

OSTEOLOGICAL REPORT OF THE BURIED INDIVIDUALS FROM THE LATE BRONZE AGE CEMETERY OF INZERSDORF OB DER TRAISEN, AUSTRIA

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Zusammenfassung

Die osteologische Analyse von Inzersdorf ob der Traisen, Österreich, konzentrierte sich auf 248 Kremierungen aus 218 Gräbern der Spätbronzezeit, darunter 18 Doppelbestattungen und sechs Dreifachbestattungen. Bei den meisten Doppelbestattungen wurde ein erwachsenes Individuum mit einem Subadulten begraben. In den meisten Brandbestattungen konnten verbrannte Knochenfragmente aus allen Körperbereichen identifiziert werden. Das durchschnittliche Gewicht der Knochenfragmente pro Grab betrug 196,25 g, wobei die Knochen von Subadulten schlechter erhalten waren und ein geringeres Gewicht aufwiesen. Das Verbrennungsstadium der Brandbestattungen von Adulten war, nach WAHL 1981, Verbrennungsstufe III (Temperaturen um 550 °C), wobei die Subadulten im Durchschnitt bei höheren Temperaturen verbrannt wurden. Das Verhältnis von Erwachsenen zu Subadulten betrug 1:1,05. Das Geschlecht konnte bei 80 erwachsenen Individuen bestimmt werden. Das Verhältnis von männlichen Individuen zu weiblichen Individuen betrug 1:1,12 (Individuen, die nur eine Tendenz zu einem bestimmten Geschlecht hatten, wurden hier ausgeschlossen). Von den 118 subadulten Individuen waren über 83 % jünger als 13 Jahre, wobei nur sieben Individuen Jugendliche waren. Die Sterblichkeitsrate war bei jungen Menschen hoch (ca. 14 %). Die Sterblichkeitsrate sank in der Pubertät auf 4 % und stiegen wieder ab der Altersklasse Spätadult (34–40 Jahre) an, wobei die Raten bei Männern und Frauen ähnlich waren. Subadulte Individuen litten überwiegend an Stoffwechselkrankheiten, während erwachsene Individuen starke Muskelmarker und altersbedingte Krankheiten aufwiesen.

Schlagwörter

Kremierung, demografische Analysen, späte Bronzezeit, Urnenfeldkultur, Inzersdorf ob der Traisen

Abstract

The osteological analysis of Inzersdorf ob der Traisen, Austria, focused on the 248 cremated human remains from 218 Late Bronze Age graves, among them 18 double burials and 6 triple burials. Most double burials involved an adult individual buried with a subadult. Most graves were complete, and bone fragments of all body areas could be identified. The average weight of calcined bone fragments per grave was 196.25 g, with subadults having lower bone preservation stages and bone weights than adults. The burning stage for adult graves was III (after WAHL 1981), indicating temperatures around 550°C, with subadults cremated at higher temperatures on average. The ratio of adults to subadults was 1:1.05, with 80 adult individuals having sex determination. The sex ratio was 1:1.12 of males to females when individuals with only a tendency towards a certain sex were excluded. Of 118 subadult individuals, over 83% were younger than 13 years old, with only seven individuals being adolescents. Mortality rates were high in young individuals (approx. 14%), dropped to 4% in puberty, and increased again in the late adult age group (34–40 years), with similar rates between males and females. Subadult individuals were

predominantly infected by metabolic diseases, whereas adult individuals showed signs of extensive occupation and age-related diseases.

Keywords

Human cremated remains, demographic analysis, Late Bronze Age, Urnfield culture, taphonomy, anthropology

Introduction

This article sums up the osteological results of the human cremated remains from the Late Bronze Age cemetery of Inzersdorf ob der Traisen in Austria (FRITZL et al. 2025). This report contains information on burning conditions, bone preservation and biological profiles of the deceased, and the demographic composition of this assemblage. The osteological data was also used in a previously published article on a mobility study using strontium isotope analysis (FRITZL et al. 2024) and in a study of pathological lesions in cremated remains of juveniles (ŠIKANJIC et al. 2024).

