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Occupational injuries among healthcare workers and objective workload at a tertiary hospital in Lebanon: a retrospective study

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ABSTRACT

Background Healthcare workers (HCWs) are at an increased risk of occupational injuries due to exposure to many hazards at work. The COVID-19 pandemic exacerbated these occupational risks, particularly with hospital employees working in increasingly demanding environments. HCW shortages further increase the risk of injury to remaining HCWs who shoulder the patient load with fewer human resources. This study aims to explore trends of occupational injuries in Lebanon—a country that faced a multi-faceted healthcare crisis with a severe economic collapse, a resulting massive HCW exodus, coupled with increased workload due to the COVID-19 pandemic. This study further investigates the association between HCW injuries and objective workload measures.

Methods This is a retrospective study examining incident reports completed by HCWs over 5 years (January 2018 to December 2022). The data were complemented by monthly workload measures (admissions, occupied beds, procedures, ED visits, clinic visits) and absenteeism data. Analysis was performed using linear regression models to assess the relationship between workload predictors and injury rate.

Results 2291 injuries were recorded, and 22.61% were sustained by registered nurses. The mean monthly injury rate was 1.68 per 100 EFTE, with an increased yearly trend. 40.39% of injuries were due to needle-pricks. Higher injury rates were found to be positively associated with workload: with each 1000 additional procedures each month (8.8% increase), the mean injury rate increased by 0.11 (95% CI 0.04 to 0.18, p value=0.002) (6.34% increase).

Conclusion HCWs sustain a high burden of occupational injuries. Understanding the socio-economic factors and the changes in workload in relation to injury trends is crucial. The study offers valuable insights into suitable staffing and workload levels and can inform policies.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Healthcare workers (HCWs) occupational injuries constitute a large burden, especially in low-resource countries.
⇒ Several psychosocial and organisational factors are known to be associated with higher injury rates among HCWs, but there is scarcity of studies examining the association of injuries with workload, as measured by objective hospital metrics. Workload was rather estimated by subjective, self-reported questionnaires and not by objective measures.

WHAT THIS STUDY ADDS

⇒ Increasing workload due to HCW shortage related to the COVID-19 pandemic and the multi-layered crisis impacted workplace injuries.
⇒ HCW injuries have increased over the past 5 years, and a large proportion is due to needle-stick injuries. The increase in the number of procedures performed was associated with an increased injury rate

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND POLICY

⇒ It is essential to balance adequate staffing with workload level, reinforce personal protective equipment use and promote employee wellness, especially during periods of crises.

INTRODUCTION

Occupational injuries represent a major public health problem. According to the Global Burden of Disease, an estimated 1.53 million deaths and 76.1 million disability-adjusted life years (DALYs) are attributed to occupational risk factors worldwide.[1] Most of these DALYs are attributable to injury, especially in the Middle East and North Africa (MENA) region.[1] Hospitals in particular constitute one of the most hazardous working environments, posing significant occupational injury risks to healthcare workers (HCWs).[2] These increased risks of injuries and illnesses are associated with frequent exposure to a wide range of hazards, including communicable diseases, cytotoxic drugs, radiation, ergonomic factors, mental stressors and violence.[2 3] Injuries

sustained by HCWs tend to be under-reported at the local,[4] regional[5] and global levels.[6]

Injuries sustained by HCWs can be broadly categorised into two main groups: injuries resulting from blood-borne pathogens (BBP) and injuries resulting from other causes. BBP injuries are sustained by HCWs due to their exposure to patients' blood and body fluids. BBPs are infectious microorganisms carried and transmitted through blood. The most common pathogens HCWs are at risk of are HIV, hepatitis B and hepatitis C virus. According to the Centers for Disease Control, HCWs are at risk of such infections by needlestick injuries (NSI) or contact of mucous membrane or non-intact skin with contaminated body fluids.[7] A recent meta-analysis showed a worldwide NSI prevalence of 41%, with a higher percentage in developing (46.6%) than developed (30.5%) countries.[8] In addition to BBP exposure, HCWs are at an increased risk of a multitude of other types of injuries, the majority being musculoskeletal (MSK) due to patient-handling activities, rapid and repetitive tasks.[9]

In Lebanon, a country located in the MENA region and recently reclassified post-crises as a lower-middle-income country by the World Bank, HCWs are at an increased risk of occupational violence.[10] Other types of exposures also showed increasing trends. A local study at one major Lebanese tertiary hospital showed an increasing rate of injuries among HCWs from 2014 to 2018, resulting mainly from exposure to contaminated sharps, blood and body fluids.[11] The COVID-19 pandemic exacerbated the prevalence of HCW injuries as employees worldwide worked under unconventional stressful conditions. This was driven not only by the increase in the number of cases but also due to personnel shortage and the need to use complicated personal protective equipment (PPE) in a way that many were not routinely used to, which further complicated the work environments.

