HUMAN REMAINS & VIOLENCE

Fallen comrades? Anthropological analysis of human remains from the siege of Turin, 1706

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Abstract

The construction of an underground car park beneath the main square of Turin, Italy in 2004 led to the unearthing of the skeletonised remains of twenty-two individuals attributable to the early eighteenth century. At this time the city was besieged during the War of the Spanish Succession in a hard-fought battle that resulted in unexpected triumph for the Piedmontese, a victory that marked a fundamental turning point in Italian history. The current study assesses the strength of evidence linking the excavated individuals to the siege and assesses their possible role in the battle through consideration of their biological profiles, patterns of pathology and the presence of traumatic injuries. This article presents the first analysis of evidence for the siege of Turin from an anthropological point of view, providing new and unbiased information from the most direct source of evidence available: the remains of those who actually took part.

Key words: siege of Turin, physical anthropology, paleopathology, osteoarchaeology, conflict archaeology, Spanish succession

Introduction and background

The War of the Spanish Succession (1701–14) is arguably less well known than it should be, and is not always afforded the significance it deserves as a key event in the formation of modern Europe. On one hand, this series of conflicts pursued across various global theatres can ostensibly be seen simply as a struggle for dominance between two great houses, the Bourbons of France (under Louis XIV) and the Habsburgs of Austria (under Emperor Leopold I), with each seeking to gain control of Spain and its colonial possessions by installing their own successor to the Spanish throne following the unexpected death of King Carlos II in 1700. However, taking a broader view, the war can alternatively be seen as a contest either to maintain or to overthrow the delicate balance of power in early modern Europe, with the Bourbons seeking to unite the French and Spanish empires under a single ruler, as opposed to the 'Grand Alliance' of the Habsburgs and various polities (particularly the maritime powers of the Dutch Republic and England) that sought

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to install an alternative monarch in order to keep Spanish power independent of France.[1]

The modern city of Turin (Torino) is the capital of Piedmont in Northern Italy (Figure 1). This region is framed by the Alps to the north and west, with Turin forming the closest urban centre to the respective borders with France and Switzerland. The city's geographical position has conferred a high level of strategic

Figure 1 Above: plan of the fortifications of Turin during the siege (amended from Boggio[2]). Below: view of Vittorio Veneto Square and the geographical location of the excavation (amended from Bresci[3]).

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importance throughout its history, which has been reflected in the construction and repeated enlargement of fortifications surrounding the settlement, from Roman times through to the early modern period. The city grew particularly in size and importance during the Middle Ages, becoming the capital of the Duchy of Savoy in 1563 and, later, the first capital of the modern state of Italy in 1861.

In 2004 development work for the regeneration of one of the largest squares in the city centre led to the discovery of multiple human skeletal remains attributed by the archaeologists to the early eighteenth century.[4] This period coincides with important events in the city's history, when the inhabitants of Turin resisted a determined siege by a large French force in 1706. Various aspects of the excavated human remains suggested that these skeletons represented individuals who had taken part in the defence of the city at this time. As such, the finds present the first opportunity to obtain information directly from the remains of people who had participated in this important episode of conflict, which is otherwise known almost exclusively from written sources. The skeletal remains were analysed to gather information regarding their biological profiles, patterns of pathology and the presence of traumatic lesions. With regard to the latter, particular attention was focused on those that were sustained during the perimortem period and are therefore plausibly linked to the events of the siege. The results of this examination are then interpreted in light of the historical context and of previous anthropological studies of similar conflict scenarios.

The siege of Turin: historical context

At the beginning of the eighteenth century two powerful dynasties, the Bourbons and the Habsburgs, drew the nation-states and many smaller polities of Europe into the twelve-year-long conflict now known as the War of the Spanish Succession. During the early years of the war both sides desired to extend their influence in the north of Italy, where the House of Savoy ruled over a relatively small territory that held a determinant role in the balance of power due to its economy, efficient army and geographical position.[5] Taking Turin, the capital of the duchy, was imperative to French ambitions in the region, as it was key to gaining strategic control of northern Italy.

Despite the fact that Savoy was surrounded by Bourbon territories, the Duke Vittorio Emanuele II decided to switch sides early in the war to support the House of Habsburg, provoking an immediate invasion of Piedmont territories by French forces.[6] Turin (see Figure 1) was besieged by a formidable army in May 1706. The siege was harsh, and was faced in conditions of total isolation, with only 15,000 men, mostly Piedmontese citizens, facing more than 41,000 professional French soldiers. Against initial expectations on both sides, Turin resisted the continuous assaults for four months (due largely to the quality of the city's recently improved fortifications) until the arrival of the Habsburg troops led by the imperial commander Prince Eugene that liberated the capital following a lightning march that covered 200 miles in twenty-four days. At the end of the war, Piedmont was devastated, although it had gained recognition among the great powers of Europe, along with a place in history that continues to be bound up with its regional identity and popular spirit.[7]

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The siege of Turin of 1706 is one of the most important events in the history of modern Italy, as the outcome of the battle established the bases for the reunion of the country almost 150 years later. Turin was, in fact, the first capital of the Italian realm and its first strong economic and military centre, playing a fundamental role in the formation of the kingdom. If the city had fallen, the development of the Italian state would likely have been very different, and perhaps even impossible.

