

The Differences in Stabbing-Related Injury Profiles of Men and Women

Michael Rozenfeld MA^{1,2}, Kobi Peleg PhD MPH^{1,2}, Adi Givon BSc¹, Israeli Trauma Group³ and Boris Kessel MD⁴

¹Israel National Center for Trauma and Emergency Medicine Research, Gertner Institute for Epidemiology and Health Policy Research, Tel Hashomer, Israel

²School of Public Health, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

³Israeli Trauma Group*

⁴Trauma Unit, Hillel Yaffe Medical Center, Hadera, Israel

ABSTRACT: **Background:** Although women comprise only a minority of patients hospitalized due to violence-related injury, the circumstances of attacks against women may make their injuries more severe.

Methods: We conducted a retrospective study using data of 9173 patients with stabbing-related injuries from 19 trauma centers participating in the Israeli National Trauma Registry between 1 January 1997 and 31 December 2014. Male and female patients were compared in terms of demographic and circumstantial factors, clinical characteristics, and outcomes.

Results: Women were found to have greater injury severity according to the Injury Severity Scale (ISS) – 18% vs. 11% of severe (ISS 16+) injuries – requiring more hospital resources. Injuries that contributed most to injury severity in the female population were head and severe abdominal trauma. Women also sustained injuries to more body sites than men; however, regression analysis showed that the contribution of this factor to the overall difference in injury severity was less important than the injured sites. Regression analysis among severely injured patients pointed at injury to lower extremities as an independent factor related to female mortality. Different from men, among women the stabbing injuries to the upper extremities were not a protective factor in terms of mortality.

Conclusions: There are significant differences in the injury profiles of male and female stabbing victims, which can be explained by the different circumstances of the injury event.

IMAJ 2019; 21: 198–202

KEY WORDS: violence, injury severity, stabbing, gender, mortality

studies of violence-related injuries show that women comprise a minority of the overall burden of injuries, violence is known to be a phenomenon too complicated to be judged based exclusively on frequency [1,3,4]. The profile, the severity of injuries, and the clinical and social outcomes that they cause are also important factors in correctly appreciating the violence-related injury burden of both genders [4,5]. The differences in the circumstances of injury, such as being less capable of repelling a physically stronger attacker or escaping the space where the attack takes place, may put women at higher risk of sustaining severe injuries [6,7].

Severity of violence-related injuries is known to be dependent on several factors, such as the number of injuries, the targeted body sites, and the mechanism of attack [8-10]. Stabbing wounds from attacks with knives and other sharp objects are frequent and present a significant risk to the victim's survival [10-12]. Although many stabbing-related injuries are usually not life threatening, the intentional use of a potentially lethal weapon, especially in repeated attacks, may be indicative of murderous intent [13,14]. Another problem with sharp weapons is their universal availability, especially at home, where women are known to be most vulnerable to violent attacks [12,13]. Therefore, with the motives behind violence known to be gender-related in some cases, vast differences could be expected in the stabbing injury profiles of male and female patients [14,15]. Thus, in this study, our goal was to compare the stabbing injuries of male and female patients, with an emphasis on injury severity and the factors contributing to it.

PATIENTS AND METHODS

STUDY SAMPLE AND DATA COLLECTION

We performed a retrospective cohort study of trauma patients who sustained interpersonal violence-related stab wounds between 1 January 1997 and 31 December 2014. The data were obtained from the records of The Israeli National Trauma Registry (INTR) maintained by Israel's National Center for Trauma and Emergency Medicine Research, at the Gertner Institute for Epidemiology and Health Policy Research. The Registry contains information concerning trauma patients hos-

Prevention of violence against women has been given priority by many organizations dealing with injury prevention, including the WHO [1,2]. The prevention efforts target many critical subthemes of violence against women, such as date rape, intimate partner violence, hate crimes, etc. Although most

*The Israel Trauma Group: H. Bahouth, M. Bala, A. Becker A, E.M. Ben, A. Braslavsky, I. Grabazev, M. Jeroukhimov, M. Karawani, Y. Klein, G. Lin, O. Merin, Y. Mnouskin, A. Rivkind, G. Shaked, D. Soffer, M. Stein and M. Weiss

pitalized in 19 hospitals, including all 6 Level I trauma centers in Israel. Data regarding the personal identity of the patients are not collected. The Registry does not include patients who were declared dead on the scene or on arrival at the hospital. During the study period, 26,252 patients were registered with violence-related injuries. Of them, 9173 with stabbing-related injuries were recognized by the first ICD E-code of E966.