Lebanon was not an exception. HCWs were facing new challenges pertaining to the increased workload and shortage of HCWs due to COVID-19-related absenteeism. In Lebanon, a study conducted at a tertiary hospital—the American University of Beirut Medical Centre (AUBMC), showed that each infected HCW had a mean time of 12.5 days away for work due to COVID-19.[12] The resulting absenteeism increased the workload on the remaining employees who reported to work.[12] In addition to the overly strained healthcare system impacted by the fast-spreading COVID-19 pandemic, HCWs in Lebanon faced additional challenges due to multiple crises that affected the country,[13] including the political uprising in 2019, COVID-19 lockdowns, the 2020 Beirut Blast and more recently the socio-economic crisis that resulted in workforce shrinkage and the exodus of a large number of HCWs.[14] Those events significantly affected the personnel shortage level and the hospital provision of care.[14]

Most studies in the literature focus on the effects of organisational (higher number of night shifts,[15] long working hours,[16 17] overtime work[18] and psychosocial factors (negative stress perception,[19] perceived physical and mental demands[20] on HCWs injuries. But there is a scarcity of studies examining the association of injuries with workload, as measured by objective hospital metrics. Workload was rather estimated by subjective, self-reported questionnaires[21] and not by objective measures. Evidence suggests that workload is perceived differently by nurses compared with the objectively measured workload due to several factors, like the severity of the illness of the patient.[22] Furthermore, self-reported estimations provide a snapshot of workload at a specific point in time but may not capture the dynamic nature of workload fluctuations. Besides, there is a scarcity of evidence from studies conducted in low-and-middle-income countries,[23 24] and further exploration of the topic is necessary to understand its burden and implications. This study seeks to address this gap by examining trends of occupational injuries and investigating the relationship of injuries with objective workload as measured by monthly hospital metrics.

METHODS

Study design, setting and participants

This is a cross-sectional, retrospective single-site study that examines injuries sustained by all HCWs at the American University of Beirut Medical Centre—a major tertiary hospital in Lebanon, over a period of 5 years from January 2018 to December 2022. Located in the capital Beirut, AUBMC is one of the largest medical facilities in the country (420-bed inpatient capacity) and offers tertiary care services to over 360 000 patients annually.

We included all HCWs who sustained an occupational injury while performing their duties and who filed an incident report at AUBMC between January 2018 and December 2022. HCWs include all employees working at the medical centre, irrespective of whether they are involved in patient care. We excluded injuries reported by part-time workers.

Theoretical framework

HCWs in Lebanon and at AUBMC in particular worked under unconventional stress over the past years due to the socioeconomic crises and COVID-19 pandemic.[14] Several theories were proposed in the literature to conceptualise job stress and link it to adverse physical and mental health outcomes, like occupational injuries.[25 26] The National Institute for Occupational Safety and Health (NIOSH) defined job stress as "the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker. Job stress can lead to poor health and even injury".[25] NIOSH proposed a Model of Job Stress. The exposure to stressful job conditions directly influences workers' safety and health. This relationship can be influenced by other individual and/or situational factors.[25] In this study, we conceptualised that an increase in workload (driven by the loss of approximately 25% of

