



Article

Exploring the Possibility of Developing a Psychosocial Exposure Limit (PSEL) for the Mitigation of Occupational Injuries

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Abstract

Safety science generally does not rely on classic “threshold values” for risk factors associated with physical injury, unlike the field of occupational hygiene. While such thresholds have been set for chemical, physical, biological, and ergonomic hazards, the psychosocial environment lacks similar analytical rigor. This study examines a possible approach to operationalizing a psychosocial exposure limit (PSEL) concerning psychosocial stressors. Methods: Utilizing a two-year longitudinal survey with 2989 participants, stressors were coded as risk thresholds (scores > 2, >3, >4 on a 1–5 scale) and analyzed via logistic regressions to test associations with work injuries resulting in absence from work. Results: The results indicate that overloads of psychosocial factors were associated with significantly higher odds of injury in the next year, after controlling for demographics. An aggressive environment and organizational hindrances were associated with injuries in the next year based on mean values above 2 and 3 (OR = 2.24, CI95% 1.68–3.00; 1.47, CI 1.09–1.98, respectively), work–home conflict based on those above 3 (OR = 1.72, CI 1.26–2.35), and cognitive overload based on those above 4 (OR = 1.45, CI 1.08–1.94). Autonomy was not significantly associated with injury odds. Summing the psychosocial factors (overload of above 3) revealed that for those who remained in the same job, 45% had increased odds of injury in 2025 for each additional psychosocial factor to which they were exposed in 2024. Conclusions: These findings suggest that organizational stressors can be modeled as potential risk factors, with a threshold for monitoring, and targeted interventions to mitigate future accidents, though further scale refinement for each variable and for cumulative effect is necessary to improve diagnostic and threshold accuracy.

Keywords: psychosocial; stress; burnout; work injuries; overexposure; limit threshold

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1. Introduction

Classic occupational exposure limits, which have long been used scientifically and practically in the field of occupational hygiene and adopted by many countries, are intended to protect workers from the adverse health effects of chemical and physical hazards and from increased risk probability. Safety science generally does not rely on classic “occupational exposure limits” analogous to those used in occupational hygiene but considers some threshold-type limits. However, while we have become experts at measuring the “tangible” dangers of the shop floor, the psychosocial environment, the invisible atmosphere of stress, and interpersonal dynamics have historically lacked comparable analytical rigor or standardized monitoring.

This study examines the concept of threshold values—when psychosocial stressors are regarded as hazards and analyzed. A primary driver for this investigation is the global shift toward standardized psychosocial risk management, most notably crystallized in ISO 45003:2021 [1]. This international standard provides guidelines for managing psychological health and safety at work, emphasizing that psychosocial hazards, such as aggressive environments, a lack of autonomy, and role ambiguity, are not just “well-being” issues but are directly linked to occupational safety and health (OSH) outcomes. The importance of managing psychological health at work arises from increasing evidence of the last four decades regarding the health results of stress and burnout, such as cardiovascular diseases [2] and mental health [3], and the fact that stress and burnout are strongly related to working conditions [4]. The International Labour Organization (ILO) has recently published a report on the huge estimated impact of a stressful work environment on health and the economy worldwide, as well as regulations and policies that are implemented to mitigate these impacts [5]. The ILO report and ISO 45003 underscore that organizations must identify these hazards and measure and manage them using the same systematic approach used for physical risks. Studies support this, showing that a high-risk psychosocial safety climate is associated with an increase in the risk of physical workplace injuries [6,7]. The ILO report charts the way forward for research in terms of more consistent data through harmonized measurement tools, the integration of psychosocial indicators into OSH monitoring systems, and improvements in national statistics to better track exposures and outcomes [5] (p. 12).

Psychosocial stressors are inherently subjective and perceived. What constitutes “overload” for one worker may be perceived differently by another; however, this perception is no less real in its physiological and safety consequences. Subjective overload functions as a pervasive cognitive filter that fundamentally reshapes workers’ interaction with their environment. When the demands of a role exceed an individual’s mental or cognitive bandwidth, it impairs the brain’s capabilities of recognition, attention, memory, and selection [8]. This saturation forces the brain to shift from deliberate, analytical reasoning to rapid, heuristic-based thinking [9], which often manifests as heightened impulsivity and “inattention blindness”, a dangerous failure to detect even obvious environmental hazards because the brain lacks the capacity to process them [10,11].

As this state of cognitive overload becomes persistent, it triggers a “resource loss spiral” where emotional and mental energy is depleted faster than it can be replenished. This chronic exhaustion creates a self-reinforcing cycle where each subsequent stressor further erodes the individual’s ability to recover, ultimately culminating in occupational burnout, characterized by total emotional bankruptcy and a profound detachment from the critical safety protocols of the job [12]. Both the effects of short-term stress and prolonged stress are found to be related to a higher risk of work injuries and accidents.

This study delves into the limits of psychosocial exposure and introduces an exploratory threshold as a framework to model organizational stressors as risk factors for physical injuries. The association between stressors, stress, and burnout and the risk of injury has been studied and empirically demonstrated over the years [10,11]. This paper aims to identify the threshold that poses an extra risk. To simplify and focus on the main issue, we analyze only external organizational stressors. Personal differences in perceiving and coping with stress may mediate or moderate the association between the stress factor and its mental and cognitive effects or between the mental and cognitive effects and the worker’s coping strategy [8]. For the clarity of the discussion, the analyses bypass the “black box” of the psychological mechanisms that explain the tested association between stress factors and the risk for injury at work.

