ORIGINAL ARTICLE

A systematic review of literature on homicide followed by suicide and mental state of perpetrators

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Abstract

Background: Homicide followed by suicide is rare, devastating and perpetrated worldwide. It is commonly assumed that the perpetrator had a mental disorder, raising concomitant questions about prevention. Though events have been reported, there has been no previous systematic review of the mental health of perpetrators.

Aims: Our aims were twofold. First, to identify whether there are recognisable subgroups of homicide–suicides in published literature and, secondly, to investigate the relationship between perpetrator mental state and aspects of the incident.

Methods: We conducted a systematic review of published literature on studies of homicide followed within 24 h by suicide or serious suicide attempt that included measures of perpetrator mental state.

Results: Sixty studies were identified, most from North America or Europe. Methodologically, studies were too heterogeneous for meta-analysis. They fell into three main groups: family, mass shooter, and terrorist with an additional small mixed group. There was evidence of mental illness in a minority of perpetrators; its absence in the remainder was only partially evidenced. There was no clear association

between any specific mental illness and homicide–suicide type, although depression was most cited. Social role disjunction, motive, substance misuse and relevant risk or threat behaviours were themes identified across all groups. Pre-established ideology was relevant in the mass shooter and terrorism groups. Prior trauma history was notable in the terrorist group.

Conclusion: Research data were necessarily collected post-incident and in most cases without a standardised approach, so findings must be interpreted cautiously. Nevertheless, they suggest at least some preventive role for mental health professionals. Those presenting to services with depression, suicidal ideation, relationship difficulties and actual, or perceived, changes in social position or role would merit detailed, supportive assessment over time.

K E Y W O R D S
extended suicide, homicide suicide, mass murder suicide, mental state, systematic literature review

1 | INTRODUCTION

In August 2021, in Plymouth, UK, a man shot and killed five people and injured two others before killing himself (BBC, 2021). This is just one example of homicide–suicide events that, though rare, devastate communities world-wide. Cheung et al. (2016), drawing on seven prior studies, estimated an incidence of 0.05–0.89 per 100,000 people. Such incidents attract fear, extensive media attention and popular culture references (Friedman et al., 2018; Peterson et al., 2021). Though homicide and suicide have been independently well-researched, less is known about homicide–suicide events and little is known about the relevance of mental disorder in perpetrators (Flynn et al., 2016).

1.1 | Definition

Homicide–suicide encompasses a range of events, variously interpreted as murder–suicide, dyadic death and extended suicide (Adinkrah, 2014; Barraclough & Harris, 2002). The accepted definition is 'an incident in which an individual takes the life of one or more victims before taking their own life' (Knoll & Hatters-Friedman, 2015). In most cases, suicide occurs immediately, although the time frame varies (Marzuk et al., 1992; Rouchy et al., 2020).

1.2 | Aims

Our aims were to find:

a) What aspects of mental state have been assessed in homicide–suicide perpetrators—and when (pre-/post-event or both)?
b) Whether there are recognisable relationships between mental state and victim type, method of attack or other features of the incident?

2 | METHOD

Our protocol followed (Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA]) guidelines and is registered on the international prospective register of systematic reviews (PROSPERO Registration number CRD42019134975).

2.1 | Search criteria and process

We searched six electronic databases (EMBASE, MEDLINE, PsycINFO, PsycEXTRA, PSycCRITIQUES and Psyc-BOOKS) for literature published between 1978 and 15 October 2019. Search terms used were ('homicid*' OR 'murder*' OR 'terror*' OR 'jihad*' OR 'massacre' OR 'plane crash' OR 'avia*') AND ('suic*' OR 'self-harm').

Public inquiry reports in England for incidents of homicide followed by suicide were sought and reviewed. Titles in reference lists of relevant reviews and references and citations of included papers were reviewed. Lead authors of included papers with available email addresses (*n* = 51) were contacted to enquire about other relevant studies.

2.2 | Inclusion/exclusion criteria

Included studies were those examining homicide–suicide where:

- There was any homicide case followed by a suicide or seriously life threatening suicide attempt within 24 h; and

- For the study, there had been an attempt at assessing/describing the perpetrator's mental/emotional state, whether from existing records, contemporaneous report or *post hoc* interviews with relatives, friends or acquaintances.

Exclusion criteria:

- Homicide cases where the suicide or suicide attempt occurred over 24 h after the homicide;
- Studies published in languages other than English, except where the lead author could provide relevant information in English;
- Articles without primary data and non-peer reviewed publications, including books, dissertation theses and congress abstracts.

Where congress abstracts were identified, attempts were made to contact the presenter to request published papers, and relevant non-peer reviewed publications were searched for relevant references.

2.3 | Paper selection

Paper selection included three steps: title search, abstract and full paper review. The first 100 titles were screened by two reviewers (AT and HS) to test for co-author agreement. There was full agreement. Additional titles were screened by one reviewer (AT).

Titles for further consideration were then read in abstracts or full text, using a screening checklist (see Supporting Information S1: Supplement 1). The first 20 abstracts were reviewed and discussed by all authors as a 'training' process. Abstracts and papers were subsequently reviewed by pairs of authors with any disagreements resolved by a third (needed for 33 abstracts, 13 full papers).

2.4 | Data extraction and quality assessment

Data extraction for included papers was completed by pairs of authors using a data extraction tool devised by the research group (see Supporting Information S1: Supplement 2). Quality of included studies was assessed using standardised tools: the Centre for Evidence-Based Management (CEBMa) critical appraisal tool for case reports and case series (CEBMa, 2014); the Critical Appraisal Skills Programme (CASP) checklists for case–control and cohort studies as applicable (CASP, 2022a, 2022b). For the purposes of this review a case report described the perpetrator(s) in one incident; case series described perpetrators in several incidents without numerical data analysis; cohort studies described all incidents in a defined population and timeframe, summarising some prevalence data; and case control studies compared a defined group of homicide–suicide incidents with another defined group of homicide–suicide, suicide only, homicide only or other incidents.

2.5 | Analyses

A thematic analysis (Braun & Clarke, 2006) was conducted. A theme was noted if raised in at least one paper and a number of papers describing each theme were recorded.

Meta-analysis was considered, but due to methodological heterogeneity this was not possible. Instead, we attempted to generate crude estimates of prevalence of mental disorder among perpetrators for each identified theme.

3 | RESULTS

From 582 unique titles that remained after title screening and duplicate removal, 60 papers were eligible (see Figure 1).

3.1 | General characteristics of included studies

Four main methodological types of study were found (see Figure 2); more than two thirds of the papers (44) included quantitative data. A psychological autopsy, a specific systematic research tool developed to study incidents of suicide (see Isometsa, 2020), was described as having been completed in two case reports, one case series and one cohort study. Most other studies inferred mental disorders only from available records, including media reports.

Quality assessment details are given in Supporting Information S1: Supplements 3 and 4.

Nearly all data were from high-income countries; half of the studies were from North America and all but three of these from the USA alone (see Supporting Information S1: Supplement 5).

Almost all perpetrators were male; the only exceptions were in a study by D'Argenio and colleagues (2013) who focused on maternal filicide–suicide. Gokten and colleagues (2015) described the only incident of childhood sororicide, and Speckhard and Ahkmedova (2006) referred to female perpetrators of Chechen terrorist attacks.

Perpetrators of intrafamilial events were almost exclusively adults; in two papers adults over the age of 55 (Malphurs & Cohen, 2005; Malphurs et al., 2001) and in one adults aged 65 and over (Cheung et al., 2016). Mass shootings tended to be perpetrated by younger adults, occurring mostly in educational settings.

The most frequent perpetrator–victim relationships were familial, with 23 papers exclusively about this. Seven other papers were reports of homogenous groups—four described mass shootings and three described terrorist
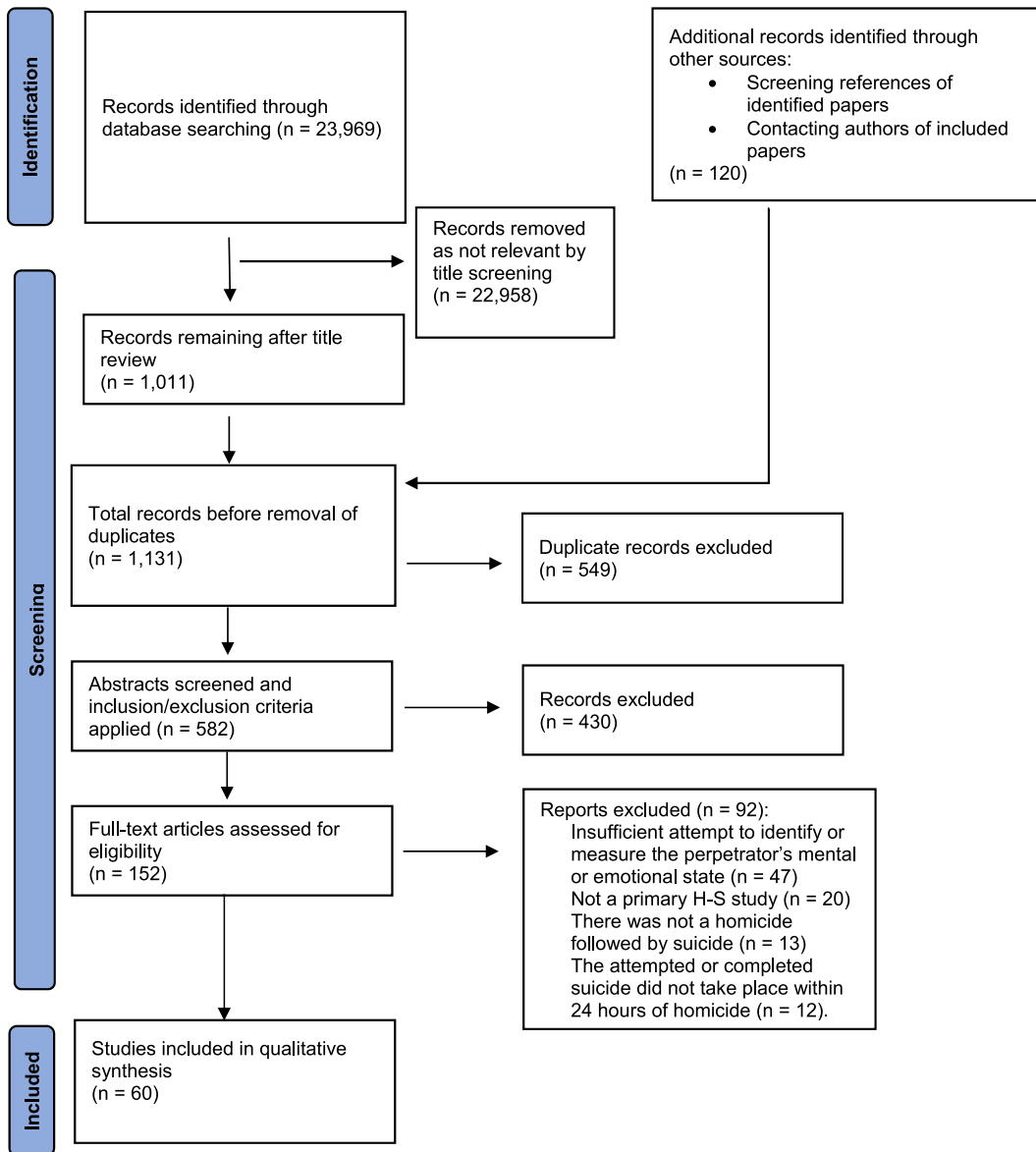
Identification

Records identified through database searching (n = 23,969)

Additional records identified through other sources:
- Screening references of identified papers
- Contacting authors of included papers
(n = 120)

Records removed as not relevant by title screening (n = 22,958)

Records remaining after title review (n = 1,011)

Screening

Total records before removal of duplicates (n = 1,131)

Duplicate records excluded (n = 549)

Abstracts screened and inclusion/exclusion criteria applied (n = 582)

Records excluded (n = 430)

Full-text articles assessed for eligibility (n = 152)

Reports excluded (n = 92):
Insufficient attempt to identify or measure the perpetrator's mental or emotional state (n = 47)
Not a primary H–S study (n = 20)
There was not a homicide followed by suicide (n = 13)
The attempted or completed suicide did not take place within 24 hours of homicide (n = 12).

