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Lone threats: a register-based study of Swedish lone actors

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ABSTRACT
This study investigates 30 lone actors in Sweden with a register-based design using a group of male lone actors and two reference groups: same-sex siblings and other male violent extremists. We compare lone actors to the reference groups along social background, criminal background, and co-offending relations (1995–2016), and mental health (1980–2016). Our results show that lone actors are primarily born in Sweden to two Swedish-born parents. They have a high degree of criminality and co-offending, indicating that they are not completely loners in their criminal behaviour. They have higher enrolment in secondary education than the reference groups, but lower enrolment in higher education than other male violent extremists. Additionally, they suffer considerably more from mental disorders compared to the reference groups. An analysis of criminality and in-and outpatient hospitalisation over the life course indicates that lone actors may have had problems in their transition into middle age.

Introduction
Although the concept of leaderless resistance is not new, lone-actor terrorism has become one of the main security concerns for intelligence and security services around the world. This is partly because terror organisations have turned to less sophisticated attacks, which they perceive as a more feasible way to succeed in the face of law enforcement having become increasingly adept at detecting and disrupting large-scale terrorist plots (Ellis et al., 2016b). Ellis et al. (2016a) report that lone-actor terror plots in Europe increased between the years 2000 and 2014. Similarly, the latest trend report on Right-Wing Terrorism and Violence in Western Europe shows that lone actors constitute the most prominent perpetrator type in 2020, as they have done for the past four years (Ravndal et al., 2021). Both the US Department of Homeland Security (DHS) in its 2020 Homeland Threat Assessment and the European Union Agency for Law Enforcement Cooperation (EUROPOL) have stated that the primary terrorist threat in the future will likely stem from lone offenders and small cells of individuals linked to violent extremism (DHS, 2020, p. 17; Europol, 2020, p. 19).

Sweden is no exception to this trend. In fact, it stands out among European countries where it comes to security threats from lone-actor terrorism. Sweden, alongside Germany, came in third in the number of lone-actor terrorism plots planned in 31 European countries between 2000 and 2014.
Meloy et al. (2015) report that three out of the fifteen European lone-acting terrorists under study were from Sweden. As such, the Swedish National Centre for Terrorist Threat Assessment (NCT) has reported that a potential terror attack in Sweden is most likely to be executed by a lone actor or small group of like-minded people using readily available means (NCT, 2017, 2020, 2021). While intelligence and security services have emphasised the potential threats from lone-actors, the basic demographic knowledge on lone-actors is limited, especially on Swedish lone-actors. In this study, we set out to fill this knowledge-gap and examine lone actors in Sweden regarding their social background, criminal background, co-offending relations, and mental health, and through that contribute to the existing scientific literature on lone actors.

Previous studies of lone actors

In general, like violent extremism, terrorism or organised crime, there is lack of clarity over the definition of the term “lone actor” in the literature (Kenyon et al., 2021). To begin with, there are different positions as to whether isolated actors should be regarded as lone actors. While some authors include small cells of two or three individuals (Ellis et al., 2016a; De Roy van Zuijdewijn & Bakker, 2016; Stern, 2003), other authors only consider individuals who have carried out attacks by themselves (Gruenewald et al., 2013a, 2013b). Furthermore, there are different opinions as to whether the definition of lone actors should encompass school shooters or not: some researchers include school shooters in their studies of lone actors (McCaul & Moskalenko, 2014), while some only include some of the school shooters when they had a broader societal goal and aimed to influence a wider audience (De Roy van Zuijdewijn & Bakker, 2016).

It has also been argued that existing typologies have been motivated by exceptional high-profile cases, such as Anders Behring Breivik, rather than more “common” cases that have received less media attention (Schuurman et al., 2019).

The lack of clarity of the definition of the term “lone actor” is further complicated by different explanations about pathways to a lone-actor attack. Theoretically, there are at least three possible different pathways to a lone-actor attack in the literature. Firstly, selection processes could operate, through which the individual is construed as odd or mentally abnormal and is thereby excluded from extremist circles (Corner et al., 2016). Secondly, some individuals might feel uncomfortable in organised groups and therefore choose to act on their own (Spaaij, 2012). Thirdly, single actors or small cells are often more successful than larger cells or organisations when it comes to carrying out attacks, and individuals thereby could choose to act on their own to increase the chances of being successful (Ellis et al., 2016b).

Consequently, it is reasonable to conclude that lone actors are not a monolithic group and cannot always be considered as a homogenous subset of extremists.

Although previous research on lone actors is similarly heterogeneous in its design, study populations and contexts, some general patterns seem to emerge. Generally speaking, lone actors tend on average to be older, more socially isolated, and to have higher levels of mental disorders than other violent extremists. Specifically, in a study on domestic extremist violence in the US, Gruenewald et al. (2013b) compared far-right lone attackers to other far-right attackers. Their multivariate analysis showed that lone attackers are older, more often divorced, more often have a military background, and more often suffer from a mental disorder, compared to the other attackers in the sample. Further, in a study of ideologically motivated active shooter events aiming to differentiate lone-wolf terrorists from mass shooters, Capellan (2015) showed that the two types of offenders share many characteristics and are more alike than different. Both types of offenders were single males in their mid-thirties, and about a quarter of the group had a confirmed mental disorder.

