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Perpetrators from Treblinka: interdisciplinary investigations of seven single graves with "Trawniki Men"

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Abstract

At the Treblinka extermination and forced labor camp only a few SS soldiers and around a hundred watchmen kept guard over thousands of prisoners. Despite their lower rank in the Nazi hierarchy than SS soldiers, watchmen were vital to implementing "Operation Reinhard" in the field. Prisoners in Nazi camps were terrified by their brutality and ruthlessness.

The guards were intermediaries between the camp's inmates and the commanding crew, so in cases of a prisoners' riot, they were the first target. The historical records mention several incidents where the watchmen died at the hands of the captives. However, little is known regarding how the dead bodies of the guards were treated nor what the funeral customs looked like in the camps.

In 2019, a row of individual burials was discovered at the former Treblinka extermination and forced labor camp. Seven of those graves were explored to identify the people buried in such an unusual manner and to find out what had caused their deaths. A thorough multidisciplinary study, combining the forensic disciplines of archaeology, anthropology, medicine, and genetics provided the answer.

Considering archaeological findings, it can be deduced that the graves belong to the Treblinka guards. The analysis conducted by an anthropologist indicates that the assessed biological profile aligns with the antemortem data of the Treblinka watchmen. Moreover, a study examining perimortem trauma has unveiled that out of the seven men studied, at least two met a violent demise. These findings are crucial in narrowing down the identification process.

The results of our study contribute to a general understanding of the funerary customs prevalent in concentration camps worldwide. Prior to this work, there had never been any analysis or publication of the characteristics of watchmen graves at Nazi camps, making our results unique.

Keywords Forensic Archaeology, Forensic anthropology, Forensic Genetics, Forensic Medicine, World War II, Burial Study

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Introduction

From the summer of 1941 until the summer of 1944, Germany enslaved hundreds of thousands of people in a forced labor camp, known as Treblinka I [1], which was located approximately 100 km from Warsaw, Poland. In the initial period of the camp's existence, the captives were brought from nearby villages as punishment for their purported criminal activity, such as not respecting the curfew, resisting the occupants, and participating in armed attacks on Germans. They were mostly of Polish nationality, but among them were also polish Jews. Later, people from other locations were brought to Treblinka I for executions (Pawiak prison captives, Jews from Warsaw ghetto, Romanis, Sinti, Italian soldiers, Jews from Hungary, and many others). The camp's conditions, as well as the camp guards' brutality, were so horrific that almost half of the captives (approximately ten thousand people) did not survive the imprisonment [2]. The crew of the camp consisted of nearly twenty SS soldiers and around a hundred watchmen, who kept guard over several thousand prisoners [3]. The watchmen (SS-Wachmannschaften) were mostly volunteers and recruits from prisoner-of-war camps, who were trained in a specially prepared facility in Trawniki near Lublin to become Nazi collaborators [4, 5].

The sentry formation units from Trawniki were created between August and September 1941 [4]. The unit had two official names: from the fall of 1941 to March 1942 it was known under the name „Guards of the representative of the Reich leader SS and chief of the German police for the establishment of the SS and police bases in the new eastern region " (Wachmannschaften des Beauftragten des Reichsführers SS Und Chefs der Deutschen Polizei für die Einrichtung der SS Und Polizeistutzpunkte in neuen Ostraum), and from April 1942 to summer 1944 it changed its name to „Guards of the SS and Police Leaders in the Lublin District " (Wachmannschaften des SS und Polizeiführers im Distrikt Lublin) [6]. The "Trawniki Men", known also among prisoners under the name "Blacks" or "Wachmann", played an essential role in Operation Reinhard, which was a secret German plan to exterminate Polish Jews in the General Government district of German Nazi occupied Poland. Without the efforts of the Trawniki Men, Nazis couldn't have implemented their "Final Solution of the Jewish Question" [3, 5]. In contrast to the Treblinka I camp victims, the names of most guards are known [3, 7], so, in theory, they could have been prosecuted after the war for the crimes they had committed if they had been caught and arrested.

In 1942, as a part of Operation Reinhard, an extermination camp, Treblinka II, was established [2]. Though the camp operated only until 1943, it is estimated that around 800.000 people lost their lives there. It was situated only 2 km north of the already existing Treblinka I forced labor camp. Regarding the detainees, there was continuous communication between the two camps [1]. Some strong and healthy captives were selected from the Death Camp and sent to the forced labor camp, and those sick and weak from the labor camp were often sent for extermination in the Treblinka II camp [8, 9]. As in Treblinka I, the crew comprised around 40 German soldiers and between 100 and 200 Trawniki Men [10]. Both camps' grounds were guarded by the watchmen [11]. Several mass graves could be found at the Treblinka II camp [11, 12], but no formal cemetery was uncovered where the crew members would be buried.

It has been recorded that the captives from both camps revolted against the guards on multiple occasions [3]. One of the most famous documented revolts was the uprising in Treblinka II on August the 2nd 1943, when the prisoners set the camp buildings on fire. They were armed with guns stolen from the camp's armory and with axes, crowbars, knives, and Molotov cocktails. During that riot, over 800 captives lost their lives and only 200 were able to escape [9]. There were several guards killed that day, but no reliable information is available on how many or how they died, or where and in what manner they were buried. Historical sources mention several other instances when Treblinka guards were killed by the captives [3, 8, 9, 13]. In addition, there were other causes of guards' deaths than armed attacks. Multiple epidemics spread through Treblinka (such as typhus, dysentery, scabies, and many more) while in operation [14, 15] resulting in the deaths of many watchmen [13]. However, little is known about where the fallen guards' bodies were buried nor about the manner of their interment.

In November 2019, during an archaeological survey on the grounds of a former Treblinka I forced labor camp [7, 16], a row of seven individual graves was uncovered. The survey was performed in a place called Execution Site, which is south of the former Treblinka I camp. In the early days of the camp's existence, the place served as a cemetery for the Treblinka I captives and later as an execution site. The site was very convenient for executions as it was heavily guarded [3, 7, 15].

