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The primary aim of *World Journal of Clinical Cases* (*WJCC*, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

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Observational Study

Is burnout a mediating factor between sharps injury and work-related factors or musculoskeletal pain?

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Abstract**BACKGROUND**

Burnout, musculoskeletal pain, and sharps injuries (SIs) affect medical workers.

AIM

To establish a model between SIs, burnout, and the risk factors to assess the extent to which burnout affects SIs.

METHODS

This questionnaire was used for an observational and cross-sectional study, which was based on members at a hospital affiliated with a medical university in Taichung, Taiwan, in 2020. The valid responses constituted 68.5% (1734 of 2531). The items were drawn from the Nordic Musculoskeletal Questionnaire and Copenhagen burnout inventory and concerned work experience, occupational category, presence of chronic diseases, sleep duration, overtime work, and work schedule. Factor analysis, chi-square test, Fisher exact test, Multiple linear, logistic regression and Sobel test were conducted. The present analyses were performed using SAS Enterprise Guide 6.1 software (SAS Institute Inc., Cary, NC, United States), and significance was set at $P < 0.05$.

RESULTS

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Personal and work-related burnout ranks, sex, work experience ranks, occupational groups, drinking in the past month, sleep duration per day, presence of chronic diseases, overtime work ranks, and work schedule were associated with SIs. Frequent upper limb and lower limb pain (pain occurring every day or once a week) determined to be related to SIs. High personal burnout (> Q3) and high work-related burnout (> Q3) mediated the relationship between SIs and frequent lower limb pain. Similarly, frequent lower limb pain mediated the relationship of SIs with high personal and high work-related burnout. High personal and high work-related burnout mediated the relationships of SIs with overtime work and irregular shift work. The mediating model provides strong evidence of an association between mental health and SIs.

CONCLUSION

Burnout was determined to contribute to SIs occurrence; specifically, it mediated the relationships of SIs with frequent musculoskeletal pain, overtime work, and irregular shift work.

Key Words: Personal burnout; Work-related burnout; Sharps injuries; Musculoskeletal pain; Mediating factor; Overtime work

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Core Tip: Burnout affects approximately half of all nurses, physicians, and other clinicians. Sharps injuries, which frequently occur among health care workers, constitute a critical problem. Our study found burnout was determined to contribute to sharps injuries occurrence; specifically, it mediated the relationships of sharps injuries with frequent musculoskeletal pain, overtime work, and irregular shift work. Results from the present study suggest that if the problem of burnout is ignored, training or safe operation may not be sufficient to effectively prevent work-related injuries. To the best of our knowledge, this finding has never been reported.

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INTRODUCTION

In May 2018, burnout was recognized as an “occupational phenomenon” in the International Classification of Diseases, 11th Revision (ICD-11) of the World Health Organization. Burnout is a state of physical, emotional, and mental exhaustion that results from long-term involvement in work situations that are emotionally demanding[1]. The specific definition of burnout in the ICD-11 is “a syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed.”

Burnout is responsible for high physician turnover and reduced clinical hours, which cause total losses of approximately 4.6 billion dollars in the United States each year[2]. Moreover, burnout affects approximately half of all nurses, physicians, and other clinicians[3]. Studies on resident physicians and nurses have indicated that most cases of burnout are personal or work-related. Studies have noted that work-related burnout (WB) and personal burnout (PB) occur in 30% and 50% of individuals with burnout, respectively[4]. Notably, burnout also affects the patient-related quality of care[5]. The numerous reasons for the development of burnout include basic demographic characteristics such as sex[4,6] and age[7]; occupational factors such as work experience (WE)[8], overtime (OT) work[9], and shift work[10]; lifestyle habits such as sleep duration (SLD)[10,11] and exercise[11]; and health status (*e.g.*, the presence of chronic diseases)[12].



In the United States, 13% of the workforce experience losses in productivity stemming from a painful physical condition, amounting to an estimated US\$61.2 billion in pain-related lost productive time each year[13]. Musculoskeletal (MS) in the lower back, shoulders, and neck are most commonly reported[14]. In addition, myofascial pain syndromes from trigger points are among the main causes of MS pain due to traumatic/micro traumatic events (often secondary to occupational postures/attitudes/activities)[15].

The United States Centers for Disease Control and Prevention defines sharp injuries (SI) as an exposure event (blood/body fluid exposure) that occurs when a needle or other sharp object penetrates the skin. SI frequently occurs among health care workers and constitutes a critical infective problem upon contamination of the sharp object. As one study noted, 0.42 hepatitis B infections, 0.05 to 1.30 hepatitis C infections, and 0.04 to 0.32 human immunodeficiency virus (HIV) infections develop per 100 cases of SI per year. The literature review conducted in that study revealed that SIs led to mean costs of €1966 if the source patient was HIV positive and had coinfections of hepatitis B and hepatitis C[16]. SI occurrence has been reported to be associated with occupational factors such as WE[17], work hours[18], and shift work schedules[19] as well as demographic characteristics such as sex[20] and age[21]. Moreover, one article asserted that the experience of SIs was related to the mental health of health care workers[22]. Therefore, the relationship between burnout level (as measured using a routine questionnaire) and SI deserves scholarly attention with regard to the prevention of work-related injuries among medical personnel. In the present study, a model of causal relationships between SI, burnout, and work-related risk factors was established to assess the extent to which burnout affects SI. This investigation serves as a basis on which the impact of mental health on occupational injuries can be further explored in the future. Specifically, the present study examined the relationship between mental health and occupational injuries, with burnout and SI as agent variables.

