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Lethal injuries in single stabs to the trunk – A study on homicides and suicides in Sweden

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ABSTRACT

Introduction: Homicides using knives or other sharp objects are the most common type of homicide in Europe, and the second most common type of homicide worldwide. In contrast, suicides using sharp objects are rarer, constituting only a few per cent of all suicides in western countries. We investigated single stab injuries to the trunk in both homicides and suicides to assess differences in extent of injuries and in medical care, which could be of value for trauma management, public health and forensic assessment.

Methods: We identified all cases in Sweden between 2010 and 2021 that died of a single stab to the trunk, in either a homicide ($n = 94$) or a suicide ($n = 45$), and that were the subject of a forensic autopsy. We obtained data on demographics, hospital care and injured structures. To assess the severity of injuries, we applied AIS (Abbreviated Injury Score) and NISS (New Injury Severity Score). The inter-rater reliability of NISS between two raters was evaluated with intra-class correlation (ICC), with 95 % confidence intervals (CI). The data was analysed using Fisher's exact test, Mann-Whitney U test and logistic regression models.

Results: The inter-rater reliability between the two NISS raters showed an ICC of 0.87 (95 % CI 0.68–0.95). We observed a larger variation of injuries in suicides, with a higher proportion of both unsurvivable (NISS 75) and minor injuries (NISS $\leq$ 8) (66.7 % and 8.9 % respectively) compared to in homicides (46.8 % and 0 % respectively). We observed a larger proportion of injuries to the heart in suicides (68.9% vs. 46.8 %, $p = 0.018$). In homicides, injuries involving vessels (52.1% vs. 13.3 %, $p < 0.001$) and hospital care (56.4 % vs. 8.9 %, $p < 0.001$) were significantly more common compared to suicides.

Discussion and conclusion: Causation (self-inflicted or assaults) seems to be associated with characteristics of injury and the likelihood of receiving hospital care. These findings could potentially be valuable for trauma management and forensic assessment of manner of death, however, determining the mortality of the injuries would require a comparison group comprising injured survivors.

Introduction

In Europe, the most common homicide is by means of a knife or another sharp object, accounting for almost 40 % of all homicides [1,2]. However, Sweden, Italy, Croatia and Greece are exceptions to this, with the use of firearms predominating in recent years [3]. This is more reflective of the global situation, where the use of sharp objects is the second most common mode surpassed by the use of firearms [4]. In cases of suicides, use of sharp objects constitutes just a few per cent of all suicides in Anglo-Saxon countries [5,6]. Nevertheless, patients with self-inflicted sharp force injuries constitute a substantial rate (15–24 %) of all injured patients due to sharp force in a trauma setting [7–9].

There are a small number of studies comparing the severity of internal injuries between homicidal and suicidal sharp force fatalities

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[10–12]. To capture the severity of injuries, the Injury Severity Score (ISS) is applied in both the trauma-setting and in research. Homicidal sharp force injuries have been observed with a higher mean ISS compared to suicidal injuries [11], with lethal injuries most commonly in the thorax and back, and with significantly more injuries to heart, lungs and thoracic vessels [10,12]. Sharp force injuries in suicides generally have a lower ISS [11], with lethal injuries mostly in the vasculature in the neck or upper extremities [10,12]. Similar differences in ISS and anatomical distribution of injuries have been observed in trauma settings between patients with stab injuries in assaults and patients with self-inflicted stab injuries [7–9]. However, it has not been observed that this difference translates into differences in mortality [7–9], in rates of surgical treatment [7,8] or in length of hospital stay [7–9]. The skewed distribution of ISS between assaults and self-inflicted sharp force injuries might be explained by more injuries per victim, and a higher ratio of stab wounds in relation to incisive wounds in homicides [10–12].

To exclude potential confounders, e.g. varying numbers of stab wounds in different anatomical locations, we studied an autopsy population that died in a single stab to the thorax and/or abdomen. As the severity of sharp force injuries seems to be associated with causation of the injuries, i.e. assaults or self-inflicted, the severity might conversely be used to assess the manner of death in the forensic setting. In addition, information on the causation might provide knowledge for the trauma assessment regarding which injuries that might be expected. The aim of this study was to study lethal injuries in single stabs to the trunk, and to investigate differences in injured anatomical structures, injury severity and hospital care between homicides and suicides in single stabs to the trunk.

