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Intimate partner homicides in Denmark 1992–2016

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ABSTRACT

Intimate partner homicide is one of the most common types of homicide and a significant contributor to domestic homicides worldwide, especially affecting females. We focus on the intimate partner homicides in Denmark during 1992–2016. Though gender identity data was unavailable, sex data from official documents enabled critical analysis. Of the 1417 homicides in the period, 26.5% were intimate partner homicides, i.e., 55.6% of female and 8.9% of male victims. The annual intimate partner homicide rate was 0.28 per 100,000 (0.44 for female victims and 0.12 for male victims), declining at a lower rate than other types of homicide. Most victims of intimate partner homicides were females (79.3%). The demographics of the victims and the characteristics of the homicides were markedly different depending on victim sex. Female victims were killed by more varied methods, with more severe injuries and followed by suicide in 26.5% and with multiple homicide victims in 8.1%.

1. Introduction

Homicide within a current or past intimate relationship is one of the most common types of homicide and a significant contributor to domestic homicides worldwide, especially affecting females [1–5]. Official statistics on various types of homicide, including intimate partner homicides can be difficult to obtain [6–9]. In Denmark we do not have such official statistics, and government reports on homicides are usually based on registries of criminal convictions of surviving offenders, which excludes the intimate partner homicides followed by offender suicide [2,5].

We have previously published data from Denmark during 1992–2016 relevant to death investigators and forensic pathologists with focus on homicides in general, sharp force homicides, gunshot homicides, blunt force homicides and homicides by asphyxia [2,10–14]. In these studies, intimate partner homicides emerged as a numerically significant group, especially within homicides with female victims, which warrants further description in detail. The World Health Organization has declared that violence against women, including intimate partner violence is a major public health problem globally and a violation of women's human rights [15]. Hopefully a study on intimate partner homicides in Denmark will help put a spotlight on violence against women and support mitigation work.

In this paper we focus on the intimate partner homicides in Denmark during 1992–2016, and how the homicides vary with respect to victim and offender demographics, methods and severity of injuries depending on victim and offender sex.

2. Materials and methods

This study is part of a larger project concerning all homicides in Denmark 1992–2016, based on the databases of the three departments of forensic medicine in Denmark [2]. The study is based on the autopsy reports (including crime scene examination of the victims), preliminary police reports, crime scene photos and autopsy photos. Approximately one-third of the files had supplementary police reports and court documents, which we reviewed in cases with unclear descriptions in the main documents. During the study period the average population size in Denmark was 5.41 (5.16–5.71) million people.

For each homicide, we registered general information about the victims, the offenders, the homicide, and the injuries, including the Abbreviated Injury Scale (AIS) [16], based primarily on autopsy reports and preliminary police reports. We have grouped the data based on sexes of the victims and offenders, using the terms males and females, as this

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was the information that was available in the autopsy reports from the departments of forensic medicine and from police reports. We had no available information regarding gender identities and therefore could not include gender identity information.

For victims and offenders, we registered the age of the victim and the offender, the number of victims killed or injured during the homicide and their sex and their relation to the victim and offender, the relationship status (current or former intimate partner), whether the intimate partners were or had been in an established cohabiting relationship rather than just being boyfriends or girlfriends not moved in together.

Regarding the homicides and injuries, we registered the homicide method, the known motives as stated in the autopsy reports and preliminary police reports, offender suicide or suicide attempt and the suicide method, the involvement of alcohol and drugs, the injuries grouped as found in the Abbreviated Injury Scale (AIS), the number of injuries, whether there were defensive injuries and survival time from injury to death. One author (AHT) has completed the AIS-training program and collected all the data. From the AIS-data we calculated the Injury Severity Score (ISS) and New Injury Severity Score (NISS) [16,17]. As ISS is known to underestimate the severity of penetrating injuries [18] we only report categorical data of NISS. The normal grouping of NISS is "minor (1–3)", "moderate (4–8)", "serious (9-15)", "severe (16–24)" and "critical (25–75)" [17]. To better suit the homicide victim population that has few victims with low scores, we define three NISS categories: "low (1-24)", "medium (25–44)" and "high (45–75)".

Homicides were grouped based on the typology of the European Homicide Monitor, that includes intimate partner homicides as part of domestic homicides [19]. We selected intimate partner homicides, defined as homicides within current or past intimate relationships, excluding casual sexual partners such as during single sexual encounters or involving a sex worker in a professional, transactional setting. Based on our registration of victim and offender sex data, intimate partner relationships included same sex relationships. As the study is primarily based on collection of data from autopsy reports, which are limited in the level of demographic data, parameters such as marriage status, income, ethnicity, education, social status, and family history, were not recorded.

We registered the above-mentioned data electronically in EpiData (EpiData Association, 2010, Odense, Denmark. http://www.epidata.dk) with double entry of the AIS-data. We exported the data to Stata (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LLC.) and Rstudio (RStudio Team (2015). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA; http://www.rstudio.com/) for statistical analysis and data visualization.

We analyzed annual data with linear regression, using "lm()" in R. We fitted models allowing for different regression lines using "lm(number ~ year)" and "MASS::glm.nb()". For differences between groups (e.g., difference in median age between female and male victims), we used permutation tests of 100,000 permutations. For each permutation, we permuted the sex and calculated the mean difference between the two groups (the null). Contingency tables were tested with the χ^2-test. For survival data, we used the Cox proportional hazards model using the "survival" package in R.