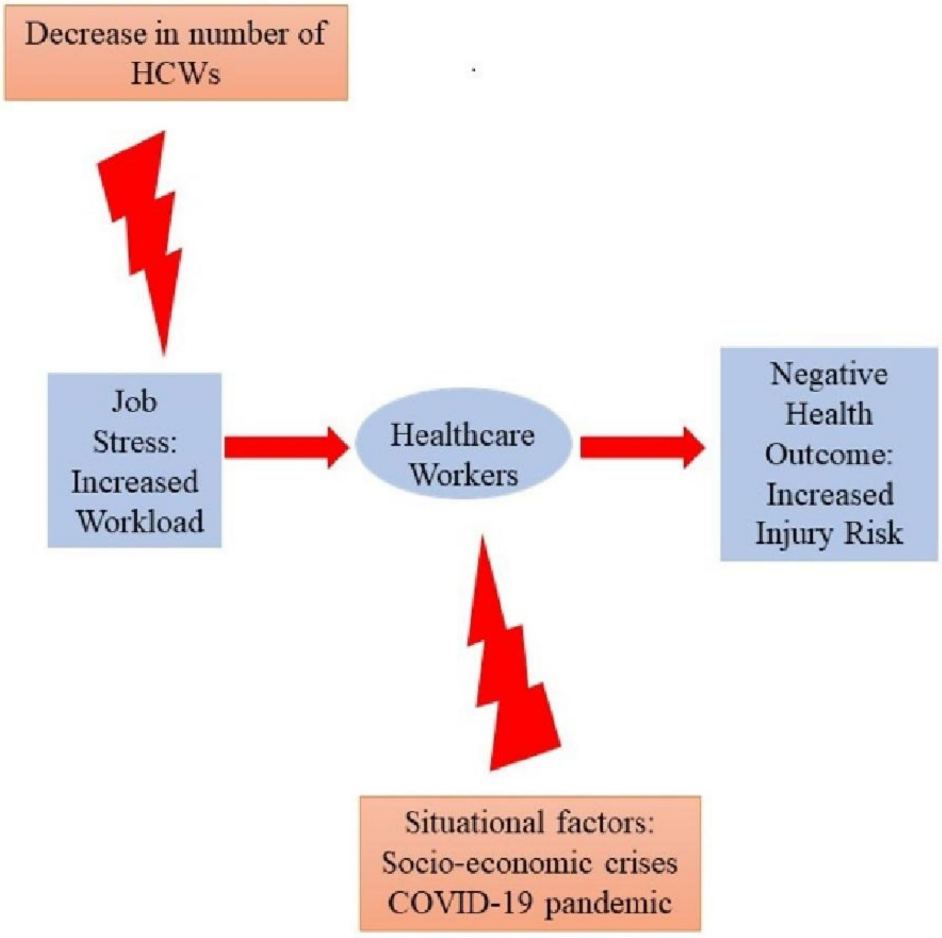

Figure 1 Theoretical framework of the study. Footnote: The 'socio-economic crises' include: the political uprising in 2019, COVID-19 lockdowns, the 2020 Beirut Blast and the economic crisis that resulted in workforce shrinkage and exodus of large numbers of HCWs.

the hospital's workforce) constitutes a stress factor that is associated with an increase in HCWs' physical injuries (figure 1).

Data collection

The study involved secondary data analysis of all incident report forms[27] completed by AUBMC HCWs and submitted to the Environmental Health, Safety and Risk Management department. Within the context of this study, we define 'incident' as an unexpected event which is not consistent with the routine operation and that adversely affects the health, safety or well-being of the HCWs, patients, visitors or property of the medical centre. Reported incidents result from exposures to different kinds of hazards during the performance of the HCW's job duties and causing an injury. The incident report form contains information on the location and time of the incident, job title of the injured HCW, department, age, gender, mechanism of injury and whether a visit to the ED was warranted. The form is separate from the employee's health record. To ensure anonymity and confidentiality, incident data were de-identified by a health and safety officer prior to sharing with the research team.

The data were juxtaposed by multiple data sources accessed from AUBMC Human Resources and Information Technology Departments to obtain objective measures of workload. The data pertained to the monthly number of HCWs (full-time employees), monthly absenteeism and monthly workload metrics between January 2018 and December 2022.

Variables

The outcome (monthly injury rate) was calculated as the number of monthly injuries per 100 effective full-time employees (EFTE), thus taking into account absenteeism. Monthly absenteeism is defined as the total days lost each month at work for any reason. If each employee works for 20 days per month, the monthly EFTE is calculated by dividing monthly absenteeism by 20 working days, then subtracting it from the total full-time employee (FTE) number.

$$\text{Monthly EFTE} = \text{Monthly FTE} - \frac{Monthlyabsenteeism(\in days)}{20}$$

$$\text{Injury rate} = \frac{Numberofmonthlyinjuries}{NumberofmonthlyEFTE} x100$$

