionnaire:

What is your age?

- 18-24 years old
- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65+ years old

Which statement best describes your current employment status?

- Full-time
- Part-time
- Unemployed
- Laid off or looking for work due to COVID-19
- Not working due to disability

What is your gender?

- Male
- Female
- Other

Appendix B. Scenario Descriptions

Recency Bias Scenario

You have worked in your job for 5 years. You regularly work with a machine that is large, heavy, and uses high energy. A failure of this machine could really harm you. The machine requires maintenance every 3 months. which involves shutting it down and de-energizing it, mechanical and electrical lock-out/tag-out procedure from your supervisor, then getting down underneath to inspect and lubricate parts. The process takes approximately 1.5 hours.

You have noticed that some workers often chose not to issue lock-out/tag-out on this and other machines before doing maintenance. There have been three incidents this year of injuries due to machine failures caused by poor maintenance, leaking, and discharging of pressure or chemicals onto workers. The last time it happened the worker got injured.

There are a few more routine jobs you must finish before you meet your quota for the day. However, it is time to perform maintenance on the hoist in your station.

Which of the following statements best describes how you will think in the situation with the machine maintenance?

1. *I will not spend time thinking about this issue.*
2. *I am not sure what to do with this situation.*
3. *I am aware of the concern with the maintenance. I will acknowledge the issue but will carry-on with my work.*

4. *I will do something about it.*

Choice options 1, 2, 3, represented the first four stages in PAPM. Choice 4 represented stage 5 in PAPM, 'Decided to Act.' Since PAPM distinguished between a decision to act (PAPM Stage 5) and Acting (PAPM Stage 6), if choice 4 was selected then the participants were asked to identify the extent to which they are committed to pursue safer resolution, either by sharing their concerns with co-workers, their supervisor, or getting engage personally in resolving the concern. The scenario was described to the participants as follows:

You decided to do something about the machine maintenance. Which of the following options best describes what you will do about the situation?:

a. *I will always perform the full lock-out/tag-out before the maintenance and encourage others to do so.*
b. *I will make my supervisor aware of my concerns with workers performing maintenance without lock-out/tag-out.*
c. *I will discuss the issue of doing maintenance without issuing lock-out/tag-out with others and I will think about performing the lock-out/tag-out from now on.*

Melioration Bias Scenario

Your job requires using handheld power tools every day. Your job is busy, but you enjoy working at the company and the production output incentive is nice. You have at least 20 years before retirement. During the last couple of annual celebration parties, you met with many retirees who worked in your station for years. All of them told you they started experiencing significant health issues with their hands shortly after retiring because of working with these tools. The severity of these issues ranges from significant tingling in their fingers, to frequent palm and finger numbness, or to lost hand dexterity. You are not experiencing any of these symptoms now.

Which of the following statements best describes what you will do about using the hand tools at work?

1. *I will not spend time thinking about this issue.*
2. *I am not sure whether I need to do anything different with my hand tools.*
3. *I will do nothing about it and will simply continue working with the tools as usual.*
4. *I will do something about it.*

If choice 4 was selected, then the following description was presented:

You decided to do something about the tools. Which of the following options best describes what you will do about the situation?

a. *I will immediately work with my supervisor and the purchasing person in the company on buying vibration resistant handheld tools.*
b. *I will talk to my co-workers and see how they feel about rotating jobs so each one of us spends less time with the tools.*
c. *I will make my supervisor aware of my concerns with vibrations and hand illness and let them take care of the issue.*

Free-Ride Social Dilemma Scenario

In your facility you are experienced with using a powerful machine that has rotating parts. There are six others who use this machine at random times every day. The availability of the machine ensures a steady workflow.

A machine guard is installed around the rotating power system to protect workers from being trapped and dragged into the machine, which may result in a significant injury. You and your co-workers walk around the machine many times throughout your shift. Recently, you noticed the guard is rattling loose and falling out of place. Fixing the loose guard requires you either staying after work for half an hour or taking a half hour from your lunch break. You would have to issue a lockout/tagout for the machine, then find the special tools to unbolt and reposition the guard. Either you or anyone of the other members of your team can perform this 30-minute fix.

Which of the following statements best describes how you will think and respond to the situation with the machine guard?

1. *I will not spend time thinking about this issue. Maybe someone else from the team will notice and fix the guard.*
2. *I am not sure what to do with this situation.*
3. *The issue is not important, I will carry-on with my work.*
4. *I will do something about it.*

If choice 4 was selected, then the following description was presented:

You decided to do something about the ineffective machine guard. Which of the following options best describes what you will do about the situation?:

a. *I will issue a lock-out/tag-out either in the evening or at lunch and tighten the loose guard and encourage others to do so in the future.*
b. *I will wait, hoping someone fixes the loose guard. If nobody does so in a week or so, I will fix it.*
c. *Make my team lead/supervisor aware of the failing guard.*
d. *Discuss the loose guard with the team.*

Appendix C. Work Stress Health Survey

1. Your job requires that you learn new things.
2. Your job requires a high level of skill.
3. Your job requires that you do things over and over.
4. Your job allows you freedom to decide how you do your job.
5. You have a lot to say about what happens in your job.
6. Your job is very hectic.
7. You are free from conflicting demands that others make.
8. Your job security is good.
9. Your job requires a lot of physical effort.
10. You are exposed to hostility or conflict from the people you work with.
11. Your supervisor is helpful in getting the job done.
12. The people you work with are helpful in getting the job done.