Materials and methods

Study population

We identified homicidal and suicidal deaths due to a single stab to the trunk that were registered in the autopsy register kept by the Swedish National Board of Forensic Medicine between 2010 and 2021. The selection from the autopsy register is described in detail in a previous study based on the same population [13]. A total of 139 cases were included, comprising 94 homicides and 45 suicides.

Collection of variables

Data on demographics, internal injuries and medical care were extracted from autopsy reports, as well as paramedic and medical records available in the autopsy register.

Age in years was included as a continuous variable and also categorized into (i) <50 years old and (ii) >=50 years old.

Sex was defined according to the designation in the autopsy report's background information.

The stab injuries were categorized in terms of involvement of (i) thoracic, (ii) abdominal or (iii) thoracic and abdominal cavity.

Injured organs and vessels were partitioned into involvement of (i) heart, (ii) vessel, (iii) lung (right and/or left), (iv) liver, (v) pancreas, (vi) spleen, (vii) urogenital system and/or (viii) stomach and intestines.

Cardiac injuries were partitioned into (i) right ventricle, (ii) left ventricle, (iii) ventricular septum, (iv) right atrium or (v) left atrium. The specific location of the injury was defined depending on where the stab wound entered the heart and, if the wound overlapped more than one location, the location of the greater part of the wound was specified.

Injuries to named vessels described in the autopsy report were defined. If more than one vessel was injured, the injury to the largest vessel was specified.

The severity of the stab injuries was scored using the Abbreviated Injury Score (AIS) from 2005, as recommended and adopted by the Swedish Trauma Registry (SweTrau). The three highest scores within each case were documented in order to calculate the New Injury Severity Score (NISS) ($AIS^2 + AIS^2 + AIS^2 = NISS$), regardless of body region [14]. The score was categorized into intervals of (i) minor ($NISS \leq 8$), (ii) moderate (NISS 9−15), (iii) severe (NISS 16−24) and (iv) critical injuries (NISS 25−75). The division (i) potential survivable ($NISS < 75$) and (ii) unsurvivable (NISS 75) was also defined.

The injuries were rated according to NISS by the first author who is a resident doctor in forensic medicine. Twenty cases were randomly selected to be rated according to NISS by a second rater who is a co-author and a doctor with a specialist degree in emergency medicine. After the first inter-rater reliability assessment, we discussed the scores that differed. We consulted an AIS instructor from the Swedish trauma register to define consistent criteria for injuries involving the heart. A stab wound entrance of 1 cm or more rendered an AIS score of 5 for atrial ruptures and an AIS score of 6 for ventricular ruptures. Detailed descriptions of the defined criteria for all the AIS codes used are presented in supplementary Table S1 and Table S2. The initial scores were changed according to these agreed definitions and a second inter-rater reliability assessment was performed with 20 other cases.

The anatomical structures injured were also categorized according to the highest AIS score for every stab injury in order to present the most severely injured structures. In cases where the highest AIS score was equal for more than one structure within the stab injury, a ranking was applied, primarily presenting injuries to the heart, secondly injuries to vessels, thereafter injuries to the lungs and finally abdominal organs. The anatomical structures were categorized as follows: (i) ventricular or atrial wall of the heart, perforation, or rupture (ii) superficial heart injury without chamber involvement, (iii) thoracic vessels, perforation, (iv) lung laceration(s), (v) pleura perforation with pneumothorax, (vi) abdominal vessels, (vii) liver laceration, (viii) stomach or intestinal perforation, (ix) peritoneal perforation without organ or vessel injuries.

Contributing causes of death were registered as listed by the forensic pathologist in the autopsy report, including diseases, inebriation and other injuries caused by incisive or blunt trauma.

Medical care was categorized into: (i) hospital care with medical/interventional therapy, (ii) ambulance care without interventional therapy or (iii) no medical care in cases where the body was found with signs of death (postmortem rigidity, lividity and/or putrefaction). Victims who were declared deceased at the hospital before receiving any interventional therapy were categorized as receiving (ii) ambulance care.

The time frame from the emergency call to the arrival at the hospital was collected from ambulance records.

Medical interventional therapy was categorized into (i) thoracotomy and/or laparotomy or just (ii) blood transfusion and/or thoracic drainage with no extensive surgery.

Length of hospital stay in days was included as a continuous variable.