For the independent variables, we used objective hospital metrics to estimate workload. The total number of monthly admissions, the actual monthly number of

occupied beds by inpatients and the total number of monthly procedures performed (surgeries, minor procedures, endoscopies and interventional radiology) reflect the level of activity inside the hospital at the inpatient level. The total number of monthly ED visits reflects the level of activity at the hospital's frontline. The total number of clinic visits reflects the level of activity at the outpatient department

Data analysis

Descriptive analyses were conducted to characterise the study sample. The Shapiro–Wilk test and the skewness and kurtosis tests confirmed the outcome's adherence to a normal distribution. Pearson's correlation was employed to explore relationships between pairs of variables. The data were checked for stationarity and assessed for any discernible trends or seasonality. Based on the Augmented Dickey–Fuller test, the p value=0.000 supports the conclusion of stationarity.

Linear regression models were used to examine the relationship between workload predictors and the injury rate. We evaluated the model's goodness-of-fit to assess its validity through appropriate regression diagnostics: occupied beds, clinic visits and ED visits were removed from the final model. The results were reported in terms of regression coefficients and their corresponding 95% CIs. Statistical significance was considered at a p value of <0.05. All analysis was conducted on Stata software version 17.

RESULTS

A total of 2291 occupational injuries were recorded through incident reporting by HCWs at AUBMC between 2018 and 2022. The mean age for injured individuals was 34.75 years (table 1) with a range between 18 to 67 years. The majority of injured HCWs were males (59.46%), and 38.21% were serious injuries requiring ED visit. Registered nurses (22.61%) and residents (21.99%) recorded the highest proportion of injuries among all other occupations. Nearly half of the injuries (1112 or 48.54%) were due to exposure to BBP (NSIs and exposure to blood and other body fluids). The most common injury mechanism was NSIs (40.39%), followed by slips, trips and falls (13.11%) (table 1).

The average number of HCWs was 3467, and this number largely fluctuates between 4035 in December 2019 (pre-COVID-19) and 2773 in January 2022 (post-crisis). The average injury rate is 1.68 per 100 EFTE per month, accounting for the effect of absenteeism. The average, SD and range for the workload metrics are presented in table 2.

The inspection of the yearly injury rate per 100 EFTE shows an increasing trend for both BBP injuries and the total injuries (that includes BBP exposures) between 2018 and 2022 (figure 2). BBP injuries increased from 8.76 per 100 EFTE in 2018 to 10.20 per 100 EFTE in 2022. All-cause injuries increased from 19.34 per 100 EFTE in 2018 to 21.29 per 100 EFTE in 2022.

The Pearson's correlation analysis in table 2 showed that all five predictors of workload are positively correlated with injury rate. This correlation is statistically significant for procedures only (p value=0.002), and the correlation coefficient is moderate in magnitude (ρ=0.396).

Regression diagnostic methods were employed to reach a final model that has a good fit. Partial regression plots (av plots) aided in determining the importance of each predictor in a model that contains all other predictors. Occupied beds, ED visits and clinic visits are probably not needed in the final model. The overall fit of the model was also checked by plotting the response against the predicted responses (Y vs Y hat). The relationship between the injury rate and the predicted responses (fitted values) looks linear. Multicollinearity among predictors was verified using the variance inflation factor (VIF). None of the VIFs exceeded 10, indicating the absence of multicollinearity. The linear association between each predictor and injury rate was assessed by plotting standardised residuals against each predictor variable using the augmented component-plus residual plot (augmented partial residual plot: acprp plot). Admissions and procedures did not exhibit any clear departure from linearity. Occupied beds, clinic visits and ED visits showed a departure from linearity; therefore, their exclusion from the final regression model was confirmed.

Based on the results of the regression diagnostics, a final linear regression model was reached, examining the association of monthly admissions and procedures on the monthly injury rate. The mean injury rate increases by 0.11 per 100 employees per 1000 additional procedures performed each month (95% CI 0.04 to 0.18, p value=0.002). An increase in monthly admissions is also associated with an increase in injury rate, but the result was not statistically significant (table 3). With an average of 11 362 procedures performed monthly, the risk of injury presents a significant burden. Specifically, with a mean injury rate of 1.68 per 100 EFTE per month, for every additional 1000 procedures performed (which represents an 8.8% increase based on the monthly mean procedures), the average injury rate increases by 6.34%.