MATERIALS AND METHODS

This questionnaire was used for an observational and cross-sectional study, which was based on members at a hospital affiliated with a medical university in Taichung, Taiwan, in 2020. Of the 2531 individuals to whom the questionnaire was sent, 1838 (72.6%) completed the questionnaire. After exclusion for missing data, 1734 questionnaires (68.5%) were determined to be valid.

The participants' WE (years) and occupational category were provided by the occupational safety department of the hospital. On the questionnaire, the participants were asked whether they had a listed chronic disease (CD), with the selection of one or more diseases classified as a "yes" response. The participants were also asked whether they had experienced a SI in the past year. In response to the question on smoking in the past month, "never" or "have quit smoking" were classified as "no." As for drinking in the preceding month, answers of "seldom" or "every day" were classified as "yes," whereas "never" was classified as "no." SLD was classified as < 5, 5–6, 6–7, 7–8, or > 8 h. The participants were asked whether they exercised at least once a day, at least once a week, at least once a month, less than once a month, or never. Possible responses to the question on OT work were the following: seldom, fewer than 45 h per month, 45–80 h per month, and more than 80 h per month. The responses were classified as seldom, < 45 h per month, and > 45 h per month accordingly. As for work schedule, the options given were day shift work, night shift work, irregular shift work, and regular shift work.

This study adopted the Nordic MS Questionnaire (NMQ) modified and translated by the Taiwan Institute of Occupational Safety and Health[23]. The NMQ, which is used in the investigation of the site and frequency of MS pain, was developed in a project funded by the Nordic Council of Ministers. The NMQ has acceptable reliability [23] and has been applied in a wide range of occupational groups, including nurses [24]. Items on the NMQ include questions on the presence of pain attributable to work-related factors in the preceding year and on the pain sites, the options for which were the neck (N1), left shoulder (N2), right shoulder (N3), upper back (N4), waist or lower back (N5), left elbow (N6), right elbow (N7), left wrist (N8), right wrist (N9), left hip/thigh/buttock (N10), right hip/thigh/buttock (N11), left knee (N12), right knee (N13), left ankle (N14), and right ankle (N15). If a participant answered "yes" to the question on the experience of work-related pain over the past year, they were instructed to indicate its frequency: every day, once a week, once a month, or once

every half year. Pain occurring every day or once a week was defined as frequent MS (FMS) pain and was scored as 1. Pain occurring once a month or once every half year was scored as 0.

In the present study, factor analysis was conducted on the NMQ results to determine the underlying variables that explained most of the questionnaire. According to the principle proposed by Hair *et al*[25], factors that should be retained have feature vector values exceeding 1. Through varimax rotation, the standardized scoring coefficients constituted new factor loadings and were defined as new factors according to the corresponding significance of the factor loadings.

The Copenhagen burnout inventory (CBI), which comprises three scales assessing PB, WB, and client-related burnout, has extremely high internal reliability and low nonresponse rate[26]. The present study used the Chinese version of CBI, which has proven to be a reliable and valid tool for assessment of burnout problems[27]; thus, it was used to evaluate burnout in the present study, with a focus on PB and WB. The first six items, which concern PB, are as follows: C1: "How often do you feel tired?" C2: "How often are you physically exhausted?" C3: "How often are you emotionally exhausted?" C4: "How often do you think 'I can't take it anymore'?" C5: "How often do you feel worn out?" C6: "How often do you feel weak and susceptible to illness?"

Items 7-13, which concern WB, are as follows: C7: "Is your work emotionally exhausting?" C8: "Do you feel burnt out because of your work?" C9: "Does your work frustrate you?" C10: "Do you feel worn out at the end of the working day?" C11: "Are you exhausted in the morning at the thought of another day at work?" C12: "Do you feel that every working hour is tiring for you?" C13: "Do you have enough energy for family and friends during leisure time?"

The response options-"always", "often", "sometimes", "seldom", and "never/almost never"-are scored as 100, 75, 50, 25, and 0 points, respectively, except for item C13, which is inverse scored (*i.e.*, the responses are scored as 0, 25, 50, 75, and 100 points, respectively). Levels of PB and WB are represented by the mean of the total PB and WB scores (the sum of scores on items C1-C6 and items C7-C13), respectively.