Statistics

The data analyses were performed using IBM SPSS Statistics Premium 28. Categorical variables were analysed using Fisher's exact test to illustrate differences between homicides and suicides, as well as between subjects who had received hospital care and those who had not. Continuous variables were compared between groups using Mann-Whitney U test. To analyse differences in NISS and categories of NISS between the two groups, a logistic regression model was performed that was adjusted for victims aged below 50 years old and sensitivity analysis excluding contributing causes of death.

The inter-rater reliability of NISS between the raters was evaluated by means of a random sample of 20 individuals, with intra-class correlation (ICC) with 95 % confidence intervals (CI). An ICC of > 0.7 was considered acceptable [15].

Results

Study population

The population consisted of 94 homicide victims and 45 suicide victims, with the majority of victims being male (Table 1). The homicide victims were significantly younger ($p < 0.001$). Five victims had contributing causes of death, such as influence of amphetamine, alcohol inebriation, pneumonia, flail chest caused by blunt violence and incisive injury with damage to superficial muscles of the forearm.

Body cavity penetration

Most stab injuries penetrated the thoracic cavity, with a similar distribution between homicidal and suicidal stabs (67.0 % and 71.1 % respectively) (Table 2).

There was also an even distribution between homicidal and suicidal injuries penetrating the abdominal cavity (14.9 % vs. 8.9 %) and involvement of both thoracic and abdominal cavities (18.1 % vs. 20.0 %).

Organ and vessel injuries

Numerous injuries involved multiple organs and/or vessels. Stab injuries involving the heart were significantly more frequent in suicidal stabs compared to homicides (68.9 % vs. 46.8 %, $p = 0.018$) (Fig. 1). There was no significant difference in injury location within the heart between homicidal and suicidal stabs (Fig. 2). The right ventricle was the most frequent location of the entrance wound in both homicidal (43.2 %) and suicidal stab injuries (61.3 %), followed by the left ventricle, 38.6 % and 35.5 % in homicidal and suicidal stabs respectively. There were a few homicidal stab wounds entering the right (9.1 %) and left (4.5 %) atrium, but no such injuries were observed in suicidal stab wounds.

Injuries to vessels were significantly more common in homicides than in suicides (52.1 % vs. 13.3 %, $p < 0.001$) (Fig. 1). Vessel injuries in homicides primarily involved thoracic (30.6 %) and abdominal aorta (18.4 %), pulmonary artery (18.4 %) and vena cava superior and inferior ($n = 1$ and $n = 5$ respectively, in total 12.2 %) (Fig. 3). Vessel injuries in suicides involved thoracic aorta (33.3 %), coronary artery (16.7 %) and pulmonary artery (50.0 %).

There were no significant differences between homicidal and suicidal injuries in lungs, liver or pancreas (Fig. 1). No stab injuries were observed in the spleen or the urogenital system. Injuries involving stomach or intestines were significantly more common in homicides compared to suicides (18.1 % vs. 4.4 %, $p = 0.034$).

Table 1
Median age, sex distribution, cases with contributing causes of death in homicide and suicide victims from single stabs to the trunk.

	Homicides $n = 94$	Suicides $n = 45$	Difference
Males, n (%) Females, n (%)	87 (92.6) 7 (7.4)	37 (82.2) 8 (17.8)	$p = 0.082$
Age, median of years (range)	33.0 (15–84)	52.0 (15–90)	$p < 0.001$
Stabs as the only cause of death, n (%)	92 (97.9)	42 (93.3)	$p = 0.33$
Contributing causes of death, n (%)	2 (2.1)	3 (6.7)	

Sex distribution of the study population was presented in numbers and percentages and the difference between homicide and suicide was estimated using Fisher's exact test. Age was presented as median age (years) and range and difference between homicide and suicide was estimated using Mann-Whitney U test.

Table 2
Proportion of body cavity penetration in homicide and suicide victims from single stabs to the trunk.

	Homicides $n = 94$	Suicides $n = 45$	Difference
Thoracic cavity, n (%)	63 (67.0)	32 (71.1)	$p = 0.70$
Abdominal cavity, n (%)	14 (14.9)	4 (8.9)	$p = 0.42$
Thoracic and abdominal cavity, n (%)	17 (18.1)	9 (20.0)	$p = 0.82$

The division of cavities penetrated by the stab injuries was presented in numbers and percentages. The differences between homicide and suicide were estimated using Fisher's exact test.