DISCUSSION

To our knowledge, this is the first study that examined the effects of changes in workload on injury rates at a tertiary hospital in Lebanon. The study examined injury rates among HCWs within a broader context of exceptional socioeconomic crisis, lay-off of employees and the COVID-19 pandemic. It constitutes an innovative approach to deal with occupational injuries during an unprecedented time of multi-faceted crisis. By recognising the interaction between economic instability, workforce restructuring and the pandemic's strain on healthcare systems, the study offers valuable insights on the interplay of external factors with HCWs' health and

Table 1 Participants' characteristics and type of injury in healthcare workers between 2018 and 2022

Covariate	Frequency (percentage)
Age at injury (mean (SD))	(34.75(10.98))
Gender	
Male	1270 (59.46%)
Female	866 (40.54%)
ED visit	
Yes	843 (38.21%)
No	1363 (61.79%)
Occupation	
Registered nurse	513 (22.61%)
Resident	499 (21.99%)
Nurse aid	331 (14.59%)
Allied health*	254 (11.19%)
Physician	166 (7.32%)
Housekeeping and laundry workers	165 (7.27%)
Physical plant worker	165 (7.27%)
Administrative staff	116 (5.11%)
Food service worker	33 (1.45%)
Protection officer	20 (0.88%)
Other†	7 (0.31%)
Mechanism of injury	
Needle stick and other sharp object injections (NSIs)‡	921 (40.39%)
Slips, trips and falls	299 (13.11%)
Contact with objects or equipment	241 (10.57%)
Off-premises incidents§	209 (9.17%)
Exposure to blood or other body fluids‡	187 (8.20%)
Overexertion and bodily reaction	147 (6.45%)
Transportation accidents	86 (3.77%)
Exposure to or contact with harmful substances	82 (3.60%)
Non-contaminated sharp object injury	54 (2.37%)
Violence	49 (2.15%)
Others	5 (0.22%)

*'Allied health' includes technicians, pharmacists, phlebotomists, anaesthesia therapists, physical therapists, radiographers, nutritionists and infection control staff.
†'Others' include parking valet, dispatcher and gardener.
‡Both NSI and exposure to blood or other body fluids are classified under 'BBP exposures'.
§Incidents occurring outside the hospital's premises during working hours or when commuting to work.

safety. It lays the ground for more targeted interventions and policy reforms.

The study findings indicated that workload, as measured by objective hospital metrics, is correlated with higher injury rates among HCWs. In fact, with a monthly facility-wide 8.8% increase in procedures (ie, surgeries at the operating room, minor procedures, endoscopies, interventional radiology procedures, etc), the mean injury rate increases by 6.34% per 100 EFTE. Injury rates at AUBMC are comparable to other rates found in the literature.[15 28 29] In fact, despite under-reporting being a common issue due to structural barriers (poor organisational practices, lack of open communication, lack of organisational trust and fear of reprisal),[6 30 31] studies have shown that the yearly incidence of NSIs fluctuates between 5 and 10 per 100 FTE,[11 15 32] while the yearly incidence rate for all injuries is approximately 20 per 100 FTE.[28 29]

The results of our study align with other findings in the literature and confirm that workload is associated with higher injury rates.[32–34] A study conducted in Croatia used objective hospital metrics of workload and showed that

Table 2 Mean, SD, range of the studied variables and bivariate analysis (monthly data between 2018 and 2022)

Variable	Mean (standard deviation)	Range	Pearson's correlation coefficient	P value *
Injuries	38.12(11.36)	19–74	–	–
Total number of HCWs	3,467.43(484.13)	2773–4035	–	–
Absenteeism (in days)	10,569.70(2451.49)	6016–16 150	–	–
Injury per 100 EFTE	1.68(0.41)	0.75–2.80	–	–
Occupied beds	228.77(30.63)	168–288	0.054	0.681
Admissions	1,834.17(448.97)	1182–2864	0.118	0.371
Procedures	11,362.43(1470.73)	6347–13 922	0.396	0.002
Clinic visits	20,105.80(4170.85)	8575–30 661	0.182	0.164
ED visits	2,884.82(951.67)	1568–4992	0.057	0.667

*p value <0.05 is considered statistically significant.
EFTE, effective full-time employee.