The categorical variables were subjected to the chi-square test or Fisher exact test. Significance in the differences among the means of continuous variables was determined using the *t* test or one-way ANOVA. Multiple linear or logistic regression was conducted to control the interference of potential risk factors in the association between the independent variables (IVs) and the dependent variable (DV)-specifically, to determine whether adjustments to variables significantly affected IV-DV associations. Mediation effects were analyzed on the basis of the strategy proposed by Baron and Kenny[28] in which: (1) The IV significantly affects the mediator (first-stage effect); (2) The IV significantly affects the DV in the absence of the mediator; (3) The mediator has a significant unique effect on the DV (second-stage effect); and (4) The effect of the IV on the DV weakens upon addition of the mediator to the model. A method for mediation suitable for a combination of categorical and continuous variables, developed by Iacobucci[29], was used; the (formula 1) are as follows.

$$\hat{Y} = b_{01} + cX$$

$$\hat{M} = b_{02} + aX$$

$$\hat{Y} = b_{03} + c'X + bM$$

$$Z_a = \hat{a}/\hat{S}_a$$

$$Z_b = \hat{b}/\hat{S}_b$$

Where *X* is an IV; *Y* is a DV; *M* is the adjusted variable (*i.e.*, the mediating factor) in a simple mediation model; *a* is a logistic/Linear regression coefficient of *X* against *M* when *M* and *X* are a DV and IV, respectively; *b* is the logistic/Linear regression coefficient of *M* against *Y* in a simple mediation model; *c* is the logistic/Linear regression coefficient of *X* against *Y*; and *c'* is the logistic/Linear regression coefficient of *X* against *Y* with *M* as the adjusting variable. The standard errors of *a* and *b* are represented by *s_a* and *s_b*, respectively.

The original formula of the Sobel test was rederived into formula 2.

$$Z_{mediation} (Z_m) = \frac{\frac{a \times b}{s_a \times s_b}}{\sqrt{Z_a^2 + Z_b^2 + 1}}$$

Results exceeding |1.96| and |2.57| (for a two-tailed test) are significant at $\alpha = 0.05$ and $\alpha = 0.01$, respectively. The present analyses were performed using SAS Enterprise Guide 6.1 software (SAS Institute Inc., Cary, NC, United States), and significance was set at $P < 0.05$.

RESULTS

As shown in **Table 1**, the mean PB and WB scores were 36.69 ± 17.59 and 34.19 ± 16.29 , respectively. SI incidence was 8.42%. Q1, Q2, and Q3 represented the lower quartile, median, and upper quartile, respectively. The highest proportions of SIs (12.55% and 12.42%) corresponded to PB and WB (rank > Q3 for both), respectively. Differences in SI occurrence were significant among the PB or WB ranks. Women reported higher PB and WB than men (37.39 vs 33.64 and 34.89 vs 31.13 , respectively; $P < 0.01$ for both), but SIs were more common in men (13.85% vs 7.17%; $P < 0.01$). Regarding WE, ranks > Q2 and \leq Q3 corresponded to the highest PB level (mean = 38.94 ± 17.60), whereas a rank > Q3 corresponded to the lowest WB level (mean = 31.36 ± 15.46). Moreover, ranks > Q1 and \leq Q2 with regard to WE corresponded to the highest proportion of SI occurrence (12.21%). Significant differences in the proportion of SI occurrence and in the levels of PB and WB were noted among occupational groups, with nurses experiencing the highest PB and WB (41.22 and 39.33). Notably, SIs occurred most commonly among physicians (15.86%). Levels of PB (mean = 39.51) and WB (mean = 36.17) were significantly higher in participants who reported drinking during the preceding month, as was SI occurrence (11.41%). SLD was significantly associated with PB level, WB level, and SI occurrence. The highest PB and WB (mean scores = 48.52 and 41.82, respectively) were observed in the participants who reported sleeping \leq 5 h per night, as was the highest SI occurrence (14.52%). The participants who exercised daily reported significantly lower PB and WB (mean scores = 31.27 and 28.84, respectively) than those who exercised less frequently, but no significant difference in SI occurrence was noted. Compared with those without such conditions, the participants with CD had significantly higher levels of PB and WB (mean scores = 38.69 and 35.43, respectively) and were more likely to have sustained an SI (10.53%). Burnout levels and SI occurrence differed significantly according to the monthly number of OT hours. Specifically, the participants who worked > 45 h per month had the highest PB and WB (mean scores = 48.51 and 43.73, respectively). These individuals were also the most likely to have sustained an SI (16.98%). Burnout levels and SI occurrence also differed significantly with work schedule. Specifically, the participants who worked irregular shifts reported the highest PB and WB (mean scores = 43.54 and 40.90, respectively) as well as the highest SI occurrence (13.45%).

Table 2 presents information on the sites and occurrence of MS pain experienced over the 12 mo as well as the sites and proportion of MS pain that occurred at least once a week (*i.e.*, FMS pain). Because the eigenvalues of factors 1 and 2 exceeded 1, these factors were retained. Although the eigenvalue of factor 3 was lower than 1, it was retained for the maximum explaining questionnaire. The factor loadings were converted into standardized scoring coefficients through varimax rotation. The relatively large factor loading values in bold for factors 1, 2, and 3 correspond to pain in the upper trunk, lower limbs, and upper limbs, respectively. Frequent upper torso pain (FUTP) occurred in the neck, both shoulders, and upper back, and its standardized coefficient was defined as FUTP. As for frequent lower limb pain (FLLP), sites included both hip/thigh/buttocks, both knees, and both ankles, and its standardized coefficient was defined as FLLP. Frequent upper limb pain (FULP) occurred in both elbows and both wrists, and its standardized coefficient was defined as FULP. The explained variation in FUTP, FLLP, and FULP was 73.86%, 23.11%, and 8.67%, respectively. This indicated that the participants experienced upper trunk pain most frequently, followed by lower limb and upper limb pain. Although FULP had the smallest explained variation of the three, it was retained because the present study was focused on the relationship between SI and upper limb pain.

