1. Introduction

The suggestion that numbers matter in conflict situations has been widely acknowledged ever since Lanchester (1916) articulated his principle of a relationship between relative strength and attrition rates in pre-gunpowder human warfare (Johnson & McKay, 2015). This claim is supported by evidence that both chimpanzees (Wilson, Britton, & Franks, 2002; Wrangham, 1999) and people (Buss & Duntley, 2003) are only likely to attack other individuals when they have a significant numerical advantage. However, Lanchester’s Law was formulated in the context of conflicts between strangers, where numerical advantage at the time of attack may well be crucial. In species that have bonded so-sicial systems in which kin form mutually protective alliances (Dunbar & Shultz, 2010), the cost–benefit ratio associated with within-group conflict may be moderated by the risk that an aggressor incurs from retribution by the victim’s relatives. In most small scale human societies, murder can trigger highly disruptive vendettas between lineages, and straightforward altruism (Berté, 1988; Betzig & Turke, 1986; Chagnon & Bugos, 1979; Hames, 1987; Hill & Hurtado, 1996; Jones, 2000; Madsen et al., 2007). Kinship might, however, play a different, but equally important, indirect role by moderating aggression between adults through the protection that kin offer a potential victim targeted by an aggressor: aggressors know that they risk retribution at the hands of the victim’s relatives. In species where kin form functional alliances for self-defense, individuals may be less willing to attack those who belong to large extended families. There is some suggestion that such effects may occur in nonhuman primates. Among Old World monkeys, juveniles are less likely to threaten individuals who belong to higher ranking matrilines, even when the members of those matrilines are not visible (Colvin, 1983; Datta, 1983; Johnson, 1987). Similarly, in both baboons and macaques, members of a matriline may precipitously lose rank following the death of the matriarch because they lack the coalitionary support that previously prevented other individuals challenging them (Bernstein & Ehrardt, 1986; Hausfater, Altmann, & Altmann, 1982).

So far, however, no studies have explicitly explored the effect of kinship on humans’ willingness to attack others. Viking Age Iceland offers a unique opportunity to test this hypothesis for several reasons (for further background, see ESM). First, North European society during the first millennium AD was unusually violent since it was underpinned by a default principle of “might is right”. Many of the conflicts that arose between individuals and families involved disputes over land, and in many cases were targeted attempts to acquire land or resources by force; in other cases, they were about the defense of individual or family honor (which in turn had implications for the likelihood that others would try to wrest resources from the family). Iceland during the Viking settlement period lacked any kind of overarching political authority to moderate the activities of powerful individuals, and male
mortality from within-community conflict was unusually high (Dunbar et al., 1995). Second, kinship and extended family were extremely important, both for reasons of land inheritance and as a source of protection. With no central authority to bring killers to account, it was the responsibility of the victim’s family, and occasionally friends, to pursue the case (Byock, 2001). By the same token, kin were regarded as equally culpable and thus legitimate targets for revenge killings, so much so that killings often triggered vendettas that continued across generations (Byock, 1982, 2001; Wallette, 2010). Killing someone was thus extremely risky because it put the killer’s entire kin group at risk. Third, Iceland boasts a unique set of historical records (the medieval family sagas) that detail events at the individual level as well as providing information from which extended community-wide pedigrees can be constructed (see ESM).

We tested the hypothesis that individuals preferred to target victims with smaller kin groups than themselves. We differentiate between three potential kinds of kin, namely biological relatives, affines (in-laws) and foster kin. In humans, affines (or in-laws) constitute an important class of relatives in this context because they significantly extend the pool of potential allies. One reason why affines might be willing to offer support in these cases is that they share an interest in the fitness of the progeny that arise from the marriage which unites the two families (Burton-Chellew & Dunbar, 2011; Hughes, 1988). In addition to these two more conventional types of kinship, the Vikings, in common with many other societies, also recognized foster kinship. This typically involved a child from one family living, or growing up, in someone else’s household, usually as a formal recognition of a special relationship between the two families (in many cases associated with political or economic deals). Fostering arrangements were common among the Vikings, with foster relationships carrying emotional and social weight that bore many superficial resemblances to kinship, not least in terms of the language used to describe the relationship (Wallette, 2010).