Bioarchaeological contributions to understanding conflict

Recent advances in the study of past conflict using material evidence derived from archaeological excavation and survey have formed an increasingly important complement to data culled from written sources and have often served to address questions which the latter simply cannot answer. A further key strand of development within the field of conflict archaeology (formerly known as battlefield archaeology) has been the growing recognition that human remains excavated from conflict-related contexts can provide further information of a kind that is arguably more direct than any other line of evidence, and also unique in the level of detail offered regarding the experience of individuals.[8] Up to the time of writing, the general distribution of such studies has formed an interesting pattern that effectively inverts the situation found among historical studies, whereby the greatest number of contributions have concerned earlier periods about which less information (or none at all) is provided by written sources[9] (see also various examples in Knüsel and Smith[10]). With notable exceptions, relatively few studies of conflicts between the Renaissance and the nineteenth century have focused on human remains.[11] In regard to this point, the burials from Turin presented in this article take on further significance as an important addition to the relatively small sample of early modern-period European conflicts for which direct evidence is accessible in the form of the skeletal remains of some of those involved.

Material

The current study presents aspects of skeletal material held by the Anthropology Laboratory of the Department of Animal and Human Biology, University of Turin. The skeletonised remains of twenty-two individuals were retrieved during the excavations of Vittorio Veneto square in 2004 (Figure 2). More precisely, eighteen of the individuals came from the excavation of the parking lot, and sixteen of these were found in two ditches close to the remains of the ancient fortifications of Turin. Because of the homogeneous filling of the ditches they appear to have been buried at the same time, and during the excavation were attributed by Cinti and colleagues to the period of the siege of Turin.[12] Two further individuals were discovered in isolated graves which were from the same stratigraphic level but were not otherwise associated with the multiple burials in the ditches. Another four skeletons were excavated separately, from the cemetery of the church of SS. Marco and Leonardo, which was situated in the same area. The bones of this portion of the sample are particularly demineralised and very fragile, presenting difficulties for both handling and examination; most of them also present green staining consistent with close contact with

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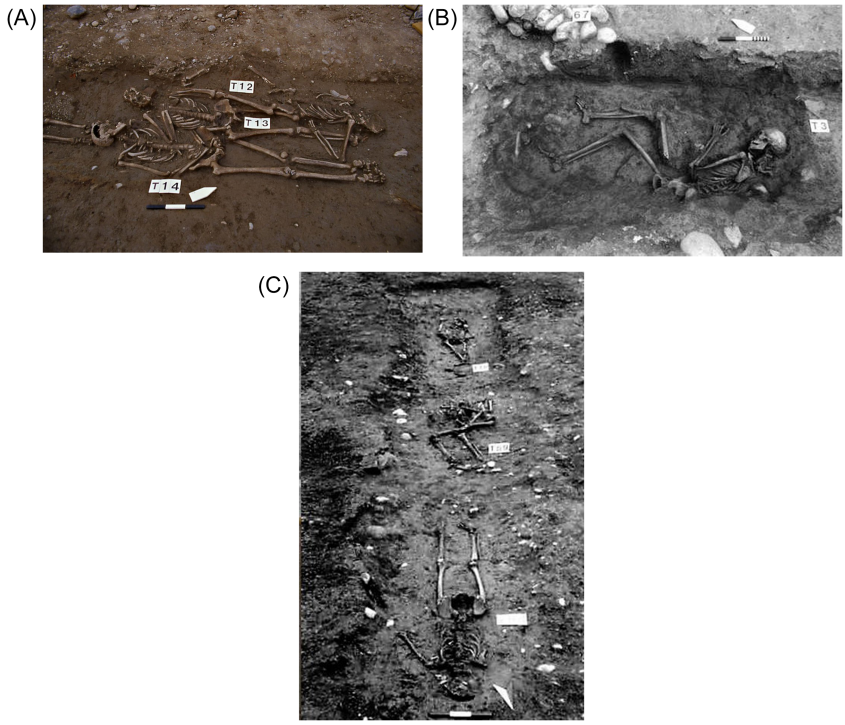

Figure 2 A) Communal grave with three individuals in ditch 110. B) Excavation of T3; the posture of the body suggests a hurried burial. C) Excavation of the Ditch US110. (From Cinti *et al*., 'L'indagine archeologica di piazza Vittorio Veneto a Torino'.)

copper or copper alloy artefacts. In the current study, each burial is referred to using a number preceded by the letter 'T' which stands for 'Tomba', the Italian word for Grave (E.g. T1). Overall, the material is fairly well preserved and complete (Grades 0-2[13]), with the exception of the burials from the churches mentioned above.