Table 3 shows that the participants who had experienced an SI in the preceding year had significantly higher FLLP and FULP scores than those who had not, but no significant differences were noted for the FUTP score. In short, FLLP and FULP were identified as risk factors for SIs.

Because of the extremely high proportion of SIs corresponding to PB or WB ranks > Q3 (**Table 1**), PB rank was reclassified as PB > Q3 and PB \leq Q3, and WB rank was reclassified as WB > Q3 and WB \leq Q3. PB > Q3 and WB > Q3 corresponded to high PB level (HPBL) and high WB level (HWBL), respectively. Similarly, the participants who worked irregular shifts had significantly higher PB and WB scores; therefore, the work schedule was reclassified as irregular work shifts (IRWS) and other work schedules. Moreover, because SIs were only reported by nine participants who worked > 45 h of OT per month, OT work was reclassified as an experience of OT (EOT) work and seldom worked OT.

Table 1 Descriptive statistics concerning the results of the Copenhagen burn inventory and occurrence of sharps injuries (*n* = 1734)

Characters	<i>n</i>	PB score	WB score	SI
		mean ± SD	mean ± SD	Subject (%)
SI in past one year	1734	36.69 ± 17.59	34.19 ± 16.29	146 (8.42)
PB ranks				1,b
> Q3	542	56.93 ± 12.20	-	68 (12.55)
> Q2 and ≤ Q3	482	37.22 ± 3.31	-	30 (6.22)
> Q1 and ≤ Q2	394	27.08 ± 2.09	-	29 (7.36)
≤ Q1	316	13.12 ± 6.79	-	19 (6.01)
WB ranks				1,b
> Q3	451	-	54.66 ± 9.45	56 (12.42)
> Q2 and ≤ Q3	572	-	36.70 ± 4.03	39 (6.82)
> Q1 and ≤ Q2	344	-	26.61 ± 1.78	25 (7.27)
≤ Q1	367	-	12.20 ± 7.27	26 (7.08)
Sex		b	b	2,b
Male	325	33.64 ± 16.48	31.13 ± 15.28	45 (13.85)
Female	1409	37.39 ± 17.77	34.89 ± 16.44	101 (7.17)
WE ranks		b	b	1,b
≤ Q1	375	36.23 ± 17.73	34.72 ± 17.37	34 (9.07)
> Q1 and ≤ Q2	434	37.29 ± 17.98	35.12 ± 16.10	53 (12.21)
> Q2 and ≤ Q3	487	38.94 ± 17.60	35.48 ± 16.06	38 (7.80)
> Q3	438	34.07 ± 16.73 ^c	31.36 ± 15.46	21 (4.79)
Occupation groups		c	c	1,b
Doctors	145	37.10 ± 17.37	34.11 ± 16.78	23 (15.86)
Nurses	627	41.22 ± 17.27	39.33 ± 15.55	55 (8.77)
Others	962	33.67 ± 17.20	30.84 ± 15.82 ^c	68 (7.07)
Right-handed				
Yes	1663	36.89 ± 17.64	34.31 ± 16.31	142 (8.54)
No	71	31.87 ± 15.62	31.34 ± 15.48	4 (5.63)
Drinking in past month		c	b	2,b
Yes	561	39.51 ± 17.05	36.17 ± 16.03	64 (11.41)
No	1173	35.34 ± 17.69	33.24 ± 16.33	82 (6.99)
Smoking in past month				
Yes	12	31.60 ± 16.80	25.89 ± 17.04	2 (16.67)
No	1722	36.72 ± 17.60	34.24 ± 16.27	144 (8.36)
SLD (per day) ranks		c	c	1,a
≤ 5 h	62	48.52 ± 20.62	41.82 ± 17.57	9 (14.52)
> 5 and ≤ 6 h	566	41.04 ± 17.91	38.26 ± 16.47	54 (9.54)
> 6 and ≤ 7 h	771	34.91 ± 16.38	32.35 ± 15.40	66 (8.56)
> 7 h	335	31.23 ± 16.47	29.89 ± 15.80	17 (5.07)
Exercise per day		b	c	
Yes	133	31.27 ± 18.88	28.84 ± 17.87	11 (8.27)
No	1601	37.14 ± 17.41	34.63 ± 16.08	135 (8.43)

		^b	^a	^{2,a}
Suffering chronic disease				
Yes	608	38.69 ± 17.95	35.43 ± 16.70	64 (10.53)
No	1126	35.61 ± 17.31	33.51 ± 16.02	82 (7.28)
OT work ranks		^c	^c	^{1,b}
> 45 h / mo	53	48.51 ± 19.78	43.73 ± 18.34	9 (16.98)
< 45 h / m	481	41.32 ± 17.21	39.27 ± 15.82	58 (12.06)
Seldom	1200	34.31 ± 17.07 ^c	31.73 ± 15.75	79 (6.58)
Work schedule classes		^c	^c	^{1,b}
Irregular shift	223	43.54 ± 18.63	40.90 ± 16.91	30 (13.45)
Regular shift	204	37.89 ± 17.15	35.19 ± 15.19	25 (12.25)
Night	204	37.77 ± 18.14	37.45 ± 16.26	17 (8.33)
Day	1103	34.88 ± 16.99	32.04 ± 15.89	74 (6.71)

¹Chi-square test.

