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Insights from linking police domestic abuse data and health data in South Wales, UK: a linked routine data analysis using decision tree classification



Natasha Kennedy, Tint Lwin Win, Amrita Bandyopadhyay, Jonathan Kennedy, Benjamin Rowe, Cynthia Mc Nerney, Julie Evans, Karen Hughes, Mark A Bellis, Angela Jones, Karen Harrington, Simon Moore, Sinead Brophy



Summary

Background Exposure to domestic abuse can lead to long-term negative impacts on the victim's physical and psychological wellbeing. The 1998 Crime and Disorder Act requires agencies to collaborate on crime reduction strategies, including data sharing. Although data sharing is feasible for individuals, rarely are whole-agency data linked. This study aimed to examine the knowledge obtained by integrating information from police and health-care datasets through data linkage and analyse associated risk factor clusters.

Methods This retrospective cohort study analyses data from residents of South Wales who were victims of domestic abuse resulting in a Public Protection Notification (PPN) submission between Aug 12, 2015 and March 31, 2020. The study links these data with the victims' health records, collated within the Secure Anonymised Information Linkage databank, to examine factors associated with the outcome of an Emergency Department attendance, emergency hospital admission, or death within 12 months of the PPN submission. To assess the time to outcome for domestic abuse victims after the index PPN submission, we used Kaplan-Meier survival analysis. We used multivariable Cox regression models to identify which factors contributed the highest risk of experiencing an outcome after the index PPN submission. Finally, we created decision trees to describe specific groups of individuals who are at risk of experiencing a domestic abuse incident and subsequent outcome.

Findings After excluding individuals with multiple PPN records, duplicates, and records with a poor matching score or missing fields, the resulting clean dataset consisted of 8709 domestic abuse victims, of whom 6257 (71.8%) were female. Within a year of a domestic abuse incident, 3650 (41.9%) individuals had an outcome. Factors associated with experiencing an outcome within 12 months of the PPN included younger victim age (hazard ratio 1.183 [95% CI 1.053–1.329], $p=0.0048$), further PPN submissions after the initial referral (1.383 [1.295–1.476]; $p<0.0001$), injury at the scene (1.484 [1.368–1.609]; $p<0.0001$), assessed high risk (1.600 [1.444–1.773]; $p<0.0001$), referral to other agencies (1.518 [1.358–1.697]; $p<0.0001$), history of violence (1.229 [1.134–1.333]; $p<0.0001$), attempted strangulation (1.311 [1.148–1.497]; $p<0.0001$), and pregnancy (1.372 [1.142–1.648]; $p=0.0007$). Health-care data before the index PPN established that previous Emergency Department and hospital admissions, smoking, smoking cessation advice, obstetric codes, and prescription of antidepressants and antibiotics were associated with having a future outcome following a domestic abuse incident.

Interpretation The results indicate that vulnerable individuals are detectable in multiple datasets before and after involvement of the police. Operationalising these findings could reduce police callouts and future Emergency Department or hospital admissions, and improve outcomes for those who are vulnerable. Strategies include querying previous Emergency Department and hospital admissions, giving a high-risk assessment for a pregnant victim, and facilitating data linkage to identify vulnerable individuals.

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Introduction

Attending police officers issue a Public Protection Notification (PPN) to document the vulnerabilities of individuals who are victims of domestic abuse.¹ Once issued, the documented information is forwarded to the Force Public Protection Unit for a comprehensive risk assessment and subsequent determination of necessary action.¹ Although individuals have a right to privacy, a PPN enables information specific to the risk of serious

harm to be shared with partner agencies when multi-agency management provides the appropriate response to those risks. Indeed, the 1998 Crime and Disorder Act requires agencies to collaborate on crime reduction strategies, including data sharing. The Domestic Abuse, Stalking, and Harassment (DASH) questionnaire is a standardised risk assessment tool adopted by the police and other agencies to identify and evaluate the potential risk of harm to victims of domestic abuse, stalking, or

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Research in context

Evidence before this study

PubMed and Web of Science were searched for studies published in any language between April 17, 2013 and April 17, 2023, that investigated health-care use by victims of domestic abuse. Using the terms (“domestic violence” or “domestic abuse” or “intimate partner violence”) and (“emergency medical attendance” or “emergency department visits” or “ED attendance” or “hospitalisation”) and (“police”), the search yielded 198 results. The results were further filtered to include papers with the full text available and limited to research involving a human cohort. We manually searched the reference lists of the resulting studies for appropriate papers and highlighted key authors for relevant further studies. Numerous studies report the prevalence of domestic abuse victims and the negative health consequences that are endured. Consequently, these adverse health outcomes result in increased interactions with health-care services. However, knowledge is not communicated between agencies on a national level, preventing the implementation of safeguarding measures. Only four studies have investigated the value of linking data from police and health-care records on domestic abuse, with studies set in the USA and Canada. The findings of these studies suggested several risk factors for adverse outcomes, including increased Emergency Department usage, subsequent injuries when the incident involved physical violence, and the perpetrator having a history of domestic

abuse. Furthermore, the studies showed that victims of domestic abuse often experience mental health disorders.

Added value of this study

In this study, we describe the value of unifying sensitive data, such as police and health-care data. This present study shows that highly vulnerable individuals frequently interact with health-care services but remain unknown to the police until a critical incident, underscoring the value in establishing data linkages across different agencies. Moreover, the study provides a use case that illustrates results that can be derived from linking whole data systems to identify points of early intervention for individuals at risk of domestic abuse, thus enabling proactive, upstream efforts to protect families.