Many organizational psychosocial factors have been studied over the past five decades [13]. Relying on Aronson’s meta-analytic review of work environments [13]

and incorporating the factor of an aggressive work environment [14], a questionnaire for an annual survey on work environments and health and well-being was developed in 2020 and has been administered annually since then. From this dataset, we chose five psychosocial factors: cognitive load, work–home conflict, organizational hindrances, (lack of) autonomy, and aggressive work environment. These were chosen because they lead to cognitive or mental overload without a direct effect on physical health, such as physical overload, shift work, and long working hours, whose correlation with injuries can be explained by factors other than the psychological perspective. We focused on these factors to estimate the indirect association between mental load and the risk of physical injury. The aim of this paper is to suggest a primary scale for assessing when a load becomes an overload and a risk factor for work injury.

2. Materials and Methods

2.1. Participants

A two-wave annual longitudinal survey was completed by participants from a professional panel in December 2024 and again in December 2025, receiving a monetary reward. The panel company sampled 21,975 working panel candidates and invited them via text message and email to participate in and complete a questionnaire. The panel company restored gender representation. Due to difficulty in obtaining a sufficient number of Arabic speakers, an additional call to this population through social media recruited another 178 participants. The 2025 questionnaire was sent to the 2024 respondents. Participants signed an informed consent form at the start or were transferred to the end of the questionnaire. Partial data were used from a broader survey aimed at mapping occupational exposures—physical, chemical, biological, ergonomic, and psychosocial—alongside safety and health outcomes. The survey has been conducted since 2020, but the participant panel was replaced in 2024. In 2024, 4912 participants responded; of them, 3035 responded in 2025 too (62% response rate). Out of them, the latter 46 were retired or unoccupied in 2025. To check whether there are significant differences between participants who answered only in 2024 and those who answered in both years, we compared the psychosocial factors of participants who answered only in 2024 with those who answered in both years for income levels and mean psychosocial factor scores. The results of a MANOVA test indicate small to no differences between the groups (2024, both years): cognitive load (3.45, 3.43), hindrances (2.32, 2.23), autonomy (3.47, 3.53), work–home conflict (2.36, 2.23), and aggressive environment (1.97, 1.69). All differences are statistically significant but with eta squared <0.01, and we found that attrition in the sample poses very little threat to external validity.

The participants in the current study consist of 2989 full survey respondents who worked in both years: 52.3% are women, 47.6% are men, and 3 (0.1%) chose “prefer other gender description”. Age in 2024 ranged from 18 to 82, with $M = 41.87$ ($SD = 12.06$). Most industries and occupations are represented, but the sample does not reflect nationwide workforce percentages, with an overrepresentation of women and educated workers and underrepresentation of risky and physical occupations.

2.2. Measurements

All scales were translated into Hebrew, shortened, and adapted to the larger questionnaire. A bilingual psychologist compared the translation to the English scale and corrected for inaccuracies. We tested all the job demands scales using Confirmatory Factor Analyses on a pilot with 500 participants. The questionnaire was then translated into Arabic by a professional translator and double-checked for clarity and meaning by two Arabic-speaking OSH professionals. The original psychometric data of the measures can be found in a previous paper [15]. The questionnaire has been used since 2020, and the wording has

been slightly changed over the years. The factors were tested since 2020 and validated for correlations with theoretically associated constructs, such as burnout, sleep problems, and leaving intentions, and for no correlations with theoretically unrelated constructs, such as sedentary behavior or commuting time.

Demographic, occupation, and organizational data collected: Gender, age, education, sector, job, and income.

Five psychosocial factors not directly related to physical hazards, such as heavy loads or awkward working postures, shifts or long working hours, were selected for initial threshold limit estimates: cognitive overload, lack of autonomy, organizational hindrances, work–home conflict, and an aggressive working environment. The first four measures asked, “to what extent the phrase describes your job/work?”, answered on a 1 to 5 Likert scale: 1—Not at all, 2—Mostly not, 3—Partially, 4—Mostly yes, and 5—Very much.

Cognitive demands and autonomy were adapted from the Work Design Questionnaire (WDQ) [16]. Cognitive demands were measured by three statements related to time pressure, concentration, and multitasking, such as “My work requires intense concentration” (α (2024) = 0.70, α (2025) = 0.69). A single-dimensional construct—fit indices are not relevant, CFI = 1.0, loadings 0.77, 0.82, 0.40—was kept for coherent long-run comparisons.

Autonomy: Working methods were measured by three statements regarding the tasks, e.g., “The job allows me to make decisions about what methods I use to complete my work”, and decision-making autonomy was assessed via four statements, e.g., “The job gives me a chance to use my personal initiative or judgment in carrying out the work” (α (2024) = 0.92, α (2025) = 0.92). The two dimensions of autonomy were aggregated into a single construct due to the high intercorrelation among the items (Cov = 0.88). The scale was reversed to capture the lack of autonomy. CFA: Loadings 0.80–0.93 (except a reversed item with a low loading of 0.46 that was kept for coherent long-run comparisons) with good fit indices of SRMR 0.03 and CFI = 0.97.

Organizational hindrances were measured using four statements addressing bureaucracy, organizational politics, time-wasting in meetings, and a lack of clarity in demands, adapted from the organizational hindrance scale [17] (α = 0.74, 2024 and 2025). A single-dimensional construct was used—fit indices are not relevant, CFI = 1.0, loadings 0.70–0.81 (except one item with a low loading of 0.41 that was kept for coherent long-run comparisons).

Work–home conflict is measured by four statements, adapted from Netemeyer et al. [18], with two referring to work-to-home disruption, for example, “My work requirements interfere with my family and home life”, and two relating to home interference causing disruption to work, for example, “My family life interferes with things at work, such as arriving on time, completing daily tasks, and overtime”. The measure demonstrated high reliability (α (2024) = 0.83, α (2025) = 0.84). CFA: Loadings 0.67–0.77 with acceptable fit indices of SRMR 0.05 and CFI = 0.91, and the two dimensions are covariates (1.0).

