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Case Report

Homicide-suicide as domestic violence: A case report with a little literature review

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ABSTRACT

The focus is on unnatural death in forensic pathology including criminal death. One special field is the murder-suicide or homicide-suicide. It is a relatively rare occurrence worldwide mainly with male perpetrators and female victims. The authors report a case about a special type of homicide-suicide which is so-called intimate partner homicide (femicide)-suicide in which the victim was a 42-year-old woman with more than 55 incised-(cuts, stabs, etc.) and blunt force injuries with external examination. The resuscitation was unsuccessful by the paramedics. Not one of the wounds was incompatible with life, some of them had life-threatening conditions, and numerous self-defense type of wounds were observed. Not so far from the crime scene, the 48-year-old perpetrator's hanging corpse was found on a high voltage electric column who previously committed suicide, talked to one of his daughters from his first marriage, left money at his funeral, and asserted he would not have gone to prison again. The authors compared this case with the international literature data.

1. Introduction

Hungary played a significant role in the high prevalence of suicide during the communist era, prior to 1989. Currently, the country ranks in the middle range globally for both suicide and homicide rates. Homicide-suicide acts represent one of the less common forms of violent death in Hungary. According to Hungarian law, in all cases where there is a suspicion of unnatural death, a medico-legal autopsy must be performed. This legal requirement ensures that thorough investigations are conducted to determine the cause and manner of death, contributing to a comprehensive understanding of violent and suspicious deaths in the country. One of the subgroups is ostensible non-criminal death (e.g. accidents, suicide, sudden death), and another is a suspicious crime [1]. In the University of Debrecen, Institute of Forensic Medicine, Hungary 1216 autopsies were performed in 2022, including 748 because of suspicion of unnatural death (service territories are Hajdú-Bihar county (No. of inhabitants: 519.141 in 2022) and Szabolcs-Szatmár-Bereg county (No. of inhabitants: 529.381 in 2022)). Hence, the latest prevalence is 71,3 /100.000 [2]. Homicide-suicide or dyadic death is a special form of fatal violence in which the perpetrator kills his/her sacrifice without permission and generally within a short time or immediately after (within 24 h) the perpetrator enacts suicide but sometimes it takes several days or months. Still, the latest has a rare occurrence [3–5]. This is not equal to the pact suicide where two or more individuals conversely agree together about the implementation of the suicide [6]. Intimate partner femicide-suicide (IPF-S) or uxoricide-suicide is a specific form of suicide-homicide when a perpetrator mainly is a husband/ex-husband, love interest, a refused would-be partner or lover of the victim [4,7]. According to international data, firearms or gun has a leading role in both homicide and suicide acts, especially in cases with multiple victims [8–10]. Men made up most of the murderers and the victims were mostly women. The most common crime scenes were the killers' or the victims' homes typically in single murders [5,11,12].

2. Case report

According to the investigational data, an assaulted 42-year-old woman victim was found at her home in the garden (Fig. 1). She was hurt by her companion with an iron rod and stabbed and slashed multiple times besides other incised injuries. The 28-minute duration of professional reanimation by the paramedics was unsuccessful. The 48-year-old murderer committed hanging and he was found a little short

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Fig. 1. a and b The victim on the crime scene after CPR (cardiopulmonary resuscitation).

way off the venue (Fig. 2). Their common two children were eyewitnesses, the senior sibling (a 10-year-old boy) also suffered defense-type injuries on the dorsal side of the III-IV—fingers of the left hand. The perpetrator made a call to one of his children from his first marriage before his suicide to report his act. In pursuance of other witness testimony, the couple's relationship was so hectic, the man was so jealous (this was a problem in his first marriage also) and doper and hence, we had to extend our toxicology examinations to drugs including synthetic cathinones, synthetic cannabinoids which are very popular in Hungary.

3. Autopsy findings of the victim

Two days postmortem, a medico-legal autopsy was conducted, prioritizing the external examination more than a standard clinical-pathological autopsy would. The clothing had been removed earlier by paramedics and law enforcement at the crime scene. Identification confirmed the body of a female victim, whose corpse was notably contaminated with dried blood, obscuring the cadaveric lividity, with rigor mortis present. The corpse measured 172 cm in height. The scalp's hair characteristics could not be determined due to over 55 external injuries, including an extensive incised wound. Defensive wounds were identified in 28 locations, with active injuries noted on the palmar surfaces and inter-digital areas, and passive defensive wounds on the dorsal surfaces, primarily along the ulnar side of the forearms and the elbow regions [13], (Fig. 3). These injuries included cuts, slashes, and stabs accompanied by blunt force trauma.