Implications of all the available evidence

The evidence presented in this study demonstrates the preventive opportunities for stakeholders across multiple sectors, which can be facilitated when agencies communicate and link data. Future research should examine whether early identification of these vulnerable groups by the police or the health-care sector could lead to improved outcomes, in addition to examining the outcomes stratified by demographic profiles. This research can guide the development of targeted interventions that might mitigate the escalation of domestic abuse and related health outcomes.

harassment.^{1,2} The DASH questionnaire comprises a series of methodically constructed questions that capture vital aspects of the situation, such as the perpetrator’s behaviour, the victim’s response, and the level of threat to the victim’s safety. The collected data are analysed to determine the risk of further harm, and the results are used to implement effective interventions to safeguard the victim.²

Domestic abuse—defined here to include domestic violence and intimate partner violence, as per the DASH questionnaire—encompasses a range of incidents characterised by coercive, controlling, and abusive behaviours directed towards another individual.³ These behaviours manifest in various forms, such as coercive control and emotional, financial, physical, psychological, or sexual violence or threats.^{3,4} A lifetime incidence of domestic abuse has been estimated to affect 27% of women globally,⁵ with a former intimate partner or spouse as the predominant perpetrator.⁴

Studies have indicated that exposure to domestic abuse results in long-term negative impacts on the victim’s physical and psychological wellbeing.^{6–8} Research into the long-term consequences of repeated victimisation is minimal; however, about two-thirds of female domestic abuse victims are revictimised.⁴ When a cycle of revictimisation is present, it exacerbates the consequences of domestic abuse, such as affecting new

relationships, introducing negative health behaviours in the form of addictions, and developing mental health disorders, including post-traumatic stress disorder.^{4,7–10} This cycle of revictimisation also increases the use of health-care services. Domestic abuse victims interact more frequently with Emergency Departments than people from the general population.^{4,11,12}

Although domestic abuse victims attend Emergency Departments frequently, these visits rarely result in the disclosure of abuse to staff or reports to the police.^{11,12} Research into the identification of domestic abuse by Emergency Department staff indicated that, of 259 visits in 1999–2001 in a semi-rural county in the USA, physicians were more likely to document the violence (83% documented by the physician) than triage nurses (62%) or treatment nurses (44%).¹¹ In the context of emergency care, it is expected that clinical personnel proactively identify and address vulnerabilities that extend beyond the initial presenting symptoms. In addition to patients’ disclosure, clinicians routinely assess their medical history using available data. Consequently, clinicians can enact safeguarding measures, including referring patients to an Independent Domestic Violence Advocate, if they perceive that the patient is at risk, even in cases where disclosure is absent. Further studies have indicated that domestic abuse victims frequently present to the Emergency Department

for non-injury-related complaints. Additionally, they also have an increased likelihood of having accompanying medical records documenting mental health and substance abuse issues.^{11,13–15} Consequently, the Emergency Department and hospital setting offers a crucial opportunity for intervention and prevention, prioritising the health and wellbeing of domestic abuse victims. However, it is necessary to establish a robust infrastructure to gather additional information to effectively address the victims' needs.

This study aimed to examine knowledge obtained by integrating information from police PPN records and health-care datasets through data linkage. The study was conducted by investigating associations with information from numerous datasets, and examining the clustering patterns of related factors, as well as their association with Emergency Department attendance, emergency hospital admission, or death within 12 months of the index PPN submission, thereby identifying opportunities to improve ascertainment of individuals at high risk of domestic abuse without disclosure.

Methods

Study design and setting

We conducted a retrospective cohort study to ascertain the risk factors associated with victims who will experience an outcome (ie, Emergency Department admission, emergency admission to hospital, or death) in the 12 months following a PPN submission for domestic abuse. The cohort was composed of residents in the South Wales Police Force Region who were domestic abuse victims resulting in a PPN submission between Aug 12, 2015 and March 31, 2020. The cohort was based on the PPN dataset that also comprises records formed from the DASH risk identification and assessment model.² Data of anonymised identified persons were linked on the individual level to health record data within the Secure Anonymised Information Linkage (SAIL) databank.^{16–18} The SAIL databank is a data repository containing over 10 billion anonymised records, with a population coverage of 100% for hospital and general practitioner (GP) data for this South Wales dataset, thus enabling person-based data linkage across numerous datasets. Each individual is assigned an encrypted anonymised linking field; this field is used to link anonymised individuals across datasets, thus facilitating longitudinal analysis of the individual's progression through the different datasets.¹⁷ The linked data includes the primary care Wales Longitudinal General Practice dataset to identify reasons for contact with health-care professionals in general practice; data collected by GPs are captured via Read Codes, version 2, which relate to diagnosis, medication, and process-of-care codes. Hospital inpatient and outpatient data are collated in the Patient Episode Database for Wales, which encompasses clinical information pertaining to patients' hospital admissions, diagnoses, operations, and discharges using

the International Classification of Diseases, 10th revision (ICD-10) clinical classification system. The Emergency Department Dataset for Wales uses three-digit alphanumeric codes to capture data regarding activity and information from Emergency Department and Minor Injury Units. The Office of National Statistics mortality dataset held within the Annual District Death Extract dataset contains demographic data, place of death, and underlying cause of death as ICD-10 codes. The Welsh Demographic Service dataset was used to identify all patients registered with a GP practice and to flag when people move in and out of Wales.

Variables

The outcomes for all analyses were Emergency Department attendance, emergency hospital admission, and death due to any cause within 12 months of the index PPN submission; where the time to event is reported, it is the time to the first event for cases where an individual had multiple events (ie, emergency admission followed by death). An Emergency Department admission includes Emergency Department attendance or emergency admission to hospital. For women, we ensured that the hospital admissions and Emergency Department attendances were non-obstetric. Emergency Department, hospital, and GP data were examined for up to 1 and 3 years before receiving the index PPN submission to highlight early risk factors of experiencing an outcome following a domestic abuse incident (appendix 1 p 1).

In terms of exposures and confounders, all variables recorded at the index PPN from the DASH questionnaire² were included: attempted strangulation, conflict over a child (ie, conflict regarding contact with the child), hurt other people, history of further violence, injury, multi-agency risk assessment conference (MARAC) referral, pregnant, and past pregnancy. Subsequent PPN visits following the initial index PPN were also included as an explanatory variable. Additionally, for the decision tree analysis, information from Emergency Department and GP (ie, diagnoses, medications, procedures, and referrals) and hospital admissions (ie, cause of admission and date) were included in the analysis up to 1 and 3 years before the index PPN. Specific codes included are in the code list in appendix 2; these were filtered to include codes that possessed a frequency of greater than or equal to 250 within the cohort. The majority of the variables from the dataset were presented in a binary form, with 1 representing the presence of a concept and 0 representing its absence. The age of individuals was presented in 10-year brackets to understand the difference between different age groups while maintaining a suitable population size for analysis.