An aggressive work environment was measured by six statements that asked about overall hostile behavior: 1. humiliation and contempt; 2. discrimination; 3. concealment of information; 4. verbal aggression; 5. physical aggression towards equipment, such as slamming doors; 6. physical violence [19]. The answers were: “never happened”, “a few times a year”, “once a month”, “once a week”, and “happens almost every day” (α (2024) = 0.88, α (2025) = 0.83). The index calculated the maximum rank—that is, the maximum frequency with which the respondent experiences any kind of aggression. The reason for this particular calculation is the theoretical biological stress and burnout process and empirical studies that support the stronger effect of less aggressive but more frequent harassment over a strong but rare event [14]. A single-dimensional construct was used—fit indices are not relevant, CFI = 1.0, loadings 0.65–0.82.

Injury: A list of 11 types of physical and physiological injuries was given to the participants: contusion or bruise; wound; laceration or cut; musculoskeletal—sprain, strain, or inflammation; fracture; burn (thermal, chemical); amputation; dehydration or heatstroke; electric shock or burn; eye injury; and respiratory damage. For each option, participants indicated whether it happened in the last year. An additional question asked whether the injury required days off and how many (1—none; 2—few hours for treatment; 3—1–3 days; 4—4–6 days (a week); 5—two weeks; 6—a month; 7—more than a month; 8—not relevant, I was not injured (the latter was for extra reliability check)). The injury measure was coded as 0—not injured and 1—injured (0—did not need time off or did not get injured). The final measure of injury concerned whether the respondent was injured and needed time off (0 = no; 1 = yes).

Risk level of the job: The risk level was calculated for stratification because the effect of a stressor on the odds of injury is expected to differ among workers with a higher likelihood of exposure to risky situations. Participants indicated the type of job they occupy each year from a list of 15 jobs. A crosstabulation test revealed that injury percentages among participants across job categories ranged from 4.6% to 22.6%. The jobs were categorized into three categories according to the average of injuries in both of the years for the job: 1—low risk with 10% or less, including professional services such as lawyers, public relations, journalism and media, programming, research and development, accounting and administration, engineering, operation, and logistics; 2—medium risk with 11–20%, including healthcare, laboratory workers, education and training, sales and customer services, and technicians; 3—high-risk jobs with greater than a 20% injury percentage including front-line workers in industry, agriculture and construction, policing, rescue and emergency services and professional drivers.

2.3. Statistical Methods

The statistical analyses for descriptives and crosstabs were conducted using SPSS 29; logistic regressions and graphs were conducted using R 4.6.0.

3. Results

The participants do not represent the exact percentages of the working population in 2024. The sample includes 52% women (more than in the working population—48.5%). Familial status was indicated as 66.8% being married, 23.7% being bachelors, 9% being divorced, and 0.4% being widowers. Half (50.7%) have children under 18, 32.7% have no children, and 16.6% have children who are all over 18. Regarding education, the sample is more educated: 21.7% have a high school diploma, 18.1% have a professional certificate, 39.3% have an academic degree, and 21% have a master's degree or higher. Higher-income groups are overrepresented in the sample: minimum wage—8.9%; up to median income—24.3%; up to average—23.8%; above average—26.5%; twice average—6.2%; and 10.2%—unwilling to indicate their income.

Demographic and employment factors are presented in Table 1 for descriptive purposes and to assess associations with injury prevalence.

The sample included in each year for 2024 and 2025, respectively, 56.6% and 56.8% who worked in low-risk jobs, 37.7% and 35.7% in medium-risk jobs, and 5.6% and 7.7% in high-risk jobs. The percentages of injuries for each level are presented in Table 2 (no statistical test of significance is reported because the levels were categorized by injury percentage).

Table 1. Demographic and employment factors—association with injuries.

	% Injured in 2024	% Injured in 2025	Association with Injury Prevalence
Gender			n.s (Not Significant)
Men	10.5	10.5	
Women	12.0	9.8	
Age			n.s
18–25	13.0	9.7	
26–35	11.4	9.7	
36–45	10.6	10.4	
46–55	11.7	10.7	
55–65	11.8	10.3	
Above 65	8.0	8.1	
Education			
High school	12.7	16.4	2024
High school exams	13.7	12.4	$\chi^2 = 10.43, p = 0.034$
Professional certificate	13.3	11.5	2025
Academic degree	10.6	9.1	$\chi^2 = 15.71, p = 0.003$
Master’s degree	8.6	7.9	
Income			
Minimum wage	19.9	14.0	2024
Up to median	10.6	11.4	$\chi^2 = 30.27, p < 0.001$
Up to average	12.3	11.8	2025
Above average	11.2	8.3	$\chi^2 = 20.80, p < 0.001$
Twice the average	4.5	3.2	
Do not want to indicate	8.2	8.8	

Table 2. Prevalence of injuries for job risk level.

	% Injured in 2024	% Injured in 2025
Low risk level	9.1 (<i>n</i> = 154)	7.5 (<i>n</i> = 126)
Medium risk	13.2 (<i>n</i> = 149)	11.9 (<i>n</i> = 127)
High risk level	20.5 (<i>n</i> = 34)	21.6 (<i>n</i> = 50)

3.1. Psychosocial Factors: Description and Association with Injuries

The most reported psychosocial factor was cognitive overload for both years (2024 and 2025, respectively) ($M = 3.44$, $SD = 0.83$; $M = 3.43$, $SD = 0.83$), followed by lack of autonomy ($M = 2.41$, $SD = 0.89$; $M = 2.43$, $SD = 0.89$), work–home conflict ($M = 2.24$, $SD = 0.90$; $M = 2.22$, $SD = 0.92$), and organizational hindrances ($M = 2.24$, $SD = 0.80$; $M = 2.19$, $SD = 0.80$). Aggressive work environment (humiliation, discrimination or exclusion, physical towards equipment or towards the employee) was reported with the highest percentages for “never happened”, 46.2% and 43.5%, while rarely was reported as 35.5% and 39.8%, about once a month 9.4% and 8.3%, about once a week 4.9% and 4.7% and a few times a week 4.0% and 3.8% ($M = 1.85$, $SD = 1.05$, $M = 1.86$, $SD = 1.01$).