The study has been approved by the Danish Data Authority and has followed the data management and data security protocols set up by the Danish Data Authority. According to the Danish legislation regarding register studies, approval from the local research ethical committee is not required or possible.

3. Results

Of the 1417 homicides in Denmark during 1992–2016, 376 (26.5%) were intimate partner homicides. The annual ratio of intimate partner homicides to all homicides ranged from 13.2% (2016) to 41.8% (1998) with no obvious time trend (Fig. 1). Intimate partner homicide victims show a strong female biased sex ratio (79.3% female victims, 298/376) in contrast to other types of homicides that show a strong male biased sex ratio (84.6% male victims, 881/1041; Table 1) [2]. Intimate partner homicides account for more than half (55.6%) of all female homicide victims but only 8.9% of all male homicide victims, with male victims becoming very rare during the period (0–3 annual homicides in the last half of the period). In strong contrast to the overall sex ratio of homicide victims of one female victim to two male victims, most intimate homicide victims were female (n=298, 79.3% female vs. n=78, 20.7% males; Table 1) [2].

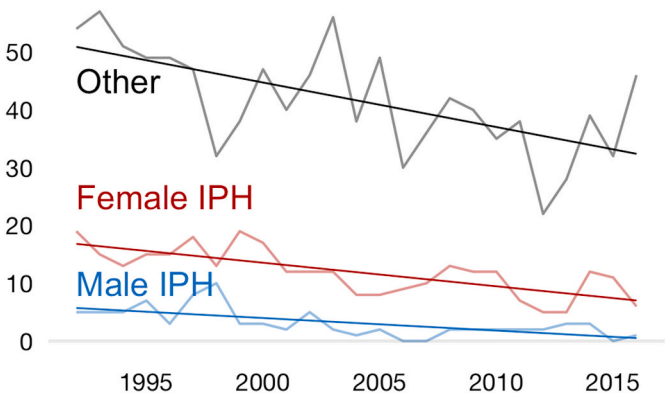

Fig. 1. Intimate partner homicides (IPH) in Denmark 1992–2016.

There was a significant declining trend of 0.62 intimate partner homicides per year (linear regression: $P < 0.01$, $F = 41.1$, $R^2 = 0.64$; Fig. 1). The absolute number of female and male intimate partner homicides declined at a lower rate than all other homicides (Fig. 1; female victims: slope −0.41, $P < 0.001$, $F = 27.96$, $R^2 = 0.53$; male victims: slope −0.22, $P < 0.001$, $F = 16.09$, $R^2 = 0.39$; other homicides: slope −0.77, $P < 0.001$, $F = 14.93$, $R^2 = 0.37$). A generalized linear model confirmed the difference in rates (t=−2.18, P=0.0346), but all linear models allow the number of victims to become negative. To elucidate the decline a little further we fitted a count based model which showed the same trends (higher female intercept, declining number of victims) but no significant difference between sexes in rate (male decline 4.7% per year, female decline 3.6% per year, z=1.28, P=0.20).

The corresponding intimate partner homicide rate was 0.28 per 100,000, 0.44 per 100,00 for females, 0.12 per 100,000 for males, with a significant decrease of 0.012 per year (linear regression: $P < 0.001$, $F = 634.3$, $R^2 = 0.68$). The decrease was significant for both female victims (linear regression: Slope = −0.016, $P < 0.001$, $F = 458.4$, $R^2 = 0.6$) and male victims (linear regression: Slope = −0.008, $P < 0.001$, $F = 230.8$, $R^2 = 0.43$).

The intimate partner homicides were committed in 376 events, distributed in 352 events with only one victim and 24 events with multiple homicide victims. There were 58 victims in the multiple victim events with 2–4 victims pr. Event, i.e., 34 non-intimate partners, mostly immediate family members. A total of 24 children of victims and/or offenders were killed during 18 of the 24 events (75%) with multiple victims, 18 (75%) girls and 6 (25% boys) (Binomial test, $p < 0.05$). The

Table 1
Victims characteristics.

	Total	Female victims	Male victims
Number of victims	376	298 (79.3%)	78 (20.7%)
Annual number, mean (min max, median)	15.0 (7–26, 14)	11.9 (5–19, 12)	3.1 (0–10, 2)
Age, mean (min-max, median)	41.5 (17–87, 39)	41.0 (17–87.38.5)	43.5 (21–74, 42.5)
Relationship status			
-Current partners	264 (70.2%)	198 (66.4%)	66 (84.6%)
-Ex-partners	112 (29.8%)	100 (33.6%)	12 (15.4%)
Cohabitation at any point	301 (80.1%)	244 (81.9%)	57 (73.1%)

victims in the remaining events were a parent or a new partner (perceived rival) of the victim, 4 (40%) females and 6 (60%) males. In 13 homicide events, 1–2 persons survived being assaulted by the offender, typically children or a new partner. All the events with multiple victims had a male offender acting alone, making up 8.1% of all intimate partner homicides with female victims.