Injury severity

The median NISS was 58 (IQR 34–75) in homicidal stab injuries and 75 (IQR 29–75) in suicidal injuries (Table 3). Unsurvivable injuries (NISS 75), including rupture of the ventricular wall of the heart, more than one perforation or the ventricular or atrial wall and perforation of the thoracic aorta with more than 20 % blood loss (Table S1), were significantly more common in suicidal stab injuries compared to homicidal injuries (66.7 % vs. 46.8 %, OR 2.3, 95 % CI 1.08–4.77). An even greater difference was observed when excluding cases with contributing causes of death and adjusting for age (OR 3.1, 95 % CI 1.4–7.2).

Most injuries were categorized as critical injuries (NISS 25–75), 93.6 % in the homicide group and 82.2 % in the suicide group. The severe and moderate injuries had an even distribution between homicidal and suicidal stabs (5.3 % vs. 6.7 % and 1.1 % vs. 2.2 % respectively). The category with minor injuries (NISS ≤ 8) was only represented by suicidal injuries, which differed significantly from the homicides (8.9 % vs. 0 %, $p = 0.010$).

The inter-rater reliability between the two NISS raters showed an ICC of 0.73 (95 % CI 0.32–0.89) after the first evaluation. After having decided on detailed definitions of the NISS codes (as seen in supplementary Table S1 and Table S2), the second evaluation presented an ICC of 0.87 (95 % CI 0.68–0.95).

Injuries through the heart wall were the most commonly damaged structures with the highest AIS score of stab injuries (Table 4). Such injuries were significantly more common in suicides compared to homicides (66.7 % vs. 43.6 %, $p = 0.012$). Injuries to thoracic vessels, more precisely thoracic aorta and pulmonary artery, constituted the most severely injured structures in 19.1 % of the homicidal stabs, significantly ($p = 0.021$) more prevalent than in suicidal stabs (4.4 %). Lung lacerations as the most severe injury were seen slightly more frequently in homicides, however the difference was not statistically significant (17.0 % vs. 13.3 %). There was only one injury to the thorax, due to a suicidal stab, which did not damage any thoracic organs or vessels, but perforated the pleura causing a pneumothorax. Stab injuries with damaged abdominal vessels were only observed in homicides (18.1 %). Stabs in which the most severe damage involved stomach with fatal bleeding or duodenum with intestinal leakage causing peritonitis ($n = 2$, 4.4 %) were solely seen in suicides. In addition, an isolated perforation of peritoneum or with perforation of omentum or mesentery ($n = 3$, 6.7 %), causing either bleeding or with intestines protruding from the wound in the anterior abdominal wall causing an incarcerated hernia, occurred solely in suicides.

Medical care

Homicide victims were brought to a hospital and subject to interventional therapy such as surgery, thoracic drainage and/or blood transfusion at a significantly higher frequency than suicide victims (56.4 % vs. 8.9 %, $p < 0.001$) (Table 5). Suicide victims were most commonly (55.6 %) found with obvious signs of death such as livores mortis, rigor mortis or cadaverositas. Thoracotomy and/or laparotomy were the most common interventions in both homicide and suicide victims (81.1 % and