The psychosocial factors were categorized into four groups by scoring scale: low (mean 1–1.99), medium (mean 2–2.99), high (mean 3–3.99), and very high (mean 4–5) (see Table 3 for distributions). The categorization was intended to visualize injury percentages.

We analyzed the prevalence of injuries across the three levels of job risk and the four levels of psychosocial factors in both years. As shown in Figure 1, each level of psychosocial factor increases the odds of injury, and this trend prevails in most cases, but it is inconclusive whether the second level (mean value 2–3) should be the threshold, as it is more prominent for high-risk jobs, or whether high levels of a psychosocial factor (mean value above 3) are a more appropriate threshold value.

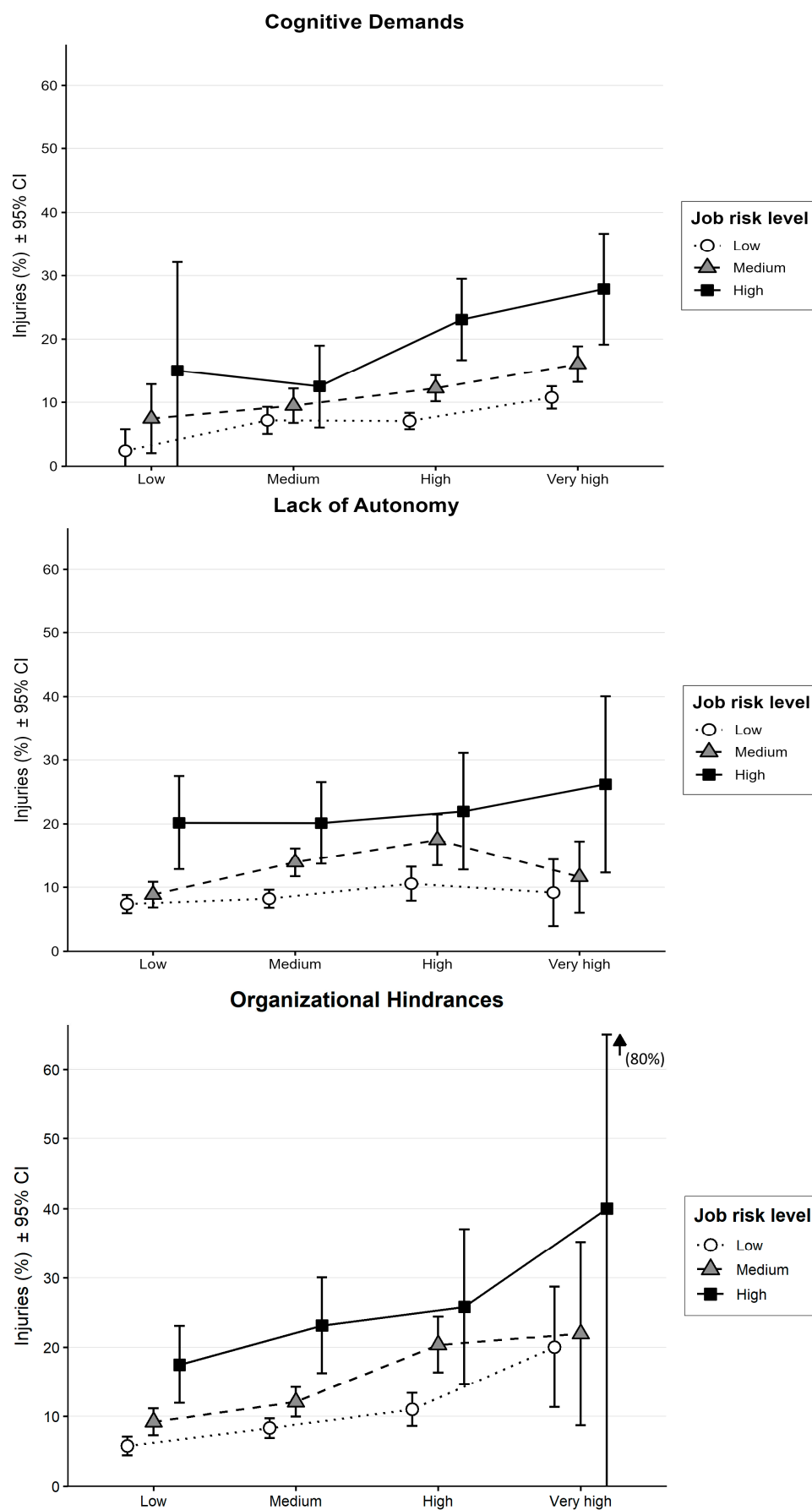


Figure 1. Cont.