2. Methods

We collated data on major social interactions described in three Icelandic family sagas: Egil’s Saga (Pálsson & Edwards, 1959), Njal’s Saga (Magnussen & Pálsson, 1970), and the Laxðaela Saga (Magnussen & Pálsson, 1975): see ESM). Laymen often mistakenly assume that a saga is a poem. In fact, it means exactly what it does in English: a story or history. The family sagas are family histories and provide accounts of actual events that engulfed an entire community, with many being written between within living memory of the events they describe. Each saga describes the events that occurred during a particular period and gives detailed information on births, marriages and deaths, as well as more casual social events (visits, fostering, plots, scheming, deals and, most important of all, feuds). As a result of the feuds that took place in the three sagas, 31 of the 87 males who appear in them as main characters were killed, showing just how violent such feuds could be (see also Dunbar et al., 1995).

We extracted data on 1891 separate social events (including conflicts and murders) involving a total of 1020 individuals. Since the sagas record births and marriages, as well as deaths, and Norse surnames are patronymics (and mothers’ names are often specified as well), we were able to build a single extended pedigree that included all these 1020 individuals, with only a small number of isolates not related by family to other community members. Most, but not all, of these isolates were slaves. In total, there were 6015 kinship connections distributed over 1101 affinal, 50 foster, 2271 paternal kin, 1689 maternal kin and 1004 sibling connections (Table 1). Due to the status assigned to concubines in Iceland, these were counted as wives and the woman’s family as her husband’s affines, despite the couple not being married. Their illegitimate offspring was therefore included in the count as half siblings (\( r = 0.25 \)) for the man’s legitimate offspring since they were often raised in the same family.

If a victim had close kin in Iceland, these relatives would have claimed the compensation they were entitled to under Norse customary law (either a revenge killing or blood-money: Dunbar et al., 1995, Byock, 2001). Since any attempts to gain compensation would have impinged on the killer and his family, it is unlikely that the victim’s kin would not have been mentioned had there been any. Honor was of paramount importance to the Vikings and failing to avenge a murdered relative incurred loss of face and opened the family up to further attacks (Byock, 2001). Thus, if no kin are listed and no type of retribution is mentioned, it can reasonably be assumed that the victim did not have any kin in Iceland. Any family they may have had outside Iceland are irrelevant because they could not do anything about the murder, and news of any such events would have taken months, even years, to make its way to Scandinavia (assuming someone was interested enough to pass it on).

Although it is inevitable that written accounts of historical events will reflect the victor’s viewpoint, there are at least four good reasons for considering the Icelandic sagas as being broadly reliable as historical documents. First, quantitative analysis of the social networks recorded in the Icelandic family sagas reveals that their structure is very similar to that for natural human social networks in the modern world. Saga networks are small world with a power law degree distribution and an exponential cutoff, and contain strong community structuring, and are quite different to the networks found in fiction and myths from the same period (e.g. Anglo-Saxon and Irish folk tales) (MacCarren & Kenna, 2013). In other words, the sagas have the appearance of describing real social worlds rather than fictional ones. Second, many of the details reported in sagas can be confirmed from independent historical and archeological sources, notably the Landnámabók which provides a detailed record of land settlement and transactions. The Landnámabók contains the names of some 3000 individuals and 1400 settlements covering the first two centuries after Iceland was first colonized in 874 AD (see ESM). Third, many individuals appear in several different sagas. Hence, it is implausible to suppose that all saga compilers, writing independently, would have failed to record the same individual’s family relationships where these actually existed, especially given the importance of rights of inheritance to land through both sides of the family. Failure by one saga to list an individual’s family is plausible if they were peripheral to the story, but failure by several sagas to do so is significantly less plausible. Indeed, large sections of the extended pedigree that provides the basis for this paper were built up by collating information across the sagas rather than from information given in a single saga. In any case, it is by no means the case that only victims lacked family: at least 10 (14%) of killers had no recorded kin. Fourth,

