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The monopolisation of violence: booms and busts of prehistoric violence linked to social inequalities

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Research Article

Keywords: violence, social inequality, European prehistory

Posted Date: August 16th, 2024

DOI: https://doi.org/10.21203/rs.3.rs-4904279/v1

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Additional Declarations: The authors declare no competing interests.

Main Manuscript for

The monopolisation of violence: booms and busts of prehistoric violence linked to social inequalities

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Abstract

In a study on the occurrence of trauma in prehistoric graves in Central Europe, evidence of violence over a period of more than 6000 years is presented diachronically for the first time. Ups and downs in the trauma sequence are recognisable in over 23,000 graves. Comparing it to our proxies for social organization of prehistoric societies, an inverse relationship appears: the higher the levels of social inequality are the lower are the signals of violence. We interpret this as an expression of a monopolisation of violence through political power. In addition to fluctuations in the intensity of violence, the long-term trend indicates an overall reduction in violence at least until the early modern period.

1 Introduction

The question of the extent to which interpersonal violence - in the sense of armed conflict - can be recorded in prehistory is linked to a philosophical and socio-political discourse that can be traced back to the Enlightenment. In this phase, the debate focused on whether the emergence of complex forms of organisation (such as states) marked a reduction in violence (Hobbes 1651, cf. Hobbes and Smith 1965) or if there rather was a shift from the “peaceful noble savages” to more violent and complex societies (Rousseau 1755, cf. Rousseau and Meier 1984).

This question has led to numerous studies in the anthropological and archaeological fields. These include holistic opinions on the origins of war (Keely 1996; Turchin 2006; Lee 2007; Pinker 2011; Ferguson 2013) and fundamental definitions of "violence" (e.g. Galtung's definitions relevant to the UNO (Galtung 1969)), as well as empirical studies on the violent behaviour of different socio-economic social formations. For example, observations and statistics on violence in acephalous or only weakly socially differentiated horticultural societies in New Guinea initially led to the assumption that the degree of injury in non-industrial and non-state societies would be extremely high even if ritual violence was taken into account (Keely 1996), later corrected (by Roscoe 2009).

Despite numerous studies have dealt with the occurrence or evidence of violence at individual sites or in specific periods, the first attempt to diachronically examine taphonomic evidence of violence on skeletons was made in 2007 (Peter-Röcher 2007). H. Peter-Röcher came to the conclusion that the relative number of victims of violence tended to increase from the Neolithic to the modern period in Central Europe.

Since then, more detailed studies taking into account more precise bioarchaeological methods for identifying interpersonal violence became available, as well as a more structured discussion on the terms "warfare", "genocide", structural and real violence. The definition and role of “warriors” in prehistory also played an increasing role in the debate (Jeunesse 2014; Harding 2007; Vandkilde 2006). It is worth mentioning some studies focusing on specific time periods or transformation phases of human societies, such as the levels of violence during the shift to a sedentary farming economy in NW Europe (Fibiger et al. 2023) or during the Bronze Age (Vandkilde 2011). Besides these large scale accounts, there are also studies of individual biographies of violence or the so-called mass finds with traumata (e.g. Sparacello et al. 2023; Schroeder et al. 2019; Furholt et al. 2023). Moreover, in order to get a clearer picture on how and what kind of violence was performed in different periods (feud, war, ritual), non-anthropological parameters such as the frequency of fortifications or weaponry, are increasingly being taken into account (Kneisel et al. 2024).

As a supplement to previous empirical studies, we present here for the first time a study that presents and interprets diachronic trauma data from Central Europe and neighbouring areas (Fig. 1; Supplement 1). Trauma frequency is primarily recorded for the more than 6000 years between the Mesolithic and the Pre-Roman Iron Age. This makes it possible for the first time to discuss the frequency of violence during very different transformation phases: the Neolithisation, the introduction of bronze and iron technology, the emergence of oppida and proxies of social differentiation. The inclusion of data up to the pre-modern period also enables a general historical discussion of the observed phenomena.

Besides the variation in the rate of traumas, we also discuss variation in their appearances, which allow recording the character of the injuries and discussing them in relation to changes in the use and type of weapons, as well as in relation to age and gender distribution. Finally, the results are discussed in relation to other aspects - demography and migration, economic and social development, ritual changes.

2 Data Sources

Based on published archaeological and anthropological data (References: Supplement 1), information on more than 23,500 buried individuals was compiled for Central Europe. 316 sites with individual graves, grave groups, collective graves, mass graves and cemeteries with usable anthropological investigations were recorded (Fig. 1). Of these, 23606 individuals were recorded. Trauma was observed in 859 individuals (Tab. 1). Other excavated graves for which no anthropological analysis is available were also summarised. Corresponding values can be used for other calculations.

In addition to location and chronological classification, the recorded age and sex were recorded for each site, the total number of injuries noted and the body parts they occurred. The human body is divided into head, arms, shoulders, torso, pelvis, thighs, lower legs, hands and feet. The type of injury is recorded for each injured body part: Slash injury, impact injury, fracture, shot injury, cut injury, trepanation, head severed and burn injury. Whether the injury is healed or not is also recorded.

Due to the relatively small number of documented sites older than 5500 BCE and the concentration on pre-Christian prehistoric burials, the database can be used primarily for the 5500-200 BCE period. The trends obtained are then compared with measures of social inequality based on edited studies on graves and settlements (cf. Marzian et al. 2024; Duffy et al. 2024).

3 Methods

Three different analyses were chosen for the investigation of the trauma sequences: first, the sequences were calculated for all available individuals divided into 200-year time slices (A), grouped by site (B) and by the type of weapon responsible for the traumas were investigated (C).

(A) *Comparison by time slices across Central Europe.* The sites were assigned to a 200-year time slice using the mean value of its dating range. Only the time slices with a number of individuals above 50 were considered. The proportion of traumas per time slice was calculated and plotted for visualisation purposes on the 5500-0 BCE time axis. Secondly, a smoothing spline (SS) is fitted to the data in order to find a temporal relationship on the variation. The same approach was also tested on an extended version of the data series including the 5500 BCE - 1800 AD time frame. SS is a statistical method used to assess the relationship between a predictor (X variable, here time) and a variable (Craven and Wahba 1979; Berry and Helwig 2021), in our case trauma. As the relationship is assumed to be non-linear a linear regression would not be able to capture the variation in the dataset. SS allow for a piecewise polynomial regression (binomial, cubic or quintic) and different parameters were tested (Craven and Wahba 1979; Berry and Helwig 2021). The results shown in this paper are the ones maximising the adjusted R2 (coefficient of determination). The function was calculated in R language and environment for statistical computing (R Core Team 2024) using the ss function from the npreg package (Helwig 2024). In particular, the parameters that proven to be more determinant in the fitting of the SS were the number of knots and the penalty order. In all cases where the SS was applied, the best penalty order was m = 2, meaning that the best fitting function was a cubic one. The knots are fixed points where the function is "connected" (aka, points where it is forced to pass). These can be set manually (x,y coordinates) or their number could be specified (Berry and Helwig 2021). The maximum number of knots is set to the number of observations. However, this value would in most cases represent an over fitting of the data and here we aimed at minimising its value whilst maximising the R2. A final variable that has an impact in the SS is the smoothing parameter (λ). Smaller values (tending to 0) would result in a spline very close to the actual data points, potentially causing an over fitting, whereas higher values would cause higher smoothing which potentially under fits the data (Berry and Helwig 2021). Here, an intermediate default value is used, which is calculated using a generalised cross validation criterion (Helwig 2024).

(B) *Comparison by time slices on a site basis*. In order to determine the possible range of variation of the trauma proportions in the time slices, the relative trauma proportions were calculated. Based on the site allocation to 200-year time slices, boxplots were generated in which quartile values and outliers represent the relative trauma differences of the sites, classified in the time slice sequence 5500-200 BCE. Here too, a smoothing spline with a confidence interval of 95% was calculated, using the same method described in §3(A). Extreme values with 0 or 100% trauma were excluded, as they have a very small number of documented individuals (less than three) or represent sites with "special biographies" (mass burials). As we did for §3(A), the same approach was used for an extended period, notably 5800 BCE - 1800 AD. However, when interpreting it caution is required, especially for the Mesolithic, due to data scarcity and patchiness.

(C) *Armament types, gender and age, healing rates.* To evaluate the character of the injuries, the relative values of the type of injury per site were used as variables for a correspondence analysis. In a second step, the chronological development of injury differences was taken into consideration. The

findings are then discussed in terms of the type of weapon used, the age and gender composition of the victims, the death and healing rate of the injuries.