3.1. The victims and the offenders

Female victims were in general a few years younger than male victims, with significant differences in age medians between sexes (Permutation test, $P < 0.0496$; Table 1; Fig. 2). There were 4 (1.1%) male-on-male intimate partner homicides, but no female-on-female intimate partner homicides. In 368 (97.9%) of homicides were there was only one offender, while the remaining 8 (2,1%) were committed with the help of another person, typically a friend of the offender. The offender's age was registered in 365 homicides with only one offender. The overall mean offender age was 42.8 years (18–88, sd=14.2, median=41), with no significant median age difference between sexes (female offenders: 39.2 years (18–71, sd=10.5, median=39)), male offenders: 43.6 years (18–88, sd=14.8, median=41); Permutation test, P<0.33; Supplementary Fig. 1). On average the male offenders were 5.3 years older than their victims, with an interval of 28 years younger to 42 years older. The female offenders on average were 2.9 years younger than their victims, with an interval of 10 years younger to 30 years older.

Most victims (70.2%) were killed by a current partner rather than an ex-partner, with current partner victims being more common in homicides with male victims compared to homicides with female victims ($\chi^2 = 8.91$, df = 1, $P < 0.01$; Table 1). Most victims (80.1%) were in or had been in an established cohabitating relationship with the offender (Table 1). The majority of victims (92.0%) were killed in a private setting, with no sex difference between victims.

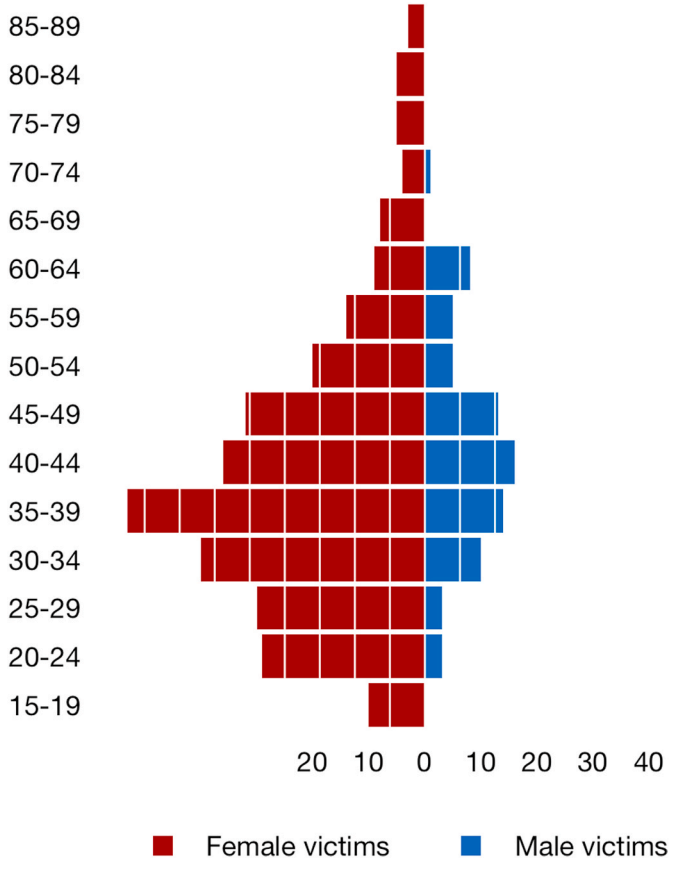

Fig. 2. Age-sex pyramid for intimate partner homicide victims. The bars show the number of homicides for each age group in 5-year intervals.

3.2. The homicides

Most male victims (75.6%) were killed by sharp force trauma, while women were victims of all four common homicide methods in a far more widely distributed way: sharp force (29.5%), asphyxia (30.5%), gunshot (22.2%) and blunt force trauma (15.1%) (Supplementary Fig. 2; Table 2). Gunshots were significantly more common in homicide events with multiple victims compared to single victim events (41.7% vs. 18.2%; $\chi^2 = 7.8$, df = 1, $P < 0.01$). Data on the motives for the homicides were available in 222 (59.0%) homicides. Of those 222 homicides, jealousy and/or separation was a factor in two out of three homicides with female victims, while the victim threatening the offender or others was a motive in half of those with male victims (Supplementary Fig. 3; Table 2).

There was offender suicide or suicide attempt in 34.9% of homicide cases with female victims, compared to only 3.9% when the victim was male, independent of offender sex (Fig. 3; Table 2) ($\chi^2 = 29.28$, df = 1, $P < 0.001$). The most common lethal suicide methods were gunshots (45.9%) and hanging (27.2%; Supplementary Fig. 4). Gunshots were significantly more common as homicide method in homicides followed by completed suicide compared to all other homicides (45.7% vs. 12.5%; $\chi^2 = 55.95$, df = 4, $P < 0.001$). The same method was used for the homicide and the suicide in 97.6% of gunshot homicides followed by suicide, while the same method was used for the homicide and the suicide in only 10.6% of those with other homicide methods ($\chi^2 = 77.6$, df = 1, $P < 0.001$). Almost all (94.3%) suicides or suicide attempts happened in conjunction with the homicide and not after apprehension of the offender. The intimate partner homicide was followed by suicide or suicide attempt in 58.3% of the intimate partner homicides with multiple victims, but only followed by suicide or suicide attempt in 26.4% of the intimate partner homicides with a single victim ($\chi^2 = 9.73$, df = 1, $P < 0.01$; Supplementary Fig. 5).

About half of the homicides involved the consumption of alcohol or drugs by the victim and/or the offender, with such consumption significantly more common in homicides with male victims (82.1% of male victims vs. 39.9% of female victims, ($\chi^2 = 42.227$, df = 1, P <

Table 2
Circumstances in intimate partner homicides.