The identified fatal wound was a stab injury in the thoracic region, located 121 cm from the soles and 5 cm to the left of the midline, directly beneath the lower quadrant of the left breast. This injury, oriented nearly perpendicularly to the body's frontal axis, measured 46 mm in

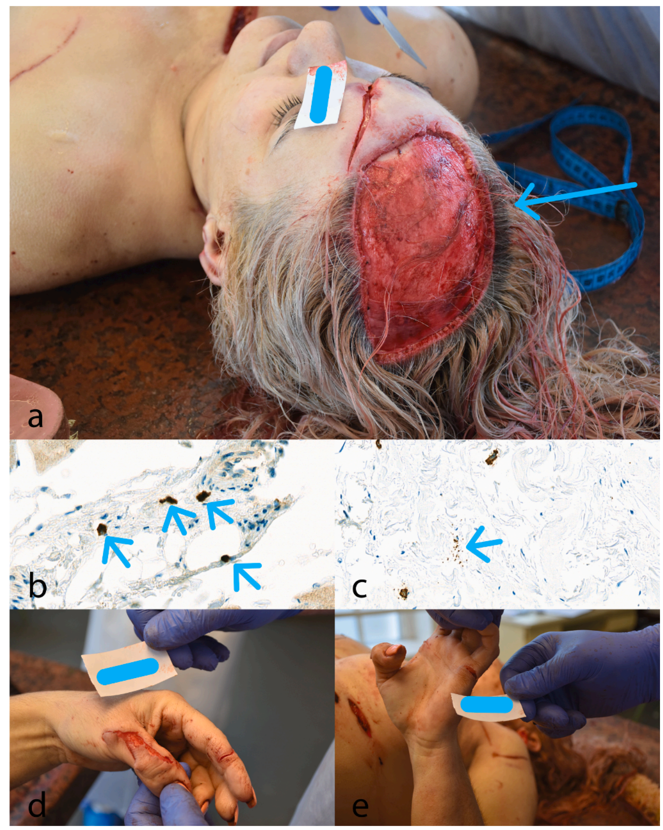

Fig. 3. a: Serious scalp injury of the victim (arrow). b: The presence of CD15-positive cells (arrows) at the wound margin (x40). The threshold is 2/10 hpf (high-power field) to prove the vitality. c: Mast cells and increased degranulation (arrow) at the scalp wound margin with tryptase immunohistochemistry (x40). d and e: Some self-defense wounds (cuts) on the left hand.

Fig. 2. a The corpse of the perpetrator after CPR with electrodes. The Paramedics considered when he was found that he was in a clinical death stage. At that moment no early changes of death were observed. b: High voltage electric column, as a place of the hanging, with a closer look of the equipment (arrow).

entry length, with a laterally sharp edge and a rounded medial margin, indicating a single-edged weapon. Sequential dissection followed the stab trajectory, which progressed left to right, caudocranially and anteroposteriorly, penetrating the intercostal muscle between ribs V-VI, then entering the pericardium at the apex of the heart, damaging the anterior wall of the right ventricle near the lateral margin (margo), extending below the anterior papillary muscle attachment (Fig. 4). The stab track length was estimated at 11.5 cm.

On the posterior neck, two almost parallel, perpendicular incised wounds were observed, 13 cm and 15 cm long, reaching the skull base at the foramen magnum (Fig. 5). Histopathological analysis, using hematoxylin-eosin staining, CD15, and tryptase immunohistochemical reactions, confirmed the absence of vital reaction consistent with witness reports indicating these were chronologically the last inflicted injuries. Further significant findings included multiple superficial stabs to the face and head, multiple thoracic stabs without organ involvement, substantial hemothorax and hemopericardium, lung collapse, blood and gastric content aspiration into the airways, and a neck stab wound penetrating the trachea. A depressed skull fracture was located in the left frontal bone, accompanied by linear fracture lines and extending into the left middle cranial fossa (Fig. 6a). The fracture track terminated externally, 2 cm below the left auricle, with an entry wound located 158 cm from the soles, measuring 2.5 cm in length. In the left middle cranial fossa and temporal bone area, a subdural hematoma was also noted (Fig. 6b). Contusions were present on both frontal lobe poles, the basal surface of the right frontal lobe, and the left temporal lobe, measuring 1.5–4 cm, along with generalized brain edema and subarachnoid hemorrhage (Fig. 6c).

In addition, moderate generalized atherosclerosis and left ventricular hypertrophy were present as natural disease findings.

Histological analysis revealed erythrocyte infiltration and interrupted tissue continuity in the skin and heart muscle at the lethal stab wound site, indicating a vital reaction. The result of CD15 and tryptase immunostaining also supported the wound vitality. Additional findings included pericellular brain edema, alveolar aspiration in the lungs, and minor fatty degeneration in the liver.