Data access

The data used in this study are available in the SAIL databank¹⁸ at Swansea University (Swansea, UK). All data

For the **Emergency Department Dataset for Wales** see <https://web.www.healthdatagateway.org/dataset/75c4dcb8-33bf-43f4-b2bb-db51b6621b2c>

For the **Annual District Death Extract dataset** see <https://web.www.healthdatagateway.org/dataset/15cf4241-abad-4dcc-95b0-8cd7c02be999>

For the **Welsh Demographic Service dataset** see <https://web.www.healthdatagateway.org/dataset/8a8a5e90-b0c6-4839-bcd2-c69e6e8dca6d>

See Online for appendix 1

For the **Wales Longitudinal General Practice dataset** see <https://web.www.healthdatagateway.org/dataset/33fc3ffd-aa4c-4a16-a32f-0c900aaea3d2>

For more on **Read Codes** see <https://digital.nhs.uk/services/terminology-and-classifications/read-codes>

For the **Patient Episode Database for Wales** see <https://web.www.healthdatagateway.org/dataset/4c33a5d2-164c-41d7-9797-dc2b008cc852>

See Online for appendix 2

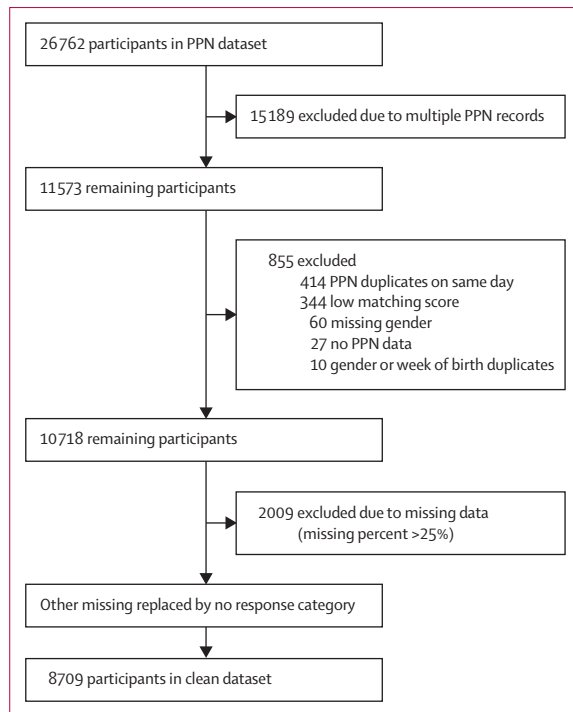


Figure 1: Study profile
PPN=Public Protection Notification.

held in the SAIL databank are anonymised; therefore, ethical approval is not mandatory in accordance with the Health Research Authority guidance and there is no legal requirement for explicit consent to participate under the Data Protection Act and UK General Data Protection Regulation. Furthermore, permission has been obtained from the relevant Caldicott Guardian or Data Protection Officer for all data contained in SAIL. In addition, proposals using SAIL data are subject to review by an Information Governance Review Panel (IGRP) to secure approval. The IGRP approval number for this study is 0916.

Statistical analysis

After the exclusion of multiple PPN records and records with missing fields or duplicates, missing values were visualised; individuals with 25% or more of missing data were removed. The missing values for the remaining individuals were replaced with a new category, NR (no response). Any categorical variables were altered to factors for analysis.

Descriptive statistics were generated to assess the rates of experiencing an outcome, stratified by both gender and age for the domestic abuse victims who were the subject of a PPN submission. We used Kaplan-Meier survival analysis to examine the time to outcome for the domestic abuse victim after the index PPN submission, censoring individuals who moved out of Wales. We used multivariable Cox proportional-hazard models, adjusted

for confounders, to identify which factors contributed the highest risk of experiencing an outcome after the index PPN submission. The hazard ratios (HRs) were reported with 95% CIs and a significance level accepted at $p < 0.05$. The reference groups were No for most factors; otherwise, the reference group was Male for gender, Standard Risk for the risk assessment factor, and the age group 20–29 years for age comparisons.

We created decision trees to identify specific groups of individuals who are at risk of experiencing a domestic abuse incident and subsequent outcome. The decision trees were not used to develop a predictive model, they were utilised in the context of descriptive epidemiology to investigate the clustering of risk factors within individuals (ie, everything represented by codes in the code list [appendix 2]). This approach facilitated the identification of the relevant nodes that could be used to classify an individual considering their risk factor clusters. The data handling and preparation were performed in SQL, using Eclipse 2020-03 (version 4.15). Final data preparation was performed in R Studio, version 4.1.3, whereas the decision trees were conducted in IBM SPSS, version 28.0.0.0.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

The PPN dataset contained 26 762 records; of these, 15 189 individuals had multiple PPN records. The exclusion of multiple PPN records resulted in a dataset comprising only the index PPN record, generating a cohort of 11 573 domestic abuse victims. We also excluded records with a poor matching score ($n=344$; appendix 1 p 1), duplicates ($n=424$), missing gender ($n=60$), and an empty PPN record ($n=27$). Individuals with 25% or more of missing data were removed ($n=2009$), resulting in a 3% decrease of male victims, disproportionate to female victims, in the 20–39-year age range.

The resulting cohort comprised 8709 individuals (figure 1), of whom 6257 (71.8%) were female (table 1). The age groups of 20–29 years (30.0%) and 30–39 years (26.4%) contributed the highest proportion of domestic abuse victims; conversely, the age groups 0–9 (0.6%) and 80 years or older (0.7%) contributed the lowest proportion of domestic abuse victims.