In a study based on a sample of lone-actor terrorists from Europe and the USA, Gill et al. (2014) reported that the individuals in the sample were between 15 and 69 years of age, with a mean age of 33 years. In line with what has been reported above, they conclude that these individuals were older
than other extremists, and that many, but not all, were socially isolated. The educational distribution was similar to that of the general population and included individuals with a PhD. The authors made a distinction between lone actors who had carried out a successful act and those who had failed. The lone actors that had carried out a successful act had higher education, were more socially isolated, had more often suffered from a mental illness and had to a higher extent been rejected by an extremist group.

Another study, based on the data mentioned above, reports that 29% of the 111 lone actor terrorists had a history of failure to affiliate with an extremist group, 30% had a history of criminal violence and 80% displayed pathway warning behaviour before the terrorist attack (Meloy & Gill, 2016). Lone actors’ attachments to existing milieus and ideologies also seem to be heterogeneous. Ellis et al. (2016a) reported that the most common lone-actor attacks in Europe were those inspired by religious ideologies (27 out of 72 attacks), followed by attacks inspired by the right-wing movement (17 out of 27 attacks). De Roy van Zuijdewijn and Bakker (2016) examined 120 European lone actor terrorists who were predominantly inspired by religious or right-wing ideology. The authors reported that the individuals were on average 29.7 years old at the time of the attack or arrest, ranging from 15 to 74 years. Using media reports, it was estimated that one third of the offenders had signs of a mental disorder.

More recently, Liem et al. (2018) compared European lone-actor terrorist homicide offenders to other homicide offenders. The authors state that the lone-actor terrorists were a heterogeneous group, but that they differed from other homicide offenders with regards to substance use, weapon use and targets chosen. The lone-actor offences more often involved firearms and explosives and occurred in public settings. In about one third of the lone actors there were indications of a mental disorder, but the authors note that this rate was not very different from the rate in the general population in Europe.

Focusing specifically on mental health, in a systematic review of the empirical literature on lone-actor terrorism Kenyon et al. (2021) found that the prevalence of mental and personality disorder characteristics is one of the main themes in the literature on lone actors. They argued that “a common perception, based on the literature, is that lone actors suffer from a certain degree of psychological problems or exhibit symptoms of personality disorders” (Kenyon et al., 2021, p. 8). For example, Gill and Corner (2017) argued that mental disorders are likely to play different roles for different types of terrorists, and mental disorders should be seen as yet one more dimension within a multi-dimensional phenomenon. Corner et al. (2016) argued that the rate of mental disorder differs depends on the level of organisation. Within the category that the authors call “group-actors” (where the majority are likely to be actors within terror cells) a very low share of the offenders suffered from mental disorders, while disorders were more prevalent among lone dyads (i.e., two individuals conducting terrorist acts together; Corner et al., 2016). Another important observation is that lone actors displaying mental disorders still can have rational motives and act in a goal-oriented fashion (Borum, 2013; Gill et al., 2014).

**Calls for more rigorous known-group empirical research designs**

There are a number of challenges in studying violent extremism in general, and lone actors in particular. To begin with, there is the difficulty in obtaining primary data and studying a hidden population; in some cases, the study group is even no longer alive (died in the act by accident, suicide, or police intervention). Furthermore, research on violent extremism in general, and research on lone actors specifically, suffers from several methodological drawbacks that may affect internal and external validity (Braddock, 2019; Götzsche-Astrup, 2018; Monahan, 2012). Monahan (2012) pointed out that the vast majority of studies has been carried out on worst-outcome cases, i.e., those that either have tried to or succeeded to carry out terrorist attacks, but in order to broaden our understanding, we also need to learn more about all violent extremists, not only those who act on their beliefs. Götzsche-Astrup (2018) has reviewed the current status of empirical studies in
political radicalisation and concluded that there is a need for improved measurement validity and larger studies with more rigorous experimental design. The few systematic reviews that have been published on this topic have also pointed to quality issues and methodological flaws in violent extremism studies (Hassan et al., 2018; Scarcella et al., 2016; Schuurman et al., 2019; Widmer et al., 2007). In a recent systematic review, Kenyon et al. (2021) found that, even among empirical articles, the majority of them reported mainly descriptive findings, and almost half of the studies relied on small samples or single cases.

Aim of the study
In the Swedish context, very little research on violent extremism has studied lone actors. Among the research that does exist are qualitative studies of single cases of lone-actor attacks in Sweden and reports featuring research overviews on lone offenders (Cohen, 2012; Gardell, 2018; Kaati et al., 2019; Lööw et al., 2017). In line with arguments by (Monahan, 2012, 2017) and (Gøtzsche-Astrup, 2018) calling for the need of more rigorous known-group empirical research designs, the present study attempts to address the research needs identified above and contribute to increase our knowledge on lone actors in general and lone actors in Sweden in particular. Thus, the aim of this study is to examine lone actors in Sweden and to compare them to two reference groups: their male siblings and other male extremists. We compare lone actors to the reference groups along several dimensions: social background (age, immigration background and education level), criminal background, co-offending relations, and mental health (diagnosis, in- and out-patient hospital care).¹

Studies that compare lone actors or violent extremist in general, to other relevant groups may not be the norm, but as previous studies have shown, the comparative approach can be useful to gain insight into the dynamics and characteristics of the violent group under study (Bartlett & Miller, 2012; Meloy et al., 2019; Nussio, 2020; Silver et al., 2019). For example, Bartlett and Miller compared violent radicals with both radical and “mainstream” non-violent sample groups and found that violent radicals in addition to being an intellectual, rational, and religious decision, becoming a terrorist is also an emotional, social, and status-conscious one (Bartlett & Miller, 2012). Altunbaş and Thornton compared home-grown Islamic terrorists in the UK to a representative sample of Muslims living in the UK and found that the likelihood to participate in terrorist acts increases if they are better educated and young, and showed that young people can become radicalised and engage in terrorism because of the conditions in their home country, even if they themselves enjoy a better-than-average income and/or education in the UK (Altunbas & Thornton, 2011).