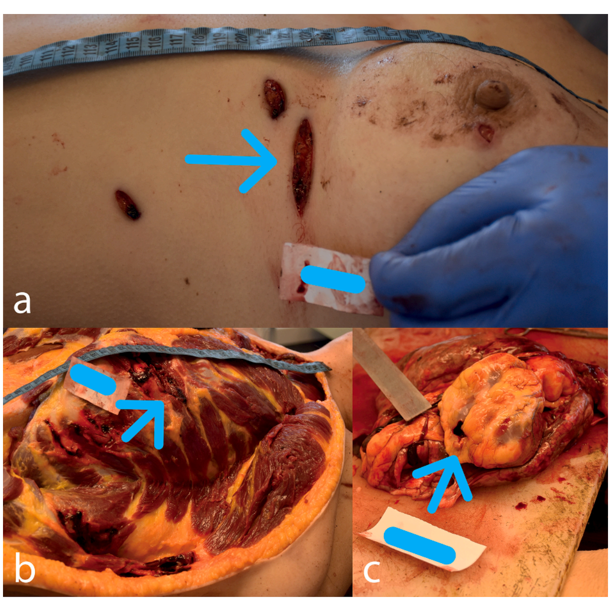

Fig. 4. The lethal stab wound on the left side of the thorax. A layer-by-layer autopsy method was applied to follow the stab channel. a: Entry wound of the stab on the skin (arrow). b: Intercostal muscle, as the next level of the stab channel with bleeding, as a sign of vital reaction (arrow). c: Continuity interruption of the heart's right ventricle (arrow).

Fig. 5. Serious incision injuries of the nuchal region without marked macroscopical and microscopical vital reactions.

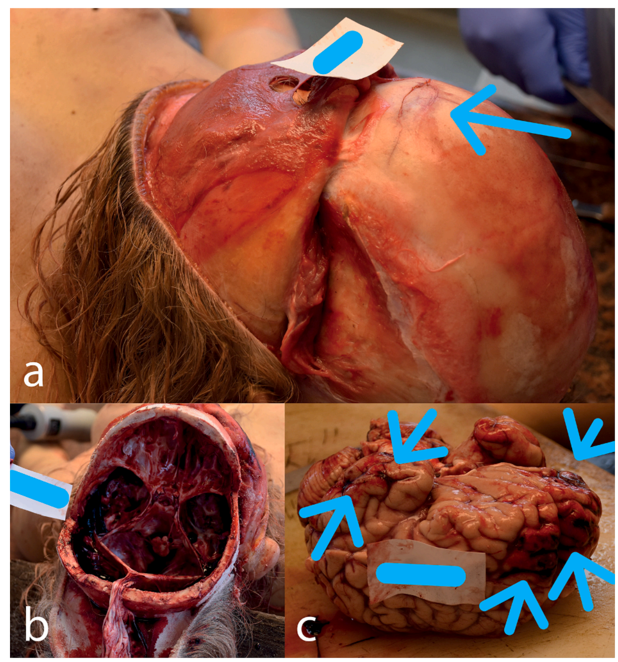

Fig. 6. a: Impression fracture of the frontal bone (arrow). b: Presence of subdural hematoma. c: Multifocal brain contusions (arrows).

4. Toxicological findings of the victim

GC (gas chromatography), GC–MS (gas chromatography-mass spectrometry), and chromatographic immunoassay rapid drug tests were applied. Urine and blood samples were examined, and yielded negative findings, there was no alcohol nor the presence of commonly tested drugs.

5. Autopsy findings of the perpetrator

The perpetrator committed suicide by hanging, using a rope attached to a high-voltage electric column, and was found suspended in the vicinity of the crime scene, approximately a few hundred meters away. The post-mortem examination was conducted 4 days after death, during which time the body had been stored in a mortuary refrigerator at 4 °C. The post-mortem examination began with the identification of the deceased and proceeded with the external examination. The body length measured 187 cm. Cadaveric lividity with imbibition was observed and rigor mortis was present throughout the entire body. The hands were contaminated with dried blood and scratches and bruises were observed across the body. The incomplete hanging mark on the neck was split before the right ear measuring 6 cm in total. One branch extended 4 cm behind the ear, while the other branched 2 cm downward towards the chin area (Fig. 7a and b). It extended beneath the chin and left ear by 4 cm and 7 cm respectively. The mark was parchment-like in appearance, with a width ranging from 10 to 16 mm and a maximum depth of 1–2 mm. A layer-by-layer dissection was performed in the neck region as a specialized technique following the removal of the brain and heart. A hemorrhage measuring 1 cm in diameter was identified in the lower part of the left sternocleidomastoid muscle, and on the right side, at the muscle's attachment of the clavicle, so-called insertion bleeding was discernible. The lungs were swollen with signs of minimal edema, and subpleural petechial hemorrhages were observed. The superior horns of thyroid cartilage were disrupted accompanied by surrounding hemorrhage in the soft tissues and at the fractured ends (Fig. 7c). Congestion of the internal organs and the face was also noted, accompanied by signs of cyanosis. The capsule of the spleen appeared wrinkled, and brain edema was observed.