Included

Studies included in qualitative synthesis (n = 60)

FIGURE 1 PRISMA diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses. [Colour figure can be viewed at wileyonlinelibrary.com]

attacks. The remaining 30 papers covered a range of relationship types and settings, in 26 of these, more than two-thirds of events were intrafamilial and were reallocated to the 'family' group—to a total of 49 familial homicide–suicide studies. Four papers remained in a 'mixed' group: one study about aviation homicide–suicide (Soubrier, 2016) and three studies including heterogeneous incidents across different settings (Table A1).

Thus, mental health had been most systematically studied in familial homicide–suicide cases, with 26 cohort and 15 case–control studies as well as four case reports and four case series. Only one paper from each of the mass shooting (Hall et al., 2019) and terrorist groups (Speckhard & Ahkmedova, 2006) described a cohort, the remainder being case reports or series. Three of the mass shooting papers (Knoll, 2010; Langman, 2020; White, 2017) described seven cases between them but, given some overlap, only five were unique cases. Hall et al. (2019) described a further 41 mass shooting cases, although only 18 ended with perpetrator suicide, with one attempted suicide and one later
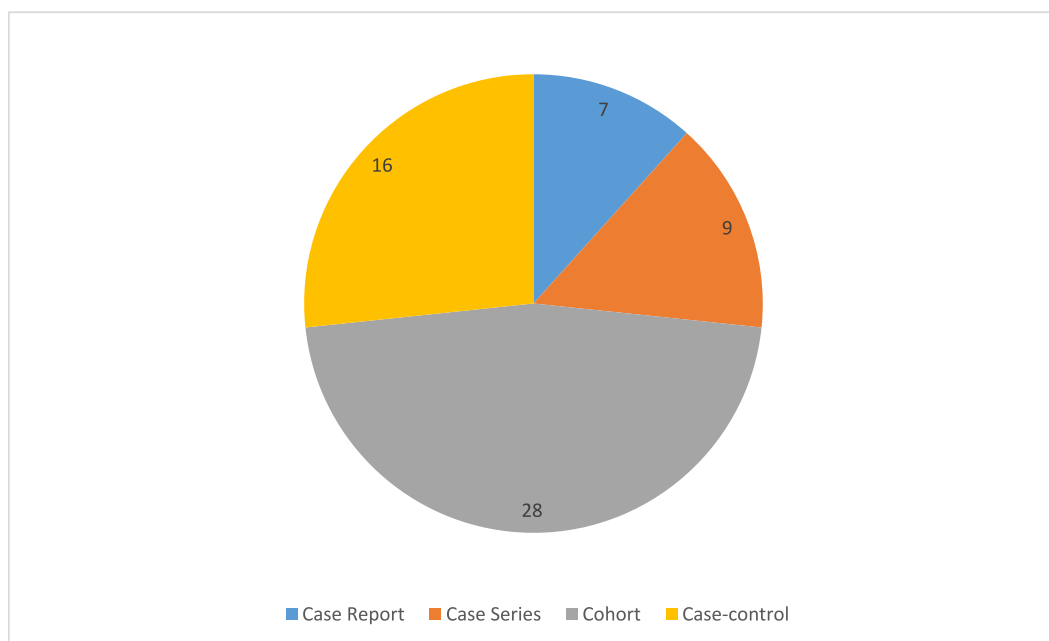
FIGURE 2 Type of included paper. [Colour figure can be viewed at wileyonlinelibrary.com]

completed suicide. The case series in the terrorist group (Lankford, 2018) included a perpetrator also described in the earlier single case study (Lankford, 2012).

3.2 | Thematic analysis

Separate thematic analyses were completed for each of these main groups. In addition to mental disorder, other themes identified included substance misuse, loss or disruption of social role and previous risk indicators, with a number of studies also considering motive, evidence of preplanning and recommendations for future research, classification and prevention. Group themes are summarised in Table 1.

3.2.1 | Mental disorder

No clear pattern of diagnoses among perpetrators emerged. Table 1 shows that almost all intrafamilial studies considered depression a relevant factor (44/49), as did most of the other groups. About half of the familial group studies considered psychosis (24/49) as did most of the other groups. Other diagnoses were much less likely to be considered or reported.

Meta-analysis was not possible but we have provided an indication of how frequently perpetrator diagnoses were linked to the event. Table 2 shows that among the intrafamilial quantitative studies (41), the prevalence of any mental disorder (collectively) was available in 23 of these studies, and information about diagnostic breakdown in 34 of them, with some overlap.

The 23 intrafamilial quantitative studies included information on 3595 perpetrators of homicide–suicide; according to these, overall, the prevalence of any mental disorder was 19%. From the 34 intrafamilial quantitative studies, including information on 3906 perpetrators of homicide–suicide with diagnostic breakdown, the most common diagnosis was depression, found in 15% of perpetrators. The prevalence of personality and of psychosis was each 1% amongst these 3906 perpetrators.

TABLE 1 Indicative prevalence of mental disorders amongst perpetrators of homicide-suicide in the intrafamilial quantitative studies where data were available.

| | Type of multiple homicide followed by suicide incident | | | |
Data examination themes and supporting data items	Within the family 49 papers	Mass shooting in a public place 4 papers	Terrorist 3 papers	Mixed 4 papers
Perpetrator mental disorder	49[a]	4	3	4
Prior diagnosis/service contact	21	3	0	2
Depression	44	3	3	3
Psychosis	24	3	2	3
Strange thinking or behaviour	6	0	1	1
Personality disorder	13	2	1	1
Autism	0	4	0	0
Learning disability	1	1	0	0
ADHD	0	1	0	0
Mental illness (other)	6	1	0	0
PTSD	0	0	2	0
Absence of illness	5	0	0	0
Alcohol or drug misuse	38	2	2	1
Alcohol alone	27	0	2	0
Drugs (illicit or misused prescribed) alone	20	2	0	0
Both alcohol and drug misuse	9	0	1	1
Any substance misuse use in conjunction with mental disorder(s)	7	0	0	0
Social role loss or disruption	44	3	3	4
Education or employment loss	18	3	3	3
Financial difficulties	21	0	0	0
Relationship difficulties				
With family and/or intimate partners	38	0	0	0
With parents and/or siblings, or parental divorce	0	2	0	0
In general	0	0	0	2
High needs of dependents	11	0	0	0
Difficulties with psychosexual development—including body issues and rage against women	0	2	1	0
Physical ill health				
As an adult	14	0	0	0
As a child	0	1	0	0
Loss of childhood associated with lack of strong role model	0	0	2	0
Loss of self-esteem/loss of sense of self	0	3	0	1
Social isolation	2	3	3	0
Trauma	6	0	3	0

TABLE 1 (Continued)

Data examination themes and supporting data items	Type of multiple homicide followed by suicide incident			
	Within the family	Mass shooting in a public place	Terrorist	Mixed
	49 papers	4 papers	3 papers	4 papers
Motive	29	3	3	2
Altruism/mercy killing	27	0	0	1
Revenge				
Rejection from actual relationship	10	0	0	0
Rejection from wished for relationship and/or feeling persecuted	0	3	0	0
Jealousy				
Of ex-partners	12	0	0	0
Of peer group	0	2	0	0
Infamy/desire to be known	0	3	0	1
Grandiosity/narcissism	0	3	0	0
Nazi/racism ideology	0	2	0	0
Religious extremism	0	0	1	0
Martyrdom	0	0	2	0
Evidence of pre-planning	19	2	3	1
Warning signs	0	2	0	0
Previous risk behaviours	40	4	3	3
To self	26	2	2	1
To others				
General	33	4	1	2
Previous violence and threats	30	1	0	1
Anger	11	0	0	2
Sadistic behaviours	0	3	0	0
Criminal history and rule breaking	0	4	1	0
Interest in weapons and military	0	3	0	0
Noting multidimensional causality	10	0	0	0
Highlighting need and recommendations for clinical prevention	9	0	3	4
Need for improving future research methodology to aid understanding	14	0	0	1
Improving classification system around homicide-suicide incidents	8	0	0	0
Noting similarities between homicide and suicide	4	0	0	0

Abbreviations: ADHD, attention deficit hyperactivity disorder; PTSD, post-traumatic stress disorder.

[a]In all cases the numbers refer to the number of papers giving data on the item.

TABLE 2 Indicative prevalence of disorders amongst perpetrators of homicide-suicide in the family cohort and case control studies.[a]

Total numbers of perpetrators	Number of studies	Depression	Psychosis	Personality disorder	Other mental disorder	Any mental disorder
3906	34	585 (15%)	47 (1%)	42 (1%)	46 (1%)	
3595	23					701 (19%)

[a]There is some overlap of studies where information on both the prevalence of any mental disorder and diagnostic breakdown were available.

Further, an absence of diagnosis does not equate to absence of disorder, but five papers specifically identified people in the family group who had no mental disorder (Chan et al., 2003; Frei et al., 2011; Hatters-Friedman et al., 2005; Ilic & Frei, 2019; Logan et al., 2008); Chan et al. (2003) provided the most extreme evidence in this respect: '*two-thirds of offenders were apparently free of mental disorder*'.

Thus, these figures suggest caution in interpreting prevalence. Taking study estimates individually, for example, the range of prevalence for depression varied from 0% to 94%, with the smaller studies tending to yield higher prevalence figures. The range of prevalence for psychosis was not quite so wide (0%–27%), but the spread still creates interpretation difficulties. Similarly, the prevalence of personality disorder amongst all perpetrators was only 1%, but the range between studies was 0%–70%. Other mental disorders were rarely cited. Anxiety and adjustment disorders were described in a small number of family perpetrators (Flynn et al., 2009; Frei et al., 2011; Lindqvist & Gustafsson, 1995) and one mass shooting paper (Hall et al., 2019). Eating disorder was described in one intrafamilial perpetrator (Moskowitz et al., 2006) and two mass shootings (Hall et al., 2019).