Materials and Method
Study group and reference groups
The study is based on datasets compiled from Swedish governmental registers on crime, mental health, education, and affiliation to antagonistic milieus in Sweden. Besides information from the Swedish Police and Swedish Security Service on affiliation to antagonistic groups in 2017, our dataset contains longitudinal information from a number of Swedish national registers for the period 1995–2016 (Mondani et al., 2021; Rostami et al., 2018). The data contain background information on demographics, education, mental health, sibling relationships, criminal background, and co-offending relations. See section on population registers for more information.

Our study group is a subset of the dataset described above, consisting of 30 Swedish male lone actors. All of them were alive by the time of identification. In addition to the study group, we have two reference groups. The first reference group comprises all male biological siblings of the lone actors (n = 34). Notable is that none of the male siblings are lone actors themselves neither
do they belong to other extremist milieux. The reference group of same-sex siblings was chosen to account for familial confounders, such as childhood socio-economic status, genetic factors, and other unobserved familial confounding factors. An underlying assumption is that lone actors and their male siblings share a considerable part of genetic, social risk, protective and other environmental factors that may have influenced their criminal behaviour and mental disorders. By comparing the individuals of the study population with their same-sex siblings, we try to account for possible unobserved genetic risk, protection and environmental factors shared by individuals in the study population and their siblings. This also means that the study population and the reference group largely share family-related background factors, such as the social exclusion and criminal history of parents and the original family, as well as the socio-economic status of the residential area (Beijers et al., 2017; Ferguson, 2010; Sariaslan et al., 2013, 2016).

The second reference group consists of 1,377 other male violent extremists from the dataset described above, who have been identified by law enforcement as belonging to three violent extremist milieux: violent Islamic extremism, violent far-right extremism, and violent far-left extremism. Of the 1,377 male violent extremists, 49% are categorised as violent Islamic extremists (n = 679), while 25% were categorised as violent far-right extremists (n = 340), 11% were categorised as violent far-left extremists (n = 158) and 15% as other extremists such as single-issue extremists (n = 200). As all lone actors were males, we only include males in the reference groups. See, Figure 1 for a visualisation of the study and reference group construction.

Our study group is pre-defined by the government agency responsible for monitoring extremism and we as researchers lack control over observation and inclusion and exclusion criteria and can only proceed from provided definitions. SÄPO defines lone actors as follows: “A lone actor offender might be motivated by a political or religious violently extremist ideology. But the offender can also have personal motive, such as a real or perceived indignity” (Swedish Security Service [Säpo], 2020). Note that this definition includes not only individuals that have perpetrated terrorist-related acts but also those assessed to pose a threat, in line with several other studies in the field (Ellis et al., 2016a; Gill & Corner, 2017; Gill et al., 2014; De Roy van Zuijdewijn & Bakker, 2016).

Figure 1. Study design and reference group construction.
Data from population registers

Data on birth year, immigrant background and education level were provided by Statistics Sweden. As an indication of educational attainment, we use categories based on the Swedish Education Nomenclature (SUN), which includes a classification of levels of education aggregated to 7 levels. We have collapsed these categories into three levels: a) primary education, b) secondary education, or c) higher education. Individuals at the first level (a) have never been enrolled in secondary education. Individuals at the second level (b) have been enrolled in or completed secondary educational programmes (gymnasium) of either 2 or 3 years of duration and/or post-secondary education shorter than 3 years. Individuals at the third level (c) have been enrolled in or completed higher education which includes post-secondary education of 3 years or longer (such as university studies) and doctoral studies. Regarding immigrant background, we use the definition used by Statistics Sweden which consists of the following categories: (i) Swedish-born, both parents Swedish-born; (ii) Swedish-born, one parent Swedish-born; (iii) Swedish-born, both parents foreign-born; or (iv) Foreign-born (Statistics Sweden [SCB], 2002).

Date of death information comes from the cause-of-death register, provided by the National Board of Welfare and Health. Information on psychiatric disorders comes from the patient register administered by the National Board of Health and Welfare. The register holds information about diagnosis, length of hospital stay, etc. for all in- and outpatient contacts in Sweden and has been used in previous studies (e.g., Sariaslan et al., 2013, 2016). We distinguish between inpatient and outpatient care in our analyses. The register covers the years 1980–2016 and due to confidentiality issues, we have access only to dichotomised variables based on a hierarchy of diagnoses (which is in line with Caman et al., 2017; Kyaga et al., 2011). The number of in- and outpatient hospital admissions for a mental health diagnosis per year was computed from the dichotomised variables and presented as the yearly numbers per five years age group per individual in each group. Due to the structure of the register in our data, we cannot distinguish the exact number of admissions when they occur in the same year for the same individual. Thus, the number of hospitalisations was collapsed per year. This means that our measure probably underestimates the real number of hospital admissions in all groups.

Data on criminal background come from the Swedish national register of persons suspected of criminal offences (henceforth register of suspected individuals) administered by the Swedish National Council for Crime Prevention (Brå) which is the agency and is responsible for the official Swedish criminal statistics. This register is based on all suspicions on reasonable grounds or higher suspicion level between 1995 and 2016, regardless of whether the individual was subsequently convicted of the crime or not. To analyse the dependence of criminal activity on age, we compute the age crime curves for our study group and reference groups. The curve shows the number of crime suspicions per individual over difference age intervals. To compute the number of individuals in each age interval, we have used the cumulated number of individuals in each group that were in Sweden at the time and had the right age interval.