the rate of NSIs per number of active hospital activities and the rate of NSIs per number of hospitalised patients significantly increased during the COVID-19 pandemic.[33] Another study in South Korea found that the rate of BBP is positively correlated with the number of beds served per HCW.[32] In addition, when accounting for sick leaves among HCWs in Canada, an increased workload defined as working during high absenteeism within a department is correlated with the risk of MSK injuries (RR=2.10).[34] A Swiss study showed that nursing home HCWs who score higher on a staffing and workload index scale are more at risk of back pain (OR=1.52).[35]

The findings provide a more in-depth understanding of the social factors and the changes in the workload in relation to injury trends. It offers valuable insights to workplaces and employers regarding the importance

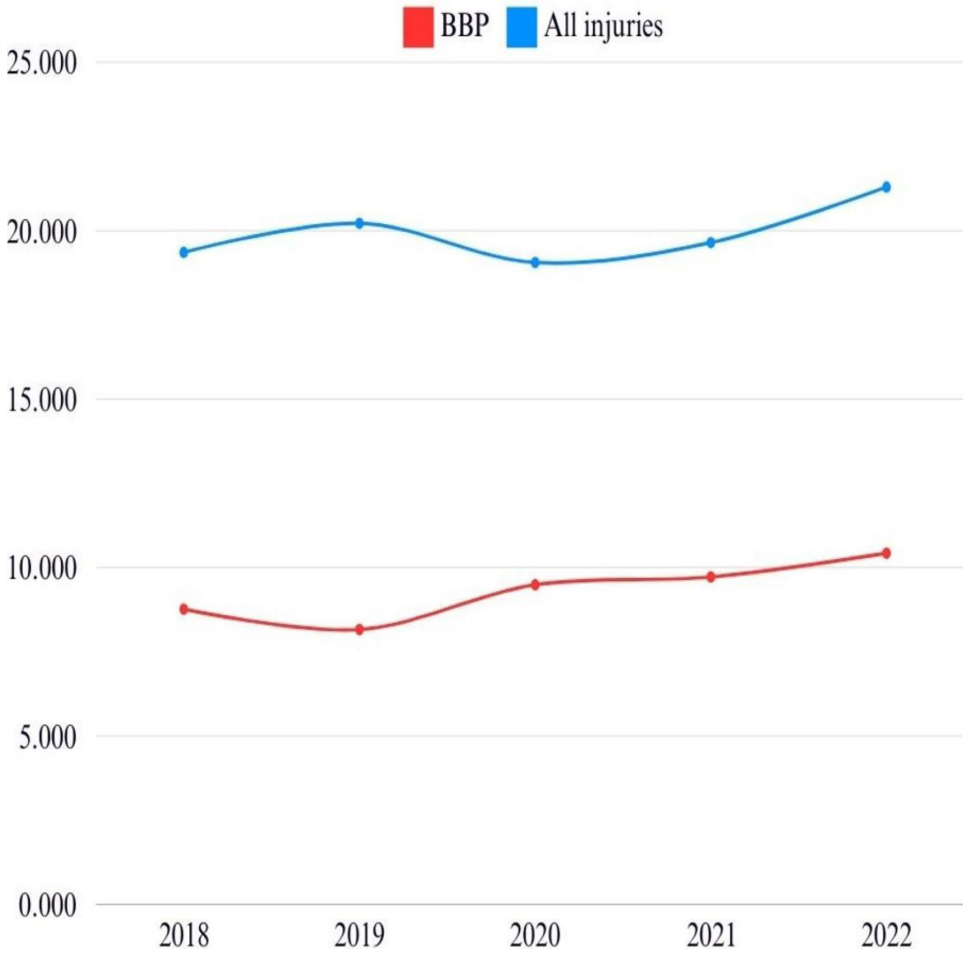

Figure 2 Change in yearly injury rates for blood-borne pathogens and all injuries from 2018 to 2022.

Table 3 Adjusted linear regression model showing the association between injury rate and monthly admissions and procedures

Variable	Coefficient*	95% CI	P value†
Admissions	0.07	(–0.16; 0.29)	0.542
Procedures	0.11	(0.04; 0.18)	0.002

*Coefficients and their respective 95% CIs are multiplied by 1000.
†p value <0.05 is considered statistically significant.

of adequate staffing levels and workload to reduce the burden of occupational injuries. These injuries have a profound impact on the workplace in terms of lost days of work, presenteeism, lost productivity and medical compensation from employers or insurances.[36 37] Furthermore, occupational injuries can have detrimental effects on workers' physical and mental health and safety[38] and financial repercussions in terms of lost wages due to short- and long-term disability.[39]