Items were rated on a 5-point Likert Scale as follows:

0 = Never
1 = Almost Never
2 = Sometimes
3 = Fairly Often
4 = Very Often.

Canadian National Population Health Survey (NPHS):
Wang, J., & Patten, S. (2001). *Perceived Work Stress and Major Depression in the Canadian Employed Population, 20-49 Years Old, Journal of Occupational Health Psychology*. 6(4), 283-289.

Appendix D. Perceived Stress Scale

1. In the last month, how often have you been upset because of something that happened unexpectedly?
2. In the last month, how often have you felt that you were unable to control the important things in your life?
3. In the last month, how often have you felt nervous and "stressed"?
4. In the last month, how often have you felt confident about your ability to handle your personal problems?
5. In the last month, how often have you felt that things were going your way?
6. In the last month, how often have you found that you could not cope with all the things that you had to do?
7. In the last month, how often have you been able to control irritations in your life?
8. In the last month, how often have you felt that you were on top of things?
9. In the last month, how often have you been angered because of things that were outside of your control?
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Items were rated on a 5-point Likert Scale as follows:

0 = Never
1 = Almost Never
2 = Sometimes
3 = Fairly Often
4 = Very Often.

Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 24, 386-396.

Appendix E. COVID-19 Questionnaire

Have you lost someone close to you due to Covid-19?
- Yes
- No

How have the expectations of your work changed since Covid-19?
- Much more
- Moderately more
- Slightly more
- About the same
- Slightly less
- Moderately less
- Much less

Have your exercise habits changed during Covid-19?
- I exercise more during Covid-19
- I exercise less during Covid-19
- My exercise habits have not changed during Covid-19

About connecting with family and/or friends, including through telecommunication or virtually, during Covid-19, please select the statement that best represents your status:
- I am connecting with family and friends as much as I did before Covid-19
- I am connecting with family and friends more than I did before Covid-19
- I am connecting with family and friends less I did before Covid-19

Adamson, Maheen. (2020). Psychological Stress Associated with the Covid-19 Crisis. *Stanford University. ID:22198*. *https://www.nlm.nih.gov/dr2/COVID-19_BSSR_Research_Tools.pdf*.

Appendix F. Covid-19 and Work History response Frequency

Covid-19:

Table E.1.

Response frequency for "Have you lost someone close to you due to Covid-19?"

Yes	**32%**
No	68%

Table E.2.

Response frequency for "How have the expectations of your work changed since Covid-19?"

Much more	**6.3%**
Moderately more	26.2%
Slightly more	36.9%
About the same	19.9%
Slightly less	4.9%
Moderately less	5.3%
Much less	0.5%

Table E.3.
Response frequency for "Have your exercise habits changed during Covid-19?"

Exercise more	**21.8%**
Exercise less	44.7%
No change in exercise	33.5%

Table E.4.
Response frequency for How many minutes/hours a day are you currently connecting with family/friends through telecommunication or virtually during Covid-19?"

Connecting as much as I did before COVID-19	**31.0%**
Connecting more than I did before COVID-19	37.4%
Connecting less than I did before COVID-19	31.6%

WORK HISTORY

Table E.5.
Response frequency for "Have you suffered a work-related injury within the last 5 years?"

Yes	**44%**
No	56%

Table E.6.
Response frequency for "Have any of the members of your team suffered a work-related injury within the last 5 years?"

Yes	**57%**
No	43%

Table E.7.
Response frequency for "Were any disciplinary actions was applied to you are to a member of your team as a result from any incident?"

Yes	**42%**
No	46%
N/A	12%

Table E.8.
Response frequency for "Have you been provided training due to changes to the company safety program within the last 5 years?"

Yes	**72%**
No	21%
Not sure	4%
Unaware of change	3%

Demographic Questionnaire
Table E.9.
Response frequency for "What is your age?"

18–24	**3.9%**
25–34	33.4%
35–44	35.0%
45–54	20.4%
55–64	6.3%
65+	1.0%

Table E.10.
Response frequency for "Which statement best describes your current employment status?"

Full-time	**86.3%**
Part-time	10.7%
Unemployed	1.0%
Laid off or looking for work due to COVID-19	0.5%
Not working due to disability	0.5%
No response provided	1.5%

Table E.11.
Response frequency for "What is your gender?"

Male	**67%**
Female	32%
Unspecified	1%

Querys

Author Query Number	Query
AQ1	AUTHOR: Please provide a running head (i.e., short title) where missing in the front matter.