Evidence of trauma in skeletal findings does not necessarily indicate interpersonal violence (cf. (Peter-Röcher 2007; Fibiger et al. 2023). For instance, it has been shown that rib fractures in non-industrialised societies tend to indicate accidents if not associated to other injuries. For this reason, if they were the only injury on the individual they have not been considered as violent trauma. As not every altercation leads to a visible injury to the skeleton, the trauma frequency only represents a minimum value for injuries caused by violence, an aspect that needs to be accounted for.

4 Results

The analyses of the trauma sequences reveal various tendencies, the significance of which must be discussed in depth:

• *Variation*: The relative trauma rates vary considerably in space and time and between sites, with very low to extremely high rates.

• *Booms and busts*: Even if there are some very high trauma rates as early as the Mesolithic, a steeper increase can be observed during the first centuries of the Neolithisation. Nevertheless, the ups and downs of the trauma rate, with very high values around 4100 BCE, 2500 BCE and 900 BCE, and relatively low rates around 3300 BCE, 1900 BCE and 500 BCE, seem more decisive to us as these fluctuations can be related to social changes.

• *Violence organisation*: Both changes in the type of weaponry and differences in the demographic composition of the victims of violence point to changes in the organisational forms of violent conflicts.

• *General reduction*: Despite the considerable fluctuations in the trauma rate, there is a linear decrease in violence from the Mesolithic to the pre-modern period.

4.1 Variation, and Booms and Busts

The trauma proportions vary considerably both within the individual time slices and per site. From 5500 - 300 BCE, the fluctuations in the time slices are between ca. 30% and 1 % (Fig. 2-3). With the onset of Neolithisation in the Central European loess areas, the proportion of trauma increases from very low values (ca. 2% between 5500-5300 BCE) to average rates of just below 10% between 5300 - 4500 BCE. Although the data are somewhat patchy thereafter, a further increase to very high trauma rates (ca. 30%) around 4100 BCE can be noted with the Neolithic development and last Mesolithic groups, which are also similarly visible in the centuries up to ca. 3700 BCE in sites that were not included in Fig. 2 due to their small number of individuals. A further decrease in trauma rates is recognisable around 3300 BCE, in the Late Neolithic societies (ca. 6%). And is followed by a continuous increase to medium to high trauma values, which can be associated to the Final Neolithic development up to a trauma rate of 18% during the 2500-2300 BCE. After this peak, values fall again to low values around 1900 BCE (4%), only to level off again at intermediate values by 1300 BCE (8%).

The results between 1000 BCE and 200 BCE are not conclusive, as the fluctuations visible could be attributed to statistical variance of the data or a real pattern, depending if we use the individual time slice data (Fig. 3), or a general variance with slight fluctuation rates in the medium trauma range (Fig.

2). Nevertheless, the observed increase in trauma to almost 15% around 700 BCE, followed by a drop to 5% by 500 BCE and the renewed increase to more than 8% by 300 BCE (Fig. 3) are remarkable and in need of further explanation.

The evaluation of the data on a site basis confirms and extends these results (Fig. 4). Although the high variance in trauma frequency between individual sites within the 200-year time periods is clear, we recognise a first increase in trauma rates between 5500-4700 BCE, which remain high until the 4100-3500 BCE time frames. This is followed by generally lower values between 3300-2900 BCE and a further considerable increase between 2900-2500 BCE. The period 2100-1500 BCE is characterised by an initial reduction in the average trauma rate per site, with a minimum reached around 1900 BCE and then a renewed increase between 1700-1500 BCE. In the subsequent Late Bronze Age and Pre-Christian Iron Age, lower rates per site are indicated, whereby the observable fluctuations in the quartile ranges also seem to confirm the developments mentioned above. In the summarised representation of the site-related trauma rates some general patterns are evident (Fig. 5). In particular, the low trauma rate in the Early and Middle Neolithic (5500-4400 BCE), the peak around 4300-4100 BCE with some fluctuations within a general decreasing trend until ca. 2900 BCE, followed by a renewed rise up to 2500 BCE and another drop until ca. 1900 BCE. After this period, the fluctuations in the curve are not statistically significant.

A summary of the trauma rates per time frame are shown in Table 2. Although there is a restriction in the spatial breadth of the results at the beginning and end of the analysed period, the sequences from low to medium to high trauma rates and from low to high can be recognised.

4.2 Violence organisation

The age and gender composition of the victims can provide an important indication of the organisation of violent confrontations. It is not surprising that in all periods the 20-40-year-olds in particular are covered by injuries, as they are certainly the most vital age groups and those involved in interpersonal actions. It is striking that in the Neolithic and Early Bronze Age all age groups, including children and older people, show injuries. For periods with a proven military system, i.e. from the Roman Empire to the Middle Ages, the age ranges Mature (40-60 years) and Senile (60-80 years) are also increasingly represented.

Male and female individuals with injuries are relatively equally represented in all time periods. It was only in the Middle Ages that the number of males increased in comparison to females. Obviously, acts of violence in the Neolithic tended to take place in smaller groups, in which not everyone necessarily fought, but men, women and children were all victims. In contrast, from the introduction of the military, conflicts were fought in led formations. Combat operations and the military are characterised by the physical separation of soldiers from women and children (Fößel 2020, 9). With the emergence of standing armies at the end of the 17th century, the military developed into a clearly demarcated place for men. As a consequence, it is clear that before the Roman Empire there was no separation between a military system and the rest of the population in Central Europe.

The type of injury certainly is related to the weapon used, which are dependent on the time period. For this reason, in the correspondence analysis, the types of injury are organised chronologically from the Neolithic to the Middle Ages - with the exclusion of fractures, which always occurred.

Changes in the number and type of injuries over time can be observed (Fig. 2). On the one hand, this reveals differences in violent acts in different time periods. On the other hand, this can sometimes be linked to the use of different weapons.

The traces on the skeletons were categorised into different types of injury during the examination. A distinction is made between slash, blow, stab, shot and cut injuries as well as fracture, head severed, trepanation and burn injury.

In the Mesolithic, slash wounds and head severances dominate. The category of severed head occurs most frequently over time, with over 20 individuals in the Mesolithic. The fact that these occur more frequently can be due to the inclusion of the skull nests from the Great Ofnet Cave in Bavaria in the dataset, which may represent a bias. Severed heads were discovered in the skull nests, with some showing clear slash injuries (Orschiedt 2015, 99). In this context it is not possible to speak with certainty of an act of interpersonal violence, as a complete reconstruction of the events cannot be carried out due to the absence of the postcranial skeleton. This period also has a few fractures, as well as isolated shot wounds, cuts and blows. These occur in such small quantities that no representative statements can be made about acts of violence.

In the Neolithic, the occurrence of injuries changed. Fractures dominate with over 120 injuries. In the study of skeletons, a distinction is made between different fracture types, which can be differentiated on the basis of characteristic detailed features (Wahl 2014, 35). In the present statistical analysis, however, fractures are presented in generalised form on the basis of the data. The fractures discovered on the skeletal remains can be interpreted in different ways. For example, they may have been caused by accidents and are therefore not necessarily an indication of violence or armed conflict. In connection with fractures, the age of the injured person is also not insignificant, as the elastic deformation capacity of bones decreases significantly with advancing age (Wahl 2014, 36). Localisation on the skeleton therefore plays an important role when examining fractures in relation to the effects of violence. For example, parry fractures indicate a blow to the arm, which was held protectively over the head as a defence. Fractures that lie above an imaginary hat brim can be explained by an act of violence. In the Neolithic, these fractures could have been caused by everyday tools such as antler axes, hoes or stone axes that were used as weapons (Lidke 2005, 63).

In addition to fractures, the Neolithic period was also characterised by blows and slashes. The impact injuries are categorised as blunt force trauma. This type of violence may have been carried out in the Neolithic using wooden clubs or clubs with axes (Dyer and Fibiger 2017, 1524). Slashing injuries differ from blows in that they are inflicted with a sharp, heavy tool equipped with at least one cutting side (Madea et al. 2003, 125). In the Neolithic, this type of injury was probably caused by axes or hatchets. Furthermore, in comparison to the other periods, the Neolithic saw a relatively high number of shot wounds caused by bows and arrows. However, it is not clear whether the shot wounds were caused by accidents while hunting or by deliberate acts of violence with lethal intent. In general, however, it can be stated for the Neolithic that there were probably interpersonal acts of violence and that the existing tools were used for this purpose.