3650 (41.9%) individuals had an outcome within a year of a domestic abuse incident; 2661 (72.9%) were female and 989 (27.1%) were male (table 1). 3544 individuals attended an Emergency Department, of whom 1085 individuals were then transferred to hospital. Overall, 1182 had an emergency hospital admission.

The age distribution of the outcome cohort indicates that more women than men had an outcome in the age range 20–39 years, which comprises the largest

proportion of domestic abuse victims. The total Emergency Department attendance rate was 572 (95% CI 554–591) per 1000 person-years and the hospitalisation rate was 185 (175–197) per 1000 person-years.

In comparison with the base age group of 20–29 years, those aged 10–19 years had an increased risk of experiencing an outcome (HR 1.183 [95% CI 1.053–1.329], $p=0.0048$; table 2; appendix 1 pp 1–4). Conversely, individuals aged 30–69 years had a decreased risk of experiencing an outcome (30–39 years: 0.882 [0.808–0.962], $p=0.0045$; 40–49 years: 0.801 [0.724–0.887], $p<0.0001$; 50–59 years: 0.772 [0.681–0.874], $p<0.0001$; 60–69 years: 0.728 [0.602–0.879], $p=0.0010$).

Cases involving attempted strangulation of the victim were associated with a higher risk of a future outcome (HR 1.311 [95% CI 1.148–1.497]; $p<0.0001$) than cases for which attempted strangulation was not present. Furthermore, victims had a higher risk of experiencing an outcome in the year proceeding a domestic abuse incident when the incident resulted in an injury (1.484 [1.368–1.609]; $p<0.0001$) than when it did not. Cases involving a pregnant household member had an increased risk of a future non-obstetric outcome (1.372 [1.142–1.648]; $p=0.0007$). Incidences where the perpetrator has hurt other people (1.218 [1.028–1.444]; $p=0.023$) or has a history of further violence (1.229 [1.134–1.333]; $p<0.0001$) resulted in an increased risk of the victim undergoing an outcome. Similarly, households that were subject to a MARAC referral (1.518 [1.358–1.697]; $p<0.0001$) or received multiple subsequent police visits after the index PPN (1.383 [1.295–1.476]; $p<0.0001$) have an increased risk of experiencing an outcome. Cases assessed as high risk, medium risk, or receiving no response from the responding police officer (high risk: 1.600 [1.444–1.773]; $p<0.0001$; medium risk: 1.117 [1.034–1.206]; $p=0.0051$; no response: 1.188 [1.075–1.312]; $p=0.0007$) were associated with a higher risk of experiencing an outcome than cases assessed as standard risk. Incidents involving conflict over a child had a lower risk of undergoing an outcome (0.856 [0.774–0.947]; $p=0.0026$) than those that did not. Furthermore, if a household member has had a child in the 18 months before the domestic abuse incident (past pregnancy), then the risk of an outcome is lowered (0.812 [0.722–0.913]; $p=0.0005$).

A decision tree combining knowledge gathered from GP and Emergency Department admissions up to a year before the domestic abuse incident, as well as information obtained by the police during the PPN submission, indicated that any Emergency Department admission before the domestic abuse incident is the most significant risk factor of experiencing an outcome (figure 2). Those with an Emergency Department admission 1 year before the event were further classified with the quantity (PPN count) and severity (MARAC referral) of their interactions with the police. Those who are known to the health-care

	Male	Female	Total
Demographics			
Total cohort	n=2452	n=6257	n=8709
Age category, years			
0–9	29 (1.2%)	22 (0.4%)	51 (0.6%)
10–19	263 (10.7%)	521 (8.3%)	784 (9.0%)
20–29	649 (26.5%)	1962 (31.4%)	2611 (30.0%)
30–39	595 (24.3%)	1700 (27.2%)	2295 (26.4%)
40–49	423 (17.3%)	1085 (17.3%)	1508 (17.3%)
50–59	275 (11.2%)	617 (9.9%)	892 (10.2%)
60–69	137 (5.6%)	211 (3.4%)	348 (4.0%)
70–79	57 (2.3%)	104 (1.7%)	161 (1.8%)
≥80	24 (1.0%)	35 (0.6%)	59 (0.7%)
Outcomes			
Overall	n=989	n=2661	n=3650
Type of outcome			
Any admission	985 (99.6%)	2656 (99.8%)	3641 (99.8%)
Emergency Department attendance	960 (97.1%)	2584 (97.1%)	3544 (97.1%)
Emergency hospital admission	266 (26.9%)	916 (34.4%)	1182 (32.4%)
Death	23 (2.3%)	25 (0.9%)	48 (1.3%)
Outcomes by age category, years			
0–9	16 (1.6%)	9 (0.3%)	25 (0.7%)
10–19	110 (11.1%)	286 (10.7%)	396 (10.8%)
20–29	294 (29.7%)	876 (32.9%)	1170 (32.1%)
30–39	227 (23.0%)	701 (26.3%)	928 (25.4%)
40–49	167 (16.9%)	411 (15.4%)	578 (15.8%)
50–59	99 (10.0%)	228 (8.6%)	327 (9.0%)
60–69	43 (4.3%)	78 (2.9%)	121 (3.3%)
70–79	21 (2.1%)	55 (2.1%)	76 (2.1%)
≥80	12 (1.2%)	17 (0.6%)	29 (0.8%)

Table 1: Descriptive statistics of the cohort split by gender

system and go on to have further contact with the police were the most at risk of having an outcome after the domestic abuse incident.

Individuals with up to one Emergency Department admission and who had subsequent interactions with the police were further split by the prescription of CNS drugs; those who were prescribed these drugs were more likely to experience an outcome. These drugs were mostly prescribed for anxiety, depression, and sleep disorders. Individuals who were not prescribed CNS drugs were split on age; the extreme age groups, 10–19 years and 80 years and older, were classified as being at greater risk of undergoing an outcome after a domestic abuse incident than those in other age groups.

For individuals who had minimal interactions with the health-care and police systems, the question about history of further violence was important as it is asked when there is an injury at the scene. Therefore, in scenarios where this question was asked, the risk of a future outcome was higher than scenarios where this question was not asked and marked as NA (ie, not applicable).