Many clandestine mass burial pits were found there during past archaeological and forensic investigations [12, 17–19]. The first forensic examination in that place began shortly after the camps had been deserted, in August 1944. Fifty-eight burial pits were found during that investigation, and only three mass graves were opened, and the bodies underwent medico-legal examinations. From 1946 until 2007, no detailed professional investigations were carried out in Treblinka. In 2007, archaeologists from Staffordshire University received permission to conduct non-invasive research on the Treblinka I and Treblinka

II camp areas. During the research seasons of 2010, 2012, and 2013, archival research, interviews with witnesses, data analyses, 3D system visualization, and surface surveys were carried out. Six features of mass burial pits were found during the research campaigns [11]. In 2013, the first three small trenches were dug to confirm the existence of the graves. All three trenches contained disarticulated human remains, belonging to many individuals. On the bones, sharp force trauma marks were detected [1, 20]. Between 2016 and 2018, research campaigns for the Historical-GIS-Treblinka project were carried out by Warsaw University of Technology scientists [18]. The research included geophysical measurements, spatial data analysis, and excavation. A number of small survey trenches were made that cut across features and allowed for surveying the entire area. The end of the trench is marked by the presence of skeletal remains. The remains were not exhumed from the graves; they were documented in situ, and the trenches were filled with the original layers of soil. Excavation work revealed five locations of skeletal remains. One was a mass grave (Trench 1), and four were individual graves (Trenches 2–5). One of the individual graves had a metal funeral wreath placed on top of a wooden coffin (Trench 4). No identification attempts were made at that time. The results helped to select the research areas in 2019. Trench 6 turned out to be natural deposits of gravel and stones.

The individual graves were distinct from the mass burial pit located seventy meters east from the row [21], not only because they contained single bodies, but in terms of the artifacts interred with them. Based on the grave types and artifacts, we hypothesized that the graves could belong to the camp guards, who were lower in the camps' hierarchy than the SS soldiers but above the prisoners. That status would permit their bodies to be buried in the camp cemetery with honors.

We conducted an in-depth archaeological, anthropological, medical, and genetic study with the ultimate goal of finding out who these seven people buried in such a particular manner were and how they died. The personal identification of the unknown skeletal remains was performed with the application of the latest methodology commonly used in forensic cases for the time period under study. The identification of the remains of soldiers and civilians killed in past conflicts with the use of forensic methods is routinely done by various agencies worldwide (e.g. DPAA in the USA, [22], ARMH in Spain, [23], ONaCVG in France, [24], CWGC for the Commonwealth soldiers [25]). However, those methods are rarely applied in the identification process of concentration camps victims. Here, we aim to identify the seven bodies not only as a group, that is distinct from the other skeletal remains found at the site, but also to a personal level.

Materials and methods

Materials

In anticipation of Treblinka Museum's planned modernization works in the forest car park, archaeological surveys began in 2019. Its primary purpose was to discover clandestine burial grounds for victims who died in the forced labor camp as well as those transferred here from Warsaw for execution.

The archaeological survey conducted in November 2019 included two sites (Fig. 1). Site 1 covered the ground of the bus parking lot and contained a clandestine burial pit [19]. Site 2, located west from site 1, in the woods, contained an area of 1300 m^2 with rows of longitudinal depressions that could signify the location of burials. The depressions were detected for the first time with the use of airborne laser scanning (ALS data) and other non-invasive methods as a part of the Historical-GIS-Treblinka project between 2016 and 2019 [16]. Based on the results of non-invasive and excavation works, the area for full archaeological surveys was set in 2019.Those pits formed a line along the east–west axis for about 20 m. The depressions themselves were oriented south-north. Site 2 was densely wooded, so it was impossible to establish surveys of regular depth, width, and length. In 2019 during the survey of marked sinkholes, outlines of potential burials were noticed under the layer of humus (Figs. 2 and 3). The outlines were fully exposed, cleaned, and documented. In total, seven burials were uncovered. In two cases it was clear that the original burial outline was distorted. One was a probable robbery action; the other was a survey that had been carried out previously by other researchers.

The skeletons were exhumed by decision of prosecutors as part of the Polish Institute of National Remembrance's investigation of Nazi crimes committed in prisoners camps between 1941 and 1944. The Institute of National Remembrance—Commission for the Prosecution of Crimes against the Polish Nation—is responsible for conducting research and dissemination the modern history of Poland and investigating crimes committed between 8 November 1917 and 31 July 1990, during the Second World War, and the communist period. The survey in 2019 was overseen by the Rabbinical Commission for Jewish Cemeteries in Poland.

Methods

Archaeological methods

Before the exploration began, the site area was surveyed with metal detectors. All the findings were inventoried on an ongoing basis, and their locations were measured within designated sectors.

The first stages of the excavation were conducted with a backhoe with a slope bucket, which removed small layers