Methods

One of the principal aims of this research was to investigate the possible roles played by the excavated individuals during the siege and to corroborate the hypothesis put forward by Cinti and colleagues that they may have been soldiers.[14] It was therefore important to gather information that could test this hypothesis. Therefore, it was decided to focus primarily on the analysis of biological characteristics in order to build a demographic profile of the overall sample, including consideration of patterns of pathology and trauma. Analysis of the collection is ongoing at the time of writing and further aspects of the remains will be covered in subsequent publications.

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Age-at-death was estimated through assessment of cranial suture closure,[15] morphology of the pubic symphysis,[16] dental wear,[17] morphology of the fourth rib[18] and epiphyseal closure.[19]

Biological sex was principally determined using the method proposed by Acsadi and Nemeskeri,[20] based on the evaluation of determined features on the cranium, mandible and innominate (pelvic) bones. However, sometimes it was necessary to evaluate other (pelvic) features, such as the shape of the ischial spine, the ventral arc, the ischiopubic ramus and the subpubic concavity.[21] Furthermore, when skull and pelvis were not available or not sufficiently well preserved for sex determination, articular dimensions of the femora were taken into consideration, in particular, the maximal diameter of the head and the bicondylar width.[22] The formulae presented by Trotter and Sjøvold[23] were used to determine stature based on measurements of long bones.[24]

Traumatic lesions were investigated separately on the basis of their timing in relation to death. While antemortem lesions are identifiable through evidence of healing,[25] the identification of perimortem fractures is more challenging, as distinguishing between perimortem injuries and post-mortem breakage can be problematic. The criteria used in the current study for the differentiation of perimortem from post-mortem injuries are based on the macroscopic characteristics of fractures in fresh and dry bones, respectively. After death, bones progressively lose their organic components and change the way they break, behaving more like an inelastic material.[26] Fractures in living bone are normally associated with sharp and regular edges, bevelled margins, radiating fracture lines and homologous colour with the rest of the bone, while dry bone (i.e., bone that has lost most of its organic content) produces irregular fracture lines, transverse fracture margins and unpatinated areas of breakage.[27]

Results

Demography

The twenty-two individuals analysed represent a relatively narrow cross-section of society from the points of view of sex and age (Figure 3A and 3B), 86 per cent of the sample (19/22) being composed of adults aged between 17 and 40 years, and eighteen individuals (81 per cent) being assessed as male. Further, most of the subjects are either late adolescents or young adults: eleven were aged between 17 and 25 years, six were aged between 26 and 40 years, while two individuals were categorised only as adults, as the quality and quantity of their bones did not allow a more accurate estimation. Finally, there are three younger individuals: one adolescent (13–16 years old) and two children (3–8 years old). Of the individuals not assessed as male, one was assessed as female, with the remaining three recorded as indeterminate. Stature was fairly homogeneous, with most individuals being around 160–165 cm, although the individuals retrieved from the church of SS. Marco and Leonardo were notable as being generally taller than the others, all being over 170 cm (Figure 3A).

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A	Sex	Age	Stature
T1	Indeterminate	3-4	/
T2	Male	18-20	161-167 cm
T3	Male	15-20	177-183 cm
T4	Male	30-40	160-165 cm
T5	Male	22-24	159-162 cm
T6	Male	23-30	164-167 cm
T7	Indeterminate	Adult	/
T8	Male	20-21	161-165 cm
T9	Male	25-30	175 cm
T10	Male	18-25	/
T11	Male	17-19	169-171 cm
T12	Female	19-20	163-169 cm
T13	Male	21-22	165-171 cm
T14	Male	24-26	167-173 cm
T15	Male	17-18	151-157 cm
T16	Male	8+-2	/
T17	Indeterminate	Adult	/
T18	Male	24-26	167-173 cm
T1S1	Male	17-24	171-174 cm
T1S2	Male	13-16	/
T1S3	Male	17-24	168-174 cm
T1S4	Male	25-28	178-182 cm
	81% Males	Average: 20.37	Average: 168.25 cm

Figure 3 A) Composition of the sample in relation to age, sex and stature. B) Distribution of sex in the sample and distribution of age among the males. C) Distribution of pathologies per number of individuals.