It is striking that neurodevelopmental disorders have rarely been considered in homicide–suicide studies. Only the mass shooter group stands out in this respect; autism was considered in all mass shootings though not found in all. Just one of the 49 family papers described the impact of learning disability (Pilszyk & Cynkier, 2015); none reported autism, although one referred to an intrafamilial perpetrator who: '*as a child … [to be] reclusive and withdrawn … he did not have close friends and preferred to stay alone in his room … socially withdrawn*' (Declercq et al., 2017). The case study of one terrorist raised the possibility of an underlying neurodevelopmental disorder, but no formal diagnosis was made (Lankford, 2012). Autism was not raised in the mixed group.

Post-traumatic stress disorder (PTSD) was uniquely reported in the terrorist group, with one case identified after direct assessment in Lankford (2018), and most of the 34 psychological autopsies in Speckhard and Ahkmedova (2006) led to descriptions of psychological changes after trauma, albeit no PTSD diagnoses. The apparent absence of PTSD in the intrafamilial group may better reflect absence of assessment rather than absence of disorder.

3.2.2 | Alcohol and drug misuse

Alcohol and/or drug intoxication and misuse was described in some of the perpetrators in each main group of homicide–suicides: 38/49 family, 2/4 mass shooting, 2/4 terrorist and 1/4 mixed papers. Although these problems were noted, there was no consistent method of assessment; some included contemporaneous alcohol and drug blood levels, others considered dependency and some considered both. Descriptions did not enable production of summary prevalence ranges. The available data suggests that substance misuse and/or intoxication is important in the family group.

3.2.3 | Loss of social role and relationships

Nearly all papers (44/49 family, 3/4 mass shooting, 3/3 terrorist, 4/4 mixed) described social problems best understood under a theme of loss, both real and perceived.

Loss of educational or employment status was described in 18/49 family papers, 3/4 mass shootings, all terrorist and 3/4 mixed papers. Researchers often described an association through financial difficulties (21/49 family; 3/4

mixed papers) but there was no consistency in reporting prevalence. Scheinin et al. (2011) cited an example of this: '*In his suicide note, he stated that he had gone from being a millionaire to being broke in a matter of months and was at the end of his "emotional, physical, and financial rope"*'.

Relationship difficulties were noted in all groups except terrorist perpetrators (38/49 family, 2/4 mass shooting and 2/4 mixed papers). Difficulties often related to intimate partner (IP) relationships and were linked with a revenge motive, as illustrated by Knoll and Hatters-Friedman (2015) who noted that in most cases (67%), '*The acts occurred in the context of a separation*' and '*All cases were characterised by relationships involving multiple separations and reunions…*'. Anticipated loss within a caregiving role was often linked to an altruistic motive. Flynn et al. (2016), for example, noted '*the most common circumstances leading to the individual's emotional distress was the loss of a close personal relationship either through imminent separation or divorce; or a significant change in the relationship due to the victim's ill health (e.g. dementia)*'.

Relationship difficulties in papers on mass shooting had often been with siblings and/or parents rather than partners, perhaps unsurprising as reported cases were mainly of adolescents. In his case report, White (2017) noted: '*In early life, parents divorced when he was aged 7, father remarried and perpetrator is described as hating his step-mother. In his manifesto there were plans to kill both her and his younger half-brother*'. However, troubled intimate relationships were not absent, merely different. Notably, 2/4 mass shooting and 1/4 terrorism papers described psychosexual development and intimate relationship problems; actual or perceived loss of desired relationships fuelled motives of envy and revenge. Langman (2020) noted of one perpetrator: '*the central failure of his life was his inability to have sex with a woman … referring to himself as a "kissless virgin" … and raged against women for rejecting him and men for succeeding where he was failing*'. Similarly, Lankford (2012) wrote, of a terrorist: '*overall, a major source of guilt and shame in Atta's life was the issue of sex … [his father] described his son as being so non-sexual that he was "like a virgin girl in his politeness and shyness"*'.

Physical ill health was considered in 14/49 family papers, but mainly as a disruptor of usual social role, especially for older couples (e.g. Milroy, 1995) and those in the military: '*military perpetrators (14.3%) were more likely to report physical complaints than were civilian perpetrators*' (Patton et al., 2017). Poor physical health in childhood, perhaps isolating the child, was noted in mass shooters (Langman, 2020).

Any lifetime experience of trauma was noted in 6/49 family and all terrorism papers, and linked to loss of childhood, feelings of guilt or shame for not protecting loved ones, hopelessness and personality changes. Speckhard and Ahkmedova (2006) noted that all 34 suicide terrorists in their sample '*had personally witnessed the death and beatings of close family members or experienced torture themselves*'.

Descriptions of low self-esteem or *loss* of sense of self were absent in the intrafamilial studies, but present in 3/4 mass shooting and 1/4 mixed papers. Oliffe et al. (2015), in their mixed group, noted: '*45 M-S [murder-suicide] cases revealed perpetrators as reacting to potentially emasculating issues capable of eroding their sense of self and identity*'. Social isolation or marginalisation was described in two family and two mass shooting papers (e.g. 7/16, Ilic & Frei, 2019).

3.2.4 | Preplanning

Preplanning was considered in 19/49 family, 2/4 mass shooting, all terrorist and 1/4 mixed papers. A particularly graphic example comes from Soubrier (2016), on the German Wings plane crash: '*This was a premeditated act, having flown gliders in the region before, he knew the area …. He had already tested how to block the autopilot … he had locked himself in the cockpit after the chief pilot went to the toilet*'.

3.2.5 | Motive

Motive was a theme that seemed to differentiate the groups described in 29/49 family, 3/4 mass shooting, all terrorist and 2/4 mixed papers, but described without systematic assessment.

Just over half of family (27/49) and 1/4 mixed papers described *'altruistic' motives*', often linked to the ill-health of a dependant, as in: '*a socially isolated and exhausted woman in the late 40s killed her chronically mentally ill husband*'

before killing herself (Buteau et al., 1993). Others, however, were not without altruism, but also perpetrator-centred '*with his and his son's death, both of them would be liberated from what he experienced as the mother's intrusive and over-bearing interference*' (Declercq et al., 2017).

Revenge was considered in 10 family and three mass shooting papers. In the family, this related to IP relationship breakdown, for example, Holland et al. (2018): '*in 17% (n = 29) of cases, the motivation behind filicide-suicides in particular was to deprive one parent custody of a child(ren)*'. In mass shootings, revenge was likely to be directed against peers and society, for example, White (2017) reported Elliot Rodger's '*wish to punish everyone who is sexually active*'. Desire for revenge may also have been linked to jealousy and envy, considered separately in 12 family (amorous jealousy) and two mass shooting papers (against peers and society).

Grandiosity did not feature in intrafamilial homicide–suicides, but three mass shooting papers described desires to be known, for example, Langman (2020) quoted Eric Harris: '*I feel like God and I wish I was, having everyone being OFFICIALLY lower than me...my belief is that if I say something, it goes. I am the law, if you don't like it, you die*'. Soubrier (2016) reports the German Wings pilot as having said, '*everyone will learn my name and so will remember it*'.

Ideological motivations, similarly not a feature of intrafamilial homicide–suicides, were described in two mass shooting and all terrorism papers. Among mass shooters, White (2017) noted that Rodger conducted online searches on Hitler and other Nazis and Langman (2020) noted that Harris wrote '*I love Nazis*'. Both had racist views. Terrorists also had explicitly religious ideologies: '*Atta attempted to fill the void in his life with something meaningful ... a commitment to radical religious ideology*' (Lankford, 2012), including martyrdom, described in 9/11 perpetrators (Lankford, 2018) and Chechen terrorists (Speckhard & Ahkmedova, 2006).

3.2.6 | Previous risk behaviours

Evidence of before event behaviours that might have raised concerns about need for intervention were considered in most papers (40/49 family, all mass shootings, all terrorist and 3/4 mixed papers).

Previous risk to self, including suicidal ideation, plans or attempts were described in some perpetrators in half the papers and across all groups. Schwab-Reese and Peek-Asa (2019), for example, noted: '*since we included suicidal thoughts and attempts in our conceptualisation, our results ... suggest that a sizeable minority of homicide-suicide incidents are perpetrated by individuals who have a history of suicide ideation and attempts*'.

Prior evidence of risk to others was commonly considered (33/49 family, 4/4 mass shooting, 1/3 terrorist, 2/4 mixed). In family and mixed papers, this related to previous violence and threats. Risk to others was sometimes inferred from evidence of anger: '*a greater proportion of the homicide-suicide group were reported to be angry, hostile or violent in comparison with the suicide group in the time leading up to death*' (Haines et al., 2010). Among perpetrators of mass shooting, three papers described sadistic behaviours. All mass shooting papers and one terrorism report described previous criminal history and rule breaking. Among Hall et al.'s (2019) series of 49 shooters, 23 were classifiable as homicide–suicides and 24% had had prior interactions with law enforcement. Both of Knoll's (2010) mass shooters had had previous histories of antisocial behaviour. Only one terrorism paper considered evidence of prior risk to others (Lankford, 2018).

3.2.7 | Prevention

The final theme emerging was 'prevention', considered in 33 papers. Suggestions included improving research methods, clinical interventions, consideration of multidimensional causality, reviewing classification systems and considering homicide–suicide acts along a continuum between suicide and homicide.

The most consistent call for *improved research methods* (14/49 family and 1/4 mixed papers) was for psychological autopsy (e.g. Knoll & Hatters-Friedman, 2015). Others considered the balance between quantitative studies and small, qualitative studies (see Declercq et al., 2017; Liem, 2010). Eight papers discussed classification complexities, but without coming to any conclusion about a universal standard.

Twelve recommendations were offered for clinicians, drawn from consideration in 16 papers (nine family, three mass shooting and all mixed):

1. Targeted men's mental health services, for men at risk of depression, substance misuse and suicide (Comstock et al., 2005; Oliffe et al., 2015).
2. Targeted multiagency work for IP violence (Comstock et al., 2005; Dogan et al., 2010; Flynn et al., 2009; Holland et al., 2018; Logan et al., 2013).
3. Ensuring effectiveness of restriction/restraining orders (Campanelli & Gilson, 2002).
4. Increased awareness in family court professionals (Shields et al., 2015).
5. Routine domestic abuse inquiry in acute health settings (Flynn et al., 2009).
6. Mental health screening of at-risk parents (Moskowitz et al., 2006).
7. Adoption of health tactics for handling conflict (Holland et al., 2018).
8. Improved barriers to accessing firearms (Campanelli & Gilson, 2002; White, 2017).
9. Understanding limits of risk assessment tools (Broadhurst et al., 2005).
10. Understanding the added value of threat assessment (Langman, 2020).
11. Increased public awareness of cues, such as prolonged depression or hopelessness (Broadhurst et al., 2005).
12. Monitoring social media of at-risk adolescents/young adults (White, 2017).