Moderate general atherosclerosis and fatty degeneration of the liver were diagnosed as an incidental finding. Serial rib fractures were observed on both sides at the midline level of the clavicles, with patchy blood infiltration around some fractured ends. These findings were considered to be the results of the resuscitation attempts.

Histological examination revealed acute emphysema of the lung, moderate fatty degeneration of the liver, and mild pericellular brain edema.

6. Toxicological findings of the perpetrator

GC, GC–MS, and UHPLC-MS/MS (ultra-high performance liquid chromatography-tandem mass spectrometry) methods were applied. In the urine and blood sample, with GC–MS, 3-CMC (3-chloromethcatinon, clophedrone) was observed. Toxicological analysis precluded the presence of alcohol or other tested substances.

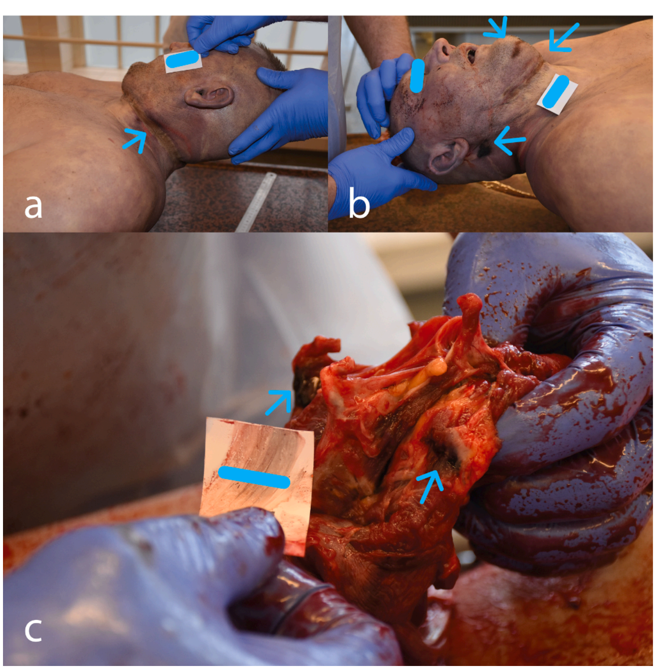

Fig. 7. a: The perpetrator's hanging mark (furrow) from the left side (arrow). b: The perpetrator's atypical –opened, partly doubled- hanging mark from the right side of the neck (arrows). c: Fractures of the thyroid cartilage superior horns with bleeding into the surroundings (arrows).

7. Discussion

According to the international data and our single institute experience, homicide-suicides are a heterogeneous phenomenon a lot of times among family members, so it is mainly a„family matter". The intimate partner homicide-suicides have the greatest incidence, it is followed by the filicide-suicide when a parent kills his child, and matricide or parricide-suicide when a child takes his mother or father's life. To be involved in this act a wider family relationship is not as frequent nor outside the family sphere [5]. „Adversary" homicide-suicides means when an ex-partner kills the new partner of his/her ex [14]. Sometimes multiple homicides overtake the committed suicide.

In Europe, the homicide-suicides rate is evaluated as 0,04–0.16 per 100.000 inhabitants as the average in the United States is 0.2. and 0.3 per 100.000 inhabitants, albeit Florida-specific data between 1998–2004 was as high as 0.7 [15,16]. In the United States and also in several European countries, firearm usage in both homicide and suicide acts is significant and represents a huge part of dyadic death but not in our region or in Hungary itself. One of the explanations is strict firearm law regulation [11].

The literature reported statistical data about numerous countries with different periods. To compare the features is not so simple, because the aspects of the analyses are not the same, it varies from country to country but there are some common denominations. The homicide part of the above-mentioned case was brutal and cruel but some features correspond to the international data (Table 1). It was a typical intimate partner homicide-suicide, they were a partnership, so the female victim knew the aggressor, who was an older, male companion perpetrator with pathological jealousy or as Marzuk et al. determined, amorous jealousy, in which, the previous abusive relationship is characteristic, as in the presented case [5,16]. Among older people „mercy killing" is one of the main motives [17]. There was only one victim. The suicide was committed within an hour after the homicide, not rapidly in minutes, it was a bit atypic. The equipment of the homicide was a cold weapon (sharp instrument-butcher's knife) as was in the utmost cases in Romania, England and Wales. The presented case also certified a blunt force instrument (iron rod) application. In Hungary, homicide-suicide acts are among the less frequent forms of violent death, with strict firearm regulations contributing to the rarity of firearm usage in such incidents. Still, according to the most statistical data, the most typical method of homicide is firearm usage [18–25]. It seems, that legal firearm ownership is correlated well with the frequency of firearm usage in femicide-homicides [22]. In Japan, the strangulation method was the most common form of murder [26]. The scene of the homicide was their house, but the suicide took place in a public place, spitting distance from the previous. Maybe the influence of synthetic cathinone abuse by the killer also had some role in the act, but alcohol consumption was excluded by toxicological examination. The toxicological analysis of the victim's biological samples yielded negative findings. The perpetrator was a blue-collar worker, we had no data about the education of the sufferer.