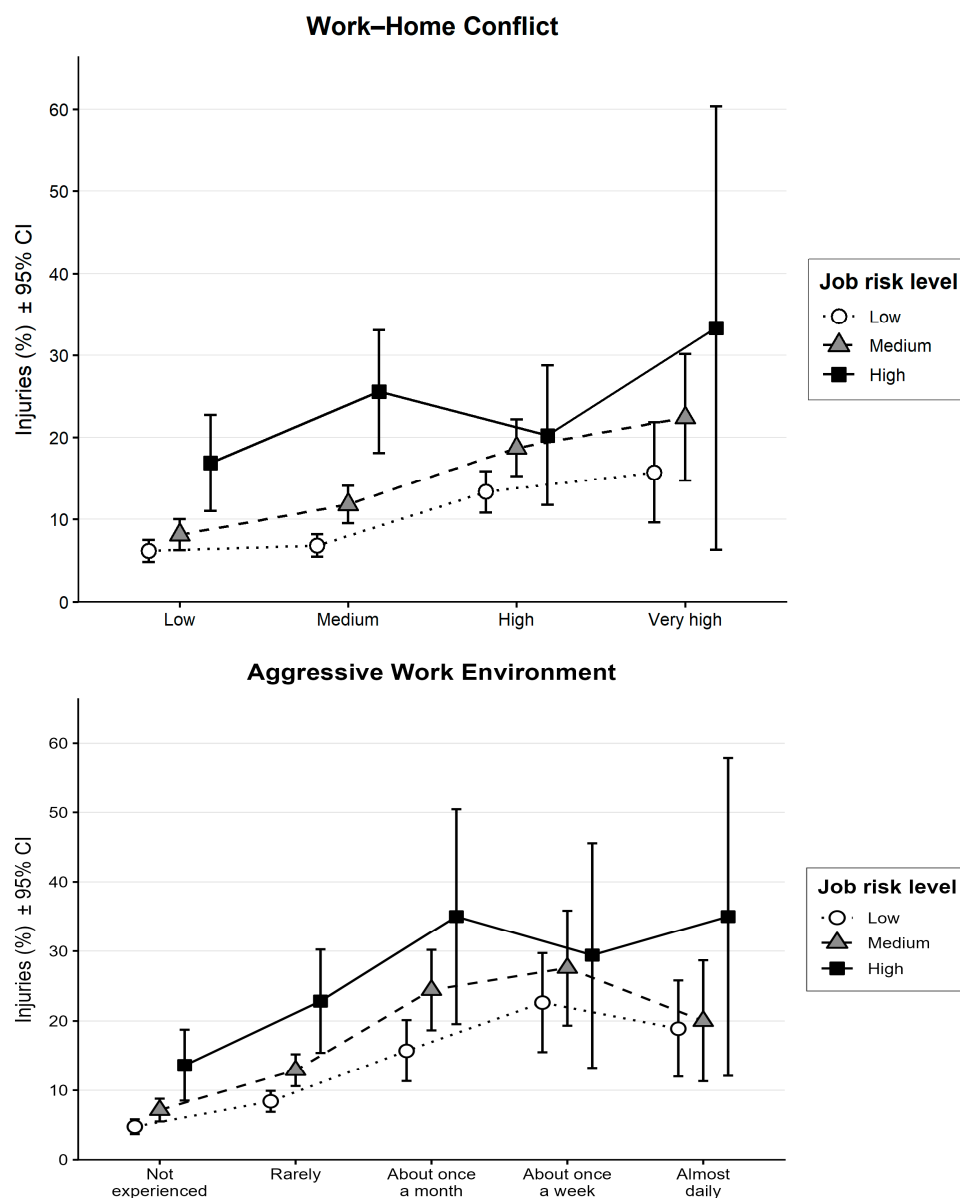


Figure 1. Percentages of injuries by level of each psychosocial factor across job risk levels for five factors for both years.

Table 3. Percentages of participants reporting exposure levels for each psychosocial factor.

Psychosocial Factor/Level	Cognitive Overload		Lack of Autonomy		Work-Home Conflict		Organizational Hindrances	
	2024	2025	2024	2025	2024	2025	2024	2025
Low	3.2	3.4	37.0	36.3	35.9	37.6	36.0	37.6
Medium	18.9	19.0	42.1	43.2	38.3	36.1	41.7	42.8
High	45.0	45.1	16.0	15.6	21.5	21.5	20.3	17.1
Very high	32.9	32.5	4.9	4.9	4.3	4.8	2.0	2.4
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Conceptually, the midpoint of 3 is neutral, and when a worker estimates the demands of their job, they indicate whether the demands are a load or an overload [20]. By treating “Partially” as an absence of true work overload, we guarantee that anyone flagged in the “Overload” category (>3) is unequivocally experiencing high workplace demands. Yet, for at least two factors, values above 2 may indicate increased odds. For an aggressive working

environment, experiencing it at least once a month is associated with elevated odds of injury, with no further increase for those more frequently experiencing an aggressive working environment for high-risk jobs, while low-risk jobs present a “peak” for experiencing such an environment weekly.

3.2. Exploring Candidates' Psychosocial Screening Threshold

Based on the trends emerging from the data visualization, three logistic regression models were used in R 4.6.0 to assess the association between the psychosocial factor and injury odds in the same year, controlling for gender, age, and income. The psychosocial factors were set to 0 or 1 for above-the-mean levels of 2, 3, and 4. As shown in Table 4, income and education are negatively associated with the odds of injury. The collinearity test revealed that all VIF values are between 1.07 and 1.38, and there is no multicollinearity threat to the model.

Table 4. Logistic regression of psychosocial factors: comparison of mean levels of psychosocial factors above 2, above 3, and above 4 for association with increased odds of injury in same year of exposure.