²Fisher exact test.

^a $P < 0.05$.

^b $P < 0.01$.

^c $P < 0.0001$. OT: Over time; PB: Personal burnout; SD: Standard deviation; SI: Sharp injuries; SLD: Sleep duration; WB: Work-related burnout.

Table 2 Sites of musculoskeletal pain and factor analysis of the Nordic musculoskeletal questionnaire, *n* (%)

Pain site	Pain past 12 months	FMS pain	Factor loadings		
	Subjects	Subjects	Factor 1: Upper torso	Factor 2: Lower limb	Factor 3: Upper limb
Neck	636 (36.68)	405 (23.36)	0.29	-0.04	-0.05
Left shoulder	370 (21.34)	234 (13.49)	0.27	-0.06	-0.03
Right shoulder	444 (25.61)	283 (16.32)	0.29	-0.05	-0.02
Upper back	327 (18.86)	210 (12.11)	0.19	0	0.01
Waist or lower back	529 (35.01)	300 (17.30)	0.12	0.02	0
Left elbow	65 (3.75)	35 (2.02)	-0.03	-0.02	0.25
Right elbow	126 (7.27)	81 (4.67)	-0.01	-0.04	0.27
Left wrist	103 (5.94)	67 (3.86)	-0.03	0	0.24
Right wrist	205 (11.82)	110 (6.34)	-0.02	-0.04	0.31
Left hip/thigh/buttock	70 (4.04)	48 (2.77)	-0.04	0.19	0.04
Right hip/thigh/buttock	70 (4.04)	45 (2.60)	-0.04	0.19	0.05
Left knee	95 (5.48)	51 (2.94)	0.04	0.2	-0.09
Right knee	88 (5.08)	51 (2.94)	0.02	0.29	-0.11
Left ankle	42 (2.42)	31 (1.79)	-0.06	0.23	0
Right ankle	51(2.94)	39 (2.25)	-0.05	0.21	0
Eigenvalues			4.02	1.26	0.47
Explained variation (%)			73.86	23.11	8.67

The relatively large factor loading values were marked in bold for corresponding to musculoskeletal pain sites.

Figure 1 shows the mediation effect of burnout in the association between SIs and the risk factors. The value of *c* must be statistically significant and greater than that of *c'*. Moreover, the values of *a* and *b* must be statistically significant. In addition, *a* × *b* and *c-c'* must differ significantly and be able to be tested by calculating the $Z_{\text{mediation}}$ value (Z_{m}). HPBL partially mediated the relationships of SI with FLLP ($Z_{\text{m}} = 2.84$),

Table 3 Differences in frequent musculoskeletal pain scores between participants who had and had not experienced an sharps injury in the preceding year

FMS pain score	With SIs in past year	Without SIs in past year	P value
	mean ± SD	mean ± SD	
FUTP	0.11 ± 0.97	-0.01 ± 0.86	
FLLP	0.24 ± 1.17	-0.02 ± 0.78	b
FULP	0.16 ± 0.96	-0.02 ± 0.70	a

^aP < 0.05.

^bP < 0.01. FMS: Frequent musculoskeletal; FUTP: Frequent upper torso pain; Sis: Sharps injuries.

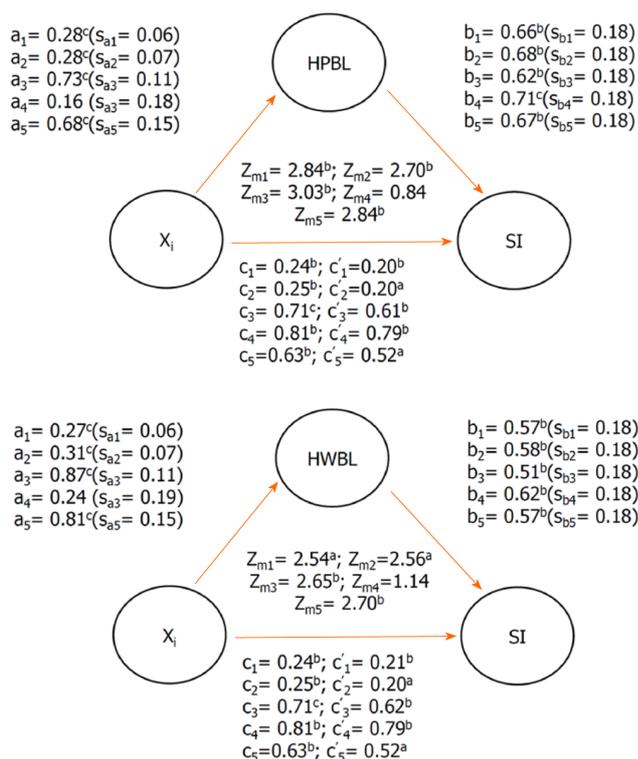


Figure 1 Mediation effects of high personal burnout level/high work-related burnout level in the association between sharps injuries and Xi.