The intimate partnership itself has to be considered as a predilection factor of homicide-suicide. This is in line with the United Nations Office on Drugs and Crime (UNODC) estimation in 2019, which established that 34 % of intentionally killed women were murdered by their intimate partners [9]. This harmonizes our mini-review statistical data (Table 1). To be a family member, intimate relationships, or a „love or ex-love interest" context are significant risk factors from the female killing standpoint of view in murder-suicides.

8. Conclusions

Intimate partner homicide-suicide is a well-known and studied phenomenon in the literature. In some articles, it is called extended

Table 1
A synopsis of the international homicide-suicide (HS), intimate partner homicide-suicide (IPH-S) inquiries.

Author(s)/year/ country/period	No. of homicide-suicide (HS)/intimate partner homicide-suicide (IPH-S)/ intimate partner femicide-suicide (IPF-S)	Perpetrator's features	Victim's features	Motives	HS/IPH-S/IPF-S features, methods
Adinkrah (2014) Ghana (January 1, 1990- December 31, 2009) [26]	HS = 50 IPHS = 36 IPF-S = 35 male perpetrators were older than female victims in every case	in 29 cases out of 35 husbands killed their wives, and in 6 cases men killed their girlfriend in 32 (91.4 %) out of 35 cases, the assailants committed suicide within 24 h 20–70 years old lower socioeconomic background	18–60 years old depending from their husbands or lower socioeconomic background age gap between couples between 1- to 35 years	in 13 cases (37.1 %) the victims suspected with unfaithful in 13 cases (37.1 %) divorce, or threat to end the relationship in 6 cases (17.1 %) marital quarrel in 3 cases unknown background	newspaper surveillance methodology16 (45,7%) shared dwelling of the couples7 (20 %) victim's natal home in 62.9 % of IPH-S, the location of the suicide was the location of the homicide application of a firearm was in 22 cases (62.9 %) of homicide, hacking or cutting with a machete in 10 cases (28.9 %), in 2 cases (5.7 %) strangulation, in 1 case (2.9 %) ablaze of the victim suicide shooting with a firearm in 18 cases (51.4 %), in 7 cases (20 %) poisoning in DDT (Dichloro Diphenyl Trichloroethane) or other agrochemicals, hanging in 5 cases (14.3 %), in 2 cases (5.7 %) self-inflicted knife wounds in 26 cases (74.3 %) evidence of premeditation or prior planning
Alexandri et al. (2022) Greece (January 2008 to December 2020) [8]	HS = 36 with 41 homicides and 36 suicides (0.02/ 100.000 persons/ year) 0 to 7 per year (mean value 2.7 events per year) IPH-S = 19 with 21 victims (52.5 % of HS)	in HS: 88.9 % male mean age 50 (ranged from26 to 90) in 11 cases of IPH-S, the perpetrator and victim were married	in HS: 19.4 % male 80.6 female mean age 39.6 (ranged from 4 to 80) 12 victims were under the age of 18 years	HS: 27.8 % family financial/social stressors 25 % amorous jealousy 19.4 % altruistic/extended suicides IPH-S: 47.4 % (9 cases) amorous jealousy 15,8% (3 cases) altruistic/ extended suicide	in 23 cases of HS (63.9 %), the suicide was with a firearm, death of the victim was with firearms (56.1 %–23 cases), stabbing (26.8 %-11 cases), strangulation, fume inhalation and fall from height (4.9 %-4.9–4.9 %-2–2–2 cases) and drowning (2.4 %-1 case) in 3 cases out of 36, there were more victims homicide and suicide location was the same in 91.7 %, and in 69,4% it was the victim's residence in 1 case of IPH-S, the killer had 3 victims (spouse, mother-in-law-daughter) in IPH-S: the application of firearm was in 80.9 % (17 out of 21 victims) of homicides, and 84.2 % (16 out of 19) of suicide
Balica (2021) Romania (2011–2015) [19]	Femicide = 298 IPF-S = 184 (61.7 %)	57.8 % lived in a rural environment 36.2 % alcohol consumption	IPF: 34,7% were married 45.5 % relation of concubinage with aggressor in 9n cases, there were more victims 95.1 % violence with only one victim 20 % alcohol abuse 1.1 % drug abuse	24.4 % conflicts between aggressor and victim 18 % jealousy 12 % suspicion of infidelity 10.3 % infidelity 6.5 % victim's separation from aggressor 6.5 % of victims refused to get back together with the aggressor 3.8 % wish to leave the violent aggressor 3.8 % filing for divorce 3.7 % refusal to have intimate relations with the aggressor	alcohol consumption registered in 15.2 % of IPF-S 46.7 % knife 35.9 % other objects (e.g. axe, fork, hammer) 0,005 % firearm (only 1 case) 54.4 % of victims and aggressors' common house 23.3 % public place 12.8 % of victims' place after separation 5 % at aggressors' place 41.8 % urban 58.2 % rural
Bridges et al. (2011) United States (1968–1975) [21]	HS = 2215 (1.8 % of all 123,467 homicide victims)	2215 offenders 1231 were spouses, 1129 were husbands, 100 were wives The male/female ratio was 5.6 the offenders were more	husbands killed women in 65 % of the female victim men were killed by their wives in 21 % of male victims 258 victims were under 15 years, 52 % were female 1915 victims were over 15	No data (Nd)	89 % were any firearm (62 % were handguns) 4 % knife or cutting instrument 1 % blunt object Family unit was involved in 1668 (75.3 %) in HS events: 56 % spouse kills spouse