Variable	Above 2 OR (95% CI)	Above 3 OR (95% CI)	Above 4 OR (95% CI)
(Intercept)	0.07 (0.03, 0.17)	0.15 (0.07, 0.32)	0.23 (0.11, 0.45)
Gender (Man = 1; Woman = 2)	1.13 (0.87, 1.47)	1.06 (0.82, 1.37)	1.01 (0.78, 1.31)
Age	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.00 (0.99, 1.01)
Income	0.81 (0.71, 0.93)	0.82 (0.72, 0.94)	0.82 (0.72, 0.93)
Education	0.90 (0.80, 0.92)	0.88 (0.80, 0.99)	0.90 (0.81, 1.01) [†]
Job (Lack of) Autonomy	1.17 (0.88, 1.55)	1.17 (0.87, 1.57)	0.67 (0.36, 1.22)
Cognitive Demands	1.10 (0.63, 1.91)	1.16 (0.88, 1.52)	1.45 (1.08, 1.94)
Hindrances	1.55 (1.15, 2.08)	1.45 (1.05, 2.00)	2.36 (0.99, 5.65) [†]
Work–Home Conflict	2.01 (1.51, 2.66)	1.72 (1.26, 2.35)	1.53 (0.79, 2.98)
Aggressive Environment	2.51 (1.91, 3.30)	2.01 (1.46, 2.90)	2.07 (1.29, 3.33)
Nagelkerke Pseudo R ²	0.10	0.05	0.03
AUC ROC Analysis	0.69 (0.66, 0.73)	0.64 (0.61, 0.68)	0.60 (0.56, 0.64)

[†] $p < 0.10$. Degrees of freedom = 2680. AUC = area under curve, ROC = Receiver operating characteristic. Bold indicates significant values.

An aggressive work environment presents the highest odds ratio for all three models (2.51, 2.01, 2.07). Organizational hindrances and work–home conflict were significantly associated with injury odds in 2024 for most models, cognitive demand overload was only significant for an overload ranking above 4 (OR = 1.45), and autonomy lost the significant association that it presented when it was analyzed using a chi-square test without controlling for other factors.

We further examined the association between psychosocial factors in 2024 and the odds of injury in 2025. First, we added a job change to the regression. This was strongly associated with a 74% higher odds of injury (8.57% of the 2088 who made no change in their job vs. 13.78% of the 900 who changed jobs). Information on whether the job change occurred before, after, or as a result of the injury was not collected; thus, we omitted this factor in subsequent analyses.

The increased odds of injury in 2025 were associated with the presence of psychosocial hazards above the mean level of 2 in 2024 for an aggressive work environment (OR = 2.24, 95% CI 1.68–3.00) and organizational hindrances (47% higher odds, 95% CI 1.09–1.98) (Table 5). For mean levels above 3, work–home conflict was also associated with significantly higher odds of injury in 2025 (OR = 1.72, CI 95% 1.26–2.35). For mean levels above 4, cognitive load had significantly higher odds of injuries in 2025 (OR = 1.45, 95% CI

1.08–1.94). The lack of autonomy in 2024 was not associated with the odds of injuries in 2025 at any level.

Table 5. Logistic regression of psychosocial factors: comparison of mean levels of exposure to psychosocial factors above 2, above 3, and above 4 in 2024 for association with increased odds of injury in next year—2025.

Variable in 2024	Above 2 OR (95% CI) in 2025	Above 3 OR (95% CI) in 2025	Above 4 OR (95% CI) in 2025
(Intercept)	0.07 (0.03, 0.17)	0.15 (0.07, 0.32)	0.23 (0.11, 0.45)
Gender (Man = 1; Woman = 2)	1.13 (0.87, 1.47)	1.06 (0.82, 1.37)	1.01 (0.78, 1.31)
Age	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.00 (0.99, 1.01)
Income	0.79 (0.69, 0.90)	0.82 (0.72, 0.94)	0.82 (0.72, 0.93)
Education	0.84 (0.74, 0.94)	0.88 (0.80, 0.99)	0.90 (0.81, 1.01) [†]
Job (Lack of) Autonomy	0.91 (0.69, 1.20)	1.17 (0.87, 1.57)	0.67 (0.36, 1.22)
Cognitive Demands	1.41 (0.79, 2.52)	1.16 (0.88, 1.52) [†]	1.45 (1.08, 1.94)
Hindrances	1.47 (1.09, 1.98)	1.45 (1.05, 2.00) [†]	2.36 (0.99, 5.65) ^{†b}
Work–Home Conflict	1.24 (0.94, 2.66)	1.72 (1.26, 2.35)	1.53 (0.79, 2.98)
Aggressive Environment	2.24 (1.68, 3.00)	2.01 (1.46, 2.90)	2.07 (1.29, 3.33)
Nagelkerke Pseudo R ²	0.10	0.05	0.03
AUC ^c ROC Analysis	0.65 (0.61, 0.68)	0.64 (0.61, 0.68)	0.60 (0.56, 0.64)

[†] $p < 0.10$. Degrees of freedom = 2678. ^b Count less than 10; ^c AUC = area under curve, ROC = Receiver operating characteristic. Bold indicates significant values.

A further investigation was conducted regarding a potential cumulative effect of different stressors. The three significant psychosocial variables were summed, excluding the aggressive work environment, to avoid overestimation, because it had a strong association with injury on its own. Table 6 presents the frequencies of exposures and the percentages of injuries associated with those exposures. Out of the 2988 participants who had answers for both years, 2685 reported no injury, and 303 (10.1%) reported an injury in 2025.

Table 6. Distributions of exposure to number of psychosocial stress factors for three levels of candidate overload limits (above 2, 3, or 4) and their association with injury percentages.

Number of Stressors	Overload = Above 2		Overload = Above 3		Overload = Above 4	
	% of Exposed	Injured <i>n</i> (%)	% of Exposed	Injured <i>n</i> (%)	% of Exposed	Injured <i>n</i> (%)
0	4.2	8 (6.3)	31.0	79 (8.5)	79.4	220 (9.3)
1	26.7	61 (7.6)	47.4	131 (9.3)	18.7	74 (13.2)
2	33.8	102 (10.1)	17.3	68 (13.2)	1.8	8 (14.8)
3	35.3	132 (12.5)	4.3	25 (19.4)	0.1	1 (33.3)
Total		303 (10.1)		303 (10.1)		303 (10.1)

The three models were then tested using logistic regressions in R 4.6.0, controlling for gender, age, education, and income. The results presented in Table 7 indicate that models 1 and 2 are similar, with higher odds of injury associated with exposure to two psychosocial stressors, whereas model 4 shows significantly higher odds of injury for the first psychosocial stressor.