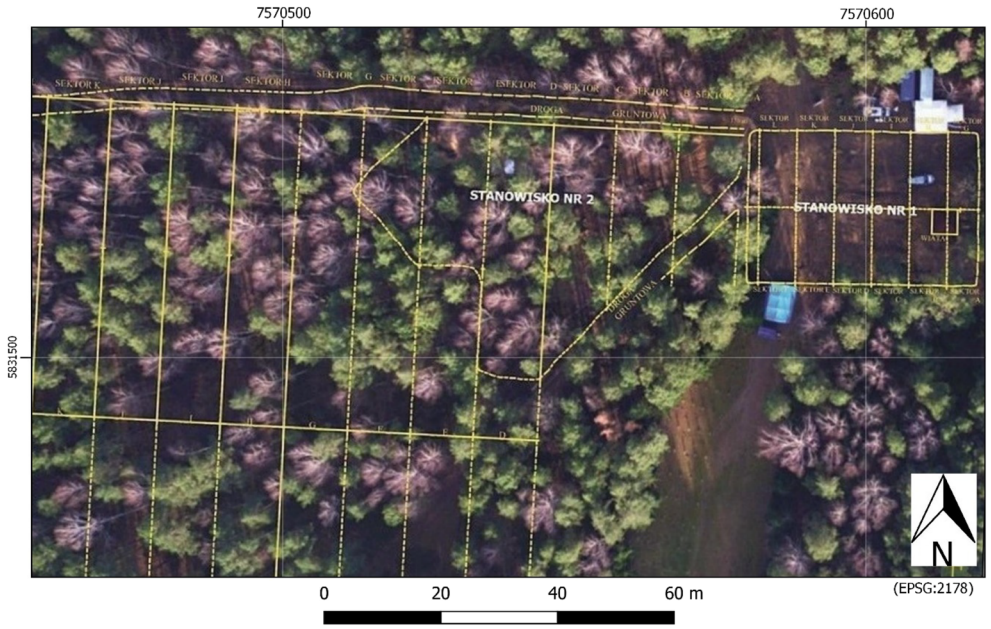

Fig. 1 Localization of the site 1 (stanowisko nr 1) and site 2 (stanowisko nr 2) with sector division

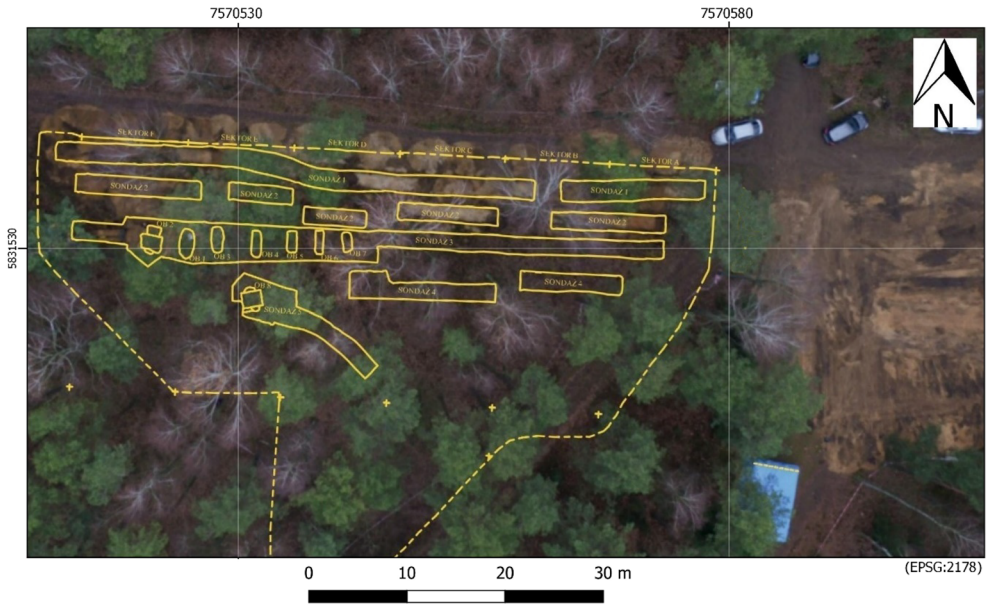

Fig. 2 The localization of individual burials in station 2

of topsoil to the bedrock level. The work of the backhoe was carried out under the constant supervision of archaeologists and anthropologists. The Museum Information Board, which is 10 cm above the ground level, served as a fixed height point for the measurements. The outlines of seven enclosed burial pits were recorded at this level. The burials contained coffins with the remains of single bodies, and artifacts that aided in the identification process. The documentation included measurements, drawings, photographs, and descriptions.

Then further exploration of the graves began. The cross-section of the individual burials was not made, except for two situations where the disturbance in the grave's continuity was noticed (graves 1 and 2, Fig. 4).

Fig. 3 The aerial shot of the single burials row in site 2

Fig. 4 Graves 1(**C** and **D**) and 2 (**A** and **B**) with robbery disturbances visible in the profile

There the burial pits were cut in half, and one-half of them was explored with shovels until the coffin lid was uncovered. The cross-sections of those graves have also been documented. The early stages of exploration in all burial pits were done with the use of backhoe and later cleaned manually with plastic shovels and tools with

blunt edges. Afterwards, the graphic, photographic, and descriptive documentation was prepared. During exhumation, each item that was discovered was inventoried and categorized. Cardboard containers were used to pack the skeletons for transportation to Pomeranian Medical University in Szczecin, Poland for anthropological, medical, and genetic analysis.

Biological anthropology methods

A detailed description of the in-situ body positions and significant taphonomic alterations was provided for each burial pit [26]. There was a double inventory of skeletons: during grave exploration and in the laboratory afterwards. Thus, we can conclude that we are dealing with single burials containing non-commingled skeletons. To evaluate the biological profiles, appropriate methods for this population were used [27]. Depending on the skeletons' preservation state (Fig. 6), the biological age was estimated with the use of auricular surface morphology [28], pubic symphysis morphology [29], teeth eruption sequence [30], teeth crown abrasion [31], teeth root translucency [32] and the developmental state of long bones [33]. The biological sex was determined with the use of skeletal elements' morphological features, mainly coxal bone and skull [34], and by applying metric methods on the coxal bone [35] and femoral or humeral head diameter [36]. The stature was calculated with the use of femoral length measurement and a regression formula based on assessed sex and ancestry [37]. The ancestry was estimated from the skull measurements with the application of two types of software, Ancestrees [38] and Cranid [39].

The skeletal trauma was described by providing information on the time of trauma occurrence, the location, the size of the lesion, the type of trauma, the lesions margin structure, and color [40, 41]. When referring to the time of trauma occurrence, the anthropological meaning of the term perimortem was used [42]. In cases of gunshot trauma, the diameters of entry and exit holes were measured and the bullet trajectory was predicted when possible. We used the endoscopic camera "WiFi Endoscope- HD 1200P" to look inside the cranium and search for traumatic lesions. Every traumatic lesion was additionally photographed with a scale (Figs. 7 and 9). Based on the observed perimortem trauma lesion, the forensic pathologist was able to determine the health consequences for the victim and determine the cause of death.

