

Health Data Science Project Report

Introduction to Health Data Science (PU5058, PU5063)
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The Ongoing Issue of Domestic Abuse in Scotland

Why is the healthcare problem important and how can data science help to address it?

Domestic abuse can be described as a pattern of controlling behaviour or abuse of physical, verbal, psychological, economical or sexual nature that can measure up to a level of criminal offence, happening within a relationship, most commonly between partners and ex-partners [1]. Undergoing domestic abuse can have life-long consequences on victims, including but not limited to poor psychological health in form of symptoms of post-traumatic stress disorders, depression and suicidal behaviour, as well as chronic physical pains and, in the case of menstruating people, inability to conceive [2]. In recent years, figures of domestic abuse incidents have been increasing [3], indicating the relevance of the issue. Thereby, growing recognition of non-physical forms of abuse has been disseminated in wide-spread effort. As part of their "Love doesn't control" campaign, Police Scotland has developed a toolkit to emphasise the various forms abusive, controlling behaviour can take [1] in an effort to raise awareness of the situation. Consequently, the Domestic Abuse (Scotland) Act 2018 [4] was passed as part of a new offence against abusers [5], officially addressing the criminality of abusive demeanor of non-physical kind.

Ensuring awareness of the forms and consequences of domestic abuse not only within the public, but even more so among policy makers, health professionals and stakeholders is a crucial first step to improve the situation for potential victims. The recognition and disclosure of cases of domestic abuse of any kind drives transforming measures such as essential changes in legislation [4] or launching of prevention programmes requiring government funding [6]. Here, data science plays a crucial role by being able to shed light on the situation as whole. Using data science, domestic abuse case numbers can be analysed in comparison to previous years to capture underlying developments. These can then be displayed in descriptive and informative forms of visualisation, allowing to communicate findings to the target audience that is to be informed. As a consequence, awareness of the threat of domestic abuse can be established among the public to help uncover suppressed victims. Simultaneously, policy makers and potential project funders can be provided with facts on the matter, emphasising the severity of the domestic abuse situation in Scotland.

What data did you use to produce your visualisation? What are the data limitations?

Here, domestic abuse figures as recorded by Police Scotland are supplied by the Scottish Government (Scottish Crime Statistics) via the Scottish Public Health Observatory (ScotPHO). They are provided in the form of the number of domestic abuse incidents and rate per 10,000 population by local authority area [7]. The data was downloaded and accessed on Nov. 7, 2022.

- Approach 1 uses domestic abuse rates per council area from the financial years 2004/2005 (simplified to 2004) and 2019/2020 (2019).
- Approach 2 uses domestic abuse rates per council area from every financial year from 2004/2005 (2004) through 2019/2020 (2019), inclusive.

The financial year 2003/2004 has been excluded with the intention of keeping a time-frame of 15 years while focusing on the most recent data.

For classifying council areas into urban and rural spaces, the Scottish Government Urban Rural Classification 2020 [8] was used. All council areas with at least 95% of the population living in spaces classified as "large urban" (4 in total) were defined as "urban", all others received the label "rural".

One notable data limitation is the missing sample size numbers per council area. It could be roughly recovered through combining absolute numbers of incidents and rate per 10,000 population. Although Scotland Police has published figures for the financial year of 2020/2021, they have not been added to ScotPHO as of Nov. 25, 2022. ScotPHO further does not provide additional information such as separate numbers and rates for different forms of abuse, or demographic characteristics of the population of each council area. Lastly, it is to be noted that, when downloading "rank" data from the ScotPHO webpage, the resulting .csv file does not contain information on which years or areas have been selected as measure and as comparator by design. This can impose difficulties on a decoupled data acquisition/management and analysis process.

Domestic abuse rates in Scotland are worse in urban spaces, but have increased the most in rural areas

Approach 1: static scatterplot

Key message and target audience The key message of this approach is that in Scotland, domestic abuse rates are worse in urban spaces, but have increased the most in rural areas over the past 15 years. Here, the average log change in rates for rural areas is 0.2, equalling an alarming 60% decimal increase in rates.