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Table 1 (*continued*)

Author(s)/year/ country/period	No. of homicide-suicide (HS)/intimate partner homicide-suicide (IPH-S)/ intimate partner femicide-suicide (IPF-S)	Perpetrator's features	Victim's features	Motives	HS/IPH-S/IPF-S features, methods
		often men 465 were non-spousal	years old, 83 % were female Race: 83 % were white, 15 % were black, 2 % were other races or unknown		13 % parent kills child 4 % other family situation 2 % child kills parent 10 % love triangle
Cavlak et al. (2023) Turkey (January 1, 2000-December 31, 2019) [7]	Intimate partner femicide-suicide (IPF-S) = 226 (average 0.81/ 100.000 women/year (aged 15 years or older) (range 0.09–0.67))	226 male (100 %) 52,6% were > 40 years 67.8 % had a higher education than lyceé or university graduate or were university student 51.3 % were married, 27.7 % were single 34.8 % were blue-collar workers, 18.4 % were soldiers, police, security staff, 12.7 % were tradespeople	226 intimate partner female (IPF) (and 57 others) IPF: 56 % were < 35 years 64,5% had a higher education than lyceé or university graduate or were university student 48.2 were married, 25.2 % were single 36.7 % were blue-collar workers, 17.6 % were officers, 13.2 % were midwife, nurse or auxiliary health personnel	18.6 % sudden controversy 9.7 % insanity 8.0 % desire of the women for divorce 7.5 % of women refused to reunite with their love/ girlfriend	84,1% firearm 14.1 % machete 1.6 % others 67 % of IPF-S were planned 80.5 % of suicide attempts were committed just after femicide 58 % of the firearms had been licensed
Cengija et al. (2012) Southwestern Croatia (1986–2009) [10]	HS = 17 events (0.2/ 100.000 people/year) with 19 victims IPH-S = 13 (76.5 % of HS)	In HS: 82 % maleOverall mean age 50 (male: 49, female 52) 62 % were sober all 3 women killers left suicide notes mostly had high school diploma or elementary school education and 1 were high school students mostly low-paid workers (blue-collar workers) or retired as it	In HS: 74 % femaleOverall mean age 40 (male 48, female 40) 73 % were sober 1 had PhD degree, others had high school diploma or elementary school education and 2 were elementary school studentsmostly low-paid workers (blue-collar workers) or retired as it	35 % amorous jealousy 29 % separation between couples 23 % consequence of mental disorders 6 % argue with an acquaintance	same method in 76.5 % of HS: firearm (59 %-10 cases), explosive (12 %-2 cases), knife (6 %-1 case) 50 % of the firearms were legal all 3 female murders used cold weapons for homicides and different methods for suicides homicide and suicide location was the same in 94 % 76 % of suicides followed the homicide rapidly, maximum within a few minutes
Colasanti et al. (2023) Italy (2009–2018) [22]	HS = 368 (average rate 0,06/100.000 persons/year) 26 to 53 per year total number of deceased 808 with 440 passive victims	331 male (89.9 %)37 female (10.1 %) 57.7 % of males and 45.9 % of females were married 25.4 % of males were retired, 20.8 % were unspecified and 54 % of females were unspecified, 16.3 % were freelancers 28.7 % of males were over 64 years, and 40.6 % of females were 35–44 years range	337 female (76.6 %)103 male (23.4 %) 49.9 % of females were married and 26.7 % were single and 12.7 % of males were married and 55.3 % were single 44.8 % of female were unspecified, 11.3 % were student/pre-school, 43.7 % of the male were student/pre-school and 26.2 % were unspecified 28.7 % of male were over 64 years of age, and 40.6 % of females were 35–44 years range	total: 44,3% romantic jealousy (47.5 % male, 16.2 % female) 23.6 % family, financial or social stressors (18.7 % male, 67.6 % female)17,9% mercy killing (19.3 % male, 5.4 % female) 40	46.5 % of total homicides were by firearm (49.5 % male, 18.9 % female) 26.1 % of total homicides were by cold weapon (26.6 % male, 21.6 % female) 8.4 % of total homicides were by asphyxiation (throttling, strangulation, hanging) (8.1 % male, 10.8 % female) 49.2 % of total suicides were by firearm (52.6 % male, 18.9 % female) 13.3 % of total homicides were by cold weapon (13.6 % male, 10.8 % female) 12.8 % of total homicides were by asphyxiation (throttling, strangulation, hanging) (12.4 % male, 16.3 % female)
Flynn et al. (2010) England and Wales (2006–2008) [20]	HS = 60	60 people, 4 % of offenders took their life (0.04/100.000 population)53 (88 %) were male median age: 44 years31 (53 %) marries/cohabiting 9 (15 %) living alone16 (28 %) unemployed33 (62 %) evidence of mental illness (mostly depression)	70 people, 54 (77 %) female victim median age: 38 yearsnearly 2/3 of the victims were the offender's spouse/partner (maybe ex)11 (16 %) unemployed	Separation and relationship breakdown	method of homicide:22 (37 %) sharp instrument18 (30 %) asphyxia6 (10 %) firearms method of suicide:20 (33 %) hanging10 (17 %) cutting/stabbing 5–5–5 (8 %-8%-8%) firearms-self-őpoisoning-drowning24 (40 %) same method of homicide and suicide51 (85 %) suicide committed < 24 h after homicide6 (10 %) multiplied victims killed 62 % had mental health problems
Gonçalves et al. (2023)	IPH-S = 20 and 7 more were attempted suicide cases	100 % male 80 % basic education or lower, 20 % higher education	100 % male 80 % basic education or lower, 20 % higher education	In 7 cases, there were no data 30 % (6 cases) separation	61.5 % firearm 19.2 % white/cold weapon 19.2 % physical force Current