Pathology

Various pathological features were observed, including dental disease, Schmorl's nodes (damage to the vertebrae relating to ruptured discs following excessive stress on the spine), sinusitis and osteochondritis dissecans (a condition caused by physical stress on joints in younger people in which the blood supply to part of the bone is damaged, resulting in localised loss of bone from the joint surface). While certainly of interest, these conditions are not directly relevant to the questions dealt with in the present article and will be presented in detail in subsequent publications.

Regarding the distribution of the main pathological features (see Figure 3C), dental diseases were clearly the most frequent pathologies, with caries (tooth decay) alone affecting thirteen individuals (Figure 4A). Also, in a third of the sample (eight individuals) the cortical bone on the shafts of the inferior limbs, in particular the tibiae, was porous and disturbed, showing signs of bone reaction and of non-specific infection referred to as periostitis and osteitis (in this sense, non-specific simply denotes that it is not possible to identify the micro-organism involved) (Figure 4D). Four subjects presented porosity and osseous reaction around the areas of the hard palate (Figure 4A), often associated with porosity of the alveolar process (the area

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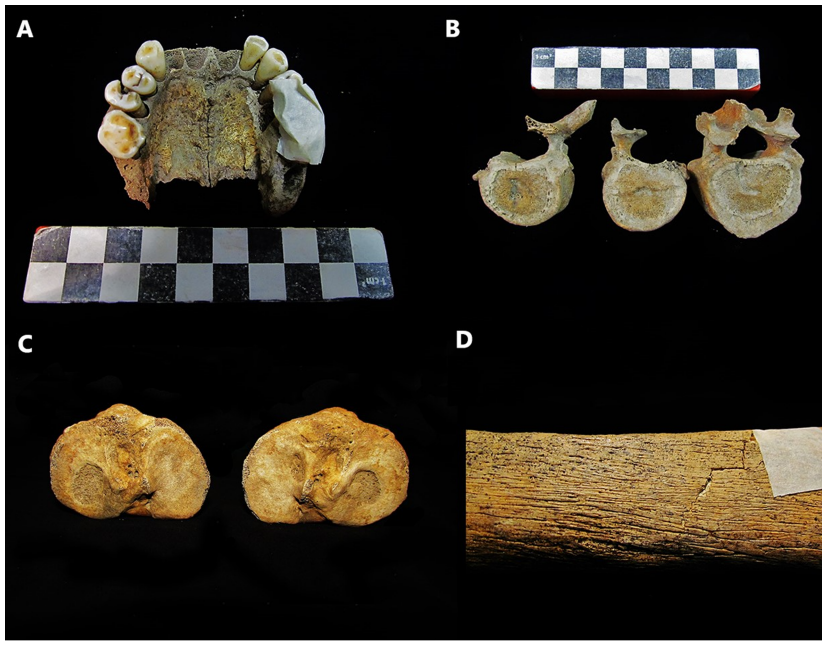

Figure 4 A) Palatine process and upper teeth of T18; it is possible to see the caries on the mesial face of the right second premolar and the porosity reaction in the area of the hard palate and tori. B) Schmorl's nodes on three thoracic vertebrae (T12). C) Osteochondritis dissecans on both tibial plates of T4. D) Periostitis and stress fracture on left tibia of T14.

of bone holding the teeth) and of the sphenoid bone (this bone sits centrally within the skull, forming the rear sections of the orbits [eye sockets] and nasal cavity). These lesions, especially in association with periostitis on the inferior limbs, have previously been interpreted as evidence of scurvy (vitamin C deficiency).[28]

Trauma

Traumatic lesions associated with the perimortem period (around the time of death – as opposed to injuries with signs of healing that must have been sustained some time before death), were found in four individuals and were observed either on the limbs (mostly inferior) or on the cranium. In more detail, one of the most interesting traumatic features was a circular lesion with a diameter of approximately 1.2 cm on the medial posterior section of the right parietal of a young adult male (T3, Figure 5). The margins of the defect were perfectly neat and perpendicular to the cranial bone on its superior and lateral parts. At the base of the circle, a section of bone is absent, apparently having detached from the rest at some time after burial. The borders of this part of the fracture are more irregular, with the exception of the lower part, which is neat and internally bevelled. A smaller fracture continues from

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Figure 5 Different views of the injury on the right parietal of T3.

the medial-inferior border of the greater lesion, forming a secondary circular feature with a diameter of 0.5 cm and a great degree of external bevelling which is very porous and rough. The neat line that makes the inferior border of this greater fracture continues postero-medially, reaching the lambda. Surrounding these features, in a circular area of approximately 5 cm diameter, the cortical bone is fractured, with the fragments still attached in place. The lower border is porous and shows some signs of bony response, with a neat depression under the circular and more uneven rim. From the superior part of the lesion, two *stellate* fractures proceed towards the anterior medial part of the parietal. In general, these features are consistent with a significant impact to the head, caused by either a firearm or a blunt implement, while the bony reaction (formation of a small amount of new bone in response to injury) indicates that the individual must have lived for a short time afterwards.