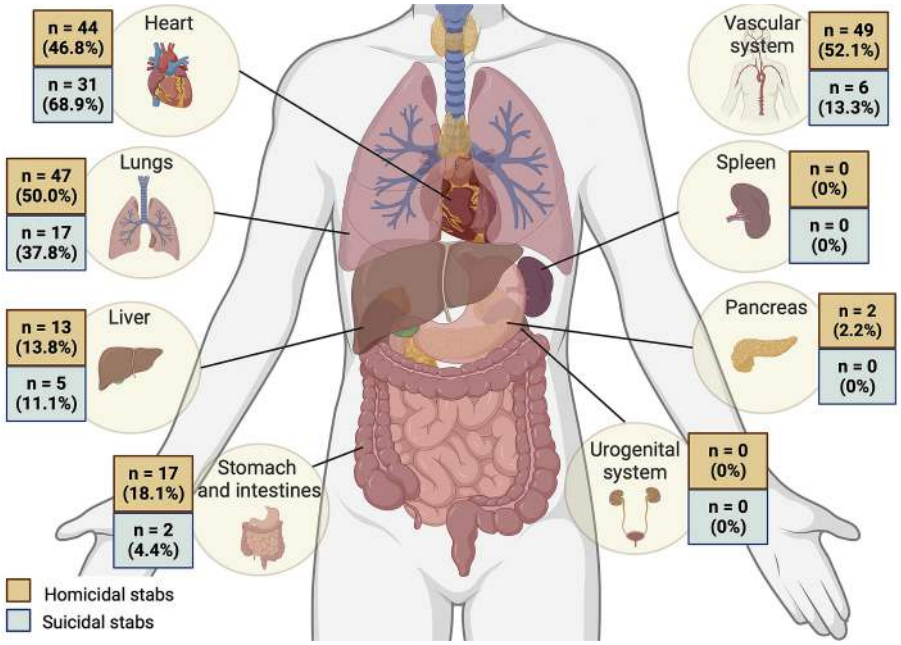

Fig. 1. Proportions of organ and vessel injuries in homicide and suicide victims from single stabs to the trunk.
Organs and vessels injured by the stabs were presented in numbers and percentages. The differences between homicide and suicide were estimated using Fisher's exact test. Stab wounds involving the heart ($p = 0.018$) were significantly more common in suicides, while injuries to vessels ($p < 0.001$) and to the stomach and intestines ($p = 0.034$) were significantly more common in homicides.

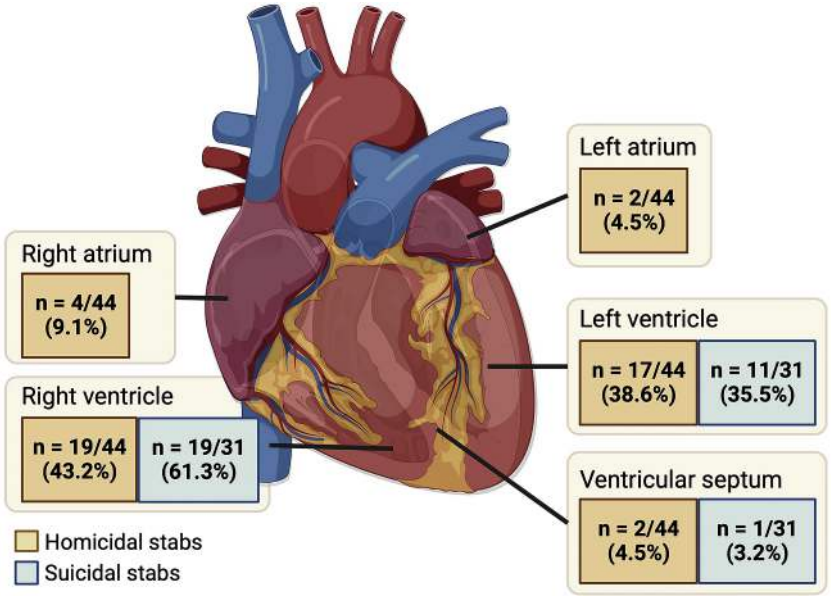

Fig. 2. Proportions of cardiac injuries in homicide and suicide victims from single stabs to the trunk.
Injuries to cardiac locations were presented in both numbers and percentages. The differences between homicide and suicide were estimated using Fisher's exact test. No significant differences were observed in the various locations of cardiac injuries between homicides ($n = 44$) and suicides ($n = 31$).

75.0 % respectively) receiving hospital care. The time frame from the emergency call until arrival at the hospital was 14 to 52 min in the homicide cases, however there was only one suicide case with this information (32 min). Those victims admitted to hospital died less than a day after arrival in 94.3 % of the homicides and 75.0 % of the suicides.

Differences between variables conditioned by hospital care

A higher proportion of males received hospital care than the proportion of women (96.5 % vs. 84.1 %, $p = 0.025$) (Table S3). In a logistic regression analysis adjusted for victims less than 50 years old, the association between males and hospital care was not conclusive. Victims who received hospital care were significantly younger than those who did not receive hospital care ($p < 0.001$). None of the victims with a contributing cause of death beyond the stab injury had received hospital care ($n = 5$).

There were no significant differences between the variables representing the severity of the stab injuries, such as NISS, the categories of NISS or AIS, between the groups of victims who received hospital care and those who did not receive hospital care (Table S3). Stab injuries