Methods

The analysis of human remains was performed following the guidelines of the British Association of Biological Anthropology and Osteoarchaeology BABAO (BRICKLEY, MCKINLEY 2004). The bone fragments were individually separated into the following anatomical areas: cranium, thorax, pelvis, upper limbs (including the shoulder girdle), lower limbs, and unidentifiable long bone fragments. Animal bones commingled with the human cremated remains were separated for zooarchaeological analysis. The total bone weight and the weight of the individual fractions were recorded. If several individuals were mixed, the MNI was estimated based on the most frequent element and further information that definitively separated two individuals from each other, for instance sex or age at death. Based on the colour of fragments (Table 1), the cremation temperatures were estimated following WAHL 1981:

Table 1: Burning stages and corresponding colouration and temperature ranges after WAHL 1981.

Burning stage	Colouration	Temperature [°C]
I	yellow-white, ivory-white	<250
II	brown to black	300–400
III	grey to blue-grey	around 550
IV	milky-white, chalky-appearance	650–700
V	off-white; calcined	around 800° and higher

Heat fractures were described after the categories of STEWART 1979 and HERRMANN, BENNETT 1999. The sex estimation was performed morphologically based on FEREMBACH et al. 1979, PHENICE 1969, and WALKER 2008 as well as metrically using an adapted version of the method published by CAVAZZUTI et al. 2019. Here, probabilities for single individuals falling into the different sex groups were calculated. If no features for a sex determination were available, sex was estimated based on a seriation of diaphyseal thickness (robusticity) to receive at least a tendency towards male or female sex. To evaluate the discrimination of morphological sex characteristics, the precision for single criteria was used based on INSKIP et al. 2019. Sex determination was performed according to the following categories in Table 2.

Table 2: Sex categories and their definition based on the accuracy of the sex determination for individuals.

Sex categories	Accuracy of sex determination methods [%]
Female/ Male	$p \geq 90$
Probably female/ probably male (female?, male?)	$80 < p < 90$
ambiguous with a tendency to a certain sex (female??. male??)	$65 < p < 80$
ambiguous	$p < 65$

Age at death was estimated based on the tooth eruption (UBELAKER 1979), the iliac auricular surface (LOVEJOY et al. 1985; BUCKBERRY, CHAMBERLAIN 2002; OSBORNE et al. 2004), transitional analysis (BOLDSEN et al. 2002), and the ossification of epiphysis (SCHAEFER et al. 2009). Individuals were classified into the age categories visible in Table 3. Due to an imprecise age-at-death estimation, single individuals may fall into a range of several age categories.

Table 3: Age categories and corresponding age ranges

Age category		Age range [y]
subadult		0–19
	foetus/neonate	<=1
	infans	0–12
		infans Ia 0–3
		infans Ib 4–6
		infans II 7–12
	adolescent	13–19
		early adolescent 13–15
		late adolescent 16–19
adult (development completed)		20+
	adult	20–40
		early adult 20–28
		middle adult 29–35
		late adult 36–40
	mature	41–60
		early mature 41–50
		late mature 51–60
	senile	61+
		early senile 61–70
		late senile 71+

The mortality rates and mortality table were calculated based on the determined age groups and the guidelines published by ASCADI, NEMESKÉRI 1970. For this, a relative top margin of 70 years was set. If individuals fell into more than one age group, the probable numbers of individuals per age group were calculated as weighted scores. For example, if one individual fell into two groups, the individual number of one was split between both groups (each 0.5). If more than two age groups were covered, middle groups received a higher score than groups further off the mean following a normal distribution as suggested by GROSSKOPF 2004.

Results

The osteological analysis of Inzersdorf included the remains of 248 cremated humans from 218 graves (raw data: see supplementary data provided as .csv).

State of preservation

In 80.6% of all individuals, bones of all body areas could be identified. 19.5% of all graves were incomplete with at least one body region missing (Table 4, Figure 1). On average, each grave contained 196.25 g of calcined bone fragments. The average bone weight and preservation stage in subadults were significantly lower than in adults (average cremation weight: subadults: 49.6 g, adults: 381.6 g; Mann-Whitney-U-test: $p < 0.001$; Figure 2).

Table 4: Bone preservation stages and corresponding bone weights in different age groups.