	Hazard ratio (95% CI)	p value
Age group, years		
20–29	Ref	
0–9	1.400 (0.938–2.092)	0.10
10–19	1.183 (1.053–1.329)	0.0048
30–39	0.882 (0.808–0.962)	0.0045
40–49	0.801 (0.724–0.887)	<0.0001
50–59	0.772 (0.681–0.874)	<0.0001
60–69	0.728 (0.602–0.879)	0.0010
70–79	1.087 (0.860–1.374)	0.48
≥80	1.110 (0.767–1.607)	0.58
Attempted strangulation		
No	Ref	
No response	0.970 (0.602–1.562)	0.90
Yes	1.311 (1.148–1.497)	<0.0001
Conflict over a child		
No	Ref	
No response	1.060 (0.709–1.584)	0.78
Yes	0.856 (0.774–0.947)	0.0026
Hurt other people		
No	Ref	
No response	0.570 (0.285–1.140)	0.11
Yes	1.218 (1.028–1.444)	0.023
History of further violence		
No	Ref	
No response	0.905 (0.649–1.263)	0.56
Yes	1.229 (1.134–1.333)	<0.0001
Gender		
Male	Ref	
Female	1.071 (0.996–1.152)	0.066

(Table 2 continues in next column)

	Hazard ratio (95% CI)	p value
(Continued from previous column)		
Injury		
No	Ref	
No response	1.143 (0.571–2.288)	0.71
Yes	1.484 (1.368–1.609)	<0.0001
MARAC referral		
No	Ref	
No response	1.024 (0.956–1.097)	0.51
Yes	1.518 (1.358–1.697)	<0.0001
Multiple police visits (PPNs)		
No	Ref	
Yes	1.383 (1.295–1.476)	<0.0001
Past pregnancy		
No	Ref	
No response	0.784 (0.516–1.193)	0.26
Yes	0.812 (0.722–0.913)	0.0005
Pregnant		
No	Ref	
No response	0.929 (0.514–1.679)	0.81
Yes	1.372 (1.142–1.648)	0.0007
Risk assessment		
Standard	Ref	
No response	1.188 (1.075–1.312)	0.0007
Medium	1.117 (1.034–1.206)	0.0051
High	1.600 (1.444–1.773)	<0.0001

MARAC=multi-agency risk assessment conference. PPN=Public Protection Notification.

Table 2: Hazard ratios and CIs for each factor for predicting an emergency attendance following a PPN, adjusted for confounders

The smoking status of the victim was indicated as an important factor for those for whom NA was the answer to history of further injury; the presence of smoking behaviour related to an increased risk of experiencing an outcome.

Incorporating additional information provided by the health-care system up to 3 years preceding the index PPN submission further indicated that multiple Emergency Department admissions before the domestic abuse incident was significantly associated with experiencing an outcome (figure 3). The individuals who were most at risk of undergoing an outcome after the domestic abuse incident were those who had more than seven Emergency Department admissions in the 3 years before and who received smoking cessation advice from their GP. Individuals who had more than three Emergency Department admissions but less than seven admissions, and have had more than two PPN submissions, are also at high risk; those who were classified as a cigarette smoker by their GP had a greater risk of experiencing an outcome than those who were not. Individuals with less than three Emergency Department admissions were split

by future PPN count; overall, those with a PPN count of less than one were at the lowest risk of having an outcome compared with the entire cohort. However, those individuals who were not known to the health-care or police systems but had been prescribed CNS drugs by their GP and who were in the extreme age group categories of 0–29 years and 70–79 years were at risk of undergoing an outcome.

Discussion

This study shows how communication between separate services can be utilised to identify points of early intervention for victims of domestic abuse up to 3 years before a potential police PPN submission. The findings demonstrate several risk factors that reflect vulnerability; when the perpetrator exhibited a pre-existing predisposition for violence, either in hurting others or with a history of violence, the domestic abuse victims were found to have an increased vulnerability for future outcomes. Furthermore, pregnant victims showed heightened vulnerability and had poorer outcomes; research has indicated that domestic abuse has been independently associated with the birth of a low-birthweight baby.¹⁹