From the Bronze Age onwards, clear changes in the number of injuries can be recognised. In the Early Bronze Age, as in the Neolithic, fractures, blows and slashes were the most common types of injury. Nevertheless, a clear decline in the number of injuries can be recognised. For the Middle and Late Bronze Age, it could be assumed that the emergence of the first swords – a weapon primarily designed for interpersonal conflict - from the 17th century BCE also led to an increase in stabbing

and slashing injuries. However, it can be seen that the number of all types of injury decreases significantly, especially from the Middle Bronze Age onwards (Fig. 7). This could be interpreted as an indication that the emergence of warlike weapons alone does not necessarily increase the potential for violence. The earliest swords can therefore be attributed a social and cultic aspect in addition to their weaponry function (Schulz 2005, 221; Sperber 1992). Additionally, the appearance of defensive weapons and an increase in fortifications might have lowered the chance of conflicts with injuries and combats (Kneisel et al. 2024).

With the beginning of the Iron Age, the picture of the number of injuries slowly begins to change. Although there is a slight increase in the number of injuries such as slashes, blows and shot wounds, fractures continue to dominate and increase significantly, especially in the Latène period. A significant increase in slash injuries can then be recognised from the Roman Imperial Period onwards. While there are still 7 traces of slash injuries in the Latène Period, 51 date to the Roman Imperial Period. Furthermore, all other types of injury, which can be explained primarily by violent actions, increased slightly in comparison to the Latène period. This could be explained by the introduction of the military system and the standardisation of weaponry in the Roman Imperial period and a different type of combat, centred around the use of slashing weapons.

In the following period, the increasing development of chop injuries continued. The Middle Ages is the first period in which slash injuries dominate and occur more frequently than fractures. In general, an increase in injuries can be recognised in the Middle Ages. The number of stab wounds and gunshot wounds almost doubles compared to the Roman Period and the Middle Ages. The number of cuts also roughly tripled. From this it can be concluded that the Middle Ages represent a period in which more acts of violence occurred. This hypothesis could be supported by medieval written sources. These often give the impression of constant feuds, wars and raids (Ohler 2000, 2). In contrast, there is little or only indirect mention of people living together peacefully. The conflicts between the various powers also led to a qualitative and quantitative development of weapons. Longbows and crossbows served as dangerous long-range weapons, but close combat with swords dominated, which would also explain the large number of slash wounds. In addition, firearms gained in importance in the course of the 15th century (Ohler 2000, 4), which would explain the increase in shot wounds.

In the Mesolithic, tools and hunting equipment were used as weapons in interpersonal conflicts (cf. Mahlsted in print). Everyday tools were used as weapons also during the Neolithic period. This changed with the beginning of the Bronze Age with the introduction of the sword, the first tool made specifically for combat. The majority of Bronze - and later on Iron - Age warriors, however, were equipped with spears, clubs, and bows and arrows. Warriors began to be uniformly armed with spears and shields whereas the sword still seems to indicate the hierarchy among the warriors. However, there is a clear change in fighting techniques, as other cutting weapons appear to have become more important. This trend continued in the Roman Imperial period. At the same time, the introduction of the Roman military system led to a standardisation of weapons. The sword, spear and lance were predominant. During this period, the Germanic tribes mostly continued to arm themselves with spears and shields. This continued during the Middle Ages, although with modified technology. Slashing combat was now the favoured method of fighting. The sword became increasingly important due to the mounted warriors.

However, the injuries observed clearly show that the weapons used have been professionalised. The changes in the types of injury can therefore be attributed to changes in weapon technology and fighting techniques.

4.3 General reduction

Taking into account the data up to the pre-modern period and the limited data available for the Mesolithic, the overall development of the trauma rate can once again be assessed from a broader diachronic perspective. Fig. 6 (time slices) shows how, after an increase in the rate of violence up to around 4100 BCE, it decreases - in waves but continuously - until around 1800 CE. The peaks of the "waves" correspond to the "peaks" and "falls" described above, which also continue in historical times. Fig. 10 uses the mean values of the sites as parameters, so that Mesolithic data can also be included. Here the picture is not as clear-cut as before, but the higher and lower peaks before 5500 BCE cannot hide the fact that a high level of violence can be observed again in the Neolithic, with the unsteady curve levelling off into the modern period. This picture is confirmed once again by the inclusion of all the sites: Fig. 11 reveals a rise in the violence curve until around 2500 BCE, only to fall steadily until around 1800 CE. The problem lies in the evaluation of the Mesolithic data, which mostly represent special forms of burial. Whether the proportion of violence actually increases with Neolithisation compared to the Late Mesolithic, remains to be analysed. However, we can clearly recognise the reduction in the potential for violence from the Neolithic to the modern period.

5 Discussion

5.1 Rates of violence and archaeological background

The results presented here point to significant changes in the intensity of violence in prehistoric Central Europe and neighbouring areas. The data for hunter-gatherer societies before 5700 BCE are the most uncertain due to their sample size and composition, which is why they were excluded from the main results. There are indications of greater variability if findings such as the large Ofnet cave with 33 skulls of different sexes and ages can be evaluated in contrast to documented individual burials without trauma evidence, e.g. Schöpsdorf or Bettenhausen (Grünberg 2000, 29-55). However, if we correctly evaluate the findings shortly before or during the Neolithisation of Central Europe, there are indications of an increase in the frequency of violence from low to medium values. The Mesolithic cemetery of Vedbæk, Denmark, for example, has no evidence of violence (Grünberg 2000, 27-29), whereas these occur in almost all Linearbandceramic cemeteries.

A detailed study on the occurrence of violence in north-western Europe also came to similar conclusions (Fibiger et al. 2023). However, the corresponding "violence curve" does not only level off at medium values in Early Neolithic Linearbandceramic societies, but also in societies of the beginning of the 5th millennium BC (e.g. Lengyel: Zengövárkony, Hungary (cf. Lichter 2001) Friebritz I, Austria (cf. Neugebauer-Maresch and Teschler-Nicola 2006)). From our point of view, the Linearbandceramic communities, for example, are acephalous societies with very little social differentiation and which, at the end of their development, find themselves in an institutional crisis that increasingly leads to feuds with group violence (cf. Fontijn 2021; Furholt et al. 2020; Lüning 2000). On the other hand, ethnographic studies show that complex foragers in particular exhibit greater inequality in the distribution of wealth than is the case with horticulturalists (Smith et al. 2010; Gurven et al. 2010).

There is at least a statistically relevant peak in evidence of violence around 4100 BCE and other data point to correspondingly high values from 4300-3700 BCE. These include Münchshöfen and Michelsberg (Großmehring, Ilsfeld, Bruchsal-Aue.- cf. Lidke 2005; Schröter 1997; Wahl 1999) but also the Mesolithic (Henriksholm/Bögebakken (Vedbaek).- cf. Grünberg 2000, 9-14) or Jelšovce near Nitra (Ludanice group.- cf. Pavúk and Bátora 1995). The conspicuously very high values are probably related to the onset of Neolithisation in north-central Europe and southern Scandinavia, the changed social conditions in southern central Europe with changing ideologies (Michelsberg) and the introduction of copper metallurgy. Just as the peak of enclosures in the Linearbandceramic can be interpreted as an indication of an increased, perhaps ritual, need for security, this is probably the case with the large and numerous Michelsberg enclosures (Klassen 2014). Reduced levels of violence around 3700 BCE (Figs. 4-5) are associated with the central German Baalberge group (cf. Weideroda-Zauschwitz (Grimm 1976) and the Altheim group (Altheim.- cf. Schröter 1978, 12-14.). Compared to other Younger Neolithic groups, Baalberge is usually assumed to be a more stratified society, which is strongly involved in the regional land development (Müller 2001).

The very low violence values between ca. 3300-2900 BCE are associated with highly organised and differentiated Late Neolithic societies. The trauma values in wall chamber graves in Walternienburg-Bernburg, for example, are very low, as are those in Wartberg gallery graves (cf. Supplement 1). In Central Germany in particular, the diversity of burial and settlement systems points to socially highly differentiated ranked societies: Flat and mound graves for individuals alongside collective graves, but also fortified and unfortified settlements with varying degrees of access to supra-regional networks (Meller et al. 2024; Müller 2001). In contrast, the higher values for the socially comparatively weakly differentiated Globular Amphora phenomenon society possibly refer to the different social conditions (Ketzin.- cf. Ullrich 1971, 52 f.; Müller 2023).

After a certain gap in the data, the considerable increase in evidence of violent impacts ca. 2900-2500 BCE is followed by the reduction in the frequency of trauma around 1900 BCE. We see the first peak in violence in connection with the more individually orientated and less stratified societies of the Final Neolithic Corded Ware with their much-discussed demographic and political changes (increased mobility, increased gender antagonism, cf. Haak et al. 2023). We link the low incidence of violence in the Central European Early Bronze Age with the development of the more stratified Únětice societies, which are associated with both the introduction of tin bronze technology and the first forms of institutionalised control of social differences (Meller 2019, Risch et al. 2021).