STUDY VARIABLES AND DATA ANALYSES

Gender was the main comparison category in the study. Male and female patients were compared in several demographic and circumstantial parameters (such as age, ethnicity, time and location of the injury event), clinical parameters [including the Abbreviated Injury Scale (AIS), the Injury Severity Score (ISS), identity and number of injured body sites, surgery and admission to the Intensive Care Unit (ICU)], and clinical outcomes [including length of stay (LOS) and in-hospital mortality]. The demographic and clinical factors were used to adjust a logistic regression equation calculating the odds of sustaining a severe injury (defined as having an ISS 16+) by patients' gender. In order to focus specifically on the interaction between the demographic and clinical factors, we did not include time and space parameters of the injury event in the equation. In order to determine what injuries are associated with mortality in both genders beyond injury severity, the influence of an injury to a certain body site on mortality was analyzed exclusively among severely injured patients (ISS 16+), adjusted by patient's age and the number of injured sites.

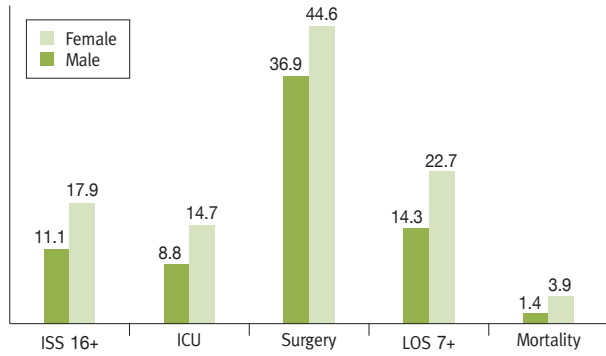
Statistical analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC, USA). Chi-square tests were used for group comparison. The level of statistical significance was set at $P < 0.05$ for all analyses. The goodness of fit of the logistic regression model was assessed with Hosmer & Lemeshow's Concordance Index (C-statistic). Since the study was performed on unidentifiable registry data, no specific approval of the institution's review board was required.

RESULTS

During the study period, 9173 patients were hospitalized with stabbing-related injuries; 95.3% (8745 patients) were male and 4.7% (428 patients) female. Despite the obvious dominance of males in terms of the overall burden of stab injuries, females were found to be at considerable disadvantage in terms of injury severity and outcome [Figure 1]. Female patients had significantly more severe (ISS 16+) injuries (17.9% vs. 11.1%), a longer LOS (22.7% vs. 14.3% of LOS 7 days or longer), and almost threefold mortality (3.9% vs. 1.4%) as compared to males. Accordingly, their utilization of hospital resources, such as operating rooms and ICU beds, was also significantly higher.

Demographic characteristics of both groups proved to be completely different from each other [Table 1]. Among

Figure 1. Injury severity, treatment, and outcomes in stabbing victims by gender (n=9173). All differences are significant ($P < 0.05$)



ISS = Injury Severity Score, ICU = intensive care unit, LOS = length of stay

Table 1. Study population demographic and injury characteristics (by gender) (n=9173)^a

Variable	Males n=8745		Females n=428		P value
	%	n	%	n	
Age (yrs)					< 0.0001
0-14	2.6	224	4.5	19	
15-29	64.9	5649	37.7	160	
30-44	24.4	2127	32.8	139	
45-59	6.6	577	17.2	73	
60+	1.5	130	7.8	33	
Ethnicity					0.0002
Jewish	57.9	5002	67.1	279	
Non-Jewish	42.1	3642	32.9	137	
Incident location					< 0.0001
Home	5.8	508	48.4	207	
Street	51.0	4461	25.9	111	
Other	43.2	3776	25.7	110	
Day of week					< 0.0001
Weekday (5 days)	57.2	4999	70.6	302	
Weekend (2 days)	42.8	3746	29.4	126	
Time of day					< 0.0001
7:00-14:59	16.1	1405	24.3	104	
15:00-22:59	39.1	3416	41.8	179	
23:00-6:59	44.8	3911	33.9	145	
Site of injury^b					
Head	9.9	972	14.9	64	0.0009
Head AIS 3+	190	2.2	5.1	22	< 0.0001
Face	9.7	851	18.5	79	< 0.0001
Neck	7.5	653	9.6	41	0.1
Chest	42.1	3681	37.8	162	0.08
Chest AIS 3+	24.8	2172	22.9	98	0.36
Abdomen	45.3	3963	45.8	196	0.85
Abdomen AIS 3+	10.9	955	14.2	61	0.03
Upper extremities	22.4	1963	28.9	124	0.0017
Lower extremities	17.2	1502	12.6	54	0.01
No. of injured sites					0.0001
1-2	87.6	7664	81.3	348	
3+	12.4	1081	18.7	80	