| Kinship category | \( r \) | Number of connections in the sampled sagas |
|-----------------|---------|------------------------------------------|
| Biological      |         |                                          |
| Full siblings   | 0.50    | 1004                                     |
| Paternal relatives: |     |                                          |
| Father          | 0.50    | 613                                      |
| Uncle, aunt, grandmother, grandfather, half sibling | 0.25 | 1051 |
| Father’s cousins | 0.125 | 607                                      |
| Maternal relatives: |     |                                          |
| Mother          | 0.50    | 262                                      |
| Uncle, aunt, grandmother, grandfather, half siblings | 0.25 | 806 |
| Mother’s cousins | 0.125 | 521                                      |
| Total           |         | 4864                                     |
| Affinal relatives |     |                                          |
| Wife/Husband    |         | 320                                      |
| Spouse’s siblings, father, mother | | 781 |
| Total           |         | 1101                                     |
| Foster kin      |         | 11                                       |
| Foster father   |         | 7                                        |
| Foster mother   |         | 7                                        |
| Foster siblings (foster parents’ children) | 32 | |
| Total           |         | 50                                       |
under Norse law, a murder entitled all the victim’s relatives to compensation, either in the form of a revenge murder or blood money (the latter in quantities closely specified by degree of relationship to the victim) (Byock, 2001). If no claims for compensation are mentioned in a saga, it is almost certain that this is because the victim had no family in Iceland rather than that the saga compiler simply failed to mention it. There was too much at stake, both for the family of the victim and the killer and his family. In short, contemporary historians now generally accept that the family sagas are historically reliable, at least as far as individual identities and the main events are concerned (Firth, 2012).

Nonetheless, the pedigrees do suffer from two potential shortcomings. Women have a less central role in the sagas: out of the 1020 people recorded in our combined pedigree, only 196 (19%) are female. Many matrilateral connections are thus likely to have been missed. However, in contrast, the number of maternal kin connections actually recorded (1589 connections) is only slightly less than the number of paternal connections (2271 connections), mainly because the maternal and paternal relationships of the core characters are invariably given equal weight (not least because, under Norse law, inheritances could be claimed through both sides of the family). A second problem arises from the fact that paternity uncertainty (Gaulin, McBurney, & Brakeman-Wartell, 1997) might result in the misreporting of actual paternal relatedness. However, in Iceland, the Grágás (Gray Goose Laws, a compilation of customary law) imposed very stiff penalties for any type of extramarital activity (as opposed to concubinage) and, combined with the importance placed on honor, the obligation to revenge slights and the inheritance rights to land, would have served to reduce the level of paternity uncertainty (Byock, 2001). We therefore consider it unlikely that paternity uncertainty would seriously bias our results. In the final analysis, however, whether or not an individual was actually someone’s biological kin is probably less important in this context than the fact that they were socially and emotionally part of the family, and therefore viewed each other as kin and likely to come to each other’s aid.

We extracted all recorded non-accidental deaths resulting from murder or fights. Any deaths that occurred in large-scale battles outside Iceland were excluded. In some cases, two individuals were involved in the death of another. If there was no clear indication of who dealt the mortal blow and the saga itself is silent on the matter, both individuals were considered responsible for the death. Since both individuals took part in the action, they both ran the risk of revenge killing from the victim’s family. This makes the total number of killer–victim pairs 162 despite the number of victims being 153. For each killer and victim, we determined the total number of kin out to cousins ($r = 0.125$) that were listed on the pedigree, including both genetic and affinal kin. Even though we could identify foster kin out to cousins, only three categories of foster kin were included (foster-fathers, foster-sons and foster-brothers), since these are the only categories mentioned by name in the sagas and appear to be the only ones regarded as socially and emotionally significant. Finally, we also distinguished between maternal and paternal kin where these could be identified.

### 3. Results

A total of 153 individual deaths which were the result of the intentional actions of 66 individual killers were recorded. Of the 1020 individuals listed in the pedigree, no less than 15% (18.5% of all adult males) were killed by another member of the community. The number of victims per killer was not evenly distributed, however: 29 individuals (44%) were multiple killers and, of these, six killed more than five times, of which three were involved in the deaths of 16, 17 and 19 victims, respectively (Fig. 1).