Table 7. Multiple logistic regression with the sum of psychosocial factors associated with the odds of work injury the next year, a comparison of thresholds 2, 3, and 4.

Factors in 2024	Model 1 (>2) Injuries in 2025 OR (95% CI)	Model 2 (>3) Injuries in 2025 OR (95% CI)	Model 3 (>4) Injuries in 2025 OR (95% CI)
(Intercept)	0.14 (0.06, 0.33)	0.20 (0.09, 0.42)	0.31 (0.15, 0.64)
Gender (man = 1; woman = 2)	0.85 (0.65, 1.12)	0.83 (0.64, 1.09)	0.80 (0.61, 1.05)
Age	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.01 (0.99, 1.02)
Income	0.79 (0.69, 0.90)	0.80 (0.70, 0.91)	0.80 (0.70, 0.91)
Education	0.84 (0.75, 0.94)	0.88 (0.78, 0.98)	0.90 (0.81, 1.01)
Sum of psychosocial factors ^a (OR compared to zero)	1.34 (1.15, 1.58)	1.35 (1.17, 1.57)	1.46 (1.11, 1.72)
One	1.74 (0.73, 4.17)	1.32 (0.96, 1.81) [†]	1.63 (1.21, 2.20)
Two	2.46 (1.04, 5.86)	1.75 (1.19, 2.59)	1.34 (0.55, 3.25) ^b
Three	3.05 (1.28, 7.28)	2.46 (1.44, 4.22)	3.82 (0.33, 44.63) ^b
Aggressive environment	2.24 (1.74, 3.09)	2.28 (1.61, 3.22)	2.20 (1.43, 3.70)
Nagelkerke pseudo R ²	0.06	0.05	0.03
ROC analysis	0.648 (0.61, 0.68)	0.643 (0.61, 0.68)	0.62 (0.58, 0.65)

[†] $p < 0.10$. Degrees of freedom = 2678. ^a The sum of psychosocial stress factors was analyzed once as a single factor and once using the “as.factor” command (in R) to estimate the odds for each additional factor. ^b Counts are less than 10. Model 1 = The sum of cognitive overload, work-home conflict, and organizational hindrances when overload is defined as above 2. Model 2 = The sum of cognitive overload, work-home conflict, and organizational hindrances when overload is defined as above 3. Model 3 = The sum of cognitive overload, work-home conflict, and organizational hindrances when overload is defined as above 4. Bold indicates significant values.

An additional test for models 1 and 2 was run only on 2088 participants who worked in 2025 in the same job as in 2024. Model 1 presented no significantly higher odds for psychosocial factors, while model 2 presented higher odds of injuries for the number of exposures to psychological stressors (OR = 1.45, CI 95% 1.18–1.78) with detailed levels for one psychosocial factor (OR = 1.84, CI 95% 1.21–2.80), two (OR = 2.05, CI 95% 1.21–3.47) and three (OR = 3.48, CI 95% 2.07–5.01) (Nagelkerke R² = 0.07; AUC = 0.66 CI 95% 0.62–0.71).

Since riskier jobs are expected to interact with stressors in predicting injuries, we tested an additional stratification by splitting the file into low-risk jobs and a combined medium- and high-risk group (due to low injury counts) to assess differences in associations and model fit. Model 1 presented higher odds of injuries only for riskier jobs when exposed to two ($p = 0.06$) or three psychosocial factors and no association for low-risk jobs. Model 2 presented higher odds of injuries for two or more psychosocial factors for low-risk jobs and for high-risk jobs. Overall, there was no significant difference in the fit indices (Nagelkerke R² and AUC) among the three models, for either low-risk or high-risk jobs.

4. Discussion

This paper aims to conceptualize psychosocial variables as indicators for setting organizational exposure limits or candidate psychosocial screening thresholds, enabling safety and human resources (HR) professionals to measure and prioritize management controls and interventions based on the risk they pose to work injuries.

Associations between psychosocial factors and higher odds of work injuries have been reported in previous studies, including a meta-analytic paper [11] and in specific industries such as construction [21]. The current paper focuses on defining perceived overload and seeks to identify a candidate psychosocial screening threshold for stressful working conditions associated with higher odds of work injuries. The analyses revealed that measuring variables on a 1–5 scale yields significant and meaningful associations with

increased odds of injury, even for psychosocial factors that “only” lead to cognitive and mental overload rather than being direct physical hazards. The results suggest that the association is not random and persists over a two-year period.

The current results suggest a few candidates for future directions in the investigation of psychosocial exposure limits: one regarding the effect of individual factors and the second regarding the cumulative effect of different factors. Our research indicates that an aggressive work environment has the strongest association with the odds of injuries in the next year across all tested overload levels (2, 3, or 4), whereas a lack of autonomy shows no association. Organizational hindrances were associated with next year’s odds of injury at levels above 2, work–home conflict at levels above 3, and cognitive demands at levels above 4.

An aggressive work environment was not only associated with the highest additional percentage of injuries, but it was also unique for being measured on a frequency scale, indicating the importance of how often the worker must deal with factors that increase their stress, rather than just “how much” the factor stresses them. The frequency of exposure to stress-causing factors may affect the risk of injury in two ways: The first is through cognitive overload that distracts the worker, which may increase the risk of missing hazards and environmental cues, leading to poor decisions or impulsive behavior [22]. The more frequently it happens, the higher the chance it will lead to a hazardous task. The second relies on the nature of burnout. Burnout is the result of prolonged stress. Frequent exposure to stressors leaves workers overstimulated for prolonged periods and at higher risk of occupational burnout [14]. Burnt-out workers have less motivation to adhere to safety rules, and they report lower safety behaviors [23]. Moreover, methodologically, frequency-scale measurements were found to be more accurate in terms of how participants answered and for interpreting the analyses [24].