Moreover, two individuals presented perimortem butterfly fractures on the inferior limbs (Figure 6A–E), namely affecting the left tibia (T3) and left femur (T9). This type of fracture generally results from a direct impact to the shaft of the bone from the side and indicates a considerable degree of force. In both lesions, the rim on the medial side of the fractures is parallel to the direction of the shaft and very neat, while the other fracture lines have an inclination of approximately 45° with the apex pointing toward the lateral side of the bone. The tibia of the individual in T3 showed a great degree of bone resorption and non-specific infection which is probably antecedent to the fracture (Figure 6D). The femur, instead, had some linear defects identified as cut marks on the anterior region, superior to the fracture (Figure 6B).

Another perimortem lesion can be observed on the medial-distal epiphysis of the right femur of the individual in T18 (Figure 6G), cutting through the anterior surface, superiorly to the medial condyle. The lesion is almost 2 cm deep and its section is V-shaped, cutting through the bone downwards with an angle of approximately −10° to the horizontal plane. In the inferior part of the lesion the cortical bone is bent inwards, while the superior part looks like a straight cut.

Finally, on the superior part of the left portion of the frontal bone of the individual in T5, near bregma, there is a triangularly shaped lesion that cuts through the bone approximately 0.5cm (Figure 6F). The left part of the wound is larger and more

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Figure 6 A–B–C Butterfly fracture on the left femur, T9. D–E Butterfly fracture on left tibia, T3. F perimortem lesion on the superior part of the left portion of the frontal bone of the individual in T5. G Sharp force trauma on the medial-distal epiphysis of the right femur of the individual in T18.

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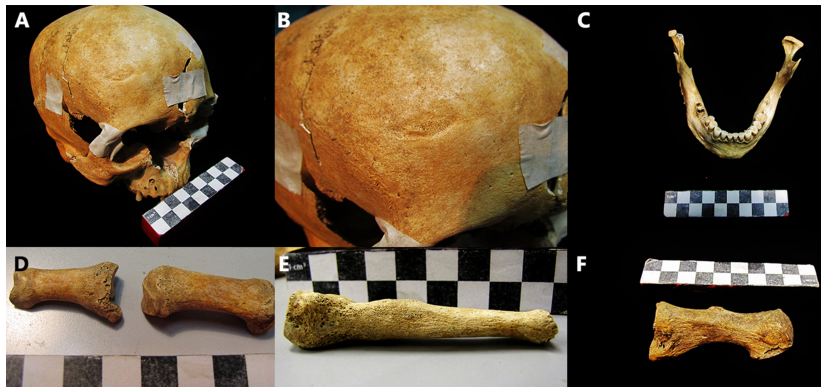

Figure 7 A-B) Ante-mortem lesion on the right portion of the frontal bone, T4. C Ante-mortem fracture on the right portion of the body of the mandible, T4. D Healed fracture of the first proximal phalanx of the left hand, T3. E Healed fracture of the right 4th metatarsal, T3. F Bone formation on the right 1st metatarsal bone, T9.

bevelled, the surrounding area is porous and shows signs of bone resorption, again indicating that the individual survived the injury for a short time.

Evidence of antemortem healed fractures was found in only three subjects: T3 presented a bony callus on one rib, on the distal part of the diaphysis of the 4th metatarsal (Figure 7E) and on the 1st proximal phalanx of the left hand, which presents a bony projection that extends laterally and superiorly from the lateral side of the proximal epiphysis (Figure 7D). In T4, the right part of the body of the mandible has a considerable thickening at the level of the first and second molars and a great degree of bone resorption is observable in the alveolar area of both teeth, characteristics consistent with a healed fracture (Figure 7C). The same individual presented a healed depression on the right frontal eminence (the area bone approximating to the forehead) which measures 2.5 cm × 1.2 cm (Figure 7A). The inferior border of the lesion is roughly crescent shaped and is the deepest part of the wound; the internal region is very porous (Figure 7B). Finally, the right 1st metatarsal in T9 presented a bony formation which is the probable consequence of a fracture (Figure 7F).