Method

We analyse the data on social background, criminal background and mental health using descriptive statistics. In order to take differences in the relative size of the groups into account, we compute statistical tests for differences. For the age variables, we use the mean difference test, and for the variables involving shares in a certain group, we use the test for the difference between two sample proportions. For the variables entailing a distribution with more than two categories (like education level), we provide chi-square tests of independence. Plots and statistical tests were computed in Excel.

Additionally, the register of suspected individuals is structured so all registered cases of suspicion contain information on the crimes and the suspects and the criminal case of the suspicion. An individual can be associated with more than one crime and be suspected more than once. This
affiliation between individuals and criminal cases allows for constructing so-called co-offending networks (Sarnecki, 2001). A connection (link) is present between two individuals (nodes) if the two are suspected of committing one or more crimes in the same criminal case. To analyse the co-offending networks, we use the methodological tools of social network analysis (SNA). Social network analysis assumes that many types of social phenomena can be represented by two fundamental elements: nodes and links between nodes. In many networks, links have a direction (e.g., A likes B, but B dislikes A). In our case, where a link is constituted by co-suspicion in crime, the links are undirected. A number of network properties are computed for the co-offending network. To begin with, a component is defined as a part of the network within which all nodes can be reached through direct or indirect links (i.e., in steps of one link or more). The smallest type of component consists of two nodes. Networks often consist of many components, so it is interesting to see how much of the network is found in the largest component, the so-called giant component. There can also exist individuals not suspected with any other individual, and these are isolated nodes network. We compute network properties with NetworkX, a python package for the analysis of complex networks (Hagberg et al., 2008) and we use Gephi for network visualisation (Bastian et al., 2009).

**Results**

**Social background**

In Table 1, we report social and criminal background variables. Looking at age in 2016, we see that lone actors are on average 31.7 years old (median age 28 years), their male siblings are on average 31.9 years old (median age 29 years) and other male violent extremists are 31.7 years old on average (median age 29 years) indicating that all groups are on average in the same age span. We performed a mean difference test for the mean ages in order to take into account the size difference, particularly between the study group and the reference group of other male violent extremists. The tests show that there is no statistically significant difference, even when accounting for group size and variation.

When it comes to country of birth, we observe that the majority of lone actors are born in Sweden, similarly to their male siblings, and both to a much higher extent than other male violent extremists, the latter difference being statistically significant. Additionally, when we compute the difference between the observed frequencies of Swedish-born individuals and the expected frequencies had the categories been independent of the group (significance of these tests are shown between brackets in Table 1), we see that both lone actors and their male siblings have significantly higher shares of Swedish-born. Regarding immigrant background, the overall chi-square test of independence shows that the frequency distribution is in fact dependent on the group up to a high significance level. Both lone actors and their male siblings have a large share of individuals born in Sweden to two Swedish-born parents (statistically significantly higher than expected the expected shares), while other male violent extremists have a lower share in the same category, again the difference between the share for lone actors and the share for other male extremists being statistically significant. Complementarily, the percentage of foreign-born individuals is highest among other male violent extremists, and the share for lone actors and male siblings is statistically significantly lower than expected shares.

Regarding education level, Sweden has nine years of compulsory primary education, three years of secondary education and free access to higher education. Looking at the highest attained educational level, we see again an overall dependence of the frequency distribution by group in the chi-square test. We further observe that lone actors are mostly enrolled in secondary education, a share of individuals similar to their male siblings but somewhat higher than for other male violent extremists, even if none of the pairwise differences between these values are statistically significant. Both lone actors and their male siblings have a low share of enrolment in higher education.
Table 1. Social and criminal background variables of male lone actors and reference groups. Mean difference test for age. Test for the difference between two sample proportions for shares. Chi-square test of independence for distributions with more than two categories.