Genetic methods

The aim of the genetic research was to obtain efficient DNA material for identification purposes. The study involved healthy teeth embedded in the jaw, secured against access of endogenous genetic material [43]. Protective procedures have been implemented from the moment of exhumation, with the use of disposable gloves and Tyvek® suits to minimize contamination and degradation. Samples were immediately frozen, and all laboratory stages were carried out in separate rooms with positive and negative controls.

The genetic material was mechanically secured, chemically cleansed, and subjected to the DNA extraction process using the PrepFiler® BTA Forensic DNA Extraction Kit (Thermo Fisher Scientific) according to the manufacturer's instructions. DNA was quantified using the Quantifiler™ Trio DNA Quantification Kit (Thermo Fisher Scientific) on a 7500 Real-Time PCR instrument (TFS), assessing the concentration of human DNA, human male DNA, the presence of PCR inhibitors, and the degree of DNA degradation. STR and Y-STR markers were amplified using the GlobalFiler™ PCR Amplification Kit and the Yfiler™ Plus (both TFS) on a GeneAmp™ PCR System 9700 (TFS) thermal cycler, and the amplicons were analyzed through electrophoresis on a 3500 Genetic Analyzer (TFS) and data was processed with GeneMapper® ID-X Software 1.6 (TFS).

Hypervariable regions of the mitochondrial genome (HVI and HVII [44]) were sequenced using the Sanger method, and the sequences were compared with the Cambridge Reference Sequence. Whole mitochondrial genome sequencing was performed using next-generation sequencing technology. Mitochondrial DNA haplogroup analysis was conducted using phylogenetic tools such as the EMPOP database [45] and HaploGrep [46]. Next-generation sequencing was carried out for four individuals: skeletons numbered 1, 4, 5, and 7.

Results

Archaeological results

The orientation of the graves was north–south in all cases, with heads facing south. The depth of the burials ranged from 80 to 125 cm. Each body was buried in a separate wooden coffin and all the graves were disturbed to varying degrees. In the cases of graves 1 and 2, the trenches that caused the grave destruction were visible in the plan (Fig. 4): grave 1 was looting, and grave 2 was caused by a previous archaeological survey. Those disturbances did not affect the skeletons' anatomical arrangement in the graves.

In the other graves, no traces of robbery activity were registered in the plan. However, because certain skeletal elements were disrupted, the anthropologist stated that the graves had been disturbed sometime after the burial, when the bodies reached the skeletonization stage of decomposition. The intervention had to be made at a time when the grave was still clearly visible in the field because it did not extend beyond the original burial pit,

which would have left visible traces, as was in the cases of graves 1 and 2. Only the remains that were laid in graves 1 and 2 were in anatomical position, and in the case of the skeleton from grave 2, valuable grave goods were present (golden wedding ring). The other skeletons showed misplaced skeletal elements, e.g., the clavicles were put with medial ends on the lateral sides, the left and right forearm bones were mixed, etc. In two cases, funeral wreaths were found. The first, braided from wire with metal leaves, was found in a layer of topsoil and was originally placed on a grave mound (grave 1), the second, made of wire hoop decorated with multicolored plastic flowers, was placed directly on the lid of the coffin (grave 4; Fig. 5). Among the grave goods found with other skeletons (Table 1), there were plastic combs, German uniform buttons, wedding rings on two skeletons (the other one was a metal ring on skeleton 7), a guard's whistle with skeleton 2 (Fig. 5), bullet cases, and a pocketknife. No artifacts were found with skeleton 6.

Biological anthropology results

The preservation state in most of the skeletons was poor (Fig. 6). However, skeleton 1 was preserved quite well, with only a few bones missing from the feet and hands, fibula, patella, and one cervical vertebra. There was no texture damage on the bone surface, and no signs of weathering. The structural damage was typical for coffin burials. On some skeletal parts (vertebra, rib ends), the dried entomofauna remained. The skeleton 2 was also preserved well, with a few elements missing, mainly from feet and hands. However, here we observe massive signs of weathering; most of the periosteum is flaking and separated from the bone core. Skeletons 3 to 7 are poorly preserved and in a fragmentary state, with many elements missing, and with very advanced taphonomic changes in the texture and structure of the bones.

The results of the assessed biological profile are presented in Table 2. The skeletons were numbered with the same numbers as the graves. The biological age of four people (skeletons 4 to 7) was below 25 at the time of death. The age-at-death of three people (skeletons 1 to 3) was estimated to be over 30. It was possible to estimate the sex of six people, in the case of the seventh person the sexual dimorphic traits were not preserved. Two of them were males, four were possible males. There was no female sex in the studied material. It was possible to assess the biogeographical origin in two cases, where there was no structural damage to the skull bones. In both cases, the result rendered European ancestry. The stature was evaluated in six cases (except for skeleton 7), and it was in the range of 157 to 176 cm for all six people.

Among the pathological lesions found on the studied seven skeletons which would be helpful in the process of personal identification, we observed a healed

Fig. 5 The grave 4 with a funeral wreath. The metal whistle found in grave 2. The Mauser rifle case found in the soil of site 2

Table 1 Grave goods found with seven skeletons

No.	Grave goods	Photos of individuals in situ
1	Plastic comb, an underwear button, pieces of funeral wreath	
2	A golden ring on left hand, a plastic comb, eight German uniform buttons, a metal whistle	
3	Two highly eroded metal objects, and two gun casings	
4	Pieces of fabric on skeletal remains, funeral wreath with flowers	
5	Military jacket's buttons, an underwear button, a pocketknife	

Table 1 (continued)

No.	Grave goods	Photos of individuals in situ
6	No artifacts were found	
7	Metal belt buckle, and a metal ring on left hand	