Even if the data are not conclusive, an increased rate of violence can be observed for the period ca. 1500-1300 BCE, which seems to be followed by a lower rate between ca. 1100-900 BCE. The corresponding development can also be seen, for example, in the deposition rates of weapons in the Nordic region; here we find fortified sites above all from ca. 1100 BCE onwards (Kneisel et al. 2024) i.e. after the emergence of a more peaceful phase. The extent, to which the higher rates of violence in 900-700 BCE that primarily relate to southern Central Europe, are connected to a reduced social differentiation in Hallstatt C must remain an open question. Obviously, however, it is no coincidence that the reduced occurrence of trauma in Hallstatt D is linked to the development of the socially highly differentiated southwestern German-eastern French Late Hallstatt societies (Fernandez-Götz 2017; Krausse et al. 2016) at the same time. The higher values in the Latène period may also be associated with less stratified societies.

5.2 Comparison with general social development

The comparisons presented above lead to the hypothesis that visible violence is reduced with increasing social differentiation and increases with decreasing inequality. We want to test this using general attempts to quantify social inequalities, which are particularly difficult for non-literate societies.

One estimate that has been extensively used in the literature is the Gini index calculation based on house size variation within settlements. This was recently presented for a part of the geographical area under consideration (Duffy et al. 2024). A compilation of settlement finds with more than 5 houses for Central Europe and neighbouring areas (Supplement 2; Fig. 12) illustrates that a continuous increase in social inequality is to be expected, especially from 2000 BCE onwards. This basic trend towards social differentiation roughly corresponds to the reduced visible violence after 2000 BCE.

For a more detailed chronological differentiation, Gini Index and other calculations are available for Central European burial data from the period 3800-200 BCE (Marzian et al. 2024). The authors assume that the increasing relative proportion of individual burials in burial mounds compared to others in shallow graves is a proxy for the social permeability of societies. With the exception of the period after 300 BCE, the peaks of social permeability (before 3800 BCE; 2800-2400 BCE; 1500-1300 BCE; 800-600 BCE) coincide with the peaks of increased visibility of violence and *vica verse* (Fig. 13). The increased social differentiation in the upper social segment of societies, which can be interpreted as an increased institutionalisation of social role differences, also synchronises with the peaks of visible violence (before 3500 BCE; 1800 BCE; 1100 BCE; 600/500 BCE).

Consequently, we increasingly recognise the connection between the distribution of social power, as expressed in the restriction of relational wealth in the tombs of non-literate societies, and the likelihood of conflict. The tendency towards the dissolution of acephalous societies and the visibility of corresponding differences in the domestic sphere is also striking.

5.3 Long-term perspective

Taking into account the additional data up to the pre-modern period, a decrease in the trauma frequency can be recognised in the overall trend (Fig. 9-11). This is the case both in the total by time slice and at the individual sites. Since the age and sex composition of the victims of violence was explained by the development of a military system from the Roman Imperial period onwards (see above), which led to the separation of soldiers and civilians, this may have led to the overall reduction observed. However, the extent to which these observations are actually true remains to be determined by more intensive studies with a larger database for the period after the turn of the first century CE. The same applies to the relations of violence before 5500 BCE, where possible differences in the Mesolithic with higher rates of violence are indicated (Fig. 10).

6 Conclusions

When analysing human skeletal material, it is important to remember that not every type of injury is a direct indication of violent or armed conflict. In addition, a considerable number of unreported cases can be expected in which no defect can be detected on the bone. Nevertheless, the results represent significant changes that obviously indicate a basic trend.

There are considerable fluctuations in the relative numbers of victims of violence. These fluctuations could be explained in prehistoric times by social changes: the higher the social inequality in a society, the lower the visible rate of violence. There is obviously a shift from visible to structural and cultural violence in the sense of Galtung (1969) e.g. in the Central German Late Neolithic, the Early Bronze Age and the Late Hallstatt period. We understand these processes as a monopolisation of violence, which in part gains in intensity with the development of non-dual weapons in the Final Neolithic and the Bronze Age. The overall historically reduced rate of violence can therefore be attributed to a stronger structuring of societies. Returning to the initial question, a complex pattern of the development of violence emerges, in which, however, the monopolisation of violence leads in the long term to a reduction and thus also domestication of a socially existing monopoly on violence .

Figures

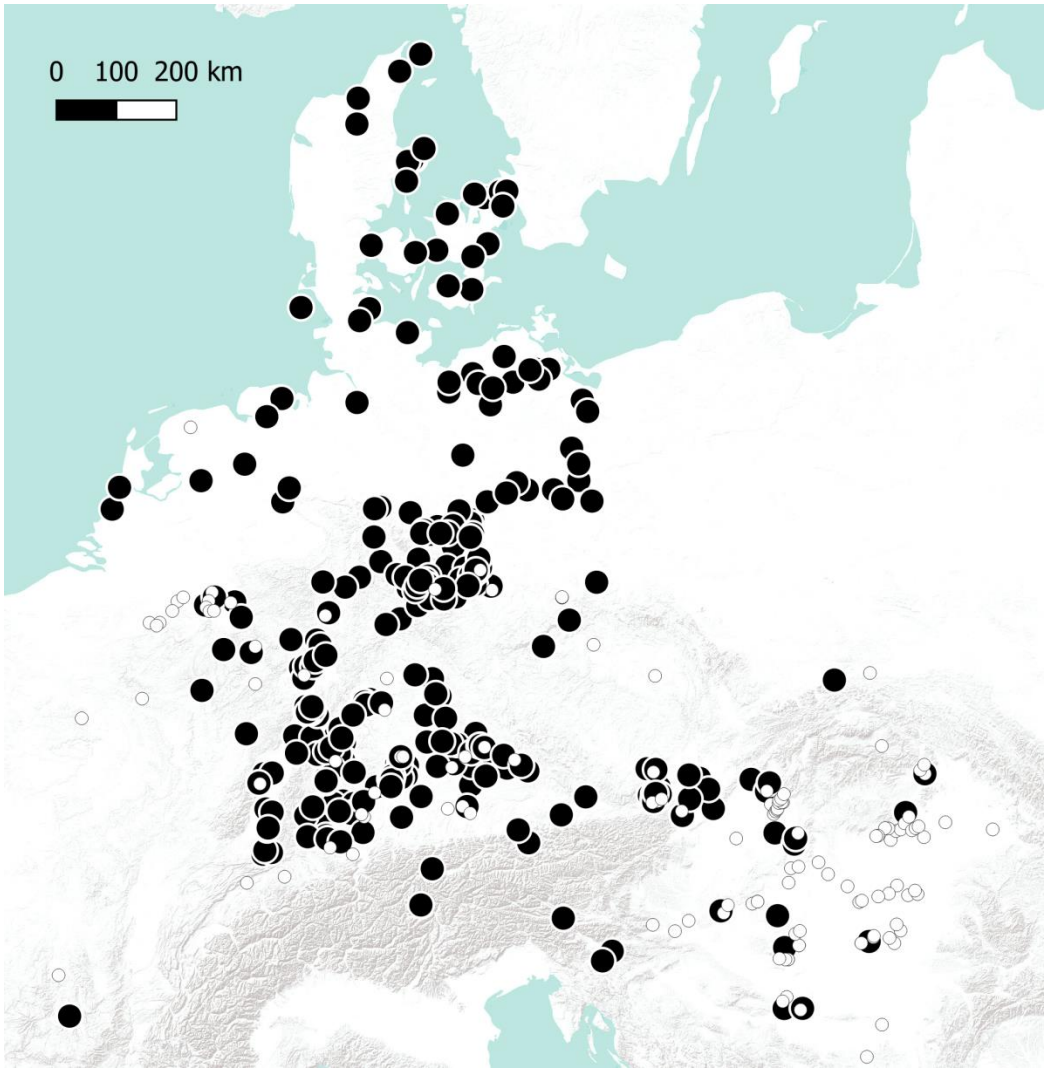


Fig. 1. 23606 buried individuals were recorded in 316 sites in Central Europe and neighbouring areas, of which 859 show observed trauma (Suppl. 01). Additonal domestic sites, for which a Gini-Index is calculated, are mapped (Suppl. 02).