^aP < 0.05, ^bP < 0.01, ^cP < 0.0001. ₁: Frequent lower limb pain; ₂: Frequent upper limb pain; ₃: Experience of overtime vs seldom worked overtime; ₄: Doctors vs Nurses and others; ₅: Irregular work shifts vs other work schedules; a_i : The logistic regression coefficient of risk factors for the association between sharps injurie (SI) and risk factors; $a_{i'}$: The standard error of a_i ; b_i : The logistic regression coefficient of burnout as an adjusted variable with regard to the association between SI and X_i ; $b_{i'}$: The standard error of b_i ; SI: Sharps injurie; HPBL: High personal burnout level; HWBL: High work-related burnout level.

FULP ($Z_m = 2.70$), EOT work ($Z_m = 3.03$), and IRWS ($Z_m = 2.84$). HWBL partially mediated the relationships of SI with FLLP ($Z_m = 2.54$), FULP ($Z_m = 2.56$), EOT work ($Z_m = 2.65$), and IRWS ($Z_m = 2.70$). A strong relationship between FMS pain and burnout was observed, but whether FMS pain also mediated the relationship between SI and burnout remains to be determined. Figure 2 shows FLLP significantly mediated the relationships of SI with HPBL ($Z_m = 2.44$) and HWBL ($Z_m = 2.40$). By contrast, the mediating effect of FULP was not significant. Neither FLLP nor FULP mediated the relationships of SI with EOT work, being a physician, and IRWS.

From the analytical results (Table 1-3, Figure 1 and 2), the following inferences can be made: an increase in the frequency of limb pain was closely correlated with an increase in SI incidence, and an increase in burnout level caused by an increase in the frequency of limb pain increased SI occurrence. The participants with HPBL accounted for a higher proportion of the SIs that occurred, and the increase in FLLP caused by HPBL also raised the proportion of SI occurrence. The participants with EOT work were more likely to sustain an SI, as were the participants experiencing serious burnout caused by OT work, which would increase the rate of SI occurrence. Similarly,

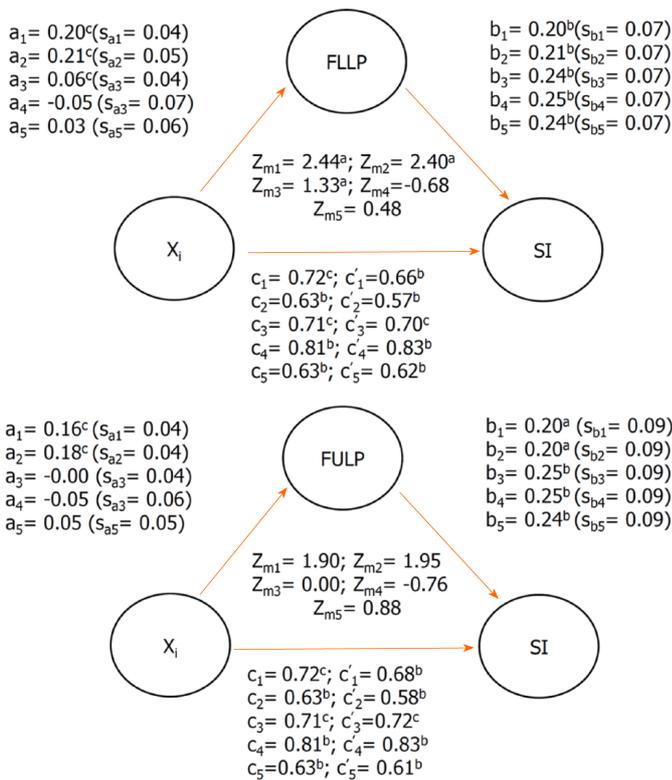


Figure 2 Mediation effects of frequent lower limb pain/frequent upper limb pain in the association between sharps injuries and X_i . ^a $P < 0.05$, ^b $P < 0.01$, ^c $P < 0.0001$. ₁: High personal burnout level; ₂: High work-related burnout level; ₃: Experience of overtime vs seldom worked overtime; ₄: Doctors vs Nurses and others; ₅: Irregular work shifts vs other work schedules; a_i: The logistic regression coefficient of risk factors for the association between sharps injuries (SI) and risk factors; s_{a_i}: The standard error of a_i; b_i: The logistic regression coefficient of burnout as an adjusted variable with regard to the association between SI and X_i ; s_{b_i}: The standard error of b_i; SI: Sharps injury; FLLP: Frequent lower limb pain; FULP: Frequent upper limb pain.

the participants with IRWS were also more likely to sustain an SI, as were the participants experiencing serious burnout caused by IRWS, which would increase the rate of SI occurrence.