The second direction for the PSEL candidate is the cumulative effect of different psychosocial factors. The more rigorous analysis of the models, limited to participants who remained in the same job, revealed that for overload values above 3, each additional psychosocial factor was associated with a 45% increase in the odds of injury. Summing up the psychosocial factors does not just return a mathematical or statistical result; it relies on the nature of the resource-lost cycles [25] that are increasing both the level of stress and the frequency with which the worker feels stressed out, resulting in them having less time and fewer opportunities to recover, therefore increasing the risk of occupational burnout [15]. The limit values will probably be derived from a matrix that first identifies the most relevant psychosocial factors for the industry, job, or environment and then calculates a value based on the frequency and magnitude of perceived exposure.

An unexpected result was that job changes were associated with higher odds of work injury. A change or transition in one’s job or organization can be considered a psychosocial risk factor because it may cause stress or require adjustment to a new environment, procedures, and hazards [26]. On the other hand, in this research, we cannot conclusively determine whether the job transition occurred after the injury or was even due to it. Therefore, the higher injury rates among workers who changed jobs warrant further investigation.

The focus of this paper was on psychosocial factors that are not directly related to physical overload. When modeling overexposure to shift work, long working hours, awkward posture, prolonged standing, noisy environments, etc., which are known to increase the risk of musculoskeletal injuries and cardiovascular or metabolic illnesses, we need to consider different thresholds and synergistic effects [27,28]. For example, there is a threshold for noise as a risk factor for hearing, while we need to consider noise as a

psychosocial risk factor for stress, not only in industrial and construction environments but also in office or open-space working environments.

Limitations

While the findings provide a framework for psychosocial risk assessment, several limitations must be acknowledged. The main limitation is that psychosocial factors are inherently subjective and are measured as attitudes, perceptions, and feelings. The injury data were also self-reported, which weakens the conclusion compared to validated external data. Nevertheless, stress and burnout are perceptions and feelings that have a tremendous effect on the body and cognition and are thus relevant for assessment using subjective tools, mainly for management purposes. The results presented are preliminary and are intended to initiate the development of standards; they are not sufficient for mandatory or regulatory purposes, and further fine-tuning is required for management purposes.

A second limitation is the study sample, which is not perfectly representative of the total working population. It is skewed toward higher-income groups and highly educated individuals, populations that are more likely to work in lower-risk jobs and occupations. Despite control for demographic and occupational factors, such as job risk, income, age, and gender, the underrepresentation of riskier jobs may mask or moderate the true effect of stressors on the risk of injury. The consistency of higher odds of injury with higher psychosocial stress factors across all risk levels, but especially for riskier jobs, suggests that we can generalize the results to other risk levels. Further investigation is needed to obtain more accurate estimates that consider the job's risk level.

A third limitation of this study is the modest discriminative performance of the logistic regression models, with the highest job risk model achieving an Area Under the Receiver Operating Characteristic Curve (AUC) of 0.66. According to established statistical frameworks, an AUC between 0.60 and 0.70 indicates a fair or modest capability to discriminate between outcomes [29]. Consequently, this model is not intended to serve as a standalone operational tool for predicting individual work-related injury occurrences. However, it is crucial to distinguish between predictive modeling, which seeks to optimize forecasting accuracy, and explanatory modeling, which focuses on testing causal hypotheses and isolating the impact of specific risk exposures [30]. The explicit goal of this analysis was explanatory: to determine whether exposure to workplace psychosocial stressors significantly shifts the odds of experiencing a work injury. Occupational injuries are inherently multifactorial, arising from a complex interplay of immediate physical hazards, environmental conditions, ergonomic strains, and compliance with safety equipment. Because our analysis isolated the incremental risk attributable to the psychosocial environment without attempting to map every physical or engineering variable in the workplace, a high overall model fit was neither theoretically expected nor mathematically viable. Despite the fair-to-medium overall fit, these findings remain valid and valuable. Demonstrating that specific values of psychosocial factors are significantly associated with elevated injury odds provides critical, actionable insights for targeted occupational health interventions.

5. Conclusions

This study's results support the notion that evaluating the levels of psychosocial factors is both possible and a practical managerial measure for mitigating occupational injuries. By applying the concept of the psychosocial exposure limit (PSEL), we demonstrated that organizational stressors can be modeled using threshold values for separate variables and a new cumulative scale that sums up psychosocial stress factors.

The results highlight that an aggressive work environment is a potent predictor of injury, more than doubling the odds of next year's injuries. Furthermore, the predictive re-

sults from measuring the variable on a frequency scale suggest that researchers may benefit from adding the dimension of exposure frequency to the perceived experience strength.

Ultimately, these findings support the evidence that safety is not just about the equipment provided and procedures but also about the psychosocial environment fostered. Transitioning to a PSEL approach may enable organizations to proactively manage the psychosocial environment and reduce risk factors for both physical and mental health.

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Abbreviations

The following abbreviations are used in this manuscript:

TLV	Threshold Limit Value
PSEL	Psychosocial Exposure Limit
ELV	Exposure Limit Value
ISO	International Standard Organization
ILO	International Labor Organization
OR	Odds Ratio
OSH	Occupational Safety and Health or Hygiene
ACGIH	American Conference of Governmental Industrial Hygienists
M	Mean
SD	Standard Deviation
DF	Degrees of Freedom
HR	Human Resources

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