<table>
<thead>
<tr>
<th>Study group, age, and country of birth</th>
<th>Male lone actors (1)</th>
<th>Male siblings (2)</th>
<th>Other male violent extremists (3)</th>
<th>Difference (1–2)</th>
<th>Difference (1–3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of individuals (n)</td>
<td>30</td>
<td>34</td>
<td>1,377</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Mean age in 2016 in years (median)</td>
<td>31.7 (28)</td>
<td>31.9 (29)</td>
<td>31.7 (29)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Born in Sweden (%)</td>
<td>90 [+; **]</td>
<td>100 [+; ***]</td>
<td>59 [-; NS]</td>
<td>NS ***</td>
<td>***</td>
</tr>
<tr>
<td><strong>Immigrant background (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swedish-born, both parents Swedish-born</td>
<td>77 [+; **]</td>
<td>88 [+; ***]</td>
<td>37 [-; NS]</td>
<td>NS ***</td>
<td>**</td>
</tr>
<tr>
<td>Swedish-born, one parent Swedish-born</td>
<td>13 [+; NS]</td>
<td>12 [+; NS]</td>
<td>9 [-; NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Swedish-born, both parents foreign-born</td>
<td>0 [-; *]</td>
<td>0 [-; *]</td>
<td>13 [+; NS]</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Foreign-born</td>
<td>10 [-; **]</td>
<td>0 [-; ***]</td>
<td>41 [+; NS]</td>
<td>–</td>
<td>**</td>
</tr>
<tr>
<td><strong>Highest education level (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not enrolled in secondary education</td>
<td>30 [+; NS]</td>
<td>21 [-; NS]</td>
<td>28 [+; NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Enrolled in secondary education</td>
<td>67 [+; NS]</td>
<td>65 [+; NS]</td>
<td>60 [-; NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Enrolled in higher education</td>
<td>3 [-; NS]</td>
<td>3 [-; NS]</td>
<td>10 [+; NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>No available information</td>
<td>0 [-; NS]</td>
<td>12 [+; NS]</td>
<td>2 [-; NS]</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Criminal background</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected of at least one crime of any type (%)</td>
<td>87 [+; NS]</td>
<td>29 [-; ***]</td>
<td>77 [+; NS]</td>
<td>*** NS</td>
<td></td>
</tr>
<tr>
<td>Mean age at suspicion (median)</td>
<td>23.8 (24)</td>
<td>27.7 (26)</td>
<td>24.4 (22)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Number of crimes (per individual)</td>
<td>597 (19.9)</td>
<td>199 (5.9)</td>
<td>17,133 (12.4)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Individuals suspected of violent crimes (%)</td>
<td>60 [+; NS]</td>
<td>21 [-; **]</td>
<td>52 [+; NS]</td>
<td>** NS</td>
<td></td>
</tr>
<tr>
<td>Number of violent crimes (per individual)</td>
<td>122 (4.1)</td>
<td>22 (0.6)</td>
<td>3,844 (2.8)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Any co-offending (%)</td>
<td>57 [+; NS]</td>
<td>18 [-; **]</td>
<td>55 [+; NS]</td>
<td>** NS</td>
<td></td>
</tr>
<tr>
<td>Any co-offending in violent crimes (%)</td>
<td>30 [-; NS]</td>
<td>18 [-; NS]</td>
<td>33 [+; NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Mean number of co-offenders per individual</td>
<td>5.6</td>
<td>1.3</td>
<td>10.3</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* p < 0.05, ** p < 0.01, *** p < 0.001, NS: p ≥ 0.05. [Difference test between observed and expected share. + observed share higher than expected, – observed share lower than expected].
compared to other male violent extremists. Given that the age distributions between lone actors and other extremists are similar, the observed differences in education level cannot be directly attributed to age differences. All in all, lone actors are on average at the same age as the reference groups, much less migration background than other male extremists, and slightly higher educational level than both reference groups.

**Criminal background**

Continuing with the results in Table 1, the majority of the lone actors in our study group had been suspected of at least one crime during the period 1995 to 2016, compared to less than a third of their siblings (the difference in shares being statistically significant, even when only the difference between observed and expected shares for siblings is statistically significant). Note that this applies to all types of offences. Lone actors in our study group are on average 25.8 years old at time of crime suspicion regardless of type of offence (median age at suspicion 24 years), while their male siblings are on average 27.7 years when suspected of crime (median age 26 years) and other male violent extremists are 24.4 years old on average at suspicion (median age 22 years). The age differences between lone actors and the reference groups are not statistically significant.

About two thirds of lone actors had been suspected of at least one violent crime, compared to a fifth of their siblings (difference in shares statistically significant, again with differences between observed and expected shares only being significant for male siblings) and roughly half of the other male violent extremists; a similar pattern than for all types of offences. Also, the number of violent crimes per individual was almost seven times higher compared to male siblings and one and a half times as high among lone actors compared to other male violent extremists. Lone actors have higher mean number of co-offenders in their criminal suspicion cases than their siblings, but around half the mean value of the other male violent extremists. Altogether, this may be an indication that the study group has more violent tendencies.

In Figure 2, we show the number of crime suspicions per individual for the study group and reference groups, by age interval, in order to study criminal activities over the life course. This analysis shows that lone actors exhibit on average higher criminal activity throughout the whole life course, compared to the reference groups. Lone actors also exhibit a shorter age crime curve than other male violent extremists, although we should keep in mind that the study group consists of considerably fewer individuals than the reference group of other male violent extremists, so the potential for activity at greater ages is higher for the reference group. Additionally, the older lone actor is in his fifties in 2016, while the oldest man in the category other violent extremists is in his early seventies in 2016, which can contribute to the observed differences in the age crime curves.

Focusing on violent crime, in Figure 3 we show analogous curves as in Figure 2 but restricted to suspicion of violent crime. Here, we see that lone actors have in general a higher number of violent crime suspicions per individual over the life course. Between the ages of 21 and 45 years, the curve for lone actors has a similar pattern as the curve for other male violent extremists. Interestingly, for ages 15–20 and 46–50, the number of violent crime suspicions per individual among lone actors is considerably higher than for the reference groups. An interesting feature is the sharp increase in the number of violent crime suspicions starting at the age interval 36–40 (a similar pattern is observed for the hospitalisation curves, see, Figure 7 below). Male siblings to lone actors have consistently lower suspicions per individual than the other two groups.

In Figure 4, we show the distribution of crime suspicions for the different offence types and groups. The number of suspicions is divided by the total number of individuals in the study group and reference groups respectively. We show distributions for the total of each group, as well as for individuals that have been suspected of crimes alone and for individuals suspected together with
two or more co-offenders. In the figure, we see that the pattern observed in Table 1, with lone actors having a higher number of suspicions per individual than the references groups, holds even when analysing the distribution by crime type.