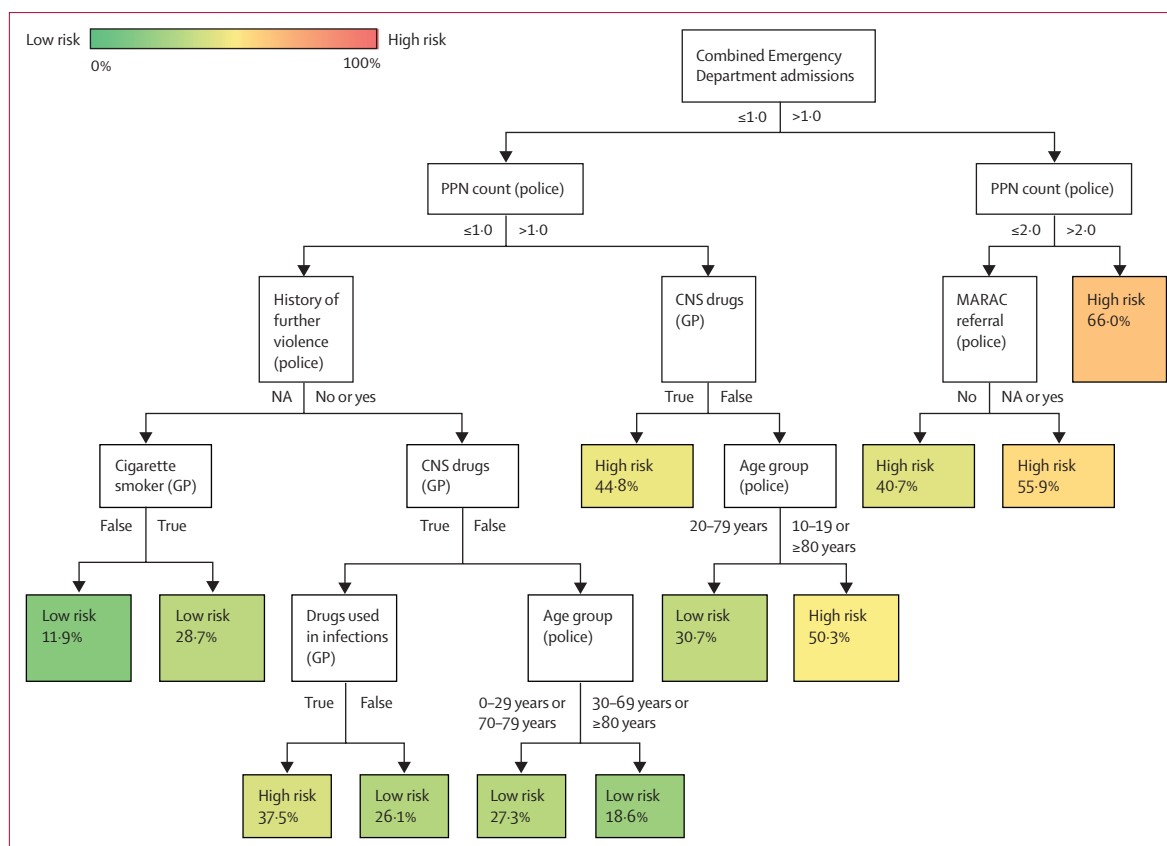


Figure 2: Decision tree to examine clustering of those who experience an outcome using data from other sources up to 1 year before the index PPN submission date

GP=general practitioner. MARAC=multi-agency risk assessment conference. NA=not applicable. PPN=Public Protection Notification.

Additionally, victims were shown to be known to Emergency Departments before the police are involved. Highly vulnerable individuals might interact frequently with Emergency Department health-care services but remain unknown to the police until a domestic abuse incident that requires an intervention;^{4,11-13} the most vulnerable individuals have been identified as those who had more than seven Emergency Department admissions up to 3 years before the index PPN submission.

The decision tree analysis highlighted several risk profiles with differing clusters of risk factors that might reflect different pathways through police contact, health care, and individual contexts. Our findings corroborated previous observations that the highest risk group of people experiencing domestic abuse are those well known to Emergency Department health-care services.¹¹ In our decision tree analysis, we found that an additional indicator for high risk was having had interactions with their GP, either for smoking cessation advice or by being identified as a cigarette smoker. This observation is in line with research that indicated that domestic abuse is associated with adverse health behaviours, such as substance abuse and addiction.^{4,7-9,11,13} Smoking could be indicative of an addiction behaviour that might serve as a

coping mechanism.²⁰ Furthermore, smoking behaviour has been shown to be more prevalent in individuals from an economically deprived background,²¹⁻²³ which has been found to be associated with domestic abuse within the household.⁶

A further set of factors suggested a subset of victims that are at high risk for a major health outcome. These individuals are repeatedly in contact with police after the index PPN submission and before the subsequent outcome event. Both decision trees indicated that those at the highest risk are split by the presence of more than two police visits. Individuals with less than two police visits but with a MARAC referral were also considered to be at high risk. This finding might indicate a progressively worsening home situation. These findings are similar to what has been found in victims of intimate partner violence; a study in the USA observed that Emergency Department use was associated with an increased number of police calls,¹³ whereas another study in Canada found it was associated with more violent abuse than for those who do not use the Emergency Department.⁴ These findings indicate that the manifestation of domestic abuse, specifically intimate partner violence in these studies, has shifted from a situation of coercive control to physical violence.

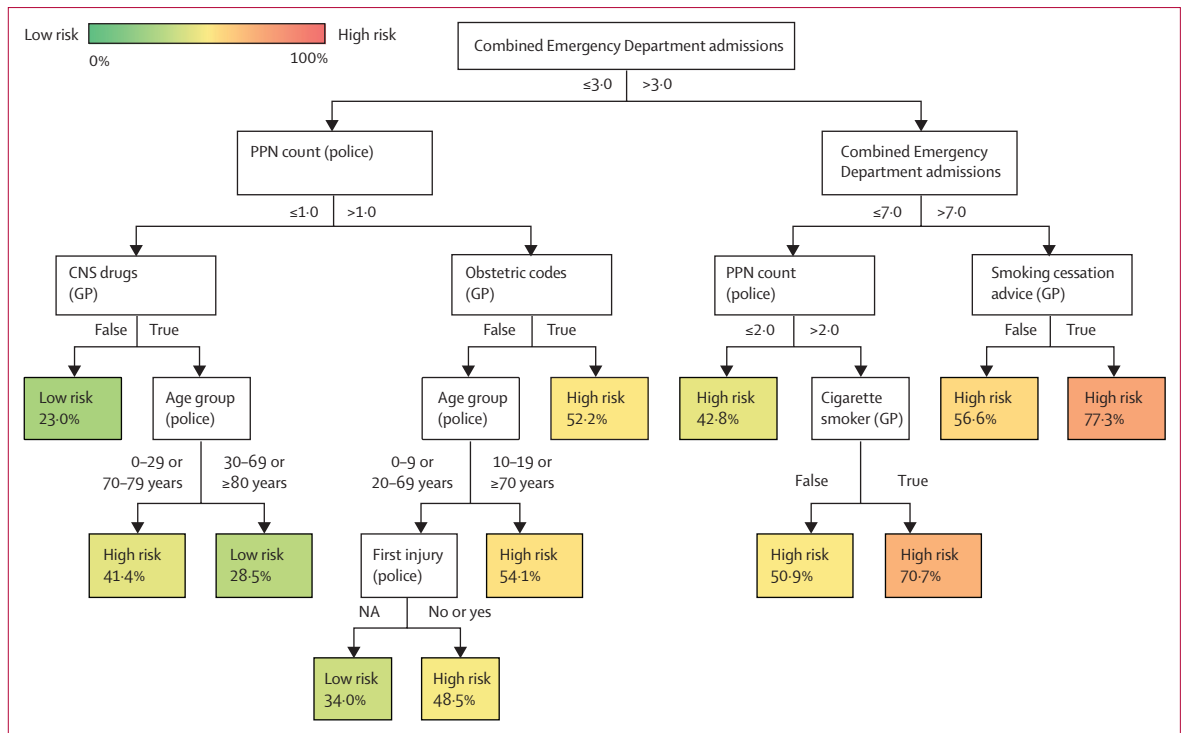


Figure 3: Decision tree to examine clustering of those who experience an outcome using data from other sources up to 3 years before the index PPN submission date
 GP=general practitioner. NA=not applicable. PPN=Public Protection Notification.