4 | DISCUSSION

To our knowledge, this is the first systematic review of research into relationships between mental state and perpetration of homicide–suicide. In the absence of a universally accepted definition of homicide–suicide incidents, we included homicides with one victim and completion or near completion of suicide within 24 h. We found that, with very few exceptions, studies fell into three main groups, the largest defined by the victims being within the family and two small ones about mass shooting or terrorist attacks.

Paper quality varied. Whilst cohort studies offered quantitative data, they often lacked systematic clinical descriptions; there were few attempts to consider the intersection of possible risk factors. From a mental health perspective, reliance on actuarial data and prior diagnosis was limiting as most perpetrators had no previous contact with mental health services. Those including psychological autopsy were the most informative and we would encourage all future studies to use this methodology.

Furthermore, it became apparent from reviewing titles and abstracts that the type of incident influenced the direction of research. Almost half of the papers excluded at full text review (47/96) did not consider the perpetrator's mental state. Those that did, were almost entirely family events, influencing homicide–suicide research classification (Hanzlick & Koponen, 1994; Harper & Voigt, 2007; Marzuk et al., 1992; Wallace, 1986). Although terrorist and mass shooting events have been studied, the focus has been on epidemiological, social risk factors and political ideology, perhaps because of social perceptual biases. We suggest that there is sufficient evidence of mental health problems in this group for psychological autopsy to be routinely conducted.

No individual mental illness or group of mental illnesses was identified as the main risk factor in any group. Depression and psychosis were the most discussed diagnoses but unrecorded in many perpetrators. It was impossible to calculate a meaningful summary of prevalence of mental disorder, even among intrafamilial homicide–suicides, because of variation in assessment methods, rigour and range. Further, our estimate of 19% with any disorder is lower than that found in a UK household survey (McManus et al., 2009); it seems unlikely that homicide–suicides, as a group, have above average mental health. Some disorders were not assessed in the intrafamilial group, for example, autism. For future research, a comprehensive, systematic approach seems essential.

There was a complex interplay between themes: mental disorder, socioeconomic and relationship difficulties and loss were often concurrent. Further research around the identified themes may enable specificity of risk factors and the development of a risk matrix.

Disturbances in relational dynamics were most likely to be found in the family studies—jealousy/revenge towards an [ex]partner, or 'altruism' towards a suffering dependant. There was no exploration of the impact of a changing dynamic on the perpetrator's sense of self. It is notable that none of the papers reviewed and discussed cultural understandings of motivation such as Oyaku Shinju (Iga, 1996).

A novel theme, not previously highlighted in reviews, was that of a sense of individual and/or sociocultural isolation, particularly evident in mass shootings and terrorist groups. There were recurring descriptions of a strong sense of personal alienation and separation from usual social structures. This included feelings of inadequacy, especially with regard to women. Withdrawal from wider society was replaced by new social circles, which endorsed the development of beliefs around threats to personal integrity. For example, since the 1990s, the INCEL movement offered an online community to those who feel sexually rejected (Broyd et al., 2023; Hoffman et al., 2020). Several mass killings followed by suicides have been reported in this context.

Isolation is of particular interest at present, given our experiences during COVID-19 lockdowns. However, whether initial alienation precedes social isolation in homicide–suicide remains unclear. Klebold (2016), mother of one of the Columbine shooters, has written a powerful account of the dilemmas for bystanders even when isolation is recognised, including striking a balance between respect for privacy and monitoring internet activity and adolescent friendships. Those with neurodevelopmental disorders may be particularly vulnerable to being drawn into high risk online forums. Primary preventive strategies may be particularly helpful here.

However, the lack of evidence-based specific guidance for preventative strategies is notable across studies. Some family papers described the need for better awareness of domestic violence risk in family courts, especially with depressed men, those abusing alcohol or drugs and/or reporting feelings of hopelessness. We recommend that health professionals enquire about domestic violence and consider the risk of parents to children when encountering service users in acute settings.

4.1 | Limitations

The lack of a universal homicide–suicide definition and classification made comparison of research studies difficult. Our initial PROSPERO protocol was confined to incidents with multiple victims, and preliminary searches demonstrated that we risked excluding much relevant material and risked reducing our learning; hence, we amended our protocol. The timing of suicide is another definitional problem—in all included studies, suicide had been completed within 24 h of the homicide in at least some cases, but we noted cases where survival had seemed unlikely and still other cases where suicide occurred later but seemed linked. It is unclear how much these details of definition matter.

Secondly, from the studies identified, we classified homicide–suicide by the main target of the homicide: family members; members of a community where there had been some attachment, as in the school/workplace killings of many mass shooters, and the strangers of terrorism events. This may prove to be arbitrary as we learn more. Furthermore, it was not possible to categorise all incidents in this way and it is unclear where some incidents best fit. Do aviation or other transport-related incidents form their own category of homicide–suicide? Only one transport-related incident was captured in our study, an aviation incident, despite other high-profile events. Kenedi et al. (2016) investigated 'Suicide and Murder–Suicide Involving Aircraft' but without meaningful assessment of perpetrator mental state. While this may suggest little research into the mental state of such operators, a psychologically informed reading of independent incident reports from outside the academic literature may be informative. The report into the Moorgate Tube disaster, for example, in which 43 people died, ruled out train malfunction and physical health crisis in the driver and extensively explored the case for suicide or mental disorder but found evidence inconclusive (nationalarchives.gov.uk/moorgate-tube-crash/). Perhaps the explicitly inconclusive is able to be academically informative.

Finally, the number of studies we found and the number of cases covered in those studies is very small relative to the number of such killings. We identified 27 papers relating to mass killings in the USA, but between 2013 and November 2023, 635 mass shootings and 39 mass murders have been recorded, including 641 murder–suicide incidents (www.gunviolencearchive.org). We have no way of knowing whether those considered in the scientific papers are typical or exceptional.

5 | RECOMMENDATIONS

Our recommendations are mainly for facilitating future research. However, we suggest that there is sufficient evidence to make clinicians aware of the need for interventions and risk management around the intersection of mental disorder, loss sense of rejection, social alienation, substance misuse and indicators of risk of previous harm to self or others. There may be added concerns with respect to social alienation following the isolation experienced globally during the COVID-19 pandemic. For further research of practical value, the following seem vital:

- Clear definition of homicide–suicide including a timeline and number of victims.
- Routine post event psychological autopsy, ideally required in law.
- Consideration of neurodevelopmental disorders.
- A standardised methodology on reporting of mental state should be developed for studying rare events, including homicide–suicide, to facilitate meta-analyses.
- Development of risk matrices to support prevention and future studies.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available in the supplementary material of this article.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

APPENDIX

TABLE A1 Summary table of included case control and cohort papers. For included case series and case report papers see Supporting Information S1: Supplement 6.

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Family victims				
Ilic and Frei (2019) 18 Swiss 5 EU 5 Other	To identify risk factors for mass murderers who had committed suicide after the crime (MMS) and those who had not (MM)	Case control Forensic psychiatric assessments reviewed	16 [15 m, 1 f]	17 [17 m] mass murder—No suicide
Knoll and Hatters-Friedman (2015) Texas, USA	To understand perpetrators, perpetrator-victim relationships, motives and dynamics of H-S	Cohort Completed psychological autopsies	18 [15 m, 3 f] 8 further cases identified however excluded as details were unavailable	None
Chan et al. (2003) Hong Kong, China	What is the prevalence and characteristics of HS in Hong Kong?	Cohort Police and coronial records review	60 [45 m, 15 f]	None
Malphurs et al. (2001) Florida, USA	How do the characteristics of male HSs compare with suicides(S) of older married males?	Case control study Review of medical examiner reports	27 [m] (HS)	36 [m] suicide only (S)
Cohen et al. (1998) Florida, USA	What are the incidence and clinical characteristics of homicide victims and suicide perpetrators of spousal/consort deaths? Is age relevant?	Cohort Psychological autopsy of medical/ FBI reports & newspaper articles	137 total 2 groups: Age <55: 89 [87 m, 2 f] Age >55: 48 [48 m]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Range 19–65 years	MMS: N = 13 (91.3%) (Ex-)Partner N = 12 (75%) biological children MM: N = 8 (47.1%) strangers N = 6 (35.3%) private acquaintances Murder method MMS: N = 11 (68.8%) private firearm N = 2 (12.5%) blunt weapon N = 1 (6.3%) military firearm N = 1 (6.3%) strangulation/ suffocation N = 1 (6.3%) poison	N = 5 (31.3%) cluster B personality disorder N = 4 (25%) No evidence of mental disorder N = 4 (35%) depression N = 4 (25%) substance misuse N = 5 (31.3%) prior psychological treatment N = 13 (81.3%) evidence of antecedent suicidal ideation However, no significant difference between the outcome of mass murder and mental disorder of the perpetrator Between group difference was motive MMS motive: Loyalty. Violence was instrumental in nature (less reactive) MM motive: Revenge
Mean 41.2 years	Victim relationship to perpetrator: Intimate partner Homicide method: N = 16 (89%) used firearms N = 1 (5.5%) gun and knife N = 1 (5.5%) arson	N = 17 (94%) depression N = 14 (78%) personal history violence N = 10 (56%) substance misuse N = 3 (17%) ASPD N = 3 (17%) personal suicide attempts N = 4 (22%) family history of suicide N = 12 (67%) indicated thoughts of H-S prior to the offence
Mean 41.9 years	Victim relationship to perpetrator: N = 19 (33.9%) spouse/lover N = 14 (25%) children N = 7 (12.5%) wives and children N = 8 (14.3%) other family members Homicide method: N = 19 (25.7%) strangled N = 18 (24.3%) stabbed/chopped N = 11 (14.9%) gassing/poisoning N = 10 (13.5%) falling from height	N = 41 (70%) no mental disorder N = 11 (18%) severe depression N = 4 (6%) schizophrenia Highlighted factors N = 37 (61.7%) low socio-economic status Motives varied
HS mean 78.2 years S mean: 80.2 years	Victim relationship to perpetrator: Spouse Homicide method: All used firearms in both groups (bar 1 case)	Higher rates of mental disorder in controls HS: N = 14 (52%) < S: N = 22 (61%) psychiatric symptoms HS: N = 10 (37%) < S: N = 21 (58%) depression HS: N = 3 (11%) = S: N = 4 (11%) alcohol/drug use HS: N = 5 (19%) > S: N = 1 (3%) marital discord Highlighted factors HS were 3× more likely to have caregiving roles
89 < 55 years 48 > 55 years	Victim relationship to perpetrator: Spouse/consort	<55: N = 10 (11%) < over 55: N = 14 (29%) depression <55: N = 13 (15%) > over 55: N = 3 (6%) alcohol/drug use <55: N = 9 (10%) < over 55: N = 3 (6%) other mental illness Highlighted factors N = 21 (44%) pain/general decline in health in older group

(Continues)

TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Milroy (1995) Yorkshire and Humberside, England	What were the reasons behind the killings and suicides of the assailants in episodes of homicide followed by suicide in Yorkshire and Humberside between 1972 and 1992?	Cohort	52 [49 m, 3 f]	None
Fishbain et al. (1985) Miami, USA	What were the characteristics and differences between female HS perpetrators compared to female HS victims and female suicide (S) victims?	Case control	10 [f]	2 groups: 50 [f] suicide only (S) 50 [f] victims of HS
Malphurs and Cohen (2005) Florida, USA	What factors differentiate older married men who commit HS compared to those who commit suicide (S) only?	Case control	20 [m] (HS)	40 [m] suicide only (S)
D'Argenio et al. (2013) Italy	What were the characteristics of 36 cases of filicide-suicide perpetrated by mothers between 1992 and 2010 in Italy?	Cohort	36 [f]	None
Kotzé et al. (2018) South Africa	What factors contributed to cases of HS in Northern Gauteng over a 6-year period?	Cohort Used psychological autopsy	35 [32 m, 3 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Mean 49 years	Victim relationship to perpetrator: Majority killed partner; however exact N not given For the remainder $N = 2$ new boyfriend of ex-wife/partner N (not given) children $N = 1$ sister-in-law $N = 3$ police officers $N = 1$ farmer Homicide method: Most common method was shooting	Exact numbers and percentages not clear due to variable denominators (21%) mental illness: Mainly depression $N = 3$ morbid jealousy (all alcoholics) $N = 1$ erotomania $N = 1$ schizophrenia Highlighted factors (29%) ethanol in blood (46%) relationship breakdown (11%) had physical ill-health (10%) financial stress (11%) criminal history
Mean 48.1 years	Victim relationship to perpetrator: Female HS perpetrators: $N = 6$ (60%) lover/ex-lover Homicide method: $N = 7$ (70%) used guns	History of depression: Suicide $N = 46$ (92%) > HS perpetrator $N = 4$ (40%) > HS victim $N = 1$ (2%) Highlighted factors $N = 2$ (20%) HS perpetrators had alcohol in their blood, compared to $N = 6$ (12%) HS victims $N = 4$ (40%) HS perpetrators more likely to leave a note.
HS Mean 73 years Suicide Mean 74 years	Victim relationship to perpetrator: Spouse Homicide method: $N = 20$ (100%) firearm	HS: $N = 13$ (65%) < S: $N = 32$ (80%) depressed mood HS: $N = 4$ (20%) < S: $N = 22$ (55%) suicidal ideation HS: $N = 5$ (25%) > S: $N = 2$ (5%) history of domestic violence HS: $N = 4$ (20%) > S: $N = 1$ (2.5%) recent illness Highlighted factors Toxicology of HS: $N = 3$ (15%) alcohol $N = 5$ (25%) analgesic $N = 4$ (20%) benzodiazepine $N = 6$ (30%) stimulants
Mean 35.4 years Mean age victim = 6.2 years	Filicide Homicide method: $N = 8$ (25%) stabbing $N = 8$ (25%) drowning $N = 8$ (25%) suffocation $N = 4$ (11%) defenestration $N = 2$ (6%) firearms $N = 2$ (6%) hanging	$N = 10$ (28%) known to mental health services $N = 6$ (17%) previous suicidal tendencies $N = 6$ (17%) were under treatment for mental health needs $N = 4$ (11%) under irregular treatment Highlighted factors $N = 4$ (11%) had children with pathology/disability $N = 18$ (50%) had marital problems $N = 7$ (19%) had financial problems
Mean 38.6 years Range 24–73 years	Victim relationship to perpetrator: $N = 22$ [m] (63%) intimate-possessive $N = 7$ [4 m, 3 f] (20%) filicide-suicide $N = 4$ [m] (11%) familicide-suicide $N = 1$ [m] (3%) Extra-familial $N = 1$ [m] familial-psychotic Homicide method: $N = 25$ (58.1%) victims shot	$N = 15$ (43%) had mental health diagnoses: $N = 9$ (26%) mood related $N = 6$ (17%) personality disorder $N = 1$ (3%) psychotic disorder $N = 7$ (20%) had substance misuse Of $N = 6$ (17%) traits suggestive of personality disorders: $N = 3$ (12%) ASPD/traits of ASPD $N = 1$ (3%) anankastic $N = 2$ (6%) borderline PD/traits

(Continues)

T A B L E   A 1   (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Patton et al. (2017) USA	What differences are there between military (M) and civilian (C) perpetrators of MS?	Case control	259 [m] military (M) 259 [m] civilians (C)	All perpetrators of MS
Holland et al. (2018) USA	What situational factors are at play in 175 cases of HS involving child victims?	Cohort- retrospective	*N* = 175 [132 m, 43 f]	None
Flynn et al. (2016) England and Wales 14 (24%) were born outside the UK	What are the characteristics (including prevalence of mental disorder, contact with mental health services, adverse events prior to the offence) of HS offenders and victims?	Cohort	60 [53 m, 7 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Military mean 57.05 years Civilian mean 41.56 years	Victim relationship to perpetrator: M: N = 203 (78.4%) spouse C: N = 190 (73.4%) spouse Homicide method: M: N = 226 (87%) firearm C: N = 230 (88%) firearm No significant difference between groups for relationship/method	Non-significant differences between groups: M: N = 24 (9.3%) C: N = 22 (8.5%) history of mental health M: N = 9 (3.5%) C: N = 7 (2.7%) history of suicide attempt M; N = 11 (4.2%) C: N = 14 (5.4%) current antidepressant M: N = 12 (4.6%) C: N = 24 (9.3%) current substance abuse M: N = 19 (7.3%) C: N = 19 (7.3%) current alcohol dependence M: N = 31 (12%) C: N = 27 (10.4%) current mental health M: N = 32 (12.4%) C: N = 32 (12.4%) current depressed mood Highlighted factors Significant differences found in primary motive and age (older military perpetrators)
Mean [m] 37.7 Mean [f] 35.5	Victim relationship to perpetrator: N = 223 (65.6%) child/stepchild N = 64 (18.8%) spouse/partner N = 30 (8.8%) other family/friend N = 23 (6.8%) stranger N = 83 adult victims N = 253 child victims Homicide method: Undocumented	N = 50 (29%) had 'Mental Health Problems' Within which: N = 17 (34%) of these had had prior MH treatment N = 39 (78%) had IPPs N = 25 (50%) suicidal ideation history, with 76% within 2 weeks of HS N = 12 (6.9%) substance abuse N = 9 (5.1%) substance abuse and mental illness Highlighted factors N = 107 (61.1%) intimate partner problems N = 44 (25.1%) criminal and legal problems N = 42 (24%) left a note Within which: N = 27 (15%) disclosed homicidal intent N = 37 (21.1%) disclosed suicidal intent
Median 44 years	Victim relationship to perpetrator: N = 45 (64%) spouse/partner N = 20 (29%) child/stepchild Homicide method: N = 22 (37%) sharp instrument N = 18 (30%) asphyxiation N = 6 (10%) firearms	Mental disorder recorded in medical records, (N = 53) Within which: N = 33 (62%) prior treatment for mental illness N = 28 (53%) depression N = 1 (2%) schizophrenia/delusional disorders N = 1 each (2%) drug/alcohol dependence N = 14 (30%) on psychotropic medication N = 41 (77%) GP contact within 12 months of offence N = 21 (42%) GP contact within 1 month of offence Findings within whole sample, (n = 60) N = 14 (23%) previous contact with mental health service (MHS) N = 7 (12%) contact with MHS within 12 months of offence N = 4 (7%) contact with MHS within 1 month of offence N = 15 (28%) history of alcohol misuse N = 13 (23%) history of substance misuse N = 14 (26%) history of self-harm/attempted suicide Highlighted factors N = 16 (28%) unemployed Criminal history: N = 27 (45%) any previous conviction N = 18 (30%) prior violence conviction N = 22 (39%) previously committed domestic violence

(Continues)

T A B L E A 1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Campanelli and Gilson (2002) New Hampshire, USA	What are the characteristics (including psychiatric history, history of domestic violence and toxicology) of 15 HS events?	Cohort Used Medical Examiner files	16 [15 m, 1 f]	None
Buteau et al. (1993) Quebec, Canada	To compare epidemiology, sociodemographic and clinical characteristics of HS events to ask what are the key etiological hypotheses and indices that may prevent further events?	Cohort Used Coroner's files	39 [35 m, 4 f]	None
Copeland (1985) Florida, USA	What characteristics (including age, race, sex, cause of death, blood alcohol and drugs detected at autopsy, instigator of act, presence/absence of a note and reason for action) can be identified from cases of dyadic death between the years 1977–1983?	Cohort	62 HS events & 3 double suicide events (63 m, 5 f) 69 homicide victims (9 m, 60 f)	N/A
Selkin (1976) Los Angeles & Denver, USA	What are the settings of events, relationships between those involved and rationalisations (from perpetrator's perspective) of HS events matched with SO events in LA and Denver?	Case control Used Coroner's files	13 [11 m, 2 f]	SO *N* not specified Matched for age, sex and rated on Lettieri lethality scale

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Mean: 38 years	Victim relationship to perpetrator: N = 11 (69%) spousal relationship N = 1 (6%) infanticide N = 1 (6%) pedicide N = 2 (12%) extra familial Homicide method: N = 11 (69%) firearms N = 3 (19%) strangled N = 1 (6%) CO poisoning N = 1 (6%) sharp force	N = 6 (38%) depression N = 1 (6%) schizophrenia N = 5 (31%) alcohol detected N = 4 (25%) chronic alcoholism Highlighted factors N = 8 (50%) domestic violence history N = 2 (12%) stalked their victims
56% <40 years 8% >60 years Specific age range not specified	Victim relationship to perpetrator: N = 21 (32%) spouses N = 23 (35%) children <14 years N = 7 (11%) known to perpetrator N = 15 (23%) stranger Homicide method: N = 22 (56%) of incidents used firearms	N = 26 (67%) evidence of mental disorder N = 18 (46%) depression N = 9 (23%) substance abuse N = 6 (15%) previous suicide attempts N = 3 (8%) evidence of suicide threats N = 8 (21%) contact with mental health services <1 year pre-event Highlighted factors N = 23 (59%) recent spousal separation
Range 21–70+	Perpetrators relationship to victim: N = 32 (49%) husband N = 16 (25.6%) boyfriend N = 4 (6.2%) fathers/wives N = 4 (6.3%) unknown Homicide method: N = 65 (94.2%) handgun wound	N = 3 (4.6%) depression over drug problems N = 1 (1.5%) depressed, not otherwise specified N = 1 (3%) 'mental problems' N = 1 (3%) 'went beserk' N = 17 (26.2%) left note indicating action N = 12 (17.6%) drug detected at autopsy N = 34 (50%) positive blood alcohol content at autopsy N = 1 (1.5%) 'drinking problems' Highlighted factors N = 27 (41.5%) marital/lover discord N = 6 (9.2%) argument N = 4 (6.1%) domestic/financial problem
HS Mean 43.8	Victim relationship to perpetrator: N = 8 (61.5%) wife N = 2 (15.4%) husband N = 1 each (5.2%) mother, rival & unknown Homicide method: N = 13 (100%) gunshot	N = 2 (15.4%) active psychological treatment at time of offence N = 3 (23%) use of alcohol: 'drinking' N = 5 (38.5%) evidence of omnipotent thinking HS cases obtain lower scores on Lettieri lethality scale because divorce less likely and family support more likely HS perpetrators were involved with other people and largely non-alcoholic