Stage of preservation	All individuals			Subadults			Adults		
	n	%	weight [g]	n	%	weight [g]	n	%	weight [g]
all body areas	200	80.6	237.1	84	71.2	62.26	104	92.9	402.30
cranium only	1	0.4	4.7	1	0.8	4.66	0	0	0
postcranial skeleton only	5	2.0	34.8	3	2.5	47.35	1	0.9	28.19
no lower limbs	17	6.9	68.2	10	8.5	28.99	6	5.4	144.16
diaphyses only	6	2.4	5.3	4	3.4	7.17	1	0.9	2.59
general bone fragments only	19	7.7	8.4	16	13.6	9.90	0	0	0

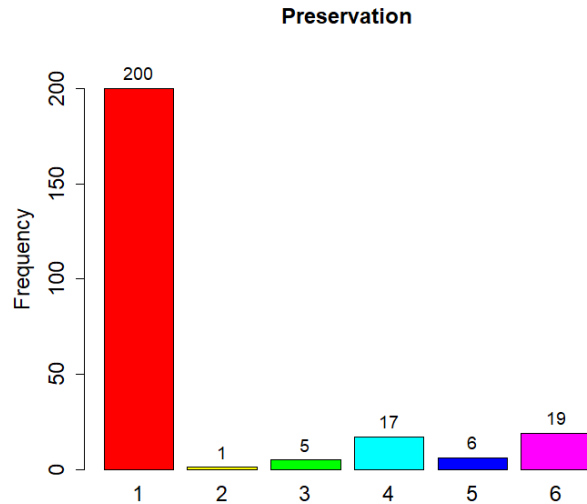


Figure 1: Bone preservation stages according to identified bone fragments which could be assigned to a certain body area: 1: fragments of the whole skeleton present, 2: cranium only, 3: postcranial fragments only, 4: all body areas except the lower limbs are present, 5: only diaphyseal fragments, 6: only tiny non-identifiable fragments present.

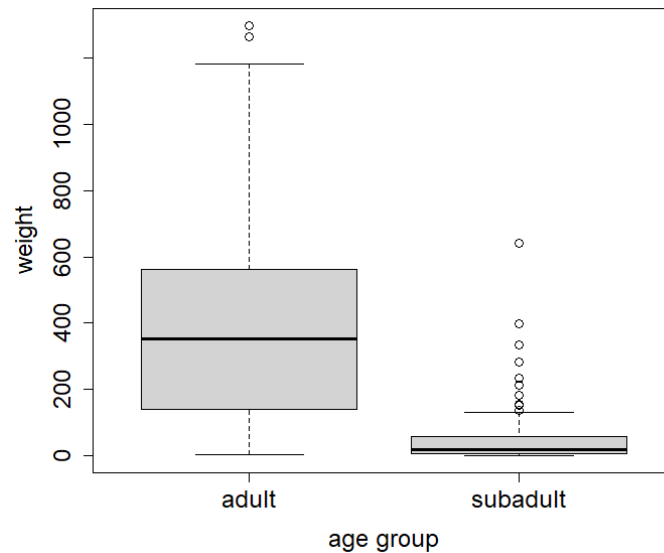


Figure 2: Bone weight distributions of subadult and adult individuals.

Looking at the stages of preservation for male, female, and ambiguous individuals (Table 5), most graves contain fragments of all body areas (470–580 g). Graves containing individuals with no possible sex determination contained fewer bones on average (149 g). There are no significant differences between males and females in bone preservation (Mann-Whitney-U-test: $p = 0.67$, Figure 3).

Table 5: Bone preservation stages and cremation weight in adult individuals separated into sex groups.