Constructed on the basis of the results presented in Figure 1 and 2 is a simple mediation model that indicates the existence of direct or mediating relationships between SI and FLLP, HPBL/HWBL, and EOT work or IRWS. HPBL and HWBL mediated the SI-FLLP relationship. Similarly, FLLP was a mediating factor in the relationships of SI with HPBL and HWBL. Furthermore, HPBL and HWBL mediated the relationships of SI with EOT work and IRWS.

DISCUSSION

In line with reports that both PB and WB levels are significantly higher among female resident physicians[4] and that male nurses experience burnout syndrome less commonly than female nurses[6], the women in the present sample reported significantly higher PB and WB than the men (Table 1). Regarding SIs, a study indicated that male health workers were 10 times more likely to sustain an SI than were female health workers[30]. The men in the present study were more likely to sustain SIs than the women (13.85% vs 7.17%).

Studies have reported that nurses and clinicians working OT are more likely to experience burnout[9]. In one study, an increase in weekly work hours increased the occurrence of SIs among nurses[31]. As shown in Table 1, a dose-response relationship between SI and OT work (> 45, < 45 h, or seldom) was observed. Similar results were noted for relationships of PB and WB with OT. Specifically, more OT work hours increased SI occurrence and the mean levels of PB and WB, and PB and WB was positively associated with SIs. These results suggest that OT work was related to PB and WB level as well as to SI occurrence. PB and WB may contribute critically to the relationship between SI and OT work; this possibility warrants further investigation. As shown in Figure 1, PB and WB partially mediated the relationship between SI and

EOT work; the effects were significant. These results suggest that EOT work affected SI directly or indirectly (through an unknown path). Studies have noted that increased OT was significantly associated with impairments in attention, executive function[32], and stress response[33]. Whether OT work affects SI incidence through these factors remains to be determined.

One study noted that burnout syndrome was more common among nurses working irregular shifts than among those working regular shifts[6]. In the same vein, studies have observed that working regular shifts exerted protective effects against SIs[19,21]. Consistent with results from other studies, in the present study, the highest mean PB and WB was reported by participants working irregular shifts (Table 1). As shown in Figure 1, PB and WB also partially mediated the relationship between SI and irregular shifts, indicating that irregular shifts may have affected SI through burnout in some participants; in others, irregular shifts may have exerted direct effects on SI through other routes.

A large study conducted in the Netherlands on MS pain occurring over 12 mo reported that lower back pain occurred the most frequently (43.9%), followed by shoulder pain (30.3%) and neck pain (31.4%)[14]. In line with these results, the corresponding occurrence of low back pain, shoulder pain, and neck pain in the present study was 35.01%, 46.95%, and 36.68%, respectively (Table 2). A study on seven occupational groups in Norway reported a significant association between burnout and MS pain[34]. In the present study, the frequency of limb pain (lower or upper) was positively associated with HPBL and HWBL ($a = 0.28, P < 0.0001$; $a = 0.28, P < 0.0001$; Figure 1). A cross-sectional study on burnout and occupational accidents in which the Maslach Burnout Inventory (MBI) questionnaire was administered to employees in the occupational medicine department of a hospital reported that each one-unit increase in the burnout score corresponded to a 9% increase in the risk of injury[35]. In a study on Chinese nurses in which the MBI questionnaire was again used, emotional exhaustion was positively associated with SI occurrence[36]. Regarding the present results obtained from the CBI, SI occurrence differed significantly in PB ($P < 0.01$) and WB ranks ($P < 0.01$) (Table 1). As shown in Figure 2, HPBL ($c = 0.72, P < 0.001$) and HWBL ($c = 0.63, P < 0.01$) were positively associated with SI occurrence. The present results are consistent with those from other studies that used the MBI. However, in an extension of the literature, we further explored the causal relationships between SI, work-related risk factors, and burnout through the analysis of mediating effects. As shown in Figure 2, FLLP also mediated the relationships of SI with HPBL and HWBL, indicating that FLLP and HPBL or HWBL form a vicious circle with SI (Figure 3). These findings serve as a valuable reference for SI prevention. To test for significance, we used the Z_m formula developed by Iacobucci[29], which can effectively test for mediating effects in samples exceeding 300 when X , Y , and M are categorical variables. The present sample size of 1734 more than meets this requirement. Therefore, the Z_m formula was suitable.

WE, drinking in the preceding year, SLD, exercise, and CD, variables adjusted in the model, were identified as risk factors for SI and burnout. The significant association of these variables with SI and burnout is supported by results from other studies. For example, studies have indicated that individuals with less WE are at a higher risk of sustaining SIs[17], and the report of burnout was significantly positively associated with higher alcohol consumption[37]. Moreover, PB has been demonstrated to be significantly associated with impaired sleep quality[11], and reductions in SLD increase the risk of occupational injury[38]. University students or nurses who engage in physical activity or exercise have been noted to report significantly lower levels of PB and fatigue[11], and individuals with burnout appear to be more susceptible to physical illness than those without burnout[39]. Therefore, the adjustment of these variables was both necessary and appropriate for reducing the impacts of possible confounders on the SI model.