	Total	Female victims	Male victims
Homicide methods			
-Sharp force	147 (39.1%)	88 (29.5%)	59 (75.6%)
-Asphyxia	94 (25.0%)	91 (30.5%)	3 (3.9%)
-Gunshot	74 (19.7%)	66 (22.2%)	8 (10.3%)
-Blunt force	50 (13.3%)	45 (15.1%)	5 (6.4%)
-Other	11 (2.9%)	8 (2.7%)	3 (3.9%)
Motives (if one or more motives registered)	222 (59.0%)	168 (56.4%)	54 (69.2%)
-Jealousy	74 (33.3%)	69 (41.1%)	5 (9.3%)
-Separation	55 (24.8%)	53 (31.6%)	2 (3.7%)
-Jealousy and/or separation	121 (54.5%)	114 (67.9%)	7 (13.0%)
-Triviality	31 (14.0%)	17 (10.1%)	14 (25.9%)
-Victim threatened	28 (12.6%)	2 (1.2%)	26 (48.2%)
-Altruism	14 (6.3%)	13 (7.7%)	1 (1.9%)
-Mental illness	14 (6.3%)	13 (7.7%)	1 (1.9%)
Died at crime scene, %	301 (80.1%)	256 (85.9%)	45 (57.7%)
Offender suicide	81 (21.5%)	79 (26.5%)	2 (2.6%)
Offender suicide attempt	26 (6.9%)	25 (8.4%)	1 (1.3%)
Alcohol involved	172 (45.7%)	111 (37.3%)	61 (78.2%)
Drugs involved	50 (13.3%)	28 (9.4%)	22 (28.2%)
Alcohol/drugs involved	183 (48.7%)	119 (39.9%)	64 (82.1%)

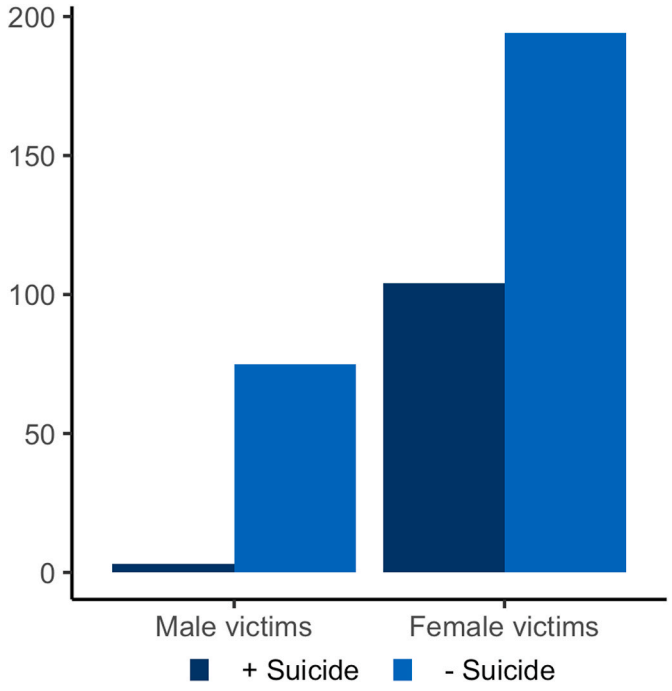

Fig. 3. The number of victims ordered by victim sex and grouped by offender suicide or suicide attempt.

0.001; Fig. 4; Supplementary Fig. 6; Table 2).

Of the female victims 89.9% died at the crime scene, while 57.7% of the male victims died at the crime scene ($\chi^2 = 30.8$, df = 1 $P < 0.001$; Table 2). In the intimate partner homicides from sharp force trauma, female victims had more severe injuries, with a higher New Injury Severity Score (NISS), more stab wounds (Permutation test, $P < 0.001$), a shorter survival time and more often had wounds interpreted as defensive lesions, than male victims (Table 3; Fig. 5; Supplementary Figs. 7 and 8) [10]. In victims killed by methods other than sharp force trauma, there were too few male victims to make a meaningful comparison of the extent of injuries.

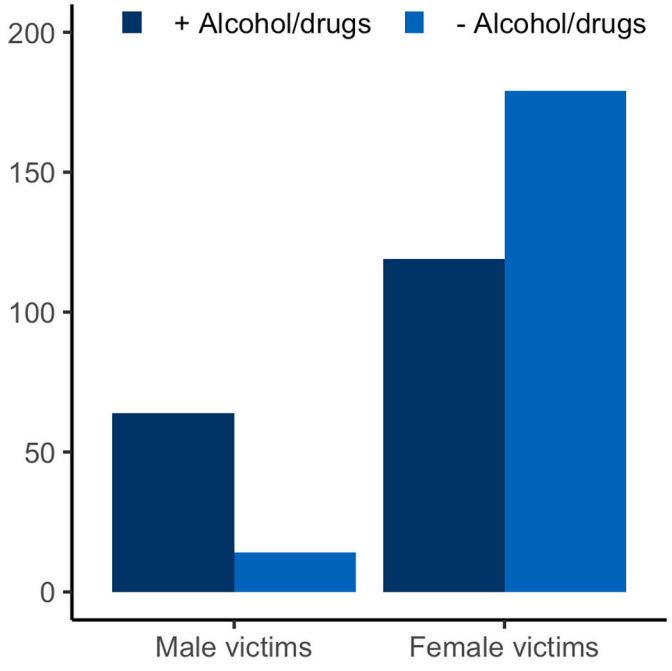

Fig. 4. The number of victims ordered by victim sex and grouped by relation to alcohol or drug consumption.