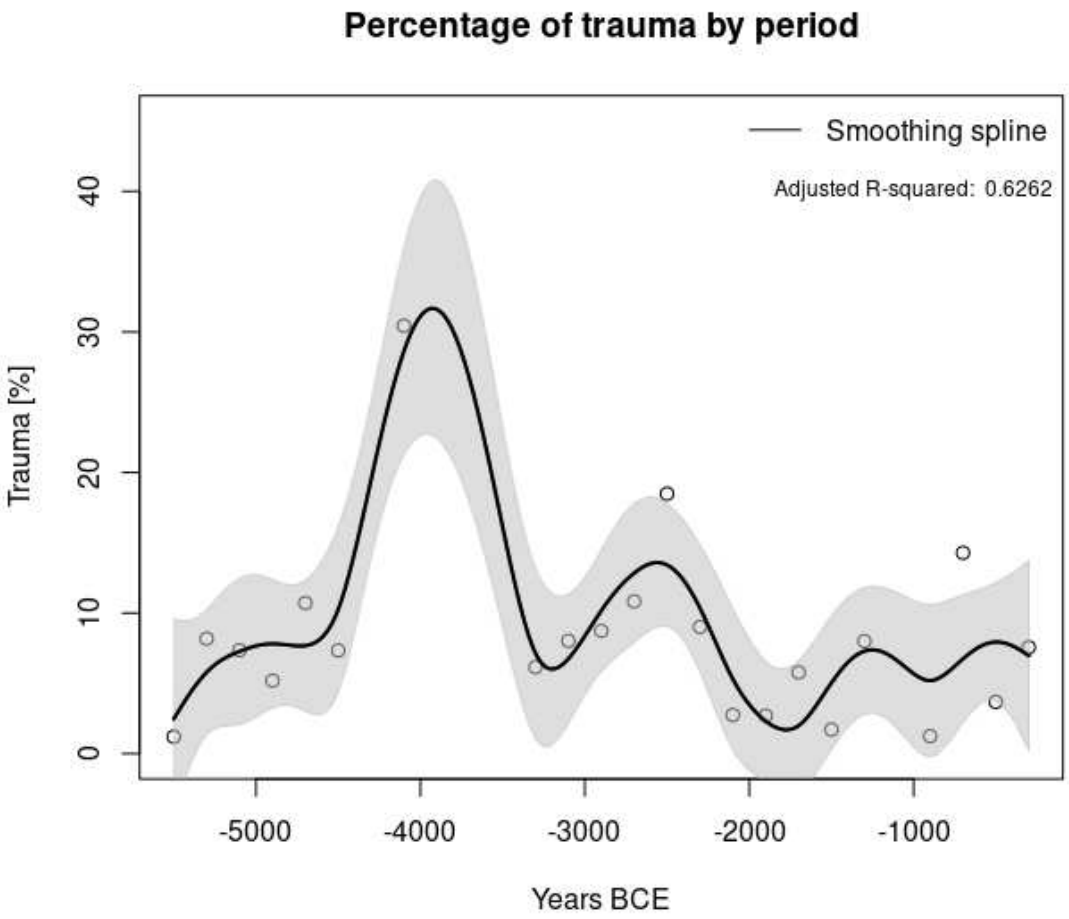


Fig. 2: The trauma rate based on a loess regression with smoothing spine and the 95% confidence interval shows fluctuations in the trauma sequence when the data are summarised in 200-year time slices (Suppl.1).

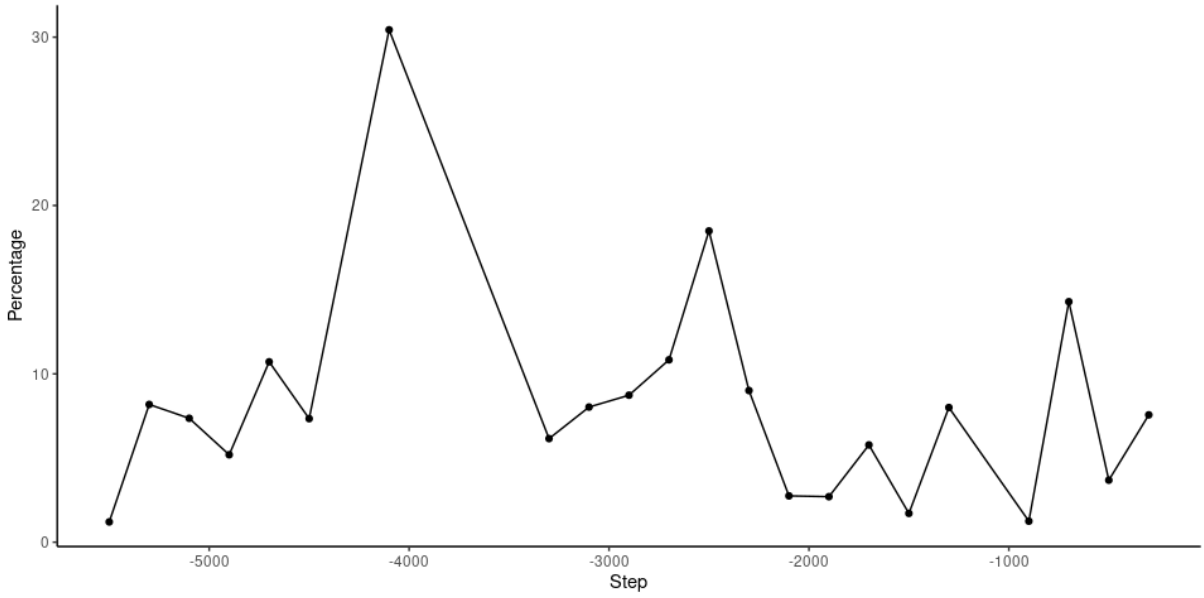


Fig. 3. The summary of the data in 200-year time slices (Suppl. 1) illustrates the high fluctuation rate, especially after 1300 BCE.

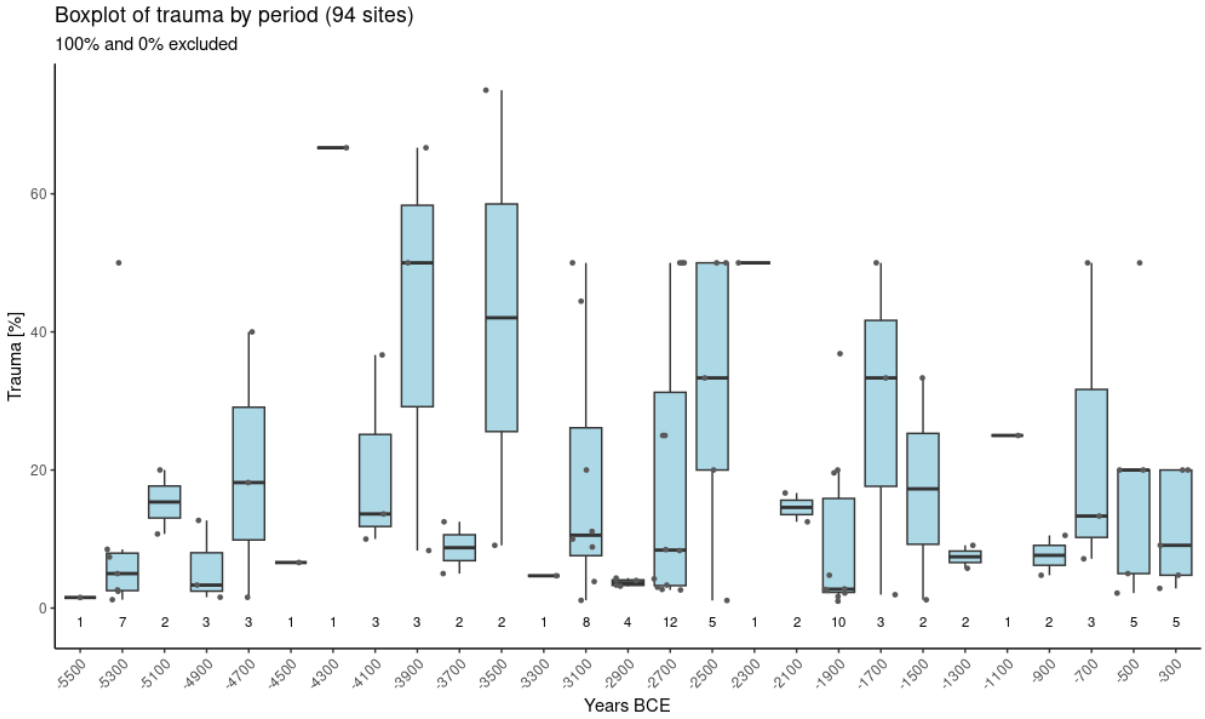


Fig. 4: Quartile representation of the trauma rate of the 96 usable sites (Suppl. 1).