(Continues)

TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
McPhedran et al. (2018) Australia	What are the unique characteristics of HS, using two unique data sets from Australia, with an emphasis on establishing whether and how HS differs from HO and SO?	Case control Used Queensland suicide register and Australian homicide Project records	60 [m]	Suicide only (S), 8014 [m] HO 251 [m]
Schwab-Reese and Peek-Asa (2019) USA	To determine the relationship between situational factors, method of death, and HS deaths, specifically comparing method of death (firearm vs. non-firearm) across these factors for HS events in the 42 states from 2013 to 2016?	Cohort Used data from national violent death reporting system	952 incidents with 954 perpetrators [892 m, 62 f]	None
Regoeczi and Gilson (2018) Ohio, USA	What trends and patterns can be identified in 26 years of HS data from Cuyahoga County, Ohio, 1991–2016?	Cohort Used Marzuk typology to construct narratives for events	81 [76 m, 5 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
HO mean 31 years +/− 10.1 S mean: 42.3 years +/− 17.3 HS mean: 47.3 years +/− 16.6	Victim relationship to HS perpetrator not clearly stated	HS significant differences from S/HO): Consultation with Mental Health Professional in 3 months prior to event: HO: N = 30 (12.9%) < HS: N = 5 (31.3%) < S: N = 1678 (45.7%) Suicide attempt(s) in 12 months prior to incident: HO: N = 25 (11.3%) < HS: N = 2 (13.3%) < S: N = 1201 (27.7%) Alcohol problems present: HS: N = 4 (30.8%) < S: N = 1295 (37.6%) < HO: N = 145 (64.4%) Alcohol used prior to incident: HS: N = 11 (20%) < S: N = 2077 (31.7%) < HO: 139 (57%) Cannabis use: HS: N = 2 (3.3%) < S: N = 733 (9.1%) < HO: N = 50 (20.3%) Amphetamine use: HS: N = 1 (1.7%) < S: N = 195 (2.4%) < HO: N = 30 (12.2%) Highlighted factors HS marital status: N = 41 (77.4%) married/de facto (Note: Significantly greater than S/HO) N = 10 (18.9%) divorced/separated N = 1 (1.9%) single/never married N = 1 (1.9%) widowed Domestic violence order in place at time of incident: HO: N = 8 (3.4%) < S: N = 218 (9.4%) < HS: N = 4 (28.6%)
Mean 47.8 years Range 18–100 years, SD 16.1	Victim relationship to perpetrator: N = 663 (60%) intimate partner only N = 130 (11.7%) other family only N = 47 (4.2%) intimate partner and family N = 75 (6.8%) extrafamilial Homicide method: N = 945 (85.6%) firearm N = 34 (3.1%) strangulation/ suffocation N = 45 (4.1%) sharp force trauma N = 12 (1.1%) poison	N = 185 (20.4%) recent mental health issues N = 129 (13.5%) recent depressed mood N = 172 (18%) recent drug/alcohol issues Highlighted factors Financial and social stressors: N = 327 (34.2%) recent fight N = 364 (38.1%) recent stressors N = 569 (59.6%) recent interpersonal stressors
Mean 42.3 years Range 58% within 19–39 years	Victim relationship to perpetrator: N = 47 (58%) intimate partner N = 14 (17.2%) ex-intimate partner N = 11 (13.5%) parent N = 9 (11.1%) other family N = 10 (12.3%) friend/ acquaintance Homicide method: N = 76 (93.8%) firearm N = 2 (2.5%) knife N = 3 (3.7%) strangulation/ suffocation	N = 32 (39.5%) evidence of depression symptoms N = 18 (22.8%) alcohol only N = 14 (17.7%) drugs only N = 7 (8.9%) alcohol and drugs Highlighted factors N = 24 (38.1%) history of domestic violence

TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control n
De Koning and Piette (2014) Belgium	To identify patterns and explore characteristics of perpetrators and victims of MSs in Ghent and surrounding areas over a period of 75 years, with a focus on motives	Cohort	80 [69 m, 11 f] 96 victims [16 m, 80 f]	None
Cengija et al. (2012) Croatia	To identify incidents and characteristics of HS events in southwestern Croatia	Cohort	17 [14 m, 3 f]	None
Roma et al. (2012) Italy	To evaluate the incidence of HS in Italy over 24 years and to compare to international data in 662 cases of HS between 1985 and 2008?	Cohort Used information from press agencies and four major Italian newspapers	662 [560 m, 102 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Mean 45 years Range 17–86 years	Victim relationship to perpetrator: N = 47 (60%) spousal/consortial bond Homicide method: N = 52 (52.2%) gunshot wounds N = 17 (17.7%) asphyxia N = 12 (12.5%) blunt force N = 9 (9.4%) sharp injury N = 3 (3.1%) rail accident	Spousal/consortial MS: Older offenders (N = 19 > 55 years): N = 4 (21.1%) mental disease N = 5 (26.3%) physical disease Younger offenders (N = 28, <55 years): N = 2 (7.1%) depression N = 10 (35.7%) used alcohol N = 2 (7.1%) left a suicide note N = 16 (80% of available data) amorous jealousy motive Filicide-suicide: (N = 12 incidents, children <16 years) 50%, depression N = 2 used alcohol N = 2 used medication 46% left suicide note 56% motive amorous jealousy Familicide-suicide (n = 8 incidents): N = 1 alcohol on toxicology N = 3 left suicide note 60% motive amorous jealousy 40% financial/social stressors in 40% Overall—15% Mercy killing and altruistic suicide
Mean 50 years	Victim relationship to perpetrator: N = 13 (76%) spousal/consortial N = 1 (6%) familial N = 3 (18%) extra familial Homicide method: N = 11 (0%) firearm N = 5 (23%) knife N = 3 (14%) explosive	N = 4 (23%) had mental disorder Within which: N = 2 (11.7%) clinically diagnosed depression N = 2 (11.7%) 'psychotic' N = 4 (23.5%) positive for alcohol on toxicology Motives suggested N = 6 (35.2%) amorous jealousy N = 5 (29%) separation between intimates Highlighted factors N = 6 [3 m, 3 f] (35.2%) left suicide notes
Modal range [m] 45–54 years Modal range [f] 25–34 years	Victim relationship to perpetrator: N = 344 (51.2%) married N = 113 (17.1%) single N = 98 (14.8%) divorced/ separated N = 16 (2.4%) widowed Homicide method: N = 453 (56.5%) firearm N = 162 (20.2%) cutting/stabbing/ blunt N = 56 (7%) strangulation/hanging	N = 72 (10.8%) psychiatric diagnosis N = 51 (7.8%) affective disorder N = 14 (19.5%) others (unspecified) N = 5 (0.8%) drug/alcohol problem N = 2 (0.3%) psychosis Motives suggested N = 156 (24%) romantic jealousy N = 72 each (10%) mercy killing & altruistic N = 113 (17%) family/financial/social stressors N = 54 (8.1%) retaliation

(Continues)

TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Merzagora et al. (2011) Milan, Italy	To analyse quantitative and qualitative features (considering temporal aspects, development of events, weapons used and epidemiological and psychopathological features of the perpetrators/victims) of cases of HS occurring in Milan between 1990 and 2009?	Cohort	69 [61 m, 8 f]	None
Haines et al. (2010) Tasmania, Australia	To examine the nature of HSs and determine ways in which they differ from suicides without homicide in terms of the demographic characteristics, suicide, medical and psychiatric history, their psychological state leading up to the suicide and their motives for the suicidal behaviour?	Case control	22 [m]	Suicide only (S) [22 m] Matched for age/ sex
Shiferaw et al. (2010) Switzerland	To analyse and characterise the victims and the perpetrators of all HS cases reported in a medico-legal setting and recorded at the UCLM Geneva between 1956 and 2005?	Cohort	23 [19 m, 4 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Mean 47.6 years	Victim relationship to perpetrator: N = 40 (52%) wife/cohabitant/ girlfriend N = 10 (13%) ex-wife/cohabitant/girlfriend N = 16 (21%) children N = 2 (3%) husband N = 5 (6%) other relative N = 4 (%) non-family Homicide method: 47% firearm 25% knife 10% asphyxia 67% same weapon used in suicide	Mental illness: No precise breakdown of data N = 23 (33.3%) psychiatric illness could be postulated N = 1 (1.4%) prior paranoia Report of history of psychotropic use, long-term psychiatric treatment and general diagnosis of depression or 'raptus' in other potential (postulated) cases
Mean 39.2 years (SD 12.7)	Victim relationship to perpetrator: 100% spouse/consort HS methods: N = 17 (77.3%) firearm N = 2 (9.1%) poisoning gas N = 1 each (13.5%) poisoning medication N = 1 (13.5%) stabbing/cutting N = 1 (13.5%) hanging	Psychiatric history: HS: N = 2 (9.1%) < S: N = 5 (22.7%) depression HS: N = 2 (9.1%) > S: N = 1 (4.5%) psychosis No significant difference with control: HS: 13.6% psychiatric disturbance HS: 18.7% recent psychiatric consultation HS: 12.5% under psychiatric supervision HS: 25% psychiatric hospitalisation HS: 0% suicidal rumination Highlighted factors HS: 86.4% (p = 0.0001) more likely to be described as angry/hostile/violent prior to offence HS: 13.6% (p = 0.07) described erratic/bizarre behaviour/ manner HS: 86.4% (p < 0.03) suicide more likely due to interpersonal conflict SO: More socially isolated (p = 0.07), suicide due to interpersonal stressful life event more likely (p = 0.05)
Male mean 43 years Female mean 38 years	Victim relationship to perpetrator: N = 8 (34.7%) wife N = 5 (21.7%) woman in intimate partnership N = 5 (21.7%) wife & child N = 1 (4.3%) child N = 1 (4.3%) husband and grandson N = 3 (13%) child Homicide method: N = 23 (67%) firearm (1 case with fall) N = 8 (24%) sharp instrument	Psychic state: N = 7 (30%) depression N = 7 (30%) alcohol found in post-mortem N = 4 (17%) psychosis N = 1 (4.3%) possible mental illness (psychosis) Highlighted factors N = 10 (43%) jealousy, imminent separation, divorce N = 10 (43%) relationship breakdown N = 2 (8.6%) frustration with life N = 1 (4.3%) family stress N = 1 (4.3%) altruism (victim illness) N = 1 (4.3%) unwanted child N = 1 (4.3%) relationship breakdown N = 1 (4.3%) financial stress

(Continues)

TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control n
Logan J et al. (2008) USA	To describe perpetrators across a full range of HS incidents that occurred within a multistate, population-based surveillance system and assess differences and similarities with other suicide decedents and homicide suspects?	Case control	408 [373 m, 35 f]	Suicide only (S) 20,183 [15,793 m, 4390 f] Homicide suspects (HO) 5089 [4569 m, 520 f]
Saleva et al. (2007) Finland	To examine whether HS in Finland resembles that described in previous studies? And consider if the incidents could have been prevented?	Case control	10 [9 m, 1 f]	Suicide only (S) methodology not adequately described
Comstock et al. (2005) USA	To determine the temporal trends of HS events occurring in Oklahoma and characterise the epidemiology of these events?	Cohort	73 [68 m, 5 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
HS Median 43 years Range 60%: 20–49 years	Victim relationship to perpetrator: N = 280 (68.6%) intimate partner (IP) only N = 24 (5.9%) intimate partners + other N = 33 (8.1%) filicide N = 29 (7.1%) other family related N = 42 (10.3%) extra familial	Filicide-suicide perpetrators: HS: N = 11 (33.3%) reported current MH problem HS: N = 7 (21.1%) ongoing MH treatment (highest proportion) HS: N = 7 (21.2%) reported depressed HS: N = 4 (36.4%) use of antidepressants (highest proportion) Compared with S, male HS less likely to report depression, MH problems, alcohol/drug abuse, history of suicide attempts, physical health problems, MH treatment, job or financial problems or to have disclosed intent. Increased IP conflicts Female HS perpetrators: N = 10 (28.6%) N = 15 (43%) current MH problem N = 11 (31.4%) current treatment for MH condition N = 12 (34.3%) history of IP conflict preceding incident HS: Intoxication suspected: [M] N = 89 (23.9%), [f] N = 2 (5.7%) HS: N = 220 (53.9%) intimate partner conflict (most common) HS: >85% not suspected to have MH problem by family/ friends
Mean 42 years (range 18–74)	Victim relationship to perpetrator: N = 6 (50%) spouse N = 5 (42%) child N = 1 (8%) cousin Homicide method: N = 8 (70%) shooting N = 1 (10%) strangulation N = 1 (10%) stabbing N = 1 (10%) fire N = 1 (10%) poisoning	HS female: N = 1 (10%) depression HS male: N = 3 (33%) depression N = 3 (33%) features of depressive disorder N = 2 (20%) possible psychosis N = 0 (0%) had contact with MH professional in past year Highlighted factors N = 2 (20%) left suicide note N = 3 (33%) long-term relationship termination occurred during the previous week in compared to 5% SO (p = 0.036)
Mean 42 years Victim mean 34	Victim relationship to perpetrator: N = 27 (30.3%) spouse N = 17 (19.1%) estranged spouse N = 17 (19.1%) offspring N = 13 (14.6%) boy/girlfriend or ex Homicide methods: N = 80 (89.9%) firearm N = 4 (4.5%) stabbing Perpetrators were significantly more likely to be older than victims	N = 5 (6.8%) psychological disorder Motives suggested N = 22 (30%) divorced/impending, estranged N = 13 (17.8%) jealousy N = 7 (9.6%) intimate partner violence/domestic problems N = 6 (8.2%) mercy killing N = 4 (5.5%) under the influence of drugs or alcohol Typology: N = 55 (75%) (possessive consort most common N = 6 (8.2%) physically ailing consort

(Continues)

TABLE A1   (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Liem (2010) Netherlands	To qualitatively assess to what extent can HS, particularly considering blame attribution, can be understood as a dichotomous phenomenon?	Case control, using qualitative methodology	Homicide parasuicide (HP) 10 [8 m, 2 f]	Parasuicide only (P) 10 HO 10 All groups stratified by perp/victim relationship
Flynn et al. (2009) England & Wales	What are the social, clinical, and criminological characteristics of a national sample of HS perpetrators? What contact was there with mental health services can we establish risk of suicide after homicide?	Case control	203 [175 m, 28 f]	HO 5096 [4596 m, 500 f] SO 46,358 [34,616 m, 11,742 f]
Yip et al. (2009) Hong Kong	To empirically classify HS events into different clusters and discuss specific evidence-based prevention initiatives	Cohort	98 incidents with 99 perpetrators [68 m, 31 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Range 70% > 31 years	Victim relationship to perpetrator: N = 6 (54%) partner/estranged partner N = 4 (36%) child N = 1 (9%) parent	Mental disorder: N = 7 (70%) personality disorder N = 3 (30%) depressive disorder N = 2 (20%) psychotic disorder N = 2 (20%) other All perpetrators had 'mental disorder', some with more than 1 Blame attribution: N = 2 (20%) blamed victim for frustrated circumstances (e.g. external attribution: Primarily homicidal in nature) N = 1 (10%) internalised blame for frustrated circumstances (e.g. internal attribution: Primarily suicidal, depression themes) Perpetrator considers HS primary solution
Mean 41 years Range (18–88)	Victim relationship to perpetrator: N = 129 (65%) current/ex intimate partner N = 37 (19%) perpetrator's child N = 14 (7%) other family members N = 15 (8%) acquaintance N = 4 (2%) strangers Homicide method: N = 44 (23%) sharp instrument N = 41 (21%) strangulation N = 31 (16%) firearms	Mental disorder: N = 20 (10%) contact with MH services in their lifetime Most common primary diagnosis: N = 6 (32%) personality disorder N = 5 (26%) affective disorder N = 3 (16%) anxiety disorder N = 2 (11%) schizophrenia/delusional disorder N = 18 (9%) secondary diagnosis, including N = 3 drug dependence N = 2 personality disorder and N = 2 alcohol dependence N = 9 mental disorder over 5 years duration N = 5 previous admission to psychiatric hospital N = 14 (7%) contact with MH services within 12 months Additionally: N = 7 missed last appointment, N = 3 contact Week prior, N = 5 seen 1–5 weeks prior Motives suggested: N = 34 (18%) rage N = 37 (14%) jealousy/revenge N = 17 (9%) irrational/motiveless N = 17 (9%) mercy killing
Male: 80% in range 20–49 years Female: 87% in range 20–49 years	Victim relationship to perpetrator: N = 46 (46.5%) spouse/lover N = 48 (48%) children N = 22 (22.4%) other people (overlap as some killed spouse and child) Homicide method: 33.7% chopping/stabbing 22.4% charcoal burning 19.4% strangulation/suffocation 14.3% falling from height	Characteristics: N = 24 (23.5%) diagnosed with psychiatric disorder prior to HS N = 16 (16.3%) past suicide attempt N = 24 (23.5%) violence history Motives suggested: 37% romantic reasons 23.9% altruistic 21.7% dispute 17.4% mental problems Clusters typified: Mental illness (N = 5 depression, N = 5 schizophrenia) Non-romantic disputes (family/outside family, altruistic (breadwinner kills his family, suicidal ideation) Conflict in loving relationship (jealousy/rage, victim attempts to leave)

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TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Moskowitz et al. (2006) New Zealand	To characterise the HS population in New Zealand over a 10-year period with attention to the relevance/presence of mental health and emerging perpetrator and victim demographic trends	Cohort	33 [28 m, 5 f]	None
Lindqvist and Gustafsson (1995) Sweden	What are the characteristics of cases of HS with special reference to the nature of the relationship between the parties involved, the occurrence of mental disorder and drug abuse and possible recurrent dynamic themes in the process preceding homicides followed by the offender's suicide?	Cohort	16 [14 m, 2 f]	None
Cooper and Eaves (1996) BC, Canada	To further understanding the circumstances under which suicide is likely to occur following a homicide in familial relationships?	Cohort	23 HS [21 m, 2 f] 6 H-attempted S [all m]	No control group

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Not specified	Victim relationship to perpetrator: $N = 33$ (61%) current/former intimate $N = 8$ (24%) filicide-suicide $N = 1$ (3%) familicide-suicide $N = 2$ (6%) adult child killing parent 18% cases involved multiple victims	Mental illness diagnosis and treatment: $N = 14$ (42.4%) evidence of mental illness $N = 8$ (24.2%) diagnosis and prior treatment $N = 3$ (9.1%) diagnosis but no evidence of prior treatment $N = 3$ (9.1%), no prior treatment or diagnosis but psychiatric symptoms around the time of the HS incident $N = 4$ (12.1%) schizophrenia or non-affective psychosis $N = 1$ (3%) anorexia nervosa $N = 9$ (27.3%) diagnosis mood disorder Within which: $N = 3$ (33%) had psychotic features Contact with MH services $N = 4$ (12.1%) <1-month prior $N = 2$ (6.1%) more than 1 month but <12 $N = 2$ (6.1%) more than 1 year but <5 Appearance of being mentally ill: 25% intimate partner 73% familial All female and 32% of male perpetrators
Male mean 40 years Female 25 and 38 years	Victim relationship to perpetrator: $N = 8$ (36%) child <18 years $N = 7$ (32%) spouse/ex spouse $N = 2$ (9%) parents of former wife's new fiancé $N = 1$ (4.5%) child >18 years $N = 1$ (4.5%) father $N = 1$ (4.5%) rival $N = 1$ (4.5%) temporary partner $N = 1$ (4.5%) close male friend	$N = 5$ (31%) major mental illness Within which: $N = 3$ depressive disorders $N = 2$ schizophrenia $N = 5$ (31%) alcohol use Within which: $N = 2$ alcohol dependence $N = 4$ alcohol intoxication (1 overlap) $N = 2$ (13%) psychoactive substance (2 overlap alcohol intox) $N = 3$ (19%) personality disorder (organic/immature/cluster B) $N = 3$ (19%) adjustment disorder (depressed/physical complaints/unspecified) $N = 1$ each (6%) dysthymia, diagnosis/condition (axis 1) $N = 1$ (5%) history post-natal psychosis $N = 10$ (63%) prior psychiatric evaluations
Not specified	HS victim relationship to perpetrator: $N = 14$ (61%) intimate partner (all male perp) $N = 6$ (26%) filicide (1 female perp) $N = 3$ (13%) familicide (1 female perp) Homicide and unsuccessful suicide victims: $N = 6$ intimate partner	HS $N = 7$ (30%) mental illness Within which: Incidents of psychosis, depression/suicide note, paranoia, depression with acute paranoia and persecutory delusions were described. Exact N unclear $N = 1$ (4.3%) alcohol/drugs $N = 12$ (52%) separation (dependence/obsession with ex/ partner) H-attempted S $N = 5$ (83%) separation $N = 1$ (16.7%) alcohol/drugs