Table 3
New Injury Severity Scores (NISS) for all intimate partner homicides and for those from sharp force trauma, including number of stab wounds and proportion with defense lesions.

	Total	Female victims	Male victims
NISS			
-Low (1-24)	34 (9.0%)	25 (8.4%)	9 (11.5%)
-Medium (25–44)	203 (54.0%)	167 (56.0%)	36 (46.2%)
-High (45–75)	139 (37.0%)	106 (35.6%)	33 (42.3%)
NISS, sharp force homicides			
-Low (1-24)	17 (11.6%)	10 (11.4%)	7 (11.9%)
-Medium (25–44)	61 (41.5%)	30 (34.1%)	31 (52.5%)
-High (45–75)	69 (46.9%)	48 (54.6%)	21 (35.6%)
Stab wounds, mean, (min max, median)	4.9 (1–35, 2)	6.7 (1–35, 3.5)	2.3 (1–21, 1)
Defense lesions, sharp force homicides, %	81 (55.1%)	64 (72.7%)	17 (28.8%)

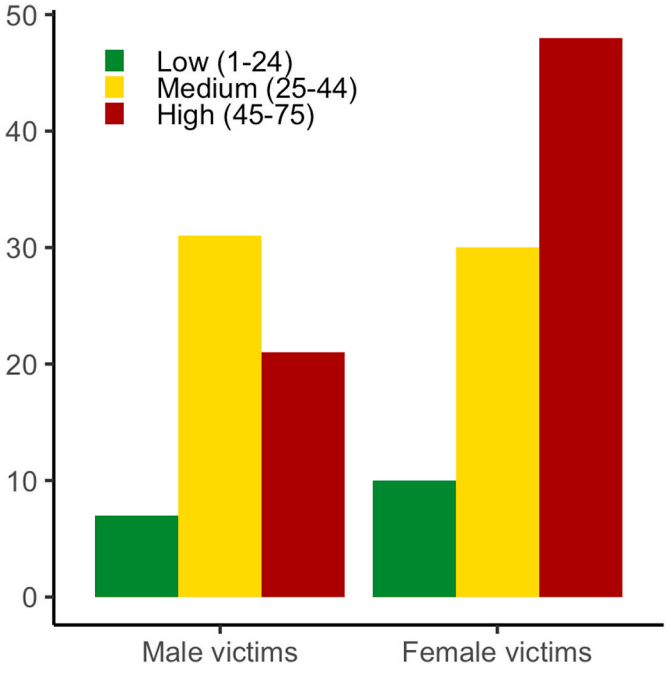

Fig. 5. The number of intimate partner homicide victims, killed by sharp force trauma, ordered by victim sex and grouped by trauma score NISS-group.

4. Discussion

Intimate partner homicides constitute a large proportion of homicides in Denmark during 1992–2016 representing one in four homicides. Females were more often victims of intimate partner homicides than males in both absolute and relative numbers. More than half of all female homicide victims were killed in intimate partner homicides vs. less than one in ten of male homicide victims. The United Nations Office on Drugs and Crime estimate that on a global scale more than half of all female homicide victims are killed within the family, often by a current or former intimate partner [1]. The global sex ratio in intimate partner homicides is estimated to 82% female victims vs. 18% male victims, i.e., the inverse ratio of homicides in general where male victims (~82% vs. ~18%) predominate [1]. While males are more likely to be victims of violence and to die in homicides than females, the opposite is observed regarding intimate partner violence and intimate partner homicides

[20].

The rate of intimate partner homicide varies with the homicide rate in a given region [4]. Overall, studies of intimate partner homicides in Europe and North America show that these homicides make up approximately 10–30% of all homicides, with annual rates from 0.1 to more than 5 per 100,000 [3–5,8,21–24]. Similar to Denmark, our neighboring countries Norway and Sweden also have ~25% intimate partner homicides, with an annual rate of intimate partner homicide of 0.15–0.3 per 100,000 [5,21]. In Greenland, a self-governing entity within the Kingdom of Denmark, with an average annual homicide rate of 16 per 100,000, intimate partner homicides are even more frequent (one in three), i.e., an annual rate of intimate partner homicide of ~5 per 100,000 [22]. Intimate partner homicides in Europe and North America make up about half or more of all female homicide victims, but less than one in ten of all male homicide victims [3–5,21,24,25]. In Europe and North America approximately 75–95% of intimate partner homicide victims are females [3–5,21,24,25]. So, the findings in our study from Denmark regarding the proportion of intimate partner homicides, the annual intimate partner homicide rate and the sex distribution of victims are similar to studies in other countries in Europe and North America.

During 1992–2016 there has been an overall decline in the number of deaths due to homicide in Denmark, which is a trend in Europe and North America [2,26]. Although intimate partner homicides in Denmark also declined, it was at a lower rate than other types of homicide, which has been found in other studies [1,5]. We have previously found that the decline in the number of homicides with stab wounds in Denmark during 1992–2016, was seen in the group with a single stab wound and found that it was in part related to improved medical treatment [11]. This could explain some of the decline in intimate partner homicides, especially those with male victims, as most male victims are killed by sharp force trauma and they often have only few stab wounds and are less likely to die at the crime scene compared to female victims [10,11].