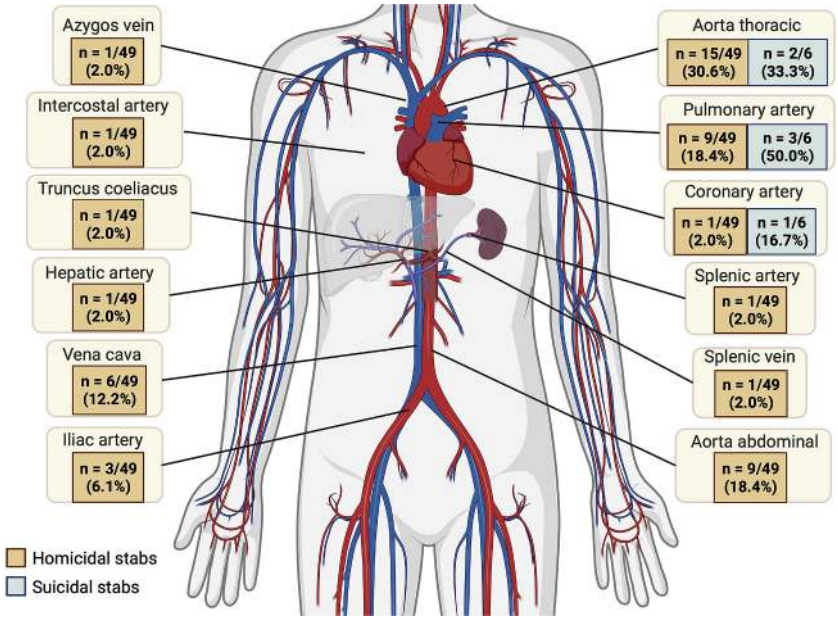

Fig. 3. Proportion of vessel injuries in homicide and suicide victims from single stabs to the trunk.
Injuries to specifically named vessels were detailed in both numbers and percentages. The differences between homicide and suicide were assessed using Fisher's exact test. No significant differences were found in the specifically named vessels between cases of homicidal vessel injuries ($n = 49$) and suicidal vessel injuries ($n = 6$).

Table 3
Median of New Injury Severity Score and proportions of its subgroups in homicide and suicide victims from single stabs to the trunk.

	Homicides $n = 94$	Suicides $n = 45$	Difference
NISS (median, IQR)	58, 34–75	75, 29–75	$p = 0.45$
Potential survivable injury (NISS < 75), n (%)	50 (53.2)	15 (33.3)	$p = 0.031$
Unsurvivable injury (NISS = 75), n (%)	44 (46.8)	30 (66.7)	
Critical injury (NISS 25–75), n (%)	88 (93.6)	37 (82.2)	$p = 0.066$
Severe injury (NISS 16–24), n (%)	5 (5.3)	3 (6.7)	$p = 0.71$
Moderate injury (NISS 9–15), n (%)	1 (1.1)	1 (2.2)	$p = 0.54$
Minor injury (NISS ≤ 8), n (%)	0 (0)	4 (8.9)	$p = 0.010$

NISS was presented in median and interquartile range (IQR) and difference between homicide and suicide was estimated using Mann-Whitney U test. Categorical variables were presented in numbers and percentages. The differences between homicide and suicide were estimated using Fisher's exact test.

Table 4
Proportions of the most severely damaged anatomical structures for every stab in homicide and suicide victims from single stabs to the trunk.

	Homicides $n = 94$	Suicides $n = 45$	Difference
Heart chamber, perforation or rupture (AIS 5–6), n (%)	41 (43.6)	30 (66.7)	$p = 0.012$
Superficial heart injury without chamber perforation (AIS 3), n (%)	0 (0)	1 (2.2)	$p = 0.32$
Thoracic aorta or pulmonary artery, perforation (AIS 3–6), n (%)	18 (19.1)	2 (4.4)	$p = 0.021$
Lung laceration(s) (AIS 3–4), n (%)	16 (17.0)	6 (13.3)	$p = 0.63$
Pleura perforation with pneumothorax (AIS 2), n (%)	0 (0)	1 (2.2)	$p = 0.32$
Abdominal aorta, celiac artery, splenic artery, iliac artery, vena cava, perforation (AIS 3–5), n (%)	17 (18.1)	0 (0)	$p = 0.001$
Liver laceration (s) (AIS 2–3), n (%)	2 (2.1)	0 (0)	$p = 1.00$
Stomach or duodenum perforation (AIS 2–3), n (%)	0 (0)	2 (4.4)	$p = 0.10$
Peritoneum, omentum or mesentery perforation (AIS 1–3), n (%)	0 (0)	3 (6.7)	$p = 0.032$

The division of damaged anatomical structures, arranged as categorical variables according to the highest AIS score for every stab injury, was presented in numbers and percentages. The differences between homicide and suicide were estimated using Fisher's exact test.

with perforation or rupture of the heart chamber (AIS 5–6) as the damaged structure with the highest AIS, were the most common stabs among both those who did (42.1 %) and did not receive hospital care (57.3 %).