Stage of preservation	Male			Female			Ambiguous			Undetermined adult individuals		
	n	%	weight [g]	n	%	weight [g]	n	%	weight [g]	n	%	weight [g]
all body areas	15	88.2	577.50	19	95.0	488.47	43	97.7	468.64	27	87.1	148.87
cranium only	0	0	0	0	0	0	0	0	0	0	0	0
postcranial skeleton only	0	0	0	0	0	0	1	2.3	28.19	0	0	0
no lower limbs	2	11.8	335.01	1	5.0	16.35	0	0	0	3	9.7	59.48
diaphyses only	0	0	0	0	0	0	0	0	0	1	3.2	2.59
general bone fragments only	0	0	0	0	0	0	0	0	0	0	0	0

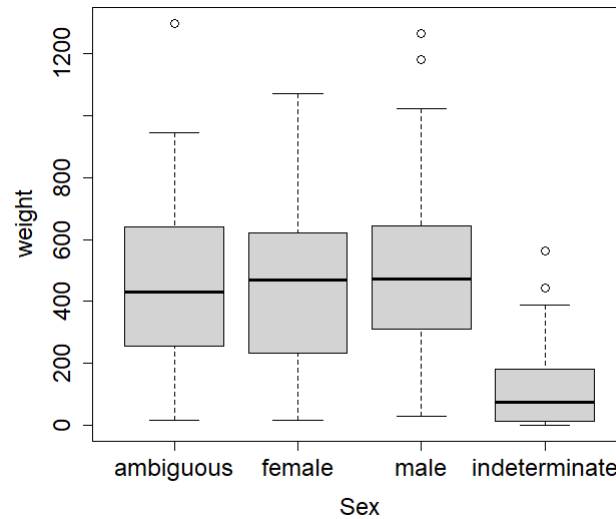


Figure 3: Average bone weights in the group female, male, and ambiguous sex determination.

Burning condition

In the median, adult graves fall into the burning stage III, which is consistent with burning temperatures of approximately 550°C. Burning stage differences between females and males are not significant (chi²-test: $p = 0.151$, Table 5). Subadult individuals were cremated at higher temperatures on average (stage: IV; chi²-test: $p < 0.001$, Table 6), which corresponds to the lower body weight.

Table 6: Frequencies of male, female, and ambiguous individuals of the burning stages

Burning stage	Male		Female		Ambiguous		Indeterminate		Adult		Subadult	
	n	%	n	%	n	%	n	%	n	%	n	%
I	0	0	0	0	0	0	0	0	0	0	0	0
II	0	0	0	0	0	0	1	3.2	1	0.9	0	0
III	17	100	16	84.2	36	81.8	17	54.8	85	75.9	27	23.1
IV	0	0	3	15.8	8	18.2	13	41.9	26	23.2	90	76.9
V	0	0	0	0	0	0	0	0	0	0	0	0

Minimum number of individuals (MNI)

From 218 graves, 194 (89% of all graves) were identified as single burials, 18 were double burials, and 6 graves contained at least three individuals. Double burials predominantly contained the remains of an adult individual buried with a subadult ($n = 14$, 78%). Only one grave contained two subadults, and two graves contained two adult individuals. In two cases, one adult male and one adult female individual were buried together. Three triple burials contained the remains of one adult and two subadults. In one grave, a female individual was buried with two subadults (G4). In the other two graves, the sex of the adult individual could not be determined.

Three further triple burials contained the remains of two adults and one subadult. Besides the subadult individual, one grave contained the remains of two females, and the other those of a female and a male. In the third grave, only the sex of one adult individual could be determined (female). Grave 14 was also expected to be a double burial. However, the cremation of the second individual was lost and could not be verified.

On average, the bone weight measured 191.4 g for individuals buried in single graves. As expected, double graves and triple graves contained more bones (double burials: 370.05 g, triple burials: 775.03 g, Figure 4). Looking at the average bone weight per individual, individuals in double graves contain 185.03 g, which is very similar to the recovered bone weight in single graves. In triple burials, individuals are slightly better preserved (258.34 g). All three grave types contain significantly different bone weights (pairwise Wilcoxon-signed-rank-test: single-double burials: $p = 0.026$; single-triple burials: $p < 0.001$, double-triple burials: $p = 0.028$).