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TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Felthous et al. (2001) Texas, USA	To determine how closely a natural series of combined HS cases would correspond to descriptive categories gleaned from the literature? To explore the motivations, psychological stressors, and psychopathology of individuals who commit HS?	Cohort	20 [19 m, 1 f]	None
Logan et al. (2013) USA	To describe homicide-followed-by-suicide (HS) incidents involving child victims?	Cohort	129 incidents with 158 perpetrators [129 m, 29 f]	None
Rosenbaum (1990) USA	What similarities or characteristic are evident when comparing cases of couples in which theme was murder followed by suicide and those in which the theme was homicide?	Case control	12 [11 m, 1 f]	24 domestic homicide alone (HO)
Hatters-Friedman et al. (2005) Ohio, USA	What commonly occurring factors can be identified in filicide-suicide offenders, to describe this phenomenon better, and ultimately to enhance prevention of child murder?	Cohort	30 [20 m, 10 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Mean: 44.7 years	Victim relationship to perpetrator: $N = 17$ (85%) consortial $N = 1$ (5%) filial $N = 1$ (5%) familial $N = 1$ (5%) other Homicide method: $N = 19$ (95%) firearm	$N = 1$ (5%) depression history $N = 1$ (5%) unconfirmed hallucinations for 2 weeks prior $N = 1$ (5%) had alcoholism $N = 13$ (65%) positive blood alcohol levels post-mortem $N = 4$ (20%) cases tested positive for drugs Highlighted factors: $N = 14$ (70%) recent relationship turmoil $N = 5$ (25%) rejected by victim, separation/divorce impending $N = 3$ (15%) awareness of another friend/lover $N = 2$ (10%) belief that no longer loved by the victim $N = 1$ (5%) and/or told to leave
Male mean 37.9 years Female mean 36.3 years	Victim relationship to perpetrator: $N = 144$ (76.6%) child/stepchild/ foster $N = 8$ (4.3%) other relative $N = 8$ (4.3%) acquaintance/friend/ stranger Weapon/mechanism of homicide: $N = 109$ (58%) firearm $N = 13$ each (6.9%) poisoning & hanging $N = 11$ (5.9%) sharp/blunt instrument	$N = 21$ (16.3%) current mental health problem: [M]: $N = 8$ (8%), [f]: $N = 15$ (48%), $(p < 0.01)$ $N = 24$ (18.6%) current depressed mood: [m]: $N = 14$ (14%), [f]: $N = 10$ (32%) $(p < 0.03)$ $N = 13$ (10.1%) current mental health treatment $N = 16$ (12.4%) disclosed suicidal ideation $N = 29$ (22.5%) left suicide note 30% MH symptoms in parental perpetrator with psychosis 2× as common in maternal versus paternal $(p < 0.01)$ Highlighted factors Parental intimate partner violence $(p < 0.01)$.and intimate partner problems (IPP) $(p < 0.01)$, were more common in paternal HS. IPP preceded 63% parental HS events
Mean: 42.3 years (SD 14.2)	All cases intimate partner H-S	$N = 9$ (75%) depressive disorder $N = 1$ (8%) adjustment disorder $N = 4$ (33%) antisocial personality disorder $N = 2$ (17%) psychoactive substance abuse $N = 2$ (17%) $N = 4$ (33%) alcohol and drug abuse HS perpetrator more likely to suffer from a depressive disorder $(p < 0.001$ broad definition used) Highlighted factors HS couples had higher socioeconomic class than HO $(p < 0.05)$ and alcohol/drug abuse/consumption more common in HO $(p < 0.05)$
Mean male: 38.2 years Mean female: 31.8 years	All cases parents to the child victim Homicide method: $N = 22$ (73%) firearms Other methods (combined at times): 10% beating, 7% each; drowning in a car, suffocation, stabbing, 3% each; arson, CO poisoning, strangulation	$N = 24$ (80%) mental illness Psychiatric hospital admission: Female [f] $N = 2$ (20%), male [m] $N = 2$ (10%), total: 13% Previous suicide attempt: [f]: $N = 2$ (20%), [m]: $N = 1$ (5%), total 10% Depression [f]: $N = 7$ (70%), [m]: $N = 10$ (50%), total: 57% Psychosis [f]: $N = 3$ (30%), [m]: $N = 5$ (25%), total: 27% Delusional [f]: $N = 2$ (20%), [m]: $N = 4$ (20%), total 20% Motives suggested: $N = 21$ (70%) altruistic -divided into two: Psychotic (16%): [M] $N = 4$ (20%), [f] $N = 1$ (10%) Non-psychotic (53%): [M] $N = 8$ (40%), [f] $N = 8$ (80%) $N = 2$ (7%) acutely psychotic [m]

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Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Broadhurst et al. (2005) Hong Kong, China	What is the prevalence and trend of HS in Hong Kong? By describing the epidemiology, what possible risk factors can be identified that are associated with HS events, to suggest preventative or intervention strategies and to provide guidance for frontline workers to assess the potential risks of HS?	Case control	73 HS events with 77 perpetrators (one event had 5 perpetrators) [56 m, 21 f]	231 domestic homicides
Frei et al. (2011) Switzerland	What are the characteristics of HS in comparison to domestic homicide without suicide (HO)?	Case control	24 [18 m, 6 f]	HO 20 [17 m, 4 f]
Mass shooting				
Hall et al. (2019) USA	What was the current/ historical psychotropic medication used in school shooters? When examining secondary factors (number of victims, locations of assaults, number of weapons used and number of successful NGRI defences), what helped identify the scope, planning required and impact of such events?	Cohort	49 school campus incidents 49 perpetrators [47 m, 2 f]	None

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Mean 41.2 years	Victim relationship to perpetrator: 30% intimate partner (spouse/lover) 28% children 12% familicide 8% other family members/relatives 8% parents Female perpetrators: 65% female cases were filicides Closer relationship with victims, rarely killed outside family Male perpetrators: 32% victim extra familial 34% multiple victim	$N = 19$ (25%) history of mental disorder: 19 (25%) $N = 12$ (16%) depression (female 28.6% vs. male 10.7%) $N = 12$ (16%) previous attempted suicide $N = 20$ (26.4%) prior violent history Consumed drugs: Total 15.9% (male 13.7%, female 22.2%) Consumed alcohol: Total 8.5% (male 7.7%, female 10.5%) Motives suggested $N = 20$ (27.4%) dispute $N = 14$ (19.2%) altruistic $N = 13$ (17.8%) termination rage $N = 9$ (12.3% revenge on prolonged and repeated $N = 5$ (6.8%) intense worries about victim $N = 3$ (4.1%) jealousy and possessive rage
Mean: 57.7 years (SD 25.914) Range: 19–97 years	Victim relationship to perpetrator: $N = 18$ (75%) spouse $N = 4$ (17%) familial $N = 2$ (8%) extra familial	$N = 4$ (17%) past psychiatric contact: $N = 2$ (9%) F0. Organic mental disorder $N = 1$ (4%) F1. Substance abuse $N = 2$ (9%) F3. Affective disorders $N = 1$ (4%) F4. Adjustment disorders $N = 5$ (22%) F6. Cluster B: Dramatic antisocial type $N = 6$ (25%) acute intoxication $N = 15$ (63%) suicide note Motives suggested: $N = 10$ (41%) altruistic (extended suicide) $N = 8$ (34%) Mercy (suicide pact) $N = 4$ (17%) amorous jealousy $N = 1$ (4%) social stressor (partly honour killing) $N = 1$ (4%) retaliation
Mean 23 years	All shooting Suicide characteristics: $N = 21$ (43%) died at the scene Of which $N = 18$, completed suicide at the time $N = 3$ killed by law enforcement $N = 26$ (53%) attempted suicide $N = 1$ (2%) shot self twice but survived $N = 1$ (2%) died by suicide before sentencing	$N = 21$ (43%) had prior mental health treatment $N = 7$ (14%) saw a psychiatrist at a previous point $N = 10$ (20%) masters ($N = 5$) or doctorate ($N = 5$) level therapist $N = 2$ (4%) saw primary care for psychotropic medications $N = 3$ (6%) saw unspecified mental health providers $N = 23$ (47%) likely prescribed psychotropic medication prior $N = 11$ (22%) history antidepressant $N = 3$ (6%) history antipsychotic $N = 3$ (6%) history benzodiazepine $N = 2$ (4%) stimulant medications Possible diagnoses: $N = 8$ (16%) major depressive disorder $N = 4$ (8%) history of active/past substance use disorder $N = 4$ (8%) schizophrenia/schizoaffective disorder $N = 4$ (8%) delusions $N = 4$ (8%) anxiety $N = 2$ (4%) personality disorder $N = 2$ (4%) Eating disorder $N = 1$ (2%) obsessive compulsive disorder $N = 3$ (6%) autism $N = 3$ (6%) attention deficit hyperactivity disorder $N = 3$ (6%) developmental/cognitive disorder $N = 3$ (6%) malingering

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TABLE A1 (Continued)

Authors, publication date & sample nationality	Research question	Study design	Sample size	Control *n*
Terrorism				
Speckhard and Ahkmedova (2006) Chechnya, Russia	To build, through interviews and empirical analysis of events, a descriptive model of the genesis and mechanisms of suicide terrorism in Chechnya and to compare this model with existing literature and data emerging from other regions in the world to learn if there are ideological, demographic, technological, and regional differences in how suicide terrorism is generated?	Cohort used qualitative methodology	34 [gender not specified]	None
Mixed				
Lester et al. (2005) USA	What are the differences between rampage killers who completed suicide at the time of the act and those who were captured? Were any characteristics of the rampage killers associated with the deadliness of the rampage?	Case control	34 [33 m, 1 f] Average victim toll 10.1 (SD 9.7)	56 [52 m, 4 f] Captured perpetrators

Abbreviations: ASPD, antisocial personality disorder; FBI, Federal Bureau of Investigation; GP, general practitioner; HO, homicide only; HS, homicide-suicide; IPPs, intimate partner problems; MH, mental health; MM, mass murder; MMS, mass murder suicide; MSs, murder suicides; NGRI, not guilty by reason of insanity; SD, standard deviation; SO, suicide only; UCLA, University Centre of Legal Medicine.

Age range (years)	Relationship with victims/ Description of incident	Findings (relating to perpetrators of HS unless otherwise stated)
Not specified	HS method: Bomb either worn, attached to vehicle, on public transport (planes, trains and metro) HS targets: $N = 13$ (46%) civilian $N = 11$ (39%) military $N = 4$ (15%) government	Mental health diagnoses based upon post-traumatic behavioural/emotional change pre-terrorist act: $N = 32$ (94%) increased social alienation and isolation $N = 21$ (62%) depressed $N = 10$ (29%) increased suspiciousness $N = 9$ (26.5%) aggression $N = 9$ (26.5%) fanaticism $N = 7$ (21%) increased conflicts with family $N = 3$ (9%) expressed guilt for not having done more to save a family member Trauma: $N = 27$ (79%) cases, trauma preceded joining a radical religious group $N = 34$ (100%) avenging the death, torture, or losses of close family members as a primary motivation $N = 2$ (6%) loss of normal childhood development $N = 2$ (6%) were infertile and divorced as a result (both female) Socioeconomic status: $N = 20$ (59%) middle, $N = 10$ (29%) good, $N = 2$ (6%) high Educational attainment: $N = 23$ (68%) completed high school $N = 11$ (32%) completed/studying university/college
Mean of total group 34.3 (SD 13.2) Not separated for each group	Victim relationship to perpetrator: $N = 14$ (41%) co-workers $N = 2$ (6%) significant other	$N = 14$ (41%) suspicious/paranoid $N = 10$ (29%) prior psychiatric care $N = 8$ (24%) drug abuse $N = 6$ (18%) schizophrenia: $N = 2$ (6%) alcohol abuse Motives suggested $N = 12$ (35%) friction at work $N = 9$ (26%) fired from work HS perpetrators significantly less likely than control to be school pupils or diagnosed as schizophrenic ($p < 0.05$) HS was significantly more likely if the killer had friction at work or the killings took place at work ($p < 0.05$)