Strengths

This study has several strengths that are worth emphasising. First, the study involves a large sample size (2291 incident reports examined) over 5 years. Second, injury rates and other predictors of workload were reported and analysed monthly, rather than yearly, unlike other injury studies. The monthly data allow for more timely detection of trends and fluctuations. It further provides a finer granularity for understanding temporal variations. This allows for a more nuanced understanding of how workload may contribute to injuries over shorter time periods. It enables researchers to pinpoint specific months or periods when certain factors might be more influential, aiding in the development of targeted interventions. Third, incident reports were filled in a relatively accurate, reliable and consistent manner. In fact, the de-identified injury data were retrieved from the incident report, electronic web-based system, that is, user-friendly. Using such records submitted electronically the day of the incident, rather than relying on participants' retrospective recollection of injuries, ensures greater data accuracy, reliability and objectivity. Finally, the study used objective metrics of workload provided by the Human Resources and Information Technology departments at AUBMC. It did not rely on participants' self-reporting of perceived workload, as such estimations may be influenced by many psychosocial and organisational factors.[40] In fact, evidence has shown that HCWs tend to over-estimate the perceived workload due to frustration from work[41] or when taking care of more critically ill patients.[22]

Limitations

This study has some limitations. First, it is a single-site study examining injuries at one tertiary hospital (AUBMC) in Lebanon. The findings may not be fully representative of broader trends in occupational injuries within the healthcare sector across Lebanon due to differences in reporting and documentation. Second, the data might have involved an over-reporting of BBP injuries and an under-reporting of MSK injuries (over-exertion and bodily reactions). We speculate that this is attributable to two main reasons: (1) HCWs tend to rigorously report all BBP exposures, especially NSIs, by fear of transmission of hepatitis B, hepatitis C and HIV. After an exposure occurs, if the source tests positive for any of these microorganisms, the HCW undergoes blood tests and regular medical follow-ups as indicated. (2) However, most MSK injuries are chronic and have a cumulative effect. In fact, most HCWs fail to recognise these injuries as work-related injuries and do not submit an incident report form. Some HCWs might also feel apprehensive to report such MSK injuries out of fear of retaliation or job transfer. So HCWs tend to underreport this category of injuries, and our results might not capture the totality of these injuries.

Recommendations

In the light of the findings of this study, we propose the following series of recommendations:

Engineering controls: this approach should be prioritised to enhance the workplace safety protocols and prevent the occurrence of injuries. This may involve the provision of safety-engineered devices (like self-retractable needles or other needleless systems) and adequate PPE.

Behavioural change interventions: regular training sessions, targeted messaging awareness and promotion of a safety culture are important to be implemented, especially during periods of high absenteeism to prevent the double burden of increased occupational injuries. These strategies, although shown to be beneficial in high-income countries,[7] need adaptation and rigorous testing in the LMIC context[11] due to resource constraints, lack of safety culture and a different workforce dynamic. Behaviours, such as needle recapping and misplacement of sharps, should be changed.

Workload Balance: hospital administration should prioritise efforts to alleviate workload strains by implementing measures such as optimising staffing levels and redistributing tasks more equitably.

Mental and physical well-being: continuous support for HCWs' mental and physical well-being is crucial, especially during periods of crises. Promoting a culture of open communication and providing resources for stress management can help mitigate the adverse effects of job strain.

CONCLUSION

Evidence from this study indicates that occupational injuries have increased over the past 5 years, particularly when the country was experiencing major socioeconomic crises and the COVID-19 pandemic. Notably, exposure to BBPs was associated with a substantial risk to HCWs, especially with an increased workload. Targeted interventions are imperative to ensure adequate HCW staffing, mitigate workload impacts and promote employee wellness, particularly during crises. Future studies should focus on evaluating the effectiveness of targeted interventions aimed at preventing occupational injuries among HCWs and mitigating the impact of high workload levels during periods of crisis.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study received ethical approval from the Institutional Review Board at the American University of Beirut (AUB IRB ID: BIO-2023-0052). Because this study uses existing data, and there was no contact with human subjects, Yale IRB Human Research Protection Program considered this as non-human-subject research (Yale IRB ID: 2000035933). No informed consent was required since the study involved a secondary analysis of de-identified incident report forms that are not linked to the medical record of the participants.

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