^aIn some cases the total does not equal the total N because some data are missing

^bThe overall numbers may be greater than 100% because many patients had injuries in several body sites

AIS = Abbreviated Injury Scale

males the age group 15–29 years was dominant (64.9% of the patients), while among females the age diversity was much higher, with 57.8% of the patients over age 30. Non-Jewish women constituted about one-third of all female patients, while among males the proportion of non-Jews was significantly higher (42.1%). While most men (51%) were injured in the street, a similar proportion of women (48.3%) were injured at home (compared to only 5.8% among men). Males were found to be at higher risk of stabbing injury during weekends, while females had an even risk on all days of the week. Both genders were at higher risk in the evening and night hours; however, females experienced a significantly higher proportion of injuries in the morning hours (24.3% vs. 16.1%).

Characteristics of injury were also significantly different between male and female stabbing victims [Table 1]. Although the proportion of neck and torso injuries was similar in both genders, serious (AIS 3+) abdominal injuries were more common among female patients (14.2% vs. 10.9%). Male patients had more injuries to the lower extremities (17.2% vs. 12.6%), while injuries to the upper extremities were more frequent among females. The greatest difference between the two groups was in head and face injuries: females suffered almost twice the number of injuries to these body sites, as compared to males. The proportion of injuries to multiple body sites was also higher among female patients.

In order to detect the factors that contributed most to the severity of stab injuries, a logistic regression for predicting the odds of sustaining a severe (ISS 16+) injury was performed. Expectedly, female patients were at higher risk of sustaining a severe stab injury, with injuries of head, chest and abdomen being the most important clinical predictors [Table 2]. Despite being significantly related to injury severity, the number of injured body sites was not associated with increased risk of sustaining a severe injury after adjustment for other factors in the equation. Patients' ethnic background also had no impact on injury severity.

To determine which injuries contribute to mortality in both genders, the effect of an injury to a certain body site on mortality was analyzed exclusively among severely injured patients (ISS 16+), separately for both comparison groups and adjusted by patient's age and the number of injured sites. The results of this analysis are presented in Figure 2.

We found that among male patients a stabbing injury to the chest was positively predictive of in-hospital mortality even among severely injured patients – odds ratio (OR) 1.7, 95% confidence interval (95%CI) 1.1–2.9. However, among female patients no such pattern was found. In addition, the association of extremity injuries with mortality was completely different in both genders. An upper extremity injury was associated with decreased mortality (OR 0.4, 95%CI 0.2–0.8) in men but not in women. On the other hand, injuries to the lower extremities

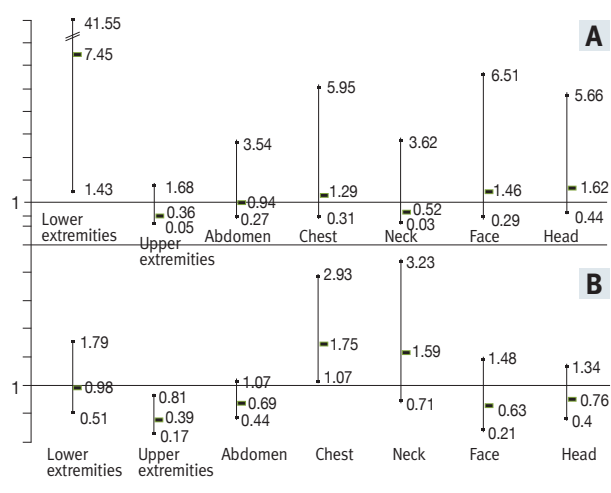
Table 2. Logistic regression for predicting the odds of sustaining a severe (ISS 16+) stabbing-related injury (n=9173)