When it comes to lone actors, violence, threats, fraud and other offences\(^8\) are quite salient, while for other male violent extremists it is violence and drugs. Drugs is also a salient category for male siblings to lone actors. Also, most of the crime suspicions per individual in the lone actor study group correspond to individuals suspected alone. When lone actors do appear suspected of co-offending together with two or more individuals, they have a lower number of crime suspicions per individual compared to other male violent extremists, mainly in violence and theft. Overall, male siblings show lower number of crime suspicions per individual.

Looking at the structure of co-offending relations, in Figure 5 we show the co-offending network of the lone actors and their co-offenders. Nodes in the network represent individuals, and links represent being suspected of one or more crimes in the same criminal case, a so-called co-offending relation (e.g., Rostami et al., 2015; Sarnecki, 2001). The co-offending network consists of 186 nodes, out of which 26 (14%) are lone actors, and 3,485 co-offending links. Among the 160 co-offenders to
lone actors, we find four other extremists and 156 non-extremist co-offenders. The co-offending network provides the opportunity to study the nexus both within the groups and with other milieus. One interesting finding is that all four other extremists in the co-offending network belong to the far-right extremist milieu. We also find a nexus with organised crime (13 individuals) and with football hooligans (33 individuals). Of the 13 individuals in the organised crime milieu, 12 are members of Outlaw Motorcycle Gangs.

Figure 4. Distribution of crime suspicions per individual in different offence types, by group and number of co-offenders.

Figure 5. Co-offending network among 26 lone actors suspected of at least one crime and 160 co-offenders from Sweden, comprising 3,485 co-offending links. Colour key: red: lone actors (n = 26), yellow: other extremists (n = 4), blue: organised crime (n = 13), green: football hooligans (n = 33) and white: non-affiliated co-offenders (n = 110). Node size proportional to total number of crime suspicions.
While the criminal relations in the co-offending network are based on lone actors’ co-offending, the node size in Figure 5 is proportional to the total number of crime suspicions the individuals had been subject to during the period 1995 to 2016. This allows us to compare the total criminal activity of lone actors with that of their co-offenders. In general, co-offenders to lone actors have a higher number of crime suspicions in total than lone actors themselves. Nine of the lone actors (34.6% of the study group) are isolated nodes in the network. Eleven lone actors (36.7% of the study group) appear in components consisting of only one lone actor and at least one co-offender that is not a lone actor. Six of the lone actors (20% of the study group) were directly or indirectly connected to each other through co-offenders, four in the network’s giant component (comprising 61.8% of the nodes in the network) and two in another component. Six lone actors (20% of the study group) appear in components with at least one member of an organised crime group, out of which four are direct links. On the other hand, five lone actors (16.7% of the study group) appear in components with at least one member of other extremist groups, out of which four are direct links. One lone actor is suspected in a case directly together with football hooligans.

To sum up, lone actors are on average older when they commit crime, and they have higher crime activity both for all type of offences and for violent crime. Although the study group has a lower mean number of co-offenders than other male violent extremists, they are not isolated in their co-offending; we find clear links of collaboration in crime, both with other lone-actor co-offenders and with other extremists and gang members.

**Mental health**

As seen in Figure 6 and Table 2, the share of lone actors who have been inpatients with a major mental disorder diagnosis was 20%, considerably higher compared both to their male siblings (3%) and to other male violent extremists (2%); these differences being statistically significant when accounting for differences in group sizes. The share of individuals suffering from inpatient other mental disorders shows less pronounced but existing differences between the study and reference groups, with lone actors having a share of 20%, their male siblings 9% and other male violent extremists 12%. Looking at outpatient hospitalisation, 23% of lone actors have been diagnosed with major mental disorders, compared to 3% for male siblings and 4% for other male violent extremists. Like for inpatients, the differences in shares are statistically significant. Lone actors also have the
Table 2. Mental health variables of male lone actors and reference groups. Test for the difference between two sample proportions for shares. Chi-square test of independence for distributions with more than two categories.

<table>
<thead>
<tr>
<th>Mental health (%)</th>
<th>Male lone actors (1)</th>
<th>Male siblings (2)</th>
<th>Other male violent extremists (3)</th>
<th>Difference (1-2)</th>
<th>Difference (1-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient, Major mental disorder</td>
<td>20 [+ , *]</td>
<td>3 [+ , NS]</td>
<td>2 [- , NS]</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Inpatient, Other mental disorders</td>
<td>20 [+ , NS]</td>
<td>9 [- , NS]</td>
<td>12 [- , NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>In patient, no contact due to mental disorders</td>
<td>0 [- , NS]</td>
<td>3 [- , NS]</td>
<td>3 [+ , NS]</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Outpatient, Major mental disorder</td>
<td>23 [+ , *]</td>
<td>3 [- , NS]</td>
<td>4 [- , NS]</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Outpatient, Other mental disorders</td>
<td>33 [+ , NS]</td>
<td>21 [- , NS]</td>
<td>24 [- , NS]</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Outpatient, No contact due to mental disorders</td>
<td>3 [+ , NS]</td>
<td>0 [- , NS]</td>
<td>3 [+ , NS]</td>
<td>–</td>
<td>NS</td>
</tr>
<tr>
<td>No contact due to mental disorders or substance use</td>
<td>40 [- , NS]</td>
<td>71 [+ , NS]</td>
<td>65 [+ , ***]</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

* p<0.05, ** p<0.01, *** p<0.001, NS: p>=0.05. [Difference test between observed and expected share. + observed share higher than expected, - observed share lower than expected].

Figure 7. Number of in- and outpatient hospitalisations per individual due to mental health diagnosis, by age interval and group.