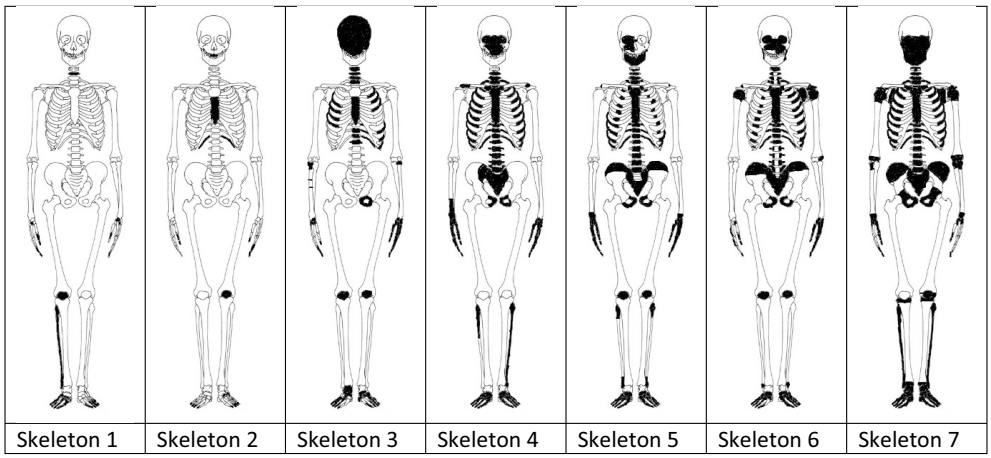

Fig. 6 Preservation charts of the seven examined skeletons. Missing parts are colored in black

fracture on proximal third of right fibula bone in skeleton 3. The other skeletal changes include Schmorl's Nodes in lower thoracic vertebra in skeleton 1 and a non-metric trait- the accessory bone in the bregma point in skeleton 4. The poor preservation state of skeletons 5 to 7 did not allow to record any pathological lesions nor trauma.

The perimortem trauma was observed on two skeletons. On skeleton 2 there was perimortem trauma on the skull (Table 3).

The observed gunshot injuries on the skull indicate at least three shots that were possibly inflicted by a weapon of the same caliber (Figs. 7 and 8).

It is not possible to determine the order in which the shots were fired as not all injuries resulted in additional fractures, therefore it is not possible to apply Puppe's rule [47]. Nevertheless, it is possible to draw some conclusions about the possible bullet trajectory or the angle of bullet penetration on the skull (Figs. 7, 8). Injury number 2 features of a bullet entry hole with a crater adjacent to

Table 2 The results of anthropological analysis (GST- gunshot trauma; BFT- blunt force trauma; NA- not applicable)

The skeleton number	Age	Sex	Ancestry	Stature [cm]	Trauma
1	34–44	Male	European	165–173	No
2	34–49	Male	European	169–176	3 × GST to the head
3	34–44	Male?	NA	157–165	No
4	18–25	Male?	NA	164–174	BFT to the head, GST on the patella
5	18–25	NA	NA	165–172	No
6	18–25	Male?	NA	167–174	No
7	18–30	Male?	NA	NA	No

the entry hole on the inner side of the bone and radiating incomplete fractures. There are no definite traces of the bullet's exit. It is possible that the bullet ricocheted off the internal structure of the skull and exited through the foramen magnum, hitting the edge of it, and causing fracture number 3. The oval shape of injury number 1 (Fig. 8) may indicate that the bullet penetrated the skull at an angle different than 90°. Based on the analysis of the bone beveling at the lower edge of the defect, it is assumed that the shot came from above. The bullet may have hit a part of the skull base, causing incomplete fractures, and bending of the bone fragments from the inside outwards to the right of the skull base. The green staining can mean that the bullet did not exit the skull but stuck in the bone and degraded due to erosion. The trajectory of the bullet of injury number 5 (Fig. 8) may be consistent with the shape of the defect. After using the probe to assess the bullet trajectory, on the underside of the injury, it can be assumed that the bullet hit the posterior wall of the maxillary sinus, causing a defect on the posterior side and an incomplete fracture on the anterior side, described as injury number 7. Based on the pathology report, the described gunshot injuries, especially those of numbers 1 and 2, penetrated the cranial cavity and caused extensive damage to the central nervous system, resulting in the death of the victim.

On skeleton 4, perimortem lesions were observed on skull bones and right patella (Table 4, Fig. 9).

The embedded shrapnel or a bullet in the right patella (Fig. 9) caused no additional injuries nor fractures to the patella, nor the skeletal elements forming the knee. There is no definite gunshot trauma to the skull detected. Injuries numbered 1 to 3 have features typical of blunt force trauma, but it is not possible to match a specific type of tool that caused specific damage nor to infer the order of the blows. The state of preservation did not permit a more thorough analysis of the traumatic lesions. The possible cause of death was the injuries to the central nervous system.

Genetic results

The genetic results of sex estimation and mitochondrial haplogroup type are shown in Table 5.

As a result of genetic analysis, the biological sex of six out of seven studied individuals was found to be male. Out of seven studied cases, it was possible to obtain a genetic profile and estimate mitochondrial haplogroup for six people. The results are in line with the anthropological analysis of ancestry estimation.