Overall, killers had significantly more kin than victims (Fig. 2). We show a boxplot here to give a sense of the overall distribution in the two cases. The difference is highly significant (mean number of kin: $16.4 ± 11.9$ vs $5.8 ± 8.8$; $F_{1,322} = 82.72, p < 0.0001$). Of the 66 killers, 10 (14%) had no recorded kin, while 51 of the 153 victims (32%) had no recorded kin. Of the 51 victims who lacked kin, six were foreigners or slaves brought from Ireland, five were killed abroad, three were introduced in the sagas using only their first names (indicating their lack of social importance) and four were only distantly related ($r < -0.125$) to other members of the community. Of the 10 killers who had no known kin, seven killed only once (and all their victims lacked recorded kin). If we discount all cases where either the killer or the victim had no recorded kin, the results are still highly significant (mean kin $17.8 ± 11.0$ vs $8.7 ± 9.5$; $F_{1,258} = 44.31, p < 0.0001$).

Of the 153 victims, none were related to their killer at the level of cousin ($r = 0.125$) or closer. One victim was, however, an affine (sister-in-law) of her killer. Foster kin were the most numerous type of close kin to be killed (a foster son and two foster brothers) (all the result of a love triangle central to the story in the Laxdaela Saga). Of the complete sample of 1020 individuals as the reference population, killers were significantly more likely to kill non-kin than either biological kin ($\chi^2 = 282.7, df = 1, p < 0.0001$) or affines (in-laws) ($\chi^2 = 22.3, df = 1, p < 0.001$). This was not, however, true of foster relatives ($\chi^2 = 3.33, df = 1, p = 0.068$), though the sample is much smaller in this case.

For the 162 killer–victim pairs, the killer had more kin of all kinds than the victim in 120 cases whereas the victim had as many or more kin in only 42 (including 10 ties, of which seven had no kin in either case) (excluding ties, $\chi^2 = 37.6, df = 1, p < 0.0001$). Considering only biological kin, killers had more kin than victims in 105 cases while victims had as many or more in 57 (including 14 ties) ($\chi^2 = 14.2, df = 1, p < 0.001$). Weighting biological relatives by their estimated degree of relatedness, $r$, to the individual concerned, killers have a higher...
average kin degree in 117 cases while victims are higher in 36 cases (with 9 ties) ($\chi^2 = 42.9$, df = 1, $p < 0.0001$).

Since side of family might be important, we repeated this analysis considering paternal and maternal kin separately. Killers had more paternal biological kin than victims in 101 cases while victims had as many or in more in 61 cases (with 37 ties, including the seven with no kin at all) ($\chi^2 = 9.9$, df = 1, $p < 0.01$). The mean number of paternal kin was significantly higher for killers (3.05) than victims (2.2) (Wilcoxon matched pairs test, $Z = -2.17$, $p = 0.03$). Killers also had more maternal biological kin than their victims in 115 cases while victims had as many or in more in 47 cases (with 32 ties) ($\chi^2 = 28.5$, df = 1, $p < 0.001$). The mean number of recorded maternal kin was 2.74 for killers vs 1.17 for victims (Wilcoxon $Z = -3.56$, $p < 0.001$). Killers had more affinal kin (in-laws: since all killers were male, by definition on the female side) than their victims in 109 cases while victims had as many or in more in 53 cases (with 32 ties, including seven with no listed affines at all) ($\chi^2 = 19.4$, df = 1, $p < 0.001$). The mean number of affines differed significantly between killers (2.35) and victims (0.7) (Wilcoxon $Z = -5.48$, $p < 0.001$).

Six individuals who feature prominently in the sagas were responsible for almost a third of all the deaths. Since these individuals are central figures in the sagas, it may be that their pedigrees are more fully recorded, and hence they may have biased the results. Reanalysing the results without these six individuals yields a total of 60 killers and 84 victims, in 91 killer–victim combinations. For all categories of kin, killers had more kin in 57 of the cases while victims had as many or in more in 34 cases (including nine ties; $\chi^2 = 5.8$, df = 1, $p = 0.05$). The average number of all kin differed significantly between killers (9.72) and victims (6.68) (Wilcoxon $Z = -2.699$, $p = 0.007$). Similarly, killers averaged 7.18 biological kin, whereas victims averaged 5.39 (Wilcoxon $Z = -2.28$, $p = 0.022$).