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Table 1 (*continued*)

Author(s)/year/country/period	No. of homicide-suicide (HS)/intimate partner homicide-suicide (IPH-S)/intimate partner femicide-suicide (IPF-S)	Perpetrator's features	Victim's features	Motives	HS/IPH-S/IPF-S features, methods
Portugal (2010–2015) [9]		or higher 54.4 % were retired, 27.3 % were active, 18.2 % were unemployed 74.1 % had no psychiatric history 80.8 % had no substance abuse	or higher 55.6 % were active, 27.8 % were unemployed, 16.7 % were retired 69.2 % had no psychiatric history	desire 30 % (6 cases) infidelity suspicion (victim) 30 % (6 cases) health problems (victim) 10 % (2 cases) following a fight	relationships were in 25.9 % (7) and former were in 74.1 % (20)
Logan et al. (2008) United States (2003–2005) [24]	HS = 420 IPH-S = 304 (74.5 % of all HS)	HS 91.4 % male 97.6 % were over 19 years of age 37.1 % were over 50 years of age median age: 43 77 % white race, 89.3 % were non-Hispanic the majority did not have prior reports of alcohol or substance abuse problems, suicide attempts, or physical health problems 11 % of males had depression and 11 % had mental health problems 28.65 of females had depression and 42.9 % had mental health problems	HS 77.7 % were female intimate partner	having a history of intimate partner conflict	HS: 88.2 % firearms 3.7 % sharp instruments 2.7 % poison IPF: 88.9 % firearms 4.2 % sharp instruments 2.5 % poison this study used 24 h to define homicide-suicide
Matthews et al. (2008) South Africa (1999) [23]	3793 of all femicides IPF-S = 261 (19,4%) fatality rate of women was 1.7 per 100.000	46.4 % were 14–29 years of age 42.4 % were 30–39 years of age 11.4 % were 40 + years of age median age: 30 years 65.3 % were employed more likely to be a professional or white-collar worker white race is a risk factor for suicide	more likely to have ended relationships 72.9 % were 14–29 years of age 19.4 % were 30–39 years of age 7.6 % were 40 + years of age median age: 26 years 44.2 % were employed and 40.3 % were unemployed 30.6 % were professional, 30.3 % were student and 28.4 % were blue-collar	53.5 % argument 29 % female-ended relationship 16.3 % alleged infidelity of victim 1.3 % other	82.7 % firearm 14.7 % sharp objects 11.3 % blunt force 2.6 % strangled/asphyxiated legal gun ownership increased the risk of IPH-S
Satoh et al. (2016) Japan: Kanagawa Prefecture (1999–2011) [17]	HS = 76 with 169 people's death24 (31.6 %) in married couples2 (2.6 %) in lovers	39 men (49.3 %)40 women (50.7 %) mean age 51.6 ± 15.5 perpetrators of IPH-S in 21 cases (81 %) were male and in 5 cases in female	39 men (43.3 %)51 women (56.7 %) mean age 35.4 ± 29.2 in 66 (86.6 %) cases had 1 victimin 6 (7.9 %) cases had 2 victims in 4 (0.5.2 %) cases 3 or more victims	in 30 (40 %) cases of HS: pain from sickness (9 cases)psychiatric disease (6 cases)family problems (6 cases)couple relationships problem (2 cases)caregiver anxiety (2 cases)maternity anxiety (1 case)	medico-legal autopsy cases incident location in 54 (67.1 %) cases in the home most common cause of perpetrator's death is hanging (34 cases-43 %), sharp injuries (13 cases-16.4 %), carbon-monoxide poisoning (10 cases-12.7 %) most common cause of victims' death is strangulation (37 victims-41.1 %), sharp injuries (17 victims-19 %), burn (11 victims 12.2 %)in 55 cases (72.4 %) the perpetrators' and victims' causes of death were the same a suicide note was found in 32 (42.1 %) cases Homicide-suicide rate 0.06 per 100.000 people
Siems et al. (2014) Gemany, Frankfurt/Main (1994–2014) [25]	HS = 5813 failed (in 7 cases the homicide of 1 victim, in 6 cases the suicide of perpetrator) IPH-S (66 %) = 38	mean age of males 57 years (30–87 years) median age of males 56 years Information of 60 % about their profession: 49 % were retired 20 % unemployed 9 % sales agent	74 victims (13 children) 1 dog 1 guinea pig mean age: 42 years median age: 43 years in 46 cases 1 victim (79 %)in 9 cases 2 victims (16 %)in 2 cases 3 victims	HS: 12 cases of financial ruin 11 cases break up conflict 11 cases high maintenance victim 8 cases of jealousy conflict6 Nd (no data)	33 of 58 cases (57 %) of homicide-firearms31 offenders (91 %) who used firearms during homicide killed himself also with it cases with several victims- the offender used the same method case identical homicide and suicide: jumping