Discussion

The single burials uncovered during the archaeological survey in 2019 on the land of the execution site at the Treblinka I labor camp contained individual skeletons

Table 3 The traumatic lesions observed on skeleton 2

Location	Trauma
Skull- occipital bone	1. An oval defect on the left side of the bone, near the lambdoid suture, of dimensions 14 × 9 mm, on the bottom side of the defect there is a slight beveling 2. A circular defect in the area of the occipital protuberance, in the middle of the squama, approximately 9 × 11 mm in size. On the left margin of the defect, there is a slight crater-like collapse of the bone fragments. From the defect goes a line of incomplete fracture that reaches the skull base 3. An incomplete fracture running from the foramen magnum at the back of the left articular surface towards the back of the skull for a length of about 22 mm 4. On the skull base, next to the spheno-occipital synchondrosis, there are raised, bulging bone structures with incomplete comminuted fractures and green bone staining
Skull- left temporal bone	5. A funnel-shaped defect along the mastoid process, of a maximum width of about 11 mm. The defect runs slightly anteriorly inferior. On the anterior side, there are perpendicular lines of incomplete fractures that extend from the fracture edges 6. An incomplete fracture running parallel to the injury described above, running across both edges of the external auditory meatus. The fracture line runs up the bone for about 18 mm
Skull- left maxilla	7. An incomplete fracture running parallel to the zygomatic-maxillary suture from the lower edge of the orbit downwards and to the posterior side. There the fracture line changes into a circular defect that exposes the maxillary sinus. It is impossible to estimate the time of the defect formation

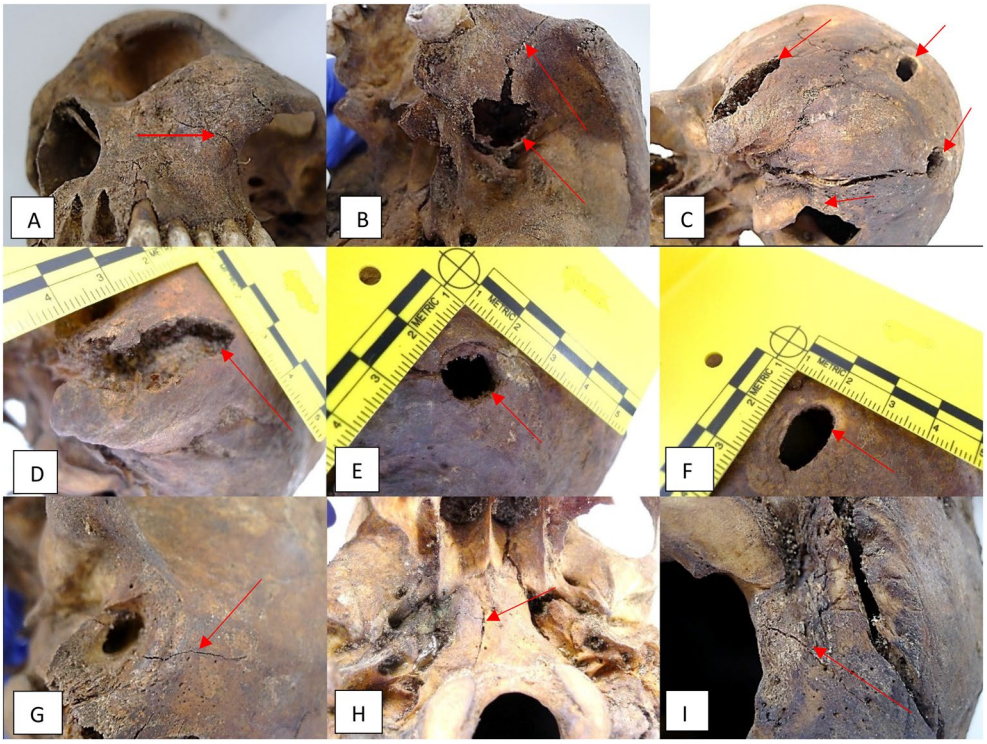

Fig. 7 **C**- the injuries on skeleton 2. **A** and **B**- injury 7, **D**- injury 5, **E**- injury 2, **F**- injury 1, **G**- injury 6, **H**- injury 4, **I**- injury 3. Red arrows point the lesions

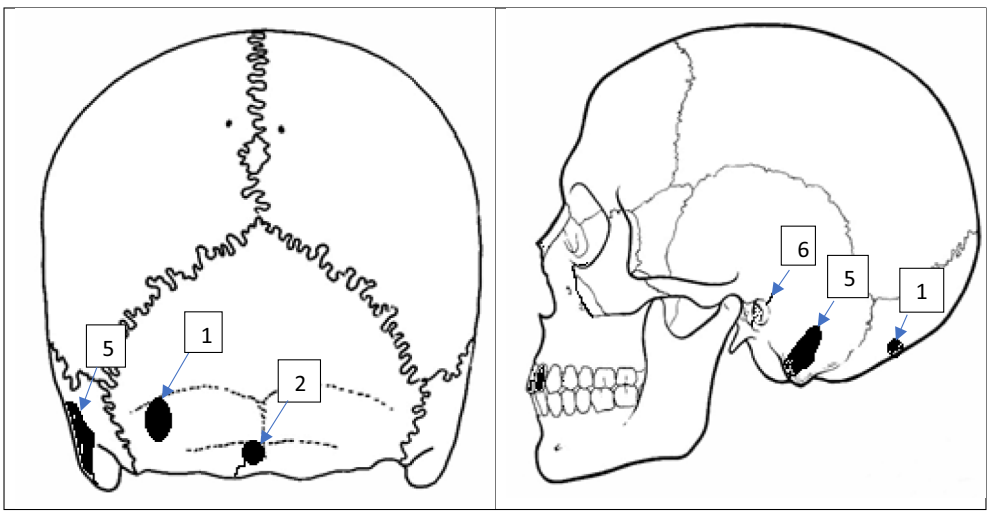

Fig. 8 Diagram of the posterior side of the skull from skeleton 2 showing traumatic defects in black. Diagram of the left side of the skull from skeleton 2 showing traumatic defects in black

from bodies buried in separate coffins. At the time of the discovery, it was unknown who the people buried in such a distinct manner were. A team of experts from various scientific disciplines was appointed to identify those deceased and, if possible, to determine the cause of their death.