Discussion

Characterising the sample

From the combination of archaeological evidence, stratigraphic data and the presence of communal burials, it is possible to assume with reasonable confidence that these individuals died during the siege in 1706 and thus to formulate three different hypotheses regarding their role during the battle: first, they could have been professional soldiers fighting either for the Piedmontese army or for the French

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besiegers. Considering this, it is important to bear in mind that in the sixteenth and seventeenth centuries most European armies had been affected by the early modern military revolution. This involved the convergence of many factors, including both political and social changes as well as the widespread adoption of portable and reliable firearms in the form of the flintlock musket, greatly elevating the role of infantry, with a simultaneous decline in the tactical effectiveness of cavalry.[29] This latter innovation was made complete by the development of the socket bayonet, after which units of pikemen (already declining for decades) were no longer required to support musketeers.[30] Moreover, the revolution led to increases in the size of armies and also to the birth of permanent armed forces and compulsory military service, with mercenaries becoming increasingly less common.[31] Consequently, most armies were comprised of relatively few seasoned professional soldiers in command of younger men and boys with limited training and little or no experience of fighting.[32] Alternatively, the excavated individuals could have been civilian inhabitants of Turin, as it is documented that all those men who were able to fight joined the defences in a massive popular participation that was essential for the survival of the citadel.[33] Finally, the sample could comprise of civilian casualties: apparently, the French incendiary bombs (called *boulet-rouges*) caused the greatest number of casualties among the population, although solid shot and explosive shells from cannons and mortars were dangerous as well. It is estimated that, during the siege, 95,000 solid cannon balls, 21,000 bombs and 27,700 mortar shells landed on the city.

The above possibilities were considered in light of the available evidence: the distribution of sex and age, the patterns of pathology and trauma, were assessed in context to understand which hypothesis best fitted the examined sample. As regards the demographic profile (see Figure 3), the overwhelming majority of adult males is a clear indicator that the sample does not represent a random portion of the population of Turin as might be expected in the case of civilian casualties of artillery assaults. This sex distribution is consistent with a warfare scenario, with the subjects being fighters for one or the other side: in fact, according to Goldstein,[34] war is the most consistently gendered human activity, with women estimated as accounting for fewer than 1 per cent of all warriors in history.[35]

Moreover, the age of 20 out of 22 individuals (91 per cent) is consistent with their participation in military activities. In fact, only two subjects are too young to have been part of the fighting: T1 and T16. However, the child in T1 was retrieved from the ditches and appeared to have a wooden structure associated with his burial, which can imply that had a formal interment in a coffin. Consequently, this subject can be considered separately, as it probably originated from a different circumstance. The presence of the eight-year-old child on the battlefield could have multiple explanations: for instance, he could have been a messenger, a scout or just an unfortunate civilian victim.

Similar distributions of sex and age are often found in archaeological sites associated with war.[36] It is therefore possible to state with confidence that these individuals most likely fought in the siege, probably as part of the army, as the sample does not reflect the demographic profile expected for attritional cemeteries, epidemics or general civilian casualties.

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Another point of interest that stands out from the study of the biological profiles is the difference in stature between the individuals excavated from the church of SS. Marco and Leonardo and the rest of the sample: the first, in fact, are considerably taller than the others, with an average stature of 174.6 cm against the 166.8 cm of the individuals found in the ditches of Vittorio Veneto square. The significant difference in stature between the two sets of individuals might indicate differences in diet and living conditions earlier in their lives, suggestive of a more privileged background. If this were the case, then these individuals might perhaps have been officers, their higher social class selecting them for separate burial in the churchyard, as opposed to less formal burials in ditches received by the enlisted men. Alternatively, the higher stature of the individuals buried in the churchyard might indicate that they belonged to different armies and that they were non-local. According to Claretta,[37] on 26 August 1706 four Austrian soldiers were buried in the cemetery of the church of SS. Marco and Leonardo. As this is the only reported case of four people buried on the same day in that location, it is arguably plausible that these four excavated individuals were indeed non-local, instead having arrived in Turin as part of the Austrian army of the Habsburgs.

Pathological observations

Overall, the studied skeletal remains did not show any severe or incapacitating pathological conditions (see Figure 3C). In fact, the most commonly found pathologies are caries and Schmorl's nodes, which respectively affect thirteen and ten individuals, followed by non-specific infections such as periostitis localised on the lower limbs. The large prevalence of caries among the sample is quite normal. Dental caries is the most prevalent disease worldwide and is widely associated with poverty and poor diet,[38] and it is reasonable to assume that this has been the case from the early modern period onwards. Schmorl's nodes, on the other hand, are often associated with physical stress such as heavy lifting at a young age; however, their formation may also be a consequence of compromised bone strength due to intrinsic factors such as vitamin deficiencies.[39] Moreover, Schmorl's nodes have been associated with military activities in several cases in the literature.[40]

Considering the above conditions along with the presence of some cases of possible scurvy, enamel hypoplasia (failures of formation of tooth enamel), cribra cranii and cribra orbitalia (areas of porous bone loss on the vault of the skull and in the orbits [eye sockets], respectively), it is clear that the studied population suffered from a period of 'biological stress' deriving from either disease or malnutrition (or both), which, once again, is consistent with a conflict scenario. Moreover, the absence of chronic, debilitating conditions fits the parameters of army selection, supporting the hypothesis that the studied individuals were soldiers.