In contrast another group comprised individuals who were less often in contact with Emergency Department health-care services. This group consists of people who have had more than one police visit after the domestic abuse incident, with less than three Emergency Department admissions up to 3 years before, or less than one Emergency Department admission up to 1 year before the domestic abuse incident. Obstetric codes recorded by the victim’s GP up to 3 years before were indicative of those at highest risk within this group: mothers with young children. Several studies have observed that victims of intimate partner violence, which is included in the definition of domestic abuse by the DASH questionnaire, are more likely to be in their childbearing years;^{11,24–26} those who suffer abuse during pregnancy reported that it worsened throughout the duration, whereas for some who previously suffered abuse, they indicated that it was a protective period.²⁵ Research has indicated that having a child can increase economic pressures;²⁷ economic hardship increases stress on relationships, which has been shown to escalate the incidence of abuse.²⁷ The survival analysis also highlighted that victims who are pregnant at the time of PPN submission were more likely to have an outcome in the following year. Conversely, cases characterised by conflict over child contact had a decreased risk of experiencing a future outcome, which might be interpreted that a co-parent and potential perpetrator no longer cohabits

within the same household, which could decrease exposure to abusive behaviour.

Finally, we identified a group that was relatively unknown to both Emergency Department health-care services and police, but who nonetheless could be considered vulnerable individuals from the presence of GP codes. Those who had less than one police visit after the PPN submission were more likely to experience an outcome if they have been prescribed CNS drugs and were in the extreme age groups of 0–29 years or 70–79 years, compared with those who have not been prescribed these drugs or who are in different age groups. Furthermore, victims who were questioned by the police about the perpetrator’s violent tendencies at the incident and were prescribed both CNS drugs and drugs used in infections are more likely to experience the outcome compared to those who are not prescribed such drugs. These codes could suggest a stressful home environment, which is associated with adverse mental health symptoms. The presence of infection codes might indicate that these people have injuries or poor living conditions.

Our findings suggest that people who are attended to by the police for cases of abuse in the household have previously been in contact with various service providers, including GPs and Emergency Department health care. The linking of data from different organisations might enhance the efficiency and effectiveness of these

organisations' response systems. By using anonymised data sharing and linkage across multiple agencies we could identify warning signs, such as frequent visits to an Emergency Department. It could also help refine the DASH questionnaire adding additional risk factors that have been identified from linked data research, such as questions regarding previous Emergency Department admissions and the prescription of antidepressants or antibiotics from their GP. The use of an anonymised linkage system with a trusted third party enables research and system learning while preserving confidentiality and anonymity of the individuals. However, the implementation of cross-organisational data linkage at the national level for long-term purposes beyond research to identify individuals requires consultation with the public and consensus on the appropriate data types, linkage objectives, and purpose for linkage. Consensus is necessary to ensure that data sharing between organisations does not prevent individuals seeking help from Emergency Departments or similar services due to fear of being identified by the police, as such awareness has potential to deter help-seeking behaviours. The results of this study underscore the importance of providing training for Emergency Department personnel to recognise and address potential cases of abuse.

There are several limitations to this study. The PPN dataset comprises records spanning 2015–20 as PPN records were not available before 2015. Consequently, left-censoring arose in this study. In addition, the inclusion criteria required that the victim first has a PPN submission before experiencing a domestic abuse-related outcome. As such, those individuals who are experiencing domestic abuse without engaging with the police are excluded from this analysis. Furthermore, the index PPN submission within this study might not be the actual first PPN submission; thus, the actual time to event might be different to the calculated time to event between the index PPN and the outcome event. Moreover, this study is predominantly descriptive; therefore factors identified cannot be used to establish cause and effect and residual confounding might operate. Finally, restricting the analysis to non-obstetric Emergency Department admissions for women might have resulted in an underestimation of the influence of household abuse in pregnancy. Notably, some events, such as pre-term delivery, which could be triggered by abuse, would have been excluded.

Highly vulnerable individuals frequently interact with health-care services but remain unknown to the police before an incident that requires an intervention. This finding underscores the potential value of linking data across different agencies to facilitate targeted prevention measures instead of reactive ones. Moreover, identifying individuals at high risk following a police interaction could enable the establishment of protective measures. The data generated by this study have the potential to identify risk without relying on disclosure, forming a

foundation for enhanced integration. Further research is needed to validate these findings and examine whether early identification of these groups by the police or in the health-care setting could lead to improved outcomes, in addition to examining the outcomes stratified by demographic profiles.

Contributors

MAB, AJ, KHa, SM, and SB conceptualised the study. AB and SM designed the study. SB secured funding, contributed to the methodology, and undertook the role of project principal investigator. NK, TLW, and CM collected the data, with NK and TLW directly accessing and verifying the underlying data. NK, TLW, AB, and JK undertook the data analysis. NK, JK, and SB interpreted the data. NK and JK generated the figures. NK drafted the report. BR, CM, JE, KHu, MAB, AJ, SM, and SB all undertook project supervisory and advisory roles for their specialities. KHa acted as a patient and public involvement advisor. All authors contributed to revisions, approved the final version, and were responsible for the decision to submit the manuscript for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The data that support the findings of this study are available from the Secure Anonymised Information Linkage (SAIL) databank,¹⁵ but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. Interested individuals can apply to the SAIL databank for access, and once approved, can apply to the corresponding author.