In the group of victims who received hospital care, a non-significant higher proportion of victims with potential survivable stab injuries (NISS < 75) was seen (56.1 % vs. 40.2 %, $p = 0.08$) (Table S3), which showed a conclusive association when excluding the victims with contributing causes of death and adjusting for victims with an age below 50 years old (OR 2.42, 95 % CI 1.13–5.20). The group of victims below 50 years old was independently associated with hospital care in the adjusted model (OR 7.14, 95 % CI 2.81–18.13).

The victims with minor injuries (NISS ≤ 8) ($n = 4$) were in the age range of 34–73 years old, with one of these victims having a contributing cause of death and none of these victims receiving hospital care (Table S3). These victims had stabs in which the most severely damaged structures were pleura perforation with pneumothorax ($n = 1$) and perforation of peritoneum, duodenum or mesentery causing either bleeding or an incarcerated abdominal wall hernia ($n = 3$) (Table S4). There were a further three stab injuries in which the most severely damaged structures were observed exclusively in victims who did not receive hospital care, namely superficial heart injury without chamber involvement ($n = 1$) and perforation of stomach or duodenum ($n = 2$) (Table S3).

Table 5
Proportions receiving medical care, interventions and hospital stay in homicide and suicide victims of single stabs to the trunk.

	Homicides *n* = 94	Suicides *n* = 45	Difference
Hospital care with interventional therapy, n (%)	53 (56.4)	4 (8.9)	$p < 0.001$
Ambulance care with no medical intervention, n (%)	27 (28.7)	16 (35.6)	$p = 0.44$
Found with death signs, n (%)	14 (14.9)	25 (55.6)	$p < 0.001$
Time from ambulance call to hospital arrival, median of minutes (range)	30 (14–52)*	*	
Thoracotomy and/or laparotomy, n (%)	43/53 (81.1)	3/4 (75.0)	$p = 1.0$
Blood transfusion and/or thoracic drainage, but no surgery, n (%)	10/53 (18.9)	1/4 (25.0)	
Death < 1 day of hospital stay, n (%)	50/53 (94.3)	3/4 (75.0)	$p = 0.11$
Death >= 1 day of hospital stay, n (%)	3/53 (5.7)	1/4 (25.0)	

Variables involving medical care, interventional therapy and hospital stay were presented in numbers and percentages. The differences between homicide and suicide were estimated using Fisher's exact test. Time from emergency call to hospital arrival was presented as median of minutes and range.

* Cases with valid information were $n = 27$ among homicides and solely one case among suicides with 32 min of time from emergency call until arrival at the hospital.

Discussion

The study presented significant differences in the subgroups of NISS. Unsurvivable injuries (NISS 75) and injuries with perforation or rupture of the heart chambers (AIS 5−6) were significantly more common in suicides. As suicidal stabs were predominantly located on the left side of the anterior thorax [13,16–18], we could speculate that suicidal individuals directed the stabbing with the intention to injure the heart in order to achieve a fatal outcome. The right ventricle of the heart was the most frequent location of the entrance wound in both homicidal and suicidal stab injuries. As the right ventricle normally constitutes the bulk of the heart surface located at the front of the body, these results were not surprising. The small number of suicidal stabs that caused damage to vessels, injured vasculature in or near the heart (thoracic aorta, coronary and pulmonary artery), could also be explained by the victims aiming to stab the heart. Factors such as hesitation or less forceful stabs in self-stabbing could possibly explain the paucity of vessel injuries in suicides, as the large vessels are located deep inside the trunk and are difficult to reach with superficial stabs to the frontal trunk. In contrast, homicide victims who had a strong predominance of vessel injuries, primarily involving the aorta (AIS 4−6), also resulted in a high overall NISS which could explain why the mean NISS did not differ significantly between homicides and suicides.

That being said, our study results did not confirm previous studies suggesting an overall higher severity (mean ISS) in stab injuries caused by assault compared to self-inflicted injuries [7–9,11]. However, we minimised confounding factors such as multiple injuries and diversity of anatomical location by including a population with single stab injuries to the trunk. This implies that the higher severity of homicidal stab injuries in previous studies [7–9,11] was a consequence of a higher number of stab wounds, and more frequently to vital parts of the body [10,12]. Hence, our study population is more homogenous in the injury distribution, than what has been the case in the previous studies.