Fig. 3 plots the numbers of kin that killers and victims had against the number of times an individual killed killer. There is a significant positive relationship between the total number of kin that a killer had and the number of times he killed ($r = 0.343$, $N = 67$ individual killers, $p = 0.005$), whereas the number of kin that the victims had is unrelated to the number of murders their killer committed ($r = -0.140$, $N = 162$ individual victims, $p = 0.076$). The difference in number of kin between killers and their victims increases linearly with the number of victims ($r = 0.516$, $N = 162$ killer–victim pairs, $p < 0.0001$). An analysis of variance comparing those who only killed once, those who killed 2–4 times and those who killed more than four times, confirms that the difference in number of kin are significant even when controlling for killer identity ($F_{1,154} = 17.05$, $p < 0.0001$), with killer identity not having a significant independent effect ($F_{1,158} = 3.32$, $p = 0.070$) and all pairwise comparisons significant (Sheffe post hoc tests, $p \leq 0.031$). These results suggest that the more violent a killer, the more likely he was to target victims with disproportionately fewer kin. Doing so both insured that the odds were in his favor and greatly reduced the risk of retaliation. Only those who killed once did not have significantly more kin than their victims (though, on average, even they had slightly more kin), perhaps because their murders were less calculated and more often spontaneous responses to insults or casual attacks.

A more serious potential source of bias in these data is the fact that killers obviously survived longer than their victims and so had an opportunity to sire offspring after the event in question. Because we cannot define time sufficiently precisely in the sagas to know whether individual killer’s offspring were born before or after a particular event (or more importantly, if born before the killing, whether or not they were adult by the time of the event and so able to take a meaningful part in any subsequent proceedings), killers’ kinship tallies might have been inflated. Indeed, killers had significantly more offspring than victims (means of 0.97 vs 0.38, $F_{1,217} = 7.69$, $p = 0.006$). Although it is unlikely that a difference between killers and victims in total number of kin (on average, about 8.2 kin) could be made up solely by offspring sired after the murder (especially given that the average number of offspring across all killers and their victims was just 0.56), this might nonetheless have an effect on the results. Omitting offspring from the calculation still yields a significant difference in the net number of all kin in favor of killers (means of 10.98 vs 5.04, $F_{1,217} = 15.38$, $p < 0.001$; excluding foster kin: means of 9.73 vs 4.91, $F_{1,217} = 15.86$, $p = 0.001$).

Killers and their victims are plotted in an extended kinship network using Netdraw ( Borgatti, 2002) in Fig. 4. With a density (the proportion of all possible dyadic connections that actually exist) of 0.0169, the connectedness of the network was in fact low, indicating that most individuals were connected to each other mainly through a small number of intermediates. In total, there were 607 kinship ties in the graph. Of these, 162 were killer–victim relations – rather more than would have been expected by chance. Some individuals had many kin ties, and many of these turn out to be a number of highly connected killers in central positions in the network. In effect, killers were related to other killers. It is also interesting to note that most affinal ties are between killers rather than between victims, suggesting a significant degree of cooperation between affinal relatives in feuds. However, many of the victims of the 34 multi-killers were also related to each other, suggesting that these multi-killers were often involved in vendettas against specific families.

4. Discussion

Our sample of known individuals drawn from three Icelandic family sagas indicated relatively high rates of mortality: around 18% of all adult males in the sample died at the hands of other members of their community. Archeological data suggest similarly high rates of mortality from violence, especially among men, in other historical populations over the past 12,000 years (Bowles, 2009; Firth, 2012; Meyer, Lohr, Gronenborn, & Alt, 2015). The pattern of killings in our study is in line with previous findings with narrower samples from other sagas (Dunbar et al., 1995; Johnson & Johnson, 1991): no killer–victim pairings involved close relatives. Our main interest, however, is with the size of kinship groups because these index the risk of revenge killings. The analyses we present confirm that victims had fewer kin than their killers, and this was true whether we counted only biological kin, only affines, only paternal kin or, within the limits of the data, only maternal kin, or all kinds of social and biological kin combined. This may not, however, be true for foster kin (who share no genetic interests at all), though the sample sizes are obviously much smaller in this case. We cannot say whether non-kin allies also played a role in these
calculations, but if they did it is clear that their effect was not sufficient to alter the main conclusion here, namely that kin count. That the difference in number of kin increases with the number of victims a killer was credited with suggests that the more successful killers may have been calculating the odds in their favor more carefully. Those who killed only once were least likely to have more kin than their victims, possibly because these cases occurred more often in the heat of the moment. Finally, the analysis of the network of kinship connections suggests that frequent killers (i.e., those who killed more than once) were more highly interconnected by descent or, especially marriage than their victims were, further indicating that killers targeted individuals who were less well connected in the wider community. There was, nonetheless, some suggestion that killer families targeted particular families as victims, suggesting either vendettas or deliberate attempts to dispose of rival claimants to land.