The preservation state described by an anthropologist was correlated with the genetic analysis' success. Those skeletons that were very well preserved contained a high enough amount of DNA for deeper genetic study. The relation between the bone structural preservation state and the possibility of full DNA profile

Table 4 The traumatic lesions observed on skeleton 4

Location	Trauma
Right patella	Embedded bullet or shrapnel fragment on the anterior side of the patella. No additional fractures were detected
Skull	1. Right parietal bone- a possible depression fracture in the middle of the bone 2. Left parietal bone- an incomplete fracture extending from the center of the bone to the left to the edge of the bone. Part of the bone, behind the fracture line is concaved, possibly due to a taphonomic process 3. In the posterior part of the left parietal bone, there are fragments from the comminuted fracture, possibly the remains from the radiating fracture type. Fractures caused a separation of two fragments near the lambdoid suture measuring approximately 34 × 41 mm and 33 × 37 mm 4. Irregular injuries of unknown etiology are visible in the area of the glabella. To the right from the point glabella, there is a semicircular lesion of diameter around 7 mm. Another semicircular injury is on the left from the glabella. From the injury goes a crack up the bone for a length of 4 mm 5. Right maxilla- perimortem fracture near the first molar

Fig. 9 Photographs of selected injuries on skeleton 4. Skull injuries- **A**- injury 1, **D**- injury 4, **E**- injury 4. **B** and **C**- patella with embedded bullet. Red arrows point the lesions

acquirement was consistent with previous findings of various researchers [48–50].

The fact that the deceased were buried in individual graves, and that they were interred in coffins with honors, which is proved by funeral wreaths found on top of two coffins, it may be inferred that those people played a significant role in the Treblinka Camps. The evidence in the form of artifacts recovered from the coffins, such as a metal whistle, bullet cases, and buttons from a German uniform, point to the possibility that the people buried in the studied graves belonged to the camp's guarding crew.

Historical sources mention that in both Treblinka camps, the guards were mostly Ukrainians, Lithuanians, and Latvians [1]. They were all males, mostly young, and under 30 years of age. But much older people, even those over 40 years old, were also present. They were equipped with Mauser vz. rifles and bayonets [3]. Although they played an important role in the camp, they were not equal in hierarchy to German SS soldiers [51]. They had to follow the orders given by the Germans. They were not permitted to beat prisoners, but there were a few exceptions. From the written survivors' testimonies, we know that Franz Swidersky was allowed to perform executions

Table 5 The results of DNA profiling within Global Filer and Y Filer Plus human identification systems (TFS), mtDNA HV1 and HV2 region sequencing, and whole mitogenome sequencing of remains from individual burial pits (ISFG Washington 2022)

Skeleton number	Global filer™	YFiler plus™	Genetic sex	mtDNA haplotype	mtDNA haplogroup
1	Full profile obtained	Full profile obtained	Male	HVR1, HVR2, and WG obtained	H
2	Full profile obtained	Full profile obtained	Male	HVR1 and HVR2 obtained	R0
3	Profile not obtained	Profile not obtained	Not detected	Not obtained	Undefined
4	Full profile obtained	Full profile obtained	Male	HVR1 (16024–16350), HVR2, and WG obtained	U5a1a1h
5	Partial profile showing signs of degradation	Partial profile showing signs of degradation	Male	WG obtained	J1c1b1a1
6	Partial profile showing signs of degradation	Full profile obtained	Male	HVR1 and HVR2 obtained	U5a2a
7	Partial profile showing signs of degradation	Partial profile showing signs of degradation	Male	WG obtained	H28a

on captives. The watchman Braun, who was a Russian volksdeutsch, was allowed to beat prisoners [1, 3, 7].

The assessed biological profile is consistent with the historical records describing the Treblinka watchmen [13, 52]. The biological sex was confirmed using anthropological and genetic methods. The age-at-death, estimated by the anthropologist, shows that over half of the studied men were under 30. The biogeographic origin evaluated by the anthropologist and geneticist point to European origin. Based on obtained haplotypes, remains tested within this study were assigned to haplogroups such as: R0, H, H28a, U5a2a, U5a1a1h and J1c1b1a1, which are common in Europe [53]. Subhaplogroups belonging to U5, such as a subclade U5a is most common in north-east Europe, with very high frequencies observed in Volga-Ural region of Russia, Estonia, Lithuania, Latvia, Ukraine, and it occurs with high frequency in Poland (up to 12.35%) [54–56]. Haplogroup H, which derives from haplogroup R0, occurs with high frequency in all European populations. Its prevalence in Europe varies between 40 and 50% [57, 58]. Haplogroup J is present at the level of almost 9% in Europe and about 13% in the Middle East [59].

The traumatic lesions noticed on two people could not be self-inflicted. The multiple gunshot wounds on the skull of skeleton 2, of which two were in the back of the head, exclude any possibility of suicide [40]. One of the entry wounds on the occipital bone has morphological characteristics typical for a contact shot [60], meaning that the perpetrator put the gun against the victim's head. A similar manner of death has been confirmed with blunt force trauma and gunshot trauma on skeleton 4. The blunt force trauma injuries are above the Hat Brim Line [61], commonly linked to interpersonal violence. The fact that the bullet stuck in the kneecap and did not produce any further fracture around the impact area, can indicate that the energy of the impact was very low [62]. This could have been caused by either the ricochet of the bullet from some other distant object or the malfunction of the firing weapon. It cannot be excluded that the weapon was self-made.

Many home-made weapons are constructed of metal piping and a sprung hammer. The lethality of those weapons is described as very low in forensic medicine cases [63]. The kinetic energy of bullets fired from self-made weaponry is usually lower than that of commercial weapons' bullets [64]. In the 1950s, home-made weapons were commonly used in juvenile gang-related encounters [65]. In Israel they are used in terror crimes [66]. The historical sources do not report any incident of using self-made fire weapons in Treblinka revolts. However, the historical sources are mainly based on the survivors' statements, and there are very few survivors of Treblinka captivity. Therefore, we cannot know whether the captives ever constructed and used a firearm to fight the camp guards.

The uprising of the extermination camp prisoners happened in many other camps as well. The uprising in the Sobibór extermination camp on October 14th, 1943 was well documented [67]. Sobibór was one of three main extermination camps set up by Nazi Germans. The other two were Bełżec and Treblinka [52]. After the Bełżec was liquidated, the prisoners in Sobibór knew that it was their last chance to riot. It is estimated that 275 people escaped from the camp, 40 prisoners died in action and 12 Germans were killed by the combatants [68]. After the revolt was contained, the bodies of the fallen Germans were lavishly buried in the cemetery with funeral wreaths on their coffins [69–71]. As shown in this example, Germans treated the bodies of their fallen colleagues with respectful manner and conducted funeral rites in extermination camps. This would explain why we found funeral wreath pieces on two coffins from Treblinka.