Additionally, it is interesting to note that one in three individuals had periosteal reactions (the growth of new bone) on their tibial shafts, characterised by a distinct bone striation and vascularisation. In some individuals the lesions on the cortical bone were more severe, also affecting the density of the trabecular bone and sometimes resulting in small fractures. In the literature this kind of injuries have been associated with Medial Tibial Stress Syndrome, commonly abbreviated as MTSS,[41]

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a painful condition very common in both athletes and soldiers, which starts with periosteal oedema and progresses to involve the bone marrow, ultimately provoking cortical stress fractures.[42] This syndrome is reported to affect between 4 per cent and 35 per cent of modern athletes and military personnel and is often associated with overtraining or abrupt increase of workout intensity.[43]

Furthermore, several cases of osteochondritis dissecans involved the bones of the feet or, less commonly, the tibiae. This lesion is known to be produced either by a single traumatic event or from chronic physical trauma resulting from repetitive movements.[44] Similar to MTSS, this condition is very common in young athletes[45] and, when affecting the bones of the feet, is often associated with military training and marches.[46] Overall, the pattern of pathological conditions found in the sample is indicative of a stressful lifestyle; the conditions on the inferior limbs are certainly compatible with military service, training and prolonged marches of the kind that had come to characterise army life in the early modern period. However, this is not definitive, as the same conditions could be derived from widely different occupations.

Hard times: classifying trauma

Finally, the traumatic lesions present in the sample were considered in relation to the historical context, and published literature regarding conflict during this period. While four individuals presented injuries attributable to the perimortem period, the real number of wounds suffered around the time of death may of course be higher, as injuries that only affected soft tissues are undetectable on skeletal remains and so the amount of perimortem trauma in the sample may be under-estimated.[47]

The circular lesion on the back of the skull of T3 is arguably the most significant lesion found in the sample and it will be analysed in more detail in further publications from the team of the Laboratory of Turin. At first, shortly after the excavation, this injury was catalogued as a gunshot trauma because of its circular shape and the characteristic stellate radiating fractures and concentric heaving fracture. However, the impact of a bullet on the cranial vault usually produces clear internal bevelling[48] at the point of entrance, while the related exit wounds are externally bevelled.[49] In this case, instead, the margins of the circular part of the wound are perfectly perpendicular to the parietal bone without any bevelling and the wound is perfectly circular. It is probable that this circular feature had been produced with a surgical instrument, most likely a trephine, a hypothesis that will be corroborated in the future. Trephination (called trepanation in the oldest cases) is a very ancient surgical technique in which a hole is drilled into the skull in order to treat intracranial diseases or to relieve cranial bleeding caused by trauma.[50] In Italy there are many archaeological examples of this practice covering an impressive time span: the most ancient case dated in the fifth millennium BC and the most recent in the nineteenth century.[51]

The underlying wound presents several characteristics common to ballistic lesions, although there was no visible exit wound and the X-ray inspection of the skull did not show the presence of any bullet inside it. It is possible therefore that the operation was successful in so far as the surgeon was able to remove the musket

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ball. On the other hand, the lesion is also consistent with the impact of a low-velocity heavy object: according to Galloway and Wedel,[52] in fact, depressed fractures caused by blunt force trauma are commonly associated with stellate fractures and internal bevelling, which is evident on the lower part of the fracture on the more irregular edge. Moreover, in the lower part of the lesion there are some early signs of bony response which, along with the surgical attempt, is proof that the individual lived for a short period after the injury but died either during or shortly after the surgery. The interpretation of this injury and its historical value as an early example of military surgery will be dealt in greater detail in a forthcoming publication from Professor Boano and colleagues.

The same individual had a perimortem butterfly fracture on the left tibia, which was very similar to the injury discovered on the left femur of another subject. In the literature, these kinds of fractures are associated with low-velocity gunshot wounds,[53] an interpretation which fits the historical context, as the most commonly used weapons in battle were muskets.[54] The fragmentation of the affected bones also fits this theory, as musket balls often cause significant shattering around the wound site.[55] For this reason, it is probable that this type of wound is under-represented in the sample, as the fragmentation may favour post-mortem modification of the edges, masking their perimortem characteristics;[56] moreover, it is then increasingly likely that such small fragments will not be recovered during excavation.