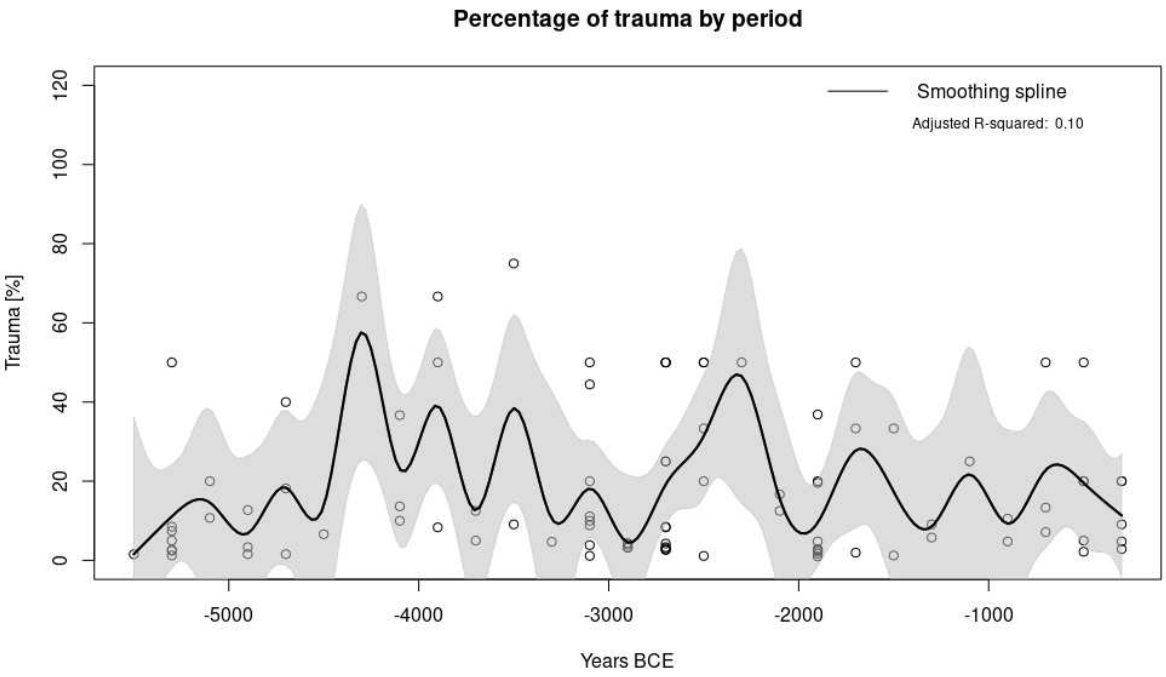


Fig. 5. The trauma rate based on a loess regression with smoothing spine and the 95% confidence interval shows variations in the trauma sequence when summarising the data by site (Suppl. 1).

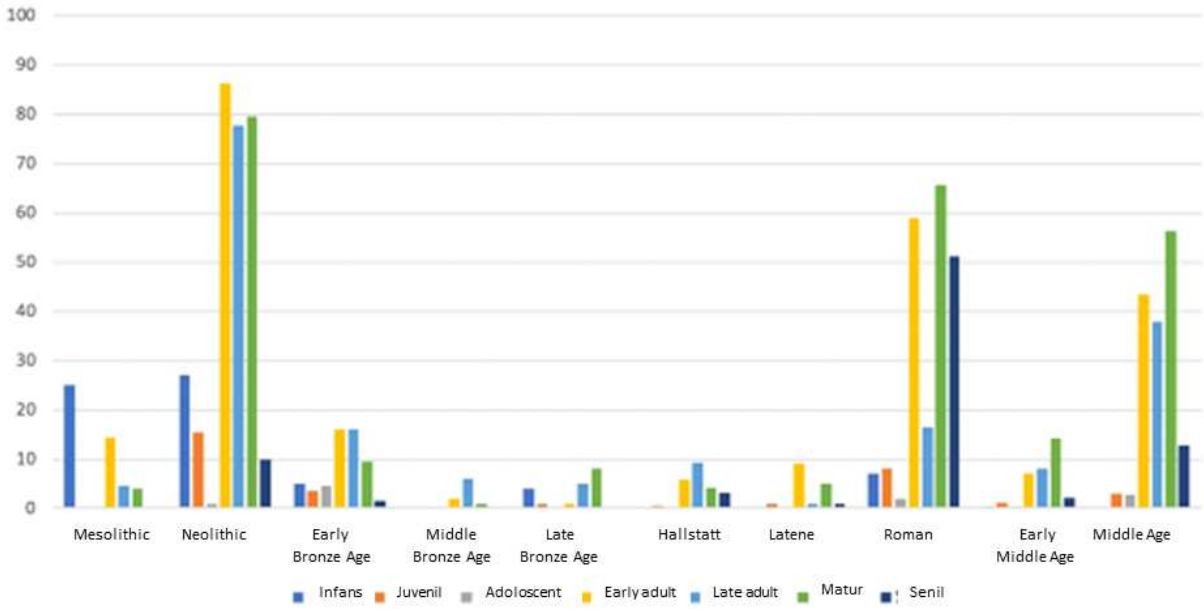


Fig. 6. Age structures with injuries (n) (Suppl. 1).

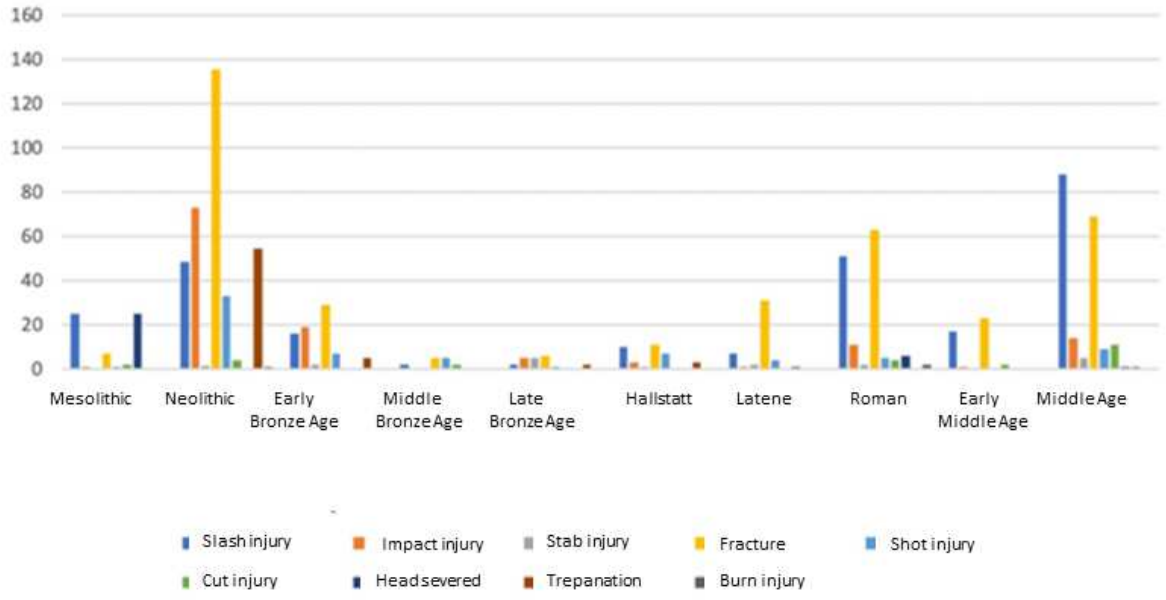


Fig. 7. Number of injury types (Suppl. 1).

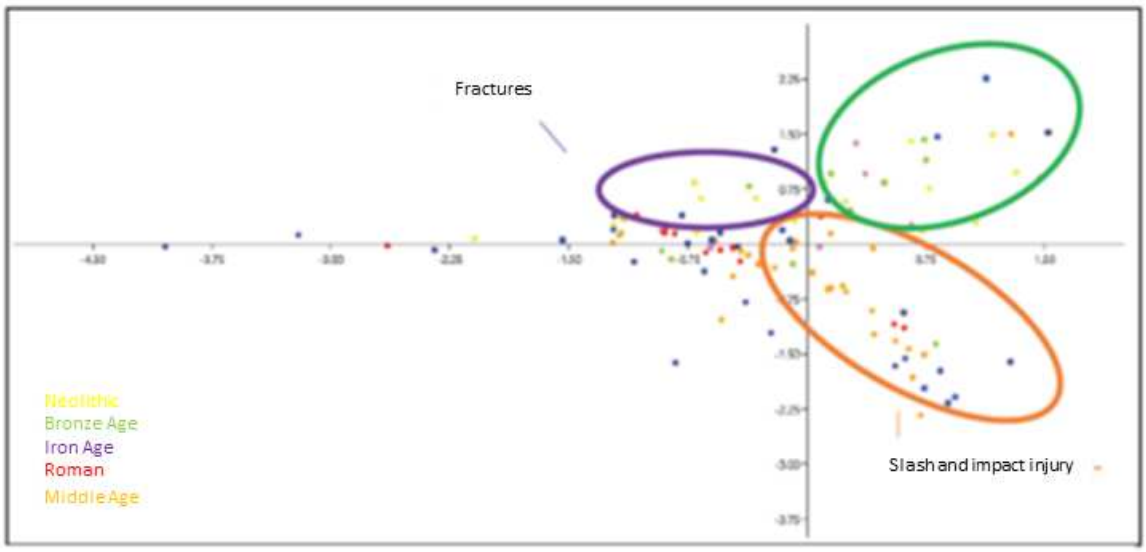


Fig. 8. Correspondence Analyses of the injury types (Suppl. 1; 3).