The absence of funeral wreaths on other coffins, and other significant grave goods, does not mean that the other five people were buried differently. It has been documented in many historical sources that after the Treblinka camp was shut down, many graves were robbed by local treasure hunters [72, 73]. Those actions were witnessed by Rachela Auerbach, Jan Królikowski, and many others. The looting lasted until the late 1960s, when the site was commemorated [7, 74].From archaeological analysis, we know that most of the seven studied graves have traces of postmortem interference. Because the robbing ditches did not interrupt the continuity of the grave's outline, they had to be made at a time when the graves were visible in the field, and the person who made it knew where to dig to reveal the fragment of interest. Traces of damage or tampering were especially visible in the torso and head areas, which is where the personal items might be expected to be found. In grave 3, there was no disruption in the roof layer, but the skeletal elements were arranged in a chaotic manner. The only undisrupted grave was number 2, as evidenced by the intact arrangement of the remains and the fact that he was not deprived of a gold ring. The destruction and displacement of the skulls accompanying robbery digs in graves 5, 6, and 7 could have been done deliberately.

Because of the postmortem damage of the skeletons that was done either by the robbers or by environmental erosion, our study faced limitations regarding the process of the biological profile components assessment and perimortem trauma analysis. It cannot be established whether all the people buried in site 2 died a violent death, possibly during the uprising or some other incident, or maybe they died because of some disease that was circulating in the camp at those times. We know from the historical records that in Treblinka there were several typhoid fever outbreaks, resulting in many deaths [1–3, 7].

Another consequence of the skeletons' incompleteness is the difficulty with personal identification of the deceased. The names of almost all the Treblinka staff are publicly known [2, 52], but it will be impossible to identify them with the use of DNA or odontology without any reference samples. One of the possible methods of identification in such cases is through facial approximation [75]. The most famous example of personal identification from a photographic picture was the case of John (Ivan) Demjanjuk, a camp guard. A retired man from Cleveland, Ohio, was accused of being a watchman called "Ivan the Terrible" stationed in the Treblinka camp during the war [42, 76]. That case showed the need for rigorous scientific standards in personal identification from photographs. Facial identifications often lack scientific rigor and are prone to high degree of error [77]. Although the method is far from perfect, there are many reports of successful identifications from forensic facial approximations [78, 79].

The preservation state of two skulls, belonging to skeleton 1 and 2, is acceptable for facial approximation as the craniofacial elements were preserved without major postmortem damage. If compared with the watchmen's ID book photographs, the reconstructions of these two faces can facilitate personal identification. Due to lack of access to the full documentation of the case, the authors of the manuscript were unable to identify the person using the aforementioned method.

More details on the genetic analysis and facial approximation process done on the watchmen skeletons will be provided in forthcoming publications. For future studies, we plan to continue exploration of other individual graves extending the seven burials at site 2 of the Treblinka camp.

Conclusion

The combined results of archaeological, anthropological, medico-legal, and genetic analysis allow us to conclude that the individual graves situated in the former execution site at the Treblinka penal labor camp belong to the camp's guards. The trauma analysis results allow us to deduce, that some of the deceased died during the famous Treblinka uprising in August 1943 or some other riot created by the Treblinka captives.

The analysis of the World War II camp guards' graves was never published in any peer-reviewed literature, which makes our study unique. The prior non-invasive studies carried out at the Treblinka Execution Site made a significant contribution to the reconstruction of the camps' architectural layout and the identification of potential mass and individual burials. However, those studies cannot identify specific individuals or establish their cause and manner of death.

With the advancement of new personal identification methods, we can gain more information on who the guards in Nazi concentration camps were. Moreover, we contribute to the knowledge of funeral rites prevalent in those camps, which like many other aspects of the concentration camp's culture, remains obscured.

Geographical coordinates

Treblinka lies in Ostrow Mazowiecka, Mazowieckie, Poland 52° 40′ 0″ North, 22° 2′ 0″ East.

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Author contributions
JD—a corresponding author: conceived and performed the main anthropological research, wrote the main manuscript; JZ and OB performed facial approximation; JJ-S, MJ performed and edited archaeological part of manuscript; DL, SC and MSz performed and wrote genetic part of manuscript; KS—consulted and edited antrhopological part of manuscript; JJ-S was in charge of the archaeological part of the project, DL sampled material and prepared for DNA extraction, MSz was responsible for NGS sequencing, MJ was archaeological consultant of the project, KS was anthropological advisor and proofreader of the manuscript; MP, AO- these authors jointly supervised this work: MP was responsible for medico-legal aspect of the research, AO supervised the project. All the authors discussed the results and contributed to the final version of the manuscript.

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Availability of data and materials
The data that support the findings of this study are available from the Institute of National Remembrance, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Institute of National Remembrance.

Declarations

Ethics approval and consent to participate
This article does not contain any studies with living human participants performed by any of the authors. All human samples are more than seventy years old and anonymous, they were subjects of criminal investigation led by the Institute of National Remembrance prosecutors. The criminal cases conducted by a prosecutor do not require ethical approval in Poland (https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU19990470480/O/D19990480.pdf). After the submission of our expert opinion we obtained the prosecutor's permission to publish our results. Moreover, we followed guidance for the ethical treatment of human remains following BABAO (https://www.babao.org.uk/assets/Uploads/BABAO-Code-of-Ethics-2019.pdf).

Consent for publication
This article does not contain any studies with human participants performed by any of the authors. All information reported in this paper is anonymized and the submission does not include images that may identify the person.

Competing interests
The authors of the submitted manuscript declare no conflicts of interest to disclose.

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