The highest share of outpatient other mental disorders (33%) compared to 21% for male siblings and 24% for other male violent extremists, although the share differences here are not statistically significant. Examining substance use disorders for both in- and outpatient hospitalisation, we find that 19% of the lone actors had such a diagnosis, while the same was true for close to 14% of the siblings and close to 13% of the other male extremists. For the share of individuals that have not had contact with the health system due to mental disorders or substance use, i.e., no entry in the population registers, we see that lone actors have a much lower share (40%) than their male siblings and other male violent extremists (71 and 65% respectively); both share differences are statistically significant.

The mental disorder analysis shown in Figure 6 provides an aggregated picture of these groups’ contact with the health system when it comes to mental disorders and substance use disorder. In order to examine the contacts over the life course, we constructed curves similar to those for criminal activity in Figures 2, 3, but instead of the number of crime suspicions we consider the number of in- and outpatient hospitalisations. As seen in Figure 7, lone actors exhibit considerably
more hospital inpatient care due to a mental health diagnosis, compared to their siblings and other male violent extremists; roughly three times higher from ages 15 to 35 years (on average 0.17 inpatient hospitalisations per individual, 0.05 for male siblings, and 0.04 for other male violent extremists). From the age of 36 years, we observe a sharp increase in the number of hospitalisations per individual for lone actors. Looking at outpatient care, we see a similar increase for lone actors from 35 years onwards, but even from 15 up to 35 years lone actors have much higher values of outpatient hospitalisation per individual (0.23 on average) than male siblings and other male violent extremists (0.10 and 0.16 on average, respectively). Due to the low number of individuals in the group, this result must be interpreted with caution. However, a similar pattern was observed for violence-related criminal activity and to a certain extent for criminal activity in general. This can be interpreted as an indication of the fact that lone actors not only have higher degrees of criminal activity and mental disorder at early ages, but also that an acceleration occurs during adulthood.

To sum up, our empirical material shows that Swedish lone actors are for the most part Swedish-born with Swedish-born parents, have average education level, and much higher violent crime figures when compared to the reference groups. The share of mental disorders among the study group is exceptionally higher than the reference groups.

**Discussion**

Comparing our results with previous research that looked at age at first terrorist-related activity, we can see that the study group is younger when age at crime suspicion is considered, but have an average age in 2016 of around 30 years, similar to previous research (Gill et al., 2014; Meloy et al., 2015; De Roy van Zuijdewijn & Bakker, 2016). When it comes to highest attained educational level, lone actors have mostly enrolled in secondary education, similarly to their male siblings and somewhat higher than other male violent extremists. Both lone actors and their male siblings have a low share of enrolment in higher education compared to other male violent extremists. Among the whole Swedish adult population (i.e., ages 25 to 64 years) in 2019, only 11% did not enrol in secondary education, 60% have enrolled in secondary education, and 29% have enrolled in higher education (Statistics Sweden [SCB], 2020). Thus, our group is comparable to the general adult population when it comes to secondary education but falls behind in higher education. This is in line with previous research showing that most lone actors were white males in their thirties with dysfunctional adult lives, either single or divorced, low education and a history of mental illness (Capellann, 2015).

Lone actors have a higher number of suspicions per individual than the references groups, even when considering various types of offences. Violence, threats, fraud and other offences are salient among lone actors, while for other male violent extremists, violence and drugs are salient. Drugs is also a salient category for male siblings to lone actors. Lone actors are lone perpetrators with fewer co-offenders compared to other male violent extremists. When lone actors are suspected of co-offending with two or more individuals, it is mainly in violence- and theft-related crimes.

Additionally, more than half of the lone actors had at least one co-offender, and also some of the lone actors were found within the same co-offending networks as others lone actors and/or other extremists. This finding challenges the view of lone actors as loners and calls for a more integrated view of the phenomenon, and are well in line with (Schuurman et al., 2019) suggestion that the term “lone wolf” is somewhat misleading in the social isolation aspect, and that it should no longer be used. Indeed, we observe a nexus to other extremists, gang members and football hooligans, particularly to violent far-right extremists and outlaw biker gangs. Some of the lone actors have extensive co-offending: there are nine lone actors that are isolates in the co-offending network, five that only have one co-offender and twelve have more than one co-offender. Furthermore, two of the isolated lone actors have major mental disorders.
Looking at inpatient hospitalisations for the years 2011 to 2016, an average of 0.2% of the male Swedish population aged 18 to 74 have been hospitalised due to a mental disorder or substance abuse. For comparison, in our lone actor study group during the same period, an average of 10% of the study group have experienced inpatient hospitalisation, meaning a fifty times higher prevalence than the male Swedish population. Our findings show that the difference in prevalence of mental disorders has probably been underestimated in previous studies. This finding could have some implications when dealing with lone actors in society and for detection and the rehabilitation process of convicted lone actors, especially given that lone actors exhibit higher rates of both major and other mental disorders compared to other male violent extremists. In addition, we find that lone actors also exhibit considerably higher rates of mental disorders compared to their same-sex siblings, with whom they share family background and social risk factors. The higher level of mental disorder found in our results is in line with previous research (Capellan, 2015; Corner et al., 2016; Ellis et al., 2016; Gill & Corner, 2017; Gruenewald et al., 2013a). We also observe that the development of mental health over the life course is not linear, but instead those that have been diagnosed have a high level of both in- and outpatient hospitalisations in relation to the reference groups, with a decrease at ages 36–40 followed by a considerable increase afterwards.