More importantly, our results suggest that Lanchester’s Law (that success is correlated with having overwhelming odds on one’s side) may apply not just to the size of ‘war parties’ but also to the size of the protagonists’ kinship groups and the background threat that these imply. In effect, it is dangerous to mess with those who can call on large support networks after the event, not just those who bring large numbers of allies to the battlefield on the day. Indeed, the sagas themselves note that people with a large number of social connections are more dangerous as opponents, while commenting that a person without any kin or friends could be killed without fear of retribution (Miller, 1983). Of particular note is the fact that the disparity in kin group size between killer and victim increased with the number of murders that the killer perpetrated. The more often an individual killed, the more likely he was to ensure that his victim had fewer kin to call on than he did, perhaps because the victims’ families were thereby more likely to opt for blood money compensation rather than a revenge murder (Dunbar et al., 1995). An alternative possibility is that first time killers who got it wrong did not often get the chance to kill again.

Most conflicts arose over competition for resources (mainly land), and killers thus disproportionately targeted unrelated lineages, often with the explicit intention of acquiring their farms. Indeed, much of the Egil’s Saga is devoted to the machinations whereby the eponymous Egil Skallagrímsson deliberately targeted individuals whose land he could acquire. If the many irritations of living in close proximity had been the cause of violent behavior, then kin should be targeted disproportionately because kin are more likely to live on the same farm or nearby (and most described non-violent interactions were with kin). The finite amount of arable land in combination with the strict inheritance system (see ESM) was likely to put close kin in conflict with each other for the same resources. In a sample that, as in the present case, spans six generations, there would have been numerous instances where an inheritance was divided between kin and hence became the source of conflict. Yet not a single close biological relative (r ≥ 0.125) was killed in a dispute over land in any of the sampled sagas. The fact that kin experienced hardly any lethal conflict (see also Dunbar et al., 1995) compared to unrelated individuals suggests that killers were not simply flailing out in frustration at those around them, but rather deliberately targeting individuals whom they might defeat with minimal cost so as to maximize the benefit to themselves.

The fact that affinal kin were spared just as much as biological kin adds further support for Hughes’ (1988) argument that affines may be as relevant to an individual’s decisions as their biological kin because affines share a genetic interest in the offspring generation. This may become especially important in humans where the wider kin circle acts as a lineage-based alliance for protection against both raiding by con-specifics and predators (Lehmann, Lee, & Dunbar, 2014). Indeed, the sagas commonly observe that affines had as great an obligation to exact revenge on behalf of their in-laws as biological kin did (Byock, 2001). Somewhat analogous findings have been reported from at least one Amazonian Indian tribal society, where lethal raids on other communities (in many cases for the purpose of acquiring women) typically involved prospective brothers-in-law who were living in the same village (Macfarlan, Walker, Flinn, & Chagnon, 2014).

The sample of foster kin was small, but the limited data available suggest that foster kinship may not have exempted individuals from being killed. Men fostered the offspring of their close (biologically unrelated) allies, usually as a way of cementing the alliance between them. It
is clear from the sagas that the relationships between foster parents and their foster children, and between foster siblings, could sometimes be as emotionally close as that between biological relatives. However, the fact that foster kinship was relatively rare compared to more conventional kinds of kinship relationships might suggest that the usual mechanisms of psychological closeness are not so easily triggered. Because foster parents were often lower ranking than the families of the children they fostered (Byock, 1982), it may be that power relations between the families sometimes undermined the psychological mechanisms that might otherwise protect relationships based on growing up in the same household. The fact that, in contrast to affinal kinship, foster kinship did not seem to protect an individual suggests that the element of indirect biological relatedness among affines (via their common genetic interest in the offspring generation) carried more weight than purely social kinship, despite the deep psychological affiliations often present in foster relationships. In this respect, foster relationships may be functionally more similar to friendships (Burton-Chellew & Dunbar, 2011).

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