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References

- 1 His Majesty's Inspectorate of Constabulary and Fire & Rescue Services. Police effectiveness 2015 (vulnerability). Dec 15, 2015. <https://www.justiceinspectors.gov.uk/hmicfrs/publications/police-effectiveness-vulnerability-2015-south-wales/> (accessed April 17, 2023).
- 2 Richards L. Domestic Abuse, Stalking and Harassment and Honour Based Violence (DASH, 2009) risk identification and assessment and management. 2009. <https://proceduresonline.com/trixcms/media/6627/dash-risk-assessment.pdf> (accessed April 17, 2023).
- 3 UK Parliament. Domestic Abuse Act. 2021. <https://www.legislation.gov.uk/ukpga/2021/17/part/1/enacted> (accessed April 17, 2023).
- 4 Nesca M, Au W, Turnbull L, Brownell M, Brownridge DA, Urquia ML. Intentional injury and violent death after intimate partner violence. A retrospective matched-cohort study. *Prev Med* 2021; **149**: 106616.
- 5 Sardinha L, Maheu-Giroux M, Stöckl H, Meyer SR, García-Moreno C. Global, regional, and national prevalence estimates of physical or sexual, or both, intimate partner violence against women in 2018. *Lancet* 2022; **399**: 803–13.
- 6 Nettet MB, Gudde CB, Mentzoni GE, Palmstierna T. Intimate partner violence during COVID-19 lockdown in Norway: the increase of police reports. *BMC Public Health* 2021; **21**: 2292.
- 7 Bacchus LJ, Ranganathan M, Watts C, Devries K. Recent intimate partner violence against women and health: a systematic review and meta-analysis of cohort studies. *BMJ Open* 2018; **8**: e019995.
- 8 Chandan JS, Thomas T, Bradbury-Jones C, et al. Female survivors of intimate partner violence and risk of depression, anxiety and serious mental illness. *Br J Psychiatry* 2020; **217**: 562–67.
- 9 Hegadoren KM, Lasiuk GC, Coupland NJ. Posttraumatic stress disorder part III: health effects of interpersonal violence among women. *Perspect Psychiatr Care* 2006; **42**: 163–73.

- 10 Alejo K. Long-term physical and mental health effects of domestic violence. May 1, 2014. <https://scholarworks.sjsu.edu/thesis/vol2/iss1/5> (accessed Feb 28, 2022).
- 11 Kothari CL, Rhodes KV. Missed opportunities: emergency department visits by police-identified victims of intimate partner violence. *Ann Emerg Med* 2006; **47**: 190–99.
- 12 Kothari CL, Rhodes KV, Wiley JA, et al. Protection orders protect against assault and injury: a longitudinal study of police-involved women victims of intimate partner violence. *J Interpers Violence* 2012; **27**: 2845–68.
- 13 Rhodes KV, Kothari CL, Dichter M, Cerulli C, Wiley J, Marcus S. Intimate partner violence identification and response: time for a change in strategy. *J Gen Intern Med* 2011; **26**: 894–99.
- 14 Coker AL, Smith PH, Bethea L, King MR, McKeown RE. Physical health consequences of physical and psychological intimate partner violence. *Arch Fam Med* 2000; **9**: 451–57.
- 15 Campbell JC. Health consequences of intimate partner violence. *Lancet* 2002; **359**: 1331–36.
- 16 Lyons RA, Ford DV, Moore L, Rodgers SE. Use of data linkage to measure the population health effect of non-health-care interventions. *Lancet* 2014; **383**: 1517–19.
- 17 Jones KH, Ford DV, Thompson S, Lyons RA. A profile of the SAIL databank on the UK Secure Research Platform. *Int J Popul Data Sci* 2019; **4**: 1134.
- 18 Ford DV, Jones KH, Verplancke JP, et al. The SAIL databank: building a national architecture for e-health research and evaluation. *BMC Health Serv Res* 2009; **9**: 157.
- 19 Bandyopadhyay A, Jones H, Parker M, et al. Weighting of risk factors for low birth weight: a linked routine data cohort study in Wales, UK. *BMJ Open* 2023; **13**: e063836.
- 20 Sullivan TP, Flanagan JC, Dudley DN, Holt LJ, Mazure CM, McKee SA. Correlates of smoking status among women experiencing intimate partner violence: substance use, posttraumatic stress, and coping. *Am J Addict* 2015; **24**: 546–53.
- 21 Martire KA, Clare P, Courtney RJ, et al. Smoking and finances: baseline characteristics of low income daily smokers in the FISCALS cohort. *Int J Equity Health* 2017; **16**: 157.
- 22 Guillaumier A, Twyman L, Paul C, Siahpush M, Palazzi K, Bonevski B. Financial stress and smoking within a large sample of socially disadvantaged Australians. *Int J Environ Res Public Health* 2017; **14**: 231.
- 23 Fry A, Littlejohns TJ, Sudlow C, et al. Comparison of sociodemographic and health-related characteristics of UK Biobank participants with those of the general population. *Am J Epidemiol* 2017; **186**: 1026–34.
- 24 Ribeiro MRC, Batista RFL, Schraiber LB, et al. Recurrent violence, violence with complications, and intimate partner violence against pregnant women and breastfeeding duration. *J Womens Health (Larchmt)* 2021; **30**: 979–89.
- 25 Alhusen JL, Ray E, Sharps P, Bullock L. Intimate partner violence during pregnancy: maternal and neonatal outcomes. *J Womens Health (Larchmt)* 2015; **24**: 100–06.
- 26 MacMillan HL, Wathen CN. Children's exposure to intimate partner violence. *Child Adolesc Psychiatr Clin N Am* 2014; **23**: 295–308, viii–ix.
- 27 Friedline T, Chen Z, Morrow S. Families' financial stress & well-being: the importance of the economy and economic environments. *J Fam Econ Issues* 2021; **42** (suppl 1): 34–51.
- 28 Spooner M. Does eligibility for protection orders prevent repeat abuse of domestic abuse victims in Caribbean states? *J Fam Violence* 2009; **24**: 377–87.