We found that female victims of intimate partner homicides were significantly younger than male victims (female victim median age = 38.5 years, male victim median age = 42.5 years), that male offenders usually were older than their victims and female offenders were younger than their victims. This distribution is similar to many other studies [3,4,20,21,27,28]. There were very few same-sex intimate partner homicides in our data, all with male offenders. Other studies have also found a low number of same-sex intimate homicides almost exclusively with male offenders, but the number could be underestimated due concealment issues in same-sex relationships [5,29,30].

In surveyed countries where firearms are readily available, homicides by firearms dominate the intimate partner homicide statistics [3,4,8,20]. It has been estimated that domestic assaults and intimate partner assaults are 12 times more likely to result in death if firearms are used, compared to other methods [20]. Our findings on gunshot homicides in Denmark during 1992–2016 showed a dramatic decline in the number of domestic homicides, including intimate partner homicides, coinciding with a similar decline in homicides by hunting weapons [12]. One possible explanation for this decline could be changes in The Danish Firearms Act in 1986 requiring a permit for smooth-bore shotguns as it is well known that restricted access to firearms reduces the risk of intimate partner homicides [3,8,12,31]. However, as we have not been able to get data on gun ownership and gun availability, we have not been able to test the correlation [12]. In Denmark, and other countries with restricted access to firearms, the homicide methods traumatic asphyxia, sharp force trauma and blunt force trauma are relatively more common in intimate partner homicides when the victim is a female, while sharp force trauma is very common when the victim is a male [2,10,12–14,21]. Both traumatic asphyxia and blunt force trauma usually requires that the offender is physically stronger than the victim in order for the assault to end in homicide, which, together with less general use of firearms for hunting and other sports by females in Denmark, are possible explanations for most male intimate partner homicide victims dying from sharp force trauma [2,10,12–14,21].

In at least two thirds of the homicides with female victims in our study, jealousy and/or separation were motives, while threatening behavior of the victim was a motive in half of homicides with male victims. This distribution has been found in many other studies, showing that intimate partner homicides differ considerably depending on victim and offender sex [20,21,28,32,33]. In a study of 77 intimate partner homicides in Denmark during 2007–2017, Rye et al. found that while 31% of female victims had at least one recorded police contact regarding domestic abuse prior to the homicide, about half of them had told other parties than the police, such as friends and family, about domestic abuse [34]. For male victims, 17% had at least one recorded police contact and about one third had told other parties [34]. Spencer and Stith found that in intimate partner homicides with male offenders and female victims, the most important risk factors were 1)access to firearms, 2) previous strangulation, 3) rape, 4) threats with a weapon or of doing harm, and 5) controlling behavior [35].

In homicide events in Denmark in general during 1992–2016, only 13.4% were followed by offender suicide or suicide attempt [2]. For intimate partner homicides with female victims this happened in one third, while it was extremely rare following intimate partner homicides with male victims in heterosexual relationships, as seen in many other studies [3,4,21,28,36,37]. Offender suicides and suicide attempts are more common in intimate partner homicides, especially in homicide events with multiple victims and often include the use of firearms [21,23,36–38]. Some of the homicides in Denmark where a parent kills a child and commits suicide are part of a conflict with the other parent, without that parent being killed [39].

In our current study, the intimate partner homicides with male victims were different from those with female victims as they in four out of five involved consumption of alcohol and drugs, while this was only the situation in two out of five with female victims. Caman et al. found that intimate partner homicides with female offenders and male victims often featured mutual intimate partner violence and alcohol intoxication [40]. We have found that the intimate partner homicides with sharp force trauma and male victims share similarities with non-intimate partner sharp force homicides committed by male offenders in the setting of nightlife (i.e. in relation to activity in and around bars, clubs, pubs, etc.) and intoxication. Both groups have a low number of stab wounds and often part of the motive is an element of self-defense or being that the victim threatened with violence [10]. In contrast the intimate partner sharp force homicides with female victims have a higher trauma score, more stab wounds, defensive lesions and a shorter survival time than male victims, as found in our current study and a former study of ours, as well as by Rogde et al., Ormstadt et al., Burke et al. and Hunt and Cowling [10,41–44]. A possible explanation for this is the motivational aspect, where female victims often are killed due to separation and jealousy, which involves greater emotional charge than killings in self-defense [44]. In some homicides, the number of wounds suggests overkill, i.e. more injuries than necessary to cause death [45,46]. While overkill undoubtedly exists, there is no precise agreed upon definition based on objective criteria, such as the number of wounds or trauma scores, making it a less useful parameter for injury quantification [45,46]. Tamsen et al. [45] have attempted to use objective criteria for overkill, requiring three or more sharp force injuries or gunshot to the head, neck, or trunk, each with underlying organ injuries, or more than 40 injuries to the skin. While this definition would make a large proportion of homicides, i.e., approximately half of sharp force homicides in Denmark [10], in the category of overkill, taking the extraordinary out of the term, it would make comparisons between studies possible.