(*continued on next page*)

Table 1 (*continued*)

Author(s)/year/ country/period	No. of homicide-suicide (HS)/intimate partner homicide-suicide (IPH-S)/ intimate partner femicide-suicide (IPF-S)	Perpetrator's features	Victim's features	Motives	HS/IPH-S/IPF-S features, methods
		3–3 % estate agent, brothel owner, lawyer, businessman, chemist, policeman, worked for security service 60 % were Geman mental health disorders were mentioned in 10 cases (5 depression, 3 hallucinations, 2 previous suicide attempts) in 39 (67 %) cases alcohol sample was taken during autopsy, mean blood alcohol level was 0.41 ‰	(3 %)in 1 case 4 victims (2 %) Profession in 38 % are known: 25 % were retired 14–14 % pupils, employed (unknown profession) nationality in 60 % was not specified	5 disease offender 4 marriage conflict 3 conflict 3 family conflict	from balcony, insulin overdose, sleeping pills, electric shock 5 cases stabbing only males using the shooting as homicide and suicide 30 (52 %) suicide-firearms 10 offenders (17 %) left a farewell letter in 6 of the 58 cases, victims survived the homicide act

suicide. The viewpoints of the interpretations are diverse, so the comparability is difficult. Despite the different economic, sociocultural, educational, demographical, ethnic, and medical backgrounds of the individual countries, some common features are detectable as in the presented case. One of the limitations of comparison is the time frame of suicide after homicide. Some studies consider the act homicide-suicide if the suicide act is committed within 24 h after the homicide, but in some literature, this duration may be weeks. The pattern of the motives depends on the sex and age. Males represent a huge part of perpetrators, the younger or middle-aged main motive is pathological jealousy, and in older the „mercy killing". In the case of female killers, family, social, or financial stressors are the major sparks. Only one victim is the most characteristic. Some monographs are based on news websites or national newspapers, and in these, there are lack of toxicological status of the victims and perpetrators, or psychiatric history and motives, so the forensic institutional observations are more detailed from this point of view with the help of the investigational data. In most countries, firearm usage is typically in both suicide and homicide, in some other places like Hungary, Romania, England and Wales the application of cold weapons (mainly sharp instruments) is characteristic as the main method. The most common scene of the acts is the victims' home or common home.

As a tragic public health issue, the multidisciplinary approach (legal, social, health care) to prevention is essential.

Ethical approval

According to the 40. § (3) of the Hungarian Act of Forensic Experts (2016. XXIX), the data of the report can be utilized freely for scientific educational purposes without special ethical permission by the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No ethics approval was necessary according to the Hungarian Law in the usage of statistical data (Act XLVI of 1993, Sec. 10).

CRediT authorship contribution statement

Beáta Ágnes Borsay: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft. **Barbara Dóra Halasi:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Róbert Kristóf Pórszász:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Péter Attila Gergely:** Conceptualization, Project administration, Supervision, Visualization, Writing – original draft.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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