Variable	N	ISS 16+ (%) ^b	Adjusted odds ratio	95%CI	P value
Gender					0.0009
Female	428	17.9	1.62	1.21–2.13	
Male	8745	11.1	1	–	
Ethnicity					0.24
Non-Jewish	3779	11.5	0.92	0.80–1.06	
Jewish	5281	11.6	1	–	
No. of injured body sites					0.29
1-2	8012	9.7	0.86	0.64–1.14	
3+	1161	23.3	1	–	
Injured body site					
Head	936	21.1	2.91	2.34–3.61	< 0.0001
Face	930	10.4	0.86	0.65–1.13	0.28
Neck	694	10.9	1.34	0.99–1.79	0.06
Chest	3843	17.7	3.92	3.31–4.64	< 0.0001
Abdomen	4159	15.9	3.23	2.72–3.84	< 0.0001
Upper extremities	2087	9.4	0.81	0.66–1.01	0.06
Lower extremities	1556	9.6	0.95	0.75–1.19	0.65
Age (continuous)					< 0.0001

^aConcordance Index 0.74

^bProportion of ISS 16+ in each group

Figure 2. Odds ratios and 95%CI for predicting stabbing-related mortality in patients with severe injuries (ISS 16+), by injured body region. **[A]** Women (n=77). **[B]** Men (n=972). Adjusted for patients' age and the number of injured sites. Injured regions were analyzed independently of one another



that were strongly associated with mortality occurred exclusively among female patients (OR 7.5, 95%CI 1.4–44.5).

DISCUSSION

Since knives, broken glass, and other sharp instruments are the most available potentially lethal agent in interpersonal conflicts, violence victims with penetrating injuries present a common burden on emergency departments and the healthcare system

in general [11,12]. With women frequently becoming victims of home battering and intimate partner violence, their potential vulnerability to severe attacks must be studied in order to improve their clinical treatment [2,4,8].

The aim of our study was therefore to analyze the influence of patient gender on the severity of stabbing injuries. We found that although males comprised the majority of patients with stab injuries (similar to other studies of violence-related injuries) [1,11,16], females' injuries were more severe and their outcome worse. The vast differences that we observed between the two genders in demographic, contextual and injury-related profiles shed some light on the factors contributing to the greater severity among women. The differences between the two groups start at the most basic level of their ethnic and age composition. Thus, while 42% of the total number of male victims were from the non-Jewish minority, among women it was only about 33%. Nevertheless, this is still substantially higher than the proportion of non-Jews in the Israeli population (about 20%) [17]. In our study, two-thirds of male stabbing victims were aged 15 to 29, which is similar to most reported series on victims of violence [11,18]. However, most injured women were significantly older (> 30 years). When viewed in relation to location, day and hour of injury, this finding demonstrates the sharp difference between the vulnerability of both genders. Men were most frequently injured in the street, on weekends and during night hours [19]. Our study clearly showed that only 5.8% of males were stabbed at home compared to 48% among women. Such domestic violence against women was found equally distributed on all days of the week. We assume that the real rates of this interpersonal violence are even higher. Since stabbing injuries at home are frequently caused by family members or roommates, some women may be reluctant to go to emergency departments with minor injuries. However, despite providing important information on the context of the violent attack, these differences do not explain the gap in injury severity. We believe that the vast differences that we found between the injury patterns in both genders could account for the disparities. The most striking difference was the targeted body site. Despite the similar proportions of chest and neck injuries (site of organs most vulnerable to penetrating trauma) [8,10], women had a significantly higher percentage of face and head injuries, especially severe head injuries. While face injuries represent a common pattern of violence against women, a stabbing-related traumatic brain injury (TBI) may suggest use of improvised weapons, such as meat choppers, axes, and screwdrivers [20]. Such tools are readily available at home in addition to all-purpose kitchen knives, and their use against women has been reported previously [4,8,12].