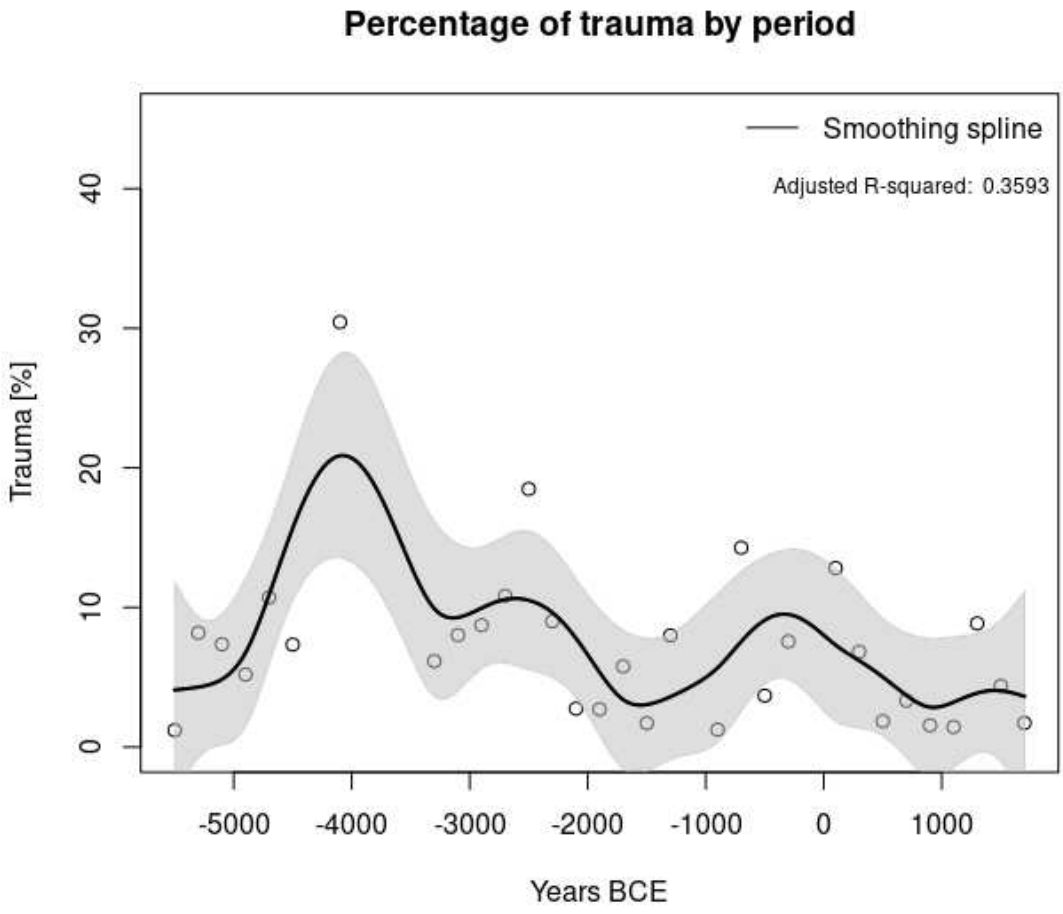


Fig. 9. The trauma rate based on a smoothing spine demonstrates variations in the trauma sequence when summarising the data in 200-year time slices, also including the data before 5500 and after 300 BCE (Suppl. 1).

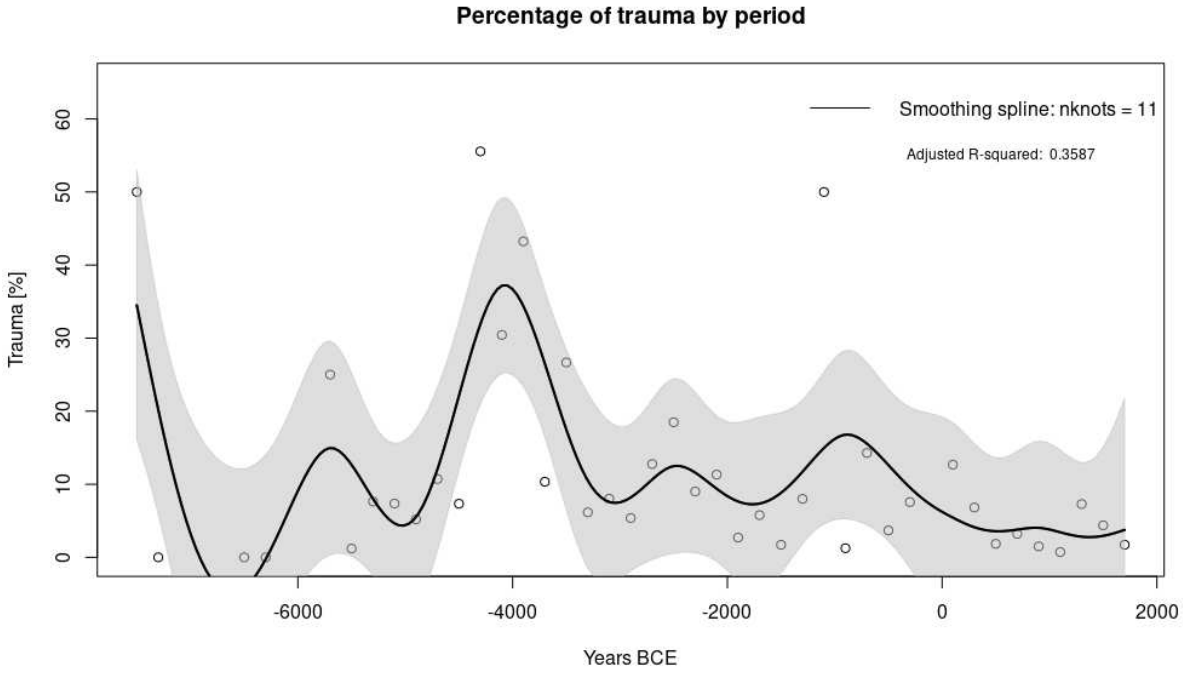


Fig. 10. The trauma rate based on smoothing spine shows variations in the trauma sequence when summarising the data by site, including the data before 5500 and after 300 BCE (Suppl. 1).

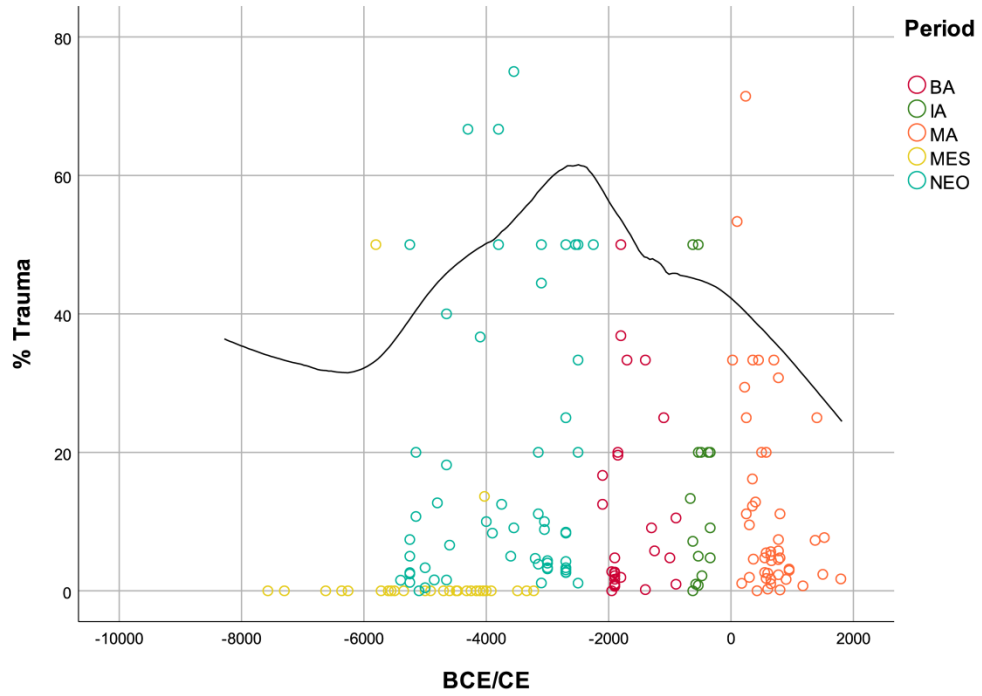


Fig. 11 Trauma rate including all sites from 8300 BCE to 1800 CE (Suppl. 1). Key: BA Bronze Age; IA Iron Age; MA Roman Period to Middle Age and Premodern Period; MES Mesolithic; NEO Neolithic.