The burnout mediation model regarding SI and occupational risk factors (*e.g.*, OT work, irregular shift, and MS pain) provides strong evidence of an association between mental health and SIs. The literature mostly examines the relationship between SI and the work process or the use of protective equipment; deeper psychological factors are seldom explored. The relationship between SIs and work-related injuries not induced by burnout warrants further investigation. A study on 112 workers in metal melting industries reported no significant association between occupational burnout and unsafe actions[40]. Despite the small sample size in that study, results from both that study and the present study suggest that if the problem of burnout is ignored, training or safe operation may not be sufficient to effectively prevent work-related injuries. Therefore, to mitigate the problem of work-related injuries, institutions should take effective countermeasures to alleviate burnout among medical personnel.

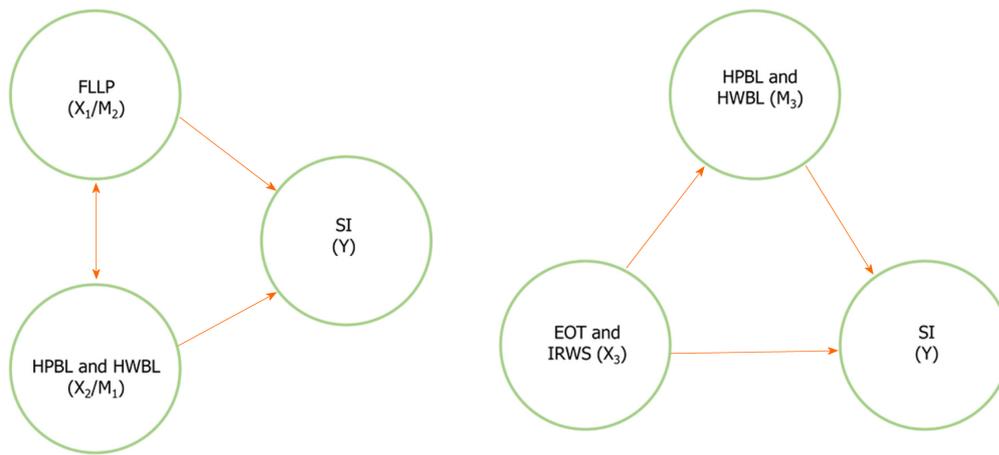


Figure 3 Simple mediation model for burnout and frequent lower limb pain. X_1 and Y are the independent and dependent variables, respectively, whereas M_1 is the mediating factor of sharps injuries (Y) and X_1 . FLLP: Frequent lower limb pain; HPBL: High personal burnout level; HWBL: High work-related burnout level; EOT: The experience of overtime (work); IRWS: Irregular work shifts.

This study was performed in the context of the coronavirus disease 2019 pandemic, which may have been more demanding on medical personnel than the non-pandemic period. Therefore, a similar study that assesses the regular work conditions and exposure of health care workers during the non-pandemic period should be replicated and compared with the result of the pandemic period.

CONCLUSION

Burnout was determined to contribute to SI occurrence; specifically, it mediated the relationships of SI with FUTP, FLLP, EOT, and IRWS. FLLP also mediated the relationship between SI and burnout, forming a vicious circle of burnout and FLLP that further increased the frequency of SIs. To the best of our knowledge, this finding has never been reported. The present findings serve as a reference for the management of mental health and the prevention of SIs among medical personnel worldwide.

ARTICLE HIGHLIGHTS

Research background

Burnout affects approximately half of all nurses, physicians, and other clinicians. Sharps injuries, which frequently occur among health care workers, constitute a critical problem in the hospital.

Research motivation

Studies conducted in many countries revealed the relationship between burnout level (as measured using a routine questionnaire) and sharps injury deserves scholarly attention with regard to the prevention of work-related injuries among medical personnel. However, studies assessing the extent to which burnout affects sharps injuries are scarce.

Research objectives

To be established a model between sharps injuries, burnout, and the risk factors to assess the extent to which burnout affects sharps injuries.

Research methods

A questionnaire was used for an observational and cross-sectional study, which was based on members at a hospital affiliated with a medical university in Taichung, Taiwan, in 2020. The valid responses constituted 68.5% (1734 of 2531). The items were drawn from the Nordic Musculoskeletal Questionnaire and Copenhagen burnout inventory and concerning work experience, occupational category, presence of chronic diseases, sleep duration, overtime work, and work schedule. Factor analysis, chi-

square test, Fisher exact test, multiple linear, logistic regression, and Sobel test were conducted.

Research results

Our study found burnout was determined to contribute to sharps injuries occurrence; specifically, it mediated the relationships of sharps injuries with frequent musculoskeletal pain, overtime work, and irregular shift work.

Research conclusions

Burnout was determined to contribute to SIs occurrence; specifically, it mediated the relationships of sharps injuries with frequent musculoskeletal pain, overtime work, and irregular shift work.

Research perspectives

A similar study that assesses the regular work conditions and exposure of health care workers during the non-pandemic period should be replicated and compared with the result of the pandemic period.

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