The target audience for this approach are policy makers, stakeholders and potential project funders: the visualisation provides sufficient information to justify its key message, yet presents it clearly enough to be employed to inform crucial viewers such as policy makers.

Strengths and limitations of the approach This approach provides a straightforward way to grasp the bigger picture. The binary usage of colours makes it easy to distinguish

mainly urban council areas from rural ones. The indication of population size per council area assists in estimating the contribution of each area to the bigger picture. Presenting average values additionally highlights the key message. The usage of two axes, one indicating change, the other displaying the actual rates, allows to illustrate the development of the situation for each council area over 15 years while also providing an estimation of the actual severity of the situation.

Because of two outliers (council areas with a small population but large value for change in domestic abuse rates), the x-axis was log-transformed to incorporate values heavily differing from the majority of values. This additional transformation however adds to the complexity of the plot and makes interpretation more challenging. Further, scatterplots do not allow the display of confidence intervals as other popular scientific plot types do. The fact that apart from the City of Edinburgh, all differences in domestic abuse rates from 2019 and 2004 were significant, does thus not become apparent. The actual numerical change however still suffices to inform potential policy makers about the situation.

Domestic abuse in Scotland on the rise

Approach 2: animated treemap

Key message and target audience The key message of this approach is that domestic abuse is on the rise in most of Scotland. Only two council areas (Aberdeen City and the City of Edinburgh) show a reduction of domestic abuse rates from 2004 to 2019. For all other council areas, some of those making up large parts of the Scottish population, domestic abuse rates have increased over the past 15 years.

As for approach 1, the target audience to be reached are policy makers, stakeholders and potential project funders: the animated nature of the treemap makes it appealing to use in presentations, for instance at conferences, with the intention of drawing attention to the change that has been happening in recent years and to the topic in general. Technically, one could easily transform the treemap into a simplified version suitable for public display such as on billboards. By reducing complexity through removing numbers from the plot (e.g. labeling the colour bar "change" with "low" and "high" only), the same message can still get across to the public without over-complicating the visualisation.

Strengths and limitations of the approach In comparison to approach 1, the animated treemap allows the display of a detailed picture for each council area. It highlights the progression of the situation by showing the change in domestic abuse rates for each year after 2004 in comparison to the baseline. Therefore, its strengths can be leveraged to raise awareness of the development. Like for approach 1, the population size of each area can provide an estimate of its relevance regarding the general situation. Explicitly labeling the council areas in the plot helps to easily identify particularly problematic areas. Against the backdrop of the aim of achieving change in policy to combat domestic abuse, this might also evoke a concerned reaction in the viewer rooted in their personal relationship with a certain council area.

The strengths of this approach simultaneously imply its drawbacks. In comparison to a static plot, the animated treemap cannot be shown in papers, letters or other static or printed media. Further, as for approach 1, the log-transformed axis is hard to interpret. Thus, if the animated treemap were used for display in public places, the legend should

be edited as described in the previous section. However, two council areas of very small population but high change in domestic abuse rate appear to "skew" the colour bar by taking up the highest values (log-change ≈ 0.6 or change ≈ 4). Since a change value of about 2 represents a doubling of the domestic abuse rate from 2004 to 2019, this should still evoke concern in the viewer. The display of especially high values of small-sized council areas and a colour bar without numerical values harbours the possibility of viewers interpreting lower values (such as log-change $0.3 \approx$ or change ≈ 2) as harmless. Another drawback of this approach in comparison to approach 1 is that the only numbers shown here are change values, which illustrate the development, but not the actual severity of the situation and might even distort the view. For instance, council areas that had an alarming rate of domestic abuse incidents in 2004 that slightly reduced over the following 15 years arguably comprise an even more serious problem than a council area that showed an increase in recent abuse rates, but which still belong to the lowest of the country. This kind of information does not become evident in this approach.

References

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