A larger proportion of the female victims of intimate partner homicide in our study die at the crime scene, compared to the male victims of intimate partner homicide. The low number of male victims in the group killed by methods other than sharp force trauma make a direct comparison of those methods difficult. In homicides in general female victims killed by gunshots and blunt force trauma, tend to have more severe injuries than male victims. This is in part due to the use of shotguns and

blunt objects. These methods generally result in more severe injuries than handguns and bodily force [12,14,47–49].

The current study was undertaken as part of a larger project on homicides in Denmark, with focus on aspects relevant to death investigators and forensic pathologists, such as the extent of injuries and detailed findings on victims relevant to each homicide method. Thus, the emphasis has been on the information that typically is captured in the autopsy reports, which is less detailed on parameters that may help identify risk factors for intimate partner violence. Identification of risk factors has important implications for preventive measures [50]. There was no special mandate to examine violence against women and girls. As part of a political agreement in Denmark it has recently been decided that all regional police departments must establish specialized units working with domestic violence and its prevention. Private organizations helping victims of domestic violence have increased public awareness on the problem via information campaigns and are also working on reaching and helping the domestic violence offenders. It is our hope that domestic violence and homicides will be reduced from these measures from the police and organizations. To find out, we need to continually monitor the number of victims of domestic violence and homicides. The Danish parliament is currently working on an action plan on domestic violence, including domestic homicides, which likely will include means for a national register on domestic violence and domestic homicides.

5. Conclusion

Intimate partner homicides made up a large proportion of homicides in Denmark during 1992–2016, and although the number declined, it was at a lower rate than other types of homicides. Most victims were females (79.3%) and male victims have become very rare during the period (0–3 annual homicides the last ten years). The demographics of the victims and the characteristics of the homicides were markedly different depending on victim sex, with female victims being killed by more varied methods with more severe injuries and often followed by suicide (34.9%) and with multiple homicide victims (8.1%).

Declaration of competing interest

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.fsisyn.2023.100337.