However, minor injuries (NISS ≤ 8), such as, injuries to peritoneum, duodenum, mesentery or pneumothorax, were exclusively present in suicide victims who did not receive hospital care. The victims of these stab injuries would most likely not have died suddenly, and possibly if having received emergency care, similarly to victims of assault, they could have survived the stab. This observation is supported by previous studies in a trauma centre setting which have shown that self-inflicted stab injuries to the abdomen are less severe than stabs due to assaults [19,20]. However, these studies also demonstrated that there was no significant difference in mortality between self-inflicted abdominal injuries and those caused by assault in patients treated in a trauma centre, indicating that the majority of these victims survive when treated with surgical intervention [19,20].

Even though urgent trauma care is a critical factor for surviving penetrating injuries [21], to our knowledge, there are no previous studies comparing assaults and self-inflicted sharp force injuries regarding the frequency of receiving hospital care. Furthermore, epidemiological research on trauma patients rarely includes both patients admitted to a hospital and those who were sent directly to a forensic institution [22]. A minor proportion of suicide cases in our study received hospital care, most of these victims would therefore not have been detected and included in studies with populations from a trauma centre setting. Such studies might consequently underestimate the burden and severity of self-inflicted sharp force trauma, and thus not provide the appropriate context when assessing the public health importance. Our findings, on which potentially fatal organ and vessel damage that are most commonly found in stab injuries, could be useful for trauma surgeons when performing explorative surgery in the emergency setting. Especially, the study might raise some awareness of internal injuries in cases of self-inflicted potentially fatal stab injuries to the trunk, as indicated by our study results, rarely are seen in a hospital setting.

According to previous studies, a large proportion of the victims were influenced by alcohol or narcotics at the time when the trauma occurred, indicating possible underlying abuse of substances/alcohol [13,22,23]. Hence, our results could further emphasize the importance of treating abuse to prevent assaults and self-harming behaviour. They also confirm the requirement for alcohol and drug screening as a routine in trauma management programmes [22].

Strengths and limitations

A strength of our study is the nationwide autopsy population based on data from the Swedish National Board of Forensic Medicine. In comparison to similar research [1–4], we had access to more detailed information from the autopsy reports such as contributing causes of death, all injured structures and the interventional hospital care. Furthermore, unlike previous studies based on data from trauma registers, we included both victims that died during hospital care and victims who were found dead at the scene and transported directly to a forensic unit.

To name a few limitations, the study is based on a small population with just 139 cases between 2010 and 2021, resulting in a low statistical power in some of the analyses. Additionally, as the study is based on an autopsy population, we did not have a comparison group with victims who survived stab injuries to determine the mortality of the injuries. Instead, we used the scoring systems AIS and NISS to define the severity of the stabs. When using NISS instead of the original ISS scoring system, an improved calibration of mortality has been shown, especially in patients with multiple serious injuries in the same body region [14]. These scoring systems are based on anatomic injuries [14], which do not involve other known predictors of survival such as physiological derangement caused by the injury, as well as age and comorbidity of the victim [24]. As our study is retrospective and limited to data obtainable from the autopsy registry, which has sparse information about physiological derangement and comorbidity, these variables were not included. However, we still performed analyses adjusting for age and sensitivity analysis excluding contributing causes of death. The satisfactory results of inter-rater reliability assessment of NISS were another strength.

We are also aware that circular reasoning could potentially be introduced as the manner of death is based on the determination of the forensic pathologists who in turn have based their statements on autopsy findings together with background information from the police reports. On the other hand, forensic pathologists are experts in determination of manner of death using the current state of knowledge for their assessments. In Sweden, all such assessments are made by two physicians, at least one of whom is a certified forensic pathologist.

Conclusion

There seems to be an association between causation (self-inflicted or in an assault) of the stabs and injured anatomical structures, which in turn determines the likelihood of surviving the stab. Additionally, if hospital care was received seems to be associated with the causation of the stab injury, since it was exclusively self-inflicted untreated minor injuries that ended up in the autopsy room. These results might be of value for trauma management of stab cases, public health, as well as for the forensic assessment of the manner of death. However, determining the mortality of the injuries would require a comparison group of injured survivors.

CRediT authorship contribution statement

Maria Berg von Linde: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Stefan Acosta:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Ardavan M. Khoshnood:** Writing – review & editing, Validation, Formal analysis, Conceptualization. **Carl Johan Wingren:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.111694.

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