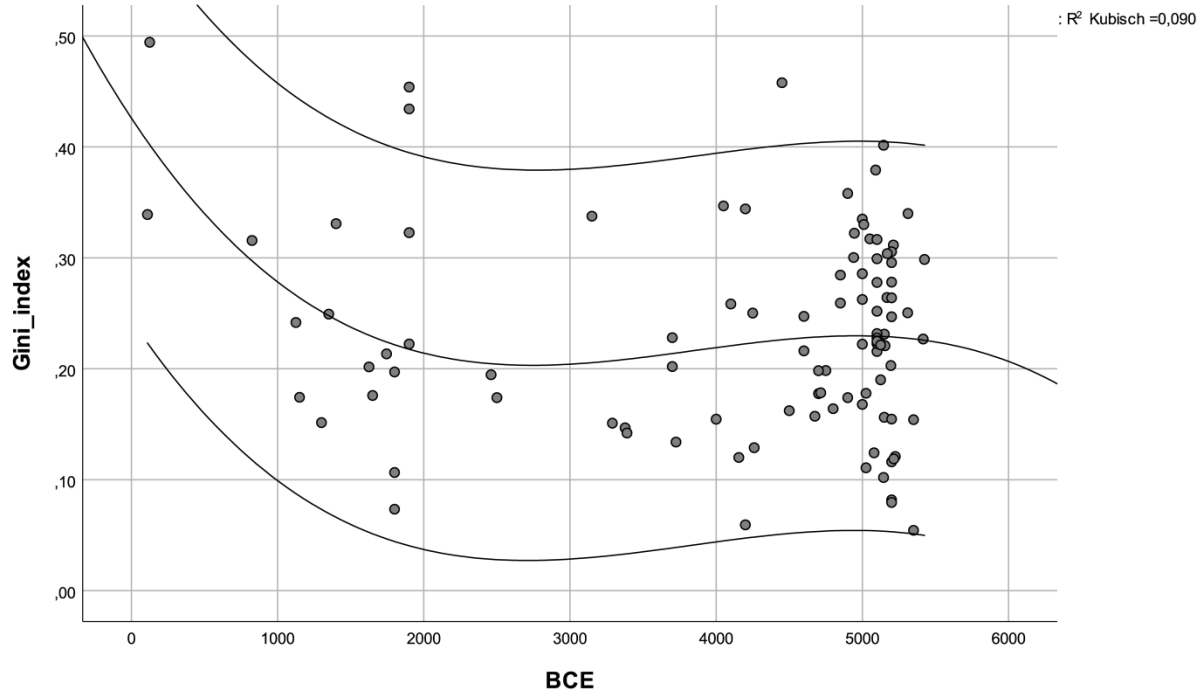


Fig. 12 Gini index calculations for Central European settlements (Suppl. 2).

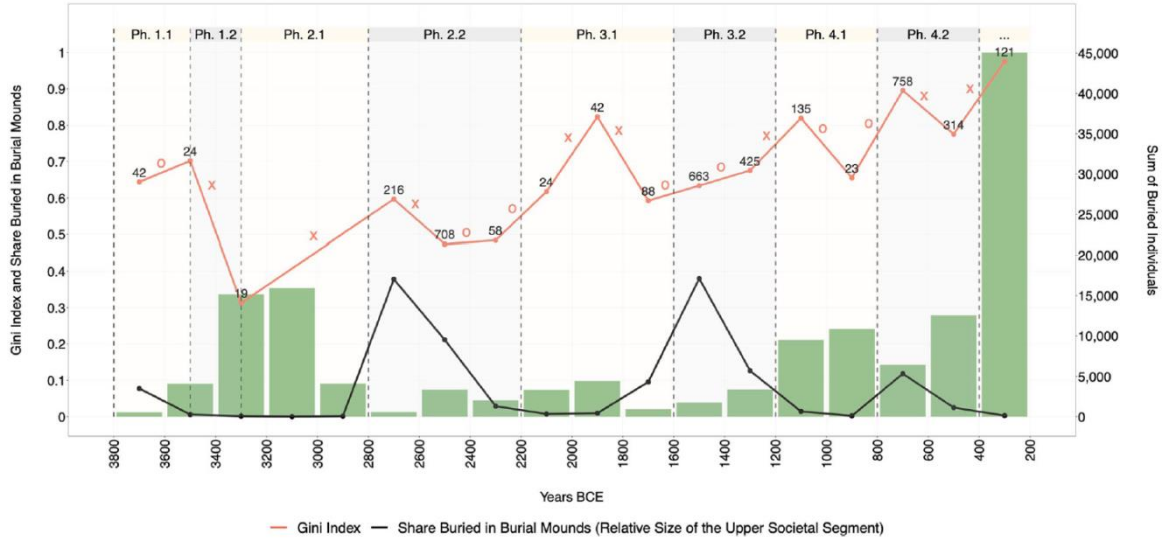


Fig. 13. Development of inequality in relational wealth between the members of the upper societal segment using time intervals of 200 years. The red and black lines display estimates and the shares of individuals buried in burial mounds. Green bars display the sum of buried individuals in the time intervals. Key: x statistically significant (p-value < 0.1).- o statistically insignificant difference (p-value ≥ 0.1).- numbers sample size (Marzian et al. 2023).

Tables

Period	Individuales (n)	Traumata (n)	Traumata(%)	Burials (n)
Mesolithic	134	47	35,1	134
Neolithic	3249	280	8,6	8000
Bronze Age	5534	121	2,2	8261
Iron Age	505	29	5,7	505
Roman and later	14184	382	2,7	14352
Sum/average	23606	859	3,6	31252

Tab. 1: Distribution of the recorded individuals over traditional chronological periods.

BCE	Burials (n)	Region	Economy	Traumata	Degree of violence
5500 -5300	436	Northern Germany und Central Germany	LM, EN	2%	Low
5300-4500	1212	Southern Scandinavia, Central Europe	LM, EN, MN	4-10%	Middle
4300-3900	144	Southern Scandinavia, Central Europe	LM, NEO	25-30%	High
3300-2900	752	Central Europe	NEO	6-8%.	Middle
2900-2300	583	Central Europe	NEO	10-20%	High
2100-1700	2994	Central Europe	BA	2,5-6%	Low
1500-1300	659	Central Europe	BA	8%	Middle
1100-900	2087	Central Europe	BA	1,2%	Low
900-700	49	Southern Central Europe	IA	14%	High
700-500	407	Southern Central Europe	IA	3-5 %	Low
500-300	49	Southern Central Europe	IA	8 %	High

Table 2: Presentation of the results and their classification. Missing time periods indicate gaps in the data, while the area indicated refers to the limited transferability to the whole of Central Europe. Key: LM Late Mesolithic; EN Early Neolithic; MN Middle Neolithic; NEO Neolithic; BA Bronze Age; IA Iron Age.

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Acknowledgements

The study was mainly funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC 2150 - 390870439. The contribution of Paul R. Duffy, Fynn Wilkes, Henry Skorna, Jutta Kneisel, and Johannes Muller was funded by the ROOTS Excellence Cluster. The work of Giacomo Bilotti, Clemens Kruckenberg and Robert Hofmann was funded by the CRC 1266 "Scales of Transformations" and the work of Johannes Müller also by the synERC "Material Minds" (Number 9120 41). Selina Pohl and Leonie Sticke, Kiel University, contributed during a student seminar to the topic.

A**uthors Contributions**

JM, GB, HS, FW designed research.-JM, GB, HS, FW, CK performed research.-JM, GB, HS, FW, CK, PD analysed data.-JM, GB, HS, FW, RH, JK, PD wrote the paper.