Moreover, the lesion on the frontal bone of the individual identified as T5 has been classified as perimortem, despite the low level of remodelling observable around the wound: in fact, the level of healing is minimal, meaning that the individual died a few days after its infliction. The trauma appears to have been caused by a sharp and penetrating weapon and the shape and dimension of the wound are compatible with a triangular-profiled socket bayonet. These were standard weapons used by all the armies involved in the siege; they had a triangular-shaped section and were used as a stabbing weapon rather than to cut in a sword-like motion. In this sense the general issue of bayonets constituted a kind of democratisation of changes that had occurred in the use of swords since the rise of firearms and the decline of armour, as it was recognised that penetrating injuries were more likely to result in the death of an opponent than slashing cuts from a bladed weapon.[57] Similar lesions observed in skeletal remains from the battle of Stoney Creek (1812) were concluded by Lockau *et al.*[58] to have been produced by bayonets, following experiments with reproduction bayonets on animal bone proxies. Finally, the lesion found on the distal right femur of the individual in T18 is consistent with a sharp force trauma, a wound probably inflicted with a bladed weapon such as a knife or a sword.

The number of observed antemortem traumata (healed injuries) in the sample is relatively low, concerning only three subjects, of which two presented more than one injury; nevertheless, in all cases it is impossible to associate them to a unique traumatic event. It is interesting to notice that the subjects which present antemortem trauma are among the oldest individuals in the sample: it is therefore possible that the low number of healed injuries is due to the overall young age of the studied remains.

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Specifically, the individual in T3 presented healed fractures on one rib, the 4th right metatarsal and the 1st proximal phalanx of the left hand. The last is a common fracture; also known as the gamekeeper's or skier's thumb fracture, it is a consequence of the avulsion of the ulnar-collateral ligament and it is common among rabbit hunters and athletes such as volleyball players.[59] Moreover, similarly to a Bennet's fracture, which involves the 1st metacarpal, this lesion can be associated with the avulsion of the thumb while punching, especially considering the 'punching technique' used in that historical period: in fact, while in the modern period punches involve straight fists and wrists and the most commonly injured bones are the 2nd or 5th metacarpals, during the eighteenth and nineteenth centuries the fists used to be placed with the thumb upwards; a position which can easily cause base-of-thumb fractures.[60]

Further possible evidence of interpersonal violence is apparent in the healed fracture of the right body of the mandible of the individual in T4. This is a lesion that usually results either from a fall onto the chin or from a lateral blow.[61] In this respect it is interesting that the healed lesion on the right frontal eminence of the same individual is probably a healed blunt force blow. In the latter, the bone appears porous in the central part of the lesion, which may indicate that it was exposed: in fact, similar response is often seen in cases of scalp infection.[62]

Moreover, fractures of the metatarsals, which affected both T3 and T9, are often associated to recurrent stress such as sustained periods of marching. For this reason, these fractures are also referred to as 'march fractures', and they are very common among soldiers, athletes and hikers.[63]

Overall, the pattern of healed trauma found in this sample is consistent with military training and service, and certainly with an active lifestyle. Several of the injuries can be associated with unarmed fighting such as the hand bone fracture in T3 or the fracture of the mandible in T4, while the presence of stress fractures in the feet is consistent with the long-distance walking and marches that these people were subjected to. Overall, considering the historical context, all the analysed perimortem injuries are consistent with military circumstances, further bolstering the hypothesis that these individuals died defending the walls of Turin.

Conclusion

From the result of this examination, it is apparent that the composition of the sample is not consistent with a random cross-section of the general population because of the overwhelming majority of young adult males. Since this composition is consistent with a military selection, the hypothesis can be upheld that the remains belonged to individuals actively involved in the city's defence.

The pathological analysis emphasises the fact that all the individuals were essentially healthy, lacking observable chronic conditions incompatible with the selection of soldiers. Similarly, several signs of malnutrition and physical stress are compatible with a situation of war, and particularly with a siege scenario; and the abundance of stress fractures on the inferior limbs, along with pathologies caused by chronic stress resulting from repetitive movements, such as the medial tibial stress syndrome

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which affected one third of the individuals or osteochondritis in legs and feet, are suggestive that these young men had marched for sustained periods. Finally, the observed injuries attributable to the perimortem period, along with the presence of communal burials and hurried inhumations, further strengthens the hypothesis that these individuals died during the battle and were hastily buried soon after death.

In conclusion, on the basis of all the assembled data, it is possible to affirm with a certain degree of confidence that the studied individuals were most likely soldiers who fought in the battle for the city of Turin. Given the young age of certain individuals, they were probably a mixture of experienced veterans and young boys recently recruited for the war.

The French besiegers never entered the city, consequently it is plausible that any dead among the attackers would have been buried outside the city walls. Therefore, the proximity of the excavated burials to the city walls, the presence of sub-adults and of a female all suggest that the bodies belonged to Piedmontese defenders or allied soldiers. Interestingly, the presence of a woman in the sample opens up to the possibility of a female participation in the defences of the city, which has never been recorded in any written evidence.

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