Although the incidence of abdominal injuries was similar in both genders in our study, their severity in women was significantly higher. This may be explained by the unequal terms of the altercation: while men are more likely to sustain penetrating

abdomen injuries when facing the opponent and actively resisting, women are more likely to be brought to the ground and therefore less likely to prevent multiple attacks to the center of mass. The higher incidence of multiple injuries and the greater proportion of wounds to the upper extremities among female patients, found in our study, corroborate this finding [6,14].

When all the differences in injury-related factors were adjusted for in a logistic regression equation, gender remained a significant predictor of injury severity, with female patients 1.6 times more likely than men to have an injury with ISS of 16 and higher. As expected, injuries of the head, chest and abdomen contributed most to higher injury severity [8,21]. Unexpectedly, after adjustment by other factors, a higher number of injured body sites, naturally associated with higher ISS due to the method of its calculation [22], was not found to be a significant risk factor for stab wound severity. It would seem that the patient's gender and the exact location of injuries on the body are more important in defining a profile of attacks with sharp weapons [22]. The ethnic background of the victims was also not a definitive factor, suggesting that gender boundaries are sometimes more definitive than ethnic and racial ones [9,23].

Due to their greater severity of stab wounds, women in our study consumed more hospital resources, undergoing more surgeries, entering the ICU more frequently, and staying longer in the hospital. This suggests that despite previously published claims of women's lower access to trauma care [24], in our study the amount of treatment was in direct proportion to the clinical presentation. The higher in-hospital mortality of female patients in our study is also interesting as it contradicts the previously accepted survival advantage of women after trauma [23,25].

Having established the role of the victim's gender on the severity of stab wounds, we attempted to analyze the effect of the injury profiles of patients of both genders on mortality beyond injury severity. For that task we performed a logistical regression predicting mortality by the injured body site (separately for both genders) exclusively among patients with ISS 16+, adjusting for the victim's age and the number of injured body sites. Several unexpected patterns emerged from the analysis, justifying its rationale. Firstly, among women, injuries to the head, chest and abdomen proved to be non-significant, clearly suggesting that these wounds contribute to mortality directly through higher injury severity. Among men, on the other hand, sustaining a chest injury increased the odds of lethal outcome by more than 1.7 times. A potential explanation is that injuries to major blood vessels, located in the chest, had a profound and immediate impact on men's ability to defend themselves from further attacks [10,20]. The mitigating effect of upper extremity injuries on mortality, also found among male patients, strengthens this explanation – in many cases these injuries could be considered “defensive wounds” sustained during attempts to deflect the penetrating object from striking the body's critical areas [20]. Among women, “defensive injuries” had no influence on

survival, emphasizing their lesser ability to defend themselves against an armed attacker. On the other hand, sustaining a lower extremity injury was found to be highly predictive of mortality among severely injured female patients, indicative of the influence of being unable to escape the attacker.

LIMITATIONS

The main limitation of our study is the inclusion criteria of the Trauma Registry. Since the Registry only includes patients who were hospitalized, our results could not be generalized to clinical assessment and interventions on the scene. Our focus in this study was therefore only the hospitalized victims of stabbing. This inclusion criterion may potentially create another limitation: the non-inclusion of stabbing victims who died at the scene or on their way to the hospital, and the mild penetrating wounds that did not require hospitalization. However, since we focused specifically on the differences between the two genders in a hospital environment and not on the population level, this could be considered a minor limitation.

CONCLUSIONS

A greater proportion of severe head and abdomen injuries is the most important predictor of greater severity of stabbing attacks against women. Their lesser ability to defend themselves, signified by distinctive patterns of extremity injuries, is an important factor explaining the difference in their injury patterns compared to those of male stabbing victims.

Correspondence

M. Rozenfeld

National Center for Trauma and Emergency Medicine Research, Gertner Institute, Tel Hashomer 52621, Israel

Phone: (972-3) 535-4252

Fax: (972-3) 535-3393

email: michaelr@gertner.health.gov.il

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“The tragedy in the lives of most of us is that we go through life walking down a high-walled lane with people of our own kind, the same economic situation, the same national background and education and religious outlook. And beyond those walls, all humanity lies, unknown and unseen, and untouched by our restricted and impoverished lives”

Florence Luscomb (1887–1985), American architect and suffragist