References

[1] UNODC, Global Study on Homicide 2019, T.U.N.O.o.D.a.C., The United Nations Office on Drugs and Crime (UNODC), Vienna, 2019.
[2] A.H. Thomsen, et al., *Homicide in Denmark 1992-2016*, Forensic. Sci. Int. Synerg. 1 (2019) 275–282.
[3] S. Geary, et al., Intimate partner homicides in North Carolina: 2011-2015, N. C. Med. J. 81 (4) (2020) 228–235.
[4] A. Pereira, D. Vieira, T. Magalhães, Fatal Intimate Partner Violence against Women in Portugal: a Forensic Medical National Study, 2013.
[5] S. Caman, et al., Trends in rates and characteristics of intimate partner homicides between 1990 and 2013, J. Crim. Justice 49 (2017) 14–21.
[6] H. Stöckl, et al., The Global Prevalence of Intimate Partner Homicide: a Systematic Review, 2013.
[7] R.E. Norman, D. Bradshaw, What is the scale of intimate partner homicide? Lancet 382 (9895) (2013) 836–838.
[8] N. Abrahams, et al., Intimate partner femicide in South Africa in 1999 and 2009, PLoS Med. 10 (4) (2013), e1001412.
[9] A.M. Zeoli, R. Malinski, H. Brenner, The intersection of firearms and intimate partner homicide in 15 Nations, Trauma Violence Abuse 21 (1) (2020) 45–56.
[10] A.H. Thomsen, et al., *Sharp Force Homicide in Denmark 1992-2016*, J. Forensic. Sci. 65 (3) (2020) 833–839.
[11] A.H. Thomsen, et al., *Improved medical treatment could explain a decrease in homicides with a single stab wound*, Forensic. Sci. Med. Pathol. 16 (3) (2020) 415–422.
[12] A.H. Thomsen, et al., *Gunshot homicides in Denmark 1992-2016*, Int. J. Legal Med. 135 (4) (2021) 1507–1514.
[13] A.H. Thomsen, et al., *Asphyxia homicides in Denmark 1992-2016*, Int. J. Legal Med. 136 (6) (2022) 1773–1780.
[14] A.H. Thomsen, et al., *Blunt force homicides in Denmark 1992-2016*, J. Forensic. Sci. 67 (6) (2022) 2343–2350.
[15] WHO. *Violence against women*. 2021 20 March 2023]; Available from: https://www.who.int/news-room/fact-sheets/detail/violence-against-women.
[16] T.A. Gennarelli, E. Wodzin, Abbreviated Injury Scale 2005 : Update 2008, Association for the Advancement of Automative Medicine, Barrington, Ill, 2008.
[17] M. Stevenson, et al., An overview of the injury severity score and the new injury severity score, Inj. Prev. 7 (1) (2001) 10–13.
[18] S.E. Rowell, et al., Specific abbreviated injury scale values are responsible for the underestimation of mortality in penetrating trauma patients by the injury severity score, J. Trauma 71 (2 Suppl 3) (2011) S384–S388.
[19] S.M. Ganpat, et al., Homicide in Finland, the Netherlands and Sweden: A First Study on the European Homicide Monitor Data, Brottsförebyggande rådet/The Swedish National Council for Crime Prevention, 2011.
[20] L. Garcia, C. Soria, E.L. Hurwitz, Homicides and intimate partner violence: a literature review, Trauma Violence Abuse 8 (4) (2007) 370–383.
[21] S.K.B. Vatnar, C. Friestad, S. Bjorkly, A comparison of intimate partner homicide with intimate partner homicide-suicide: evidence from a Norwegian national 22-year cohort, J. Interpers Violence (2019), 886260519849656.
[22] M.R. Christensen, et al., Homicide in Greenland 1985-2010, Forensic Sci. Med. Pathol. 12 (1) (2016) 40–49.
[23] S. Smucker, R.E. Kerber, P.J. Cook, Suicide and additional homicides associated with intimate partner homicide: North Carolina 2004-2013, J. Urban Health 95 (3) (2018) 337–343.
[24] S. Kristoffersen, et al., Homicides in Western Norway, 1985-2009, time trends, age and gender differences, Forensic Sci. Int. 238 (2014) 1–8.
[25] K.E. Moracco, C.W. Runyan, J.D. Butts, Female intimate partner homicide: a population-based study, J. Am. Med. Women's Assoc. 58 (1) (2003) 20–25, 1972.
[26] K. Suonpää, et al., Homicide drop in seven European countries: general or specific across countries and crime types? Eur. J. Criminol. (2022) 1–28, https://doi.org/10.1177/14773708221103799. Online ahead of print.
[27] E. Garcia-Vergara, et al., A comprehensive analysis of factors associated with intimate partner femicide: a systematic review, Int. J. Environ. Res. Publ. Health 19 (12) (2022).
[28] P.M. Leth, Intimate partner homicide, Forensic Sci. Med. Pathol. 5 (3) (2009) 199–203.
[29] A.C.T. Gannoni, Same-sex intimate partner homicide in Australia, Trends and Issues in Crime and Criminal Justice 469 (2014) 1–7.
[30] L.J. Paulozzi, et al., Surveillance for homicide among intimate partners–United States, 1981-1998, MMWR CDC Surveill.Summ. 50 (3) (2001) 1–15.
[31] J.L. Thomsen, S.B. Albrektsen, An investigation of the pattern of firearms fatalities before and after the introduction of new legislation in Denmark, Med. Sci. Law 31 (1991) 162–166.
[32] K.E. Moracco, C.W. Runyan, J.D. Butts, Femicide in North Carolina, 1991-1993, Homicide Stud. 2 (4) (1998) 422–446.
[33] A.J. Kivisto, Male perpetrators of intimate partner homicide: a review and proposed typology, J Am Acad Psychiatry Law 43 (3) (2015) 300–312.
[34] S. Rye, C. Angel, Intimate partner homicide in Denmark 2007–2017: tracking potential predictors of fatal violence, Cambridge Journal of Evidence-Based Policing 3 (1–2) (2019) 37–53.
[35] C.M. Spencer, S.M. Stith, Risk factors for male perpetration and female victimization of intimate partner homicide: a meta-analysis, Trauma Violence Abuse 21 (3) (2020) 527–540.
[36] A. Reckdenwald, S. Simone, Injury patterns for homicide followed by suicide by the relationship between victims and offenders, Homicide Stud. 21 (2) (2017) 111–132.
[37] P. Zeppegno, et al., Intimate partner homicide suicide: a mini-review of the literature (2012-2018), Curr. Psychiatr. Rep. 21 (3) (2019) 13.
[38] M. Liem, Homicide followed by suicide: a review, Aggress. Violent Behav. 15 (3) (2010) 153–161.
[39] M.H. Ottosen, et al., Drab i familien - Når børn bliver ofre, DJØF Forlag, Copenhagen, 2022.
[40] S. Caman, et al., Differentiating male and female intimate partner homicide perpetrators: a study of social, criminological and clinical factors, Int. J. Forensic Ment. Health 15 (1) (2016) 26–34.
[41] S. Rogde, H.P. Hougen, K. Poulsen, Homicide by sharp force in two Scandinavian capitals, Forensic Sci. Int. 109 (2) (2000) 135–145.
[42] K. Ormstad, et al., Patterns in sharp force fatalities–a comprehensive forensic medical study, J. Forensic Sci. 31 (2) (1986) 529–542.
[43] M.P. Burke, et al., Single stab injuries, Forensic Sci. Med. Pathol. 14 (3) (2018) 295–300.
[44] A.C. Hunt, R.J. Cowling, Murder by stabbing, Forensic Sci. Int. 52 (1) (1991) 107–112.
[45] F. Tamsen, F.K. Logan, I. Thiblin, Homicide injury quantification: correlations and reliability of injury severity scores applied to homicide victims, Homicide Stud. 19 (1) (2014) 88–100.
[46] B. Solarino, et al., A multidisciplinary approach in overkill: analysis of 13 cases and review of the literature, Forensic Sci. Int. 298 (2019) 402–407.

[47] D.K. Molina, L.E. Wood, V.J. DiMaio, Shotgun wounds: a review of range and location as pertaining to manner of death, Am. J. Forensic Med. Pathol 28 (2) (2007) 99–102.
[48] D.K. Molina, V.J. DiMaio, R. Cave, Handgun wounds: a review of range and location as pertaining to manner of death, Am. J. Forensic Med. Pathol 34 (4) (2013) 342–347.
[49] D.K. Molina, V. DiMaio, R. Cave, Gunshot wounds: a review of firearm type, range, and location as pertaining to manner of death, Am. J. Forensic Med. Pathol 34 (4) (2013) 366–371.
[50] J. Chopra, et al., Risk factors for intimate partner homicide in England and Wales, Health Soc. Care Community 30 (5) (2022) e3086–e3095.