Interestingly, a similar pattern is observed when looking at criminal background over the life course. Indeed, lone actors have in general a higher number of violent crime suspicions per individual over the life course than the reference groups, being considerably higher than the other curves for ages 15–20 and 46–50. Furthermore, male siblings have consistently lower numbers of suspicions per individual than the other two groups. This, together with the pattern in mental health, suggests that lone actors exhibit different outcomes even in relation to individuals that share the same family background and risk factors. These results partially contradict the expected pattern of the so-called age crime curve (Hirschi & Gottfredson, 1983), i.e., the assumption that crimes are most prevalent during mid to late adolescence and decrease in adulthood. This is no controversial finding though, as it has been shown that the relationship between age and crime is complex and varies across offence categories (Fagan & Western, 2005).

Our data suffer from certain limitations. The first drawback is the small number of lone actors and consequently of male siblings. A second limitation is our lack of knowledge about the political and ideological beliefs of the study group. Like in the case of other register studies, we lack control over observation and measurement. For example, the representation in the study group can be affected by the priorities set by the law enforcement agencies. The study of street gangs has shown that police-based information can deviate sharply from self-report surveys, where police-based data often underestimate certain groups such as female gang members (Klein & Maxson, 2006). Further, the hospitalisations in the register are not necessarily related to the individual’s activities that led to their classification as lone actors. Of course, only visits at hospitals show up in the register. Despite these limitations, there are three strengths: the research design with the reference groups, and that we study lone actors regardless of whether they constitute a threat or have perpetrated terrorist-related acts. Thirdly, our study is not based on open media sources, but rather real hospitalisation and crime suspicions, which proves our results provide a more solid empirical foundation. We believe that these strengths overcome the outlined limitations and can constitute the basis for more accurate policies in detecting and preventing lone actor attacks.

Even if this study has increased the grounds for viewing mental disorders as one possible causal root into lone acting behaviour, a causal relation between mental disorders and lone acting behaviour cannot be settled yet. Larger prospective studies are needed. In that sense, this study does add one level of aetiological perspective on lone acting extremism. Previous
research has also shown that mental disorders are not a prerequisite or a discriminant factor for violent extremism and terrorism (Corner & Gill, 2015; Corner et al., 2016; Gill & Corner, 2017). Rather, different types of extremist actors have different levels of mental health issues, with on average higher levels of mental health issues than the general population.

Overall, our results indicate that lone actors may have had problems in their transition into middle age. Instead of progressing, they seem to get somewhat stuck in the process, manifesting anti-social behaviour and mental health problems. Although it may be the case that mental disorder is secondary to ideological beliefs, it is difficult to address these issues with only quantitative research designs. As such, this study has not addressed the question of what developed first, the mental disorders or the extremist beliefs. We therefore advocate for more longitudinal and mixed-methods research.

Furthermore, although we have identified extensive criminal background and co-offending, there is a need for more studies such as the present one, using population-based and systematic databases on previous criminality and possible co-offending, pushing for research on violent extremism beyond non-systematic studies using mostly open-source data. As mentioned earlier, our study also shows that lone actors should not always be considered as being lonely; they are found in more organised extremist milieus. More importantly, the ability to detect extremism with high prevalence of mental disorders should be one of the main parameters in both risk management and police assessment.

Notes

2. The category “Major mental disorder” includes schizophrenia and other psychotic disorders (ICD-10: F20-24; F26-29), schizoaffective disorder (ICD-10: F25) and bipolar disorder (ICD-10: F30, F31), neuropsychiatric disorder, autism (ICD-10: F84.0, F84.1) and ADHD (ICD-10: F90). We have chosen to label severe mental disorders as “major mental disorders” rather than as “severe mental disorder” since the latter is a term used in the Swedish Forensic Mental Care Act and this is a distinction made in the Swedish context. The category “Other mental disorders” includes unipolar depression (ICD-10: F32-39), anxiety disorder (ICD-10: F40-42, F44-45, F48, F32.3, F33.3), personality disorders (ICD-10: F60-61) and other mental disorders. Substance use disorders come from other diagnoses (ICD-10: F10 except x.5 and F11-F19 except x.5).
3. There are two suspicion levels in the Swedish system: suspected on reasonable grounds or suspected on probable cause. Suspected on reasonable grounds is the lower level of suspicion. It means that there are specific circumstances that indicate, to some extent, that the individual in question has committed the act. Suspected on probable cause is a higher level of suspicion. It means that on an objective assessment of the evidence in the case, the suspicions against the person appear well-founded.
4. We use 2016 as the year for age because this is the year the register of suspected individuals and the patient register end in our database. It is also the year closest to 2017 when the Swedish law enforcement identified these individuals as lone actors.
5. See Figure A1a in the Appendix for similar curves but with the absolute number of violent crime suspicions, and Figure A1b for the curves with the number of violent crime suspicions divided by the total number of individuals in the whole group.
6. Given the small number of both individuals and violent crime suspicions for those age ranges, this pattern should be interpreted with caution. At the same time, the increase is not due to one single individual in those age ranges that concentrates all crime suspicions.
7. If the study group had been larger, we would have been able to control for small random fluctuations in the data and the presence of outliers. However, given the relatively small size of the study group, we are not able to make use of these controls.
8. The category of “Other offences” consists of offences such as sexual, traffic, vandalism, hate, environmental, smuggling etc.
9. See Figure A2a in the Appendix for similar curves but with the absolute number of in- and outpatient hospitalisations, and Figure A2b for the curves with the number of in- and outpatient hospitalisations divided by the total number of individuals in the whole group.
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