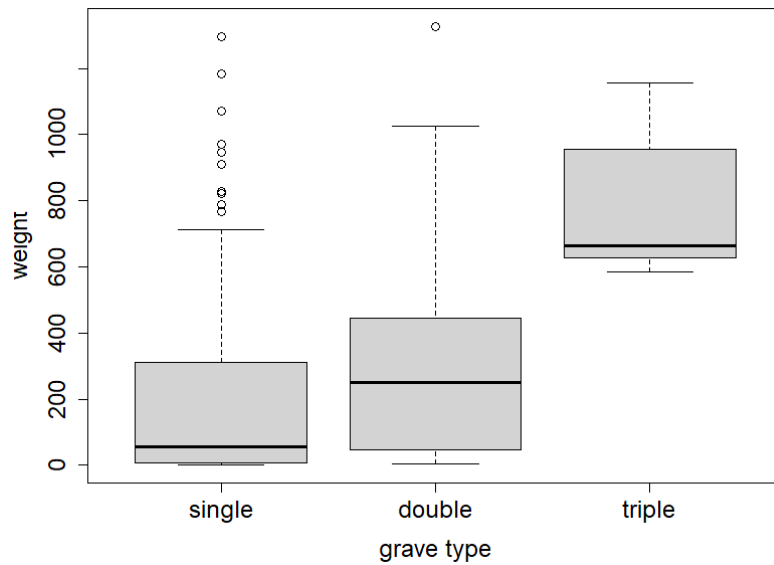


Figure 4: Distribution of bone weights recovered from single, double, and triple burials.

Demography

112 individuals could be identified as adults, 118 as subadults. A successful sex determination was possible for 36 adult individuals (32.1%, Figure 5), 10 adult individuals were identified as males, 10 as females. Six individuals fall into the group “probably male”, nine into the group “probably female” (= male? or female?, see tab 2). Eight individuals fall into the ambiguous range. 36 individuals were ambiguous but with a tendency towards one sex (female??: $n = 21$, male??: $n = 15$). This provides a ratio of 1:1.12 of males to females if individuals with a tendency towards a certain sex are excluded from the ratio. Most adult individuals did not allow a detailed age-at-death estimation ($n = 64$). 10 individuals fell into the age group “adult to mature” (20–60 years). 38 could be estimated as part of the age group mature-senile (40+ years). Seven females and 13 males provided a detailed age-at-death estimation (Table 7).

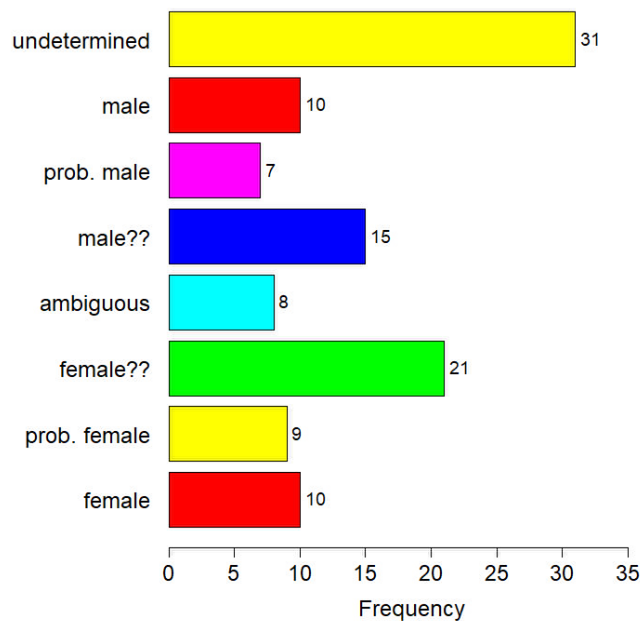


Figure 5: Frequencies of sex determination groups.

Table 7: Summary of Age groups for all adult individuals, females, and males.

	Total		Male		Female	
	n	%	n	%	n	%
adult (20-40 y)	2	1.8	0	0	0	0
adult-mature (20-60 y)	8	7.1	2	11.8	2	10.5
mature-senile (40+ y)	38	33.9	11	64.7	5	26.3
adult (20+)	64	57.1	4	23.5	12	63.2

The ratio of adults to subadults was remarkably high in Inzersdorf (1:1.05). From 118 subadult individuals, 107 individuals could be assigned to more detailed age categories. The remains of two fetuses were identified. Over 83% of all subadult individuals were younger than 13 years old (infans; $n = 98$). Of them, 56 were infans I and 27 infans II. Only seven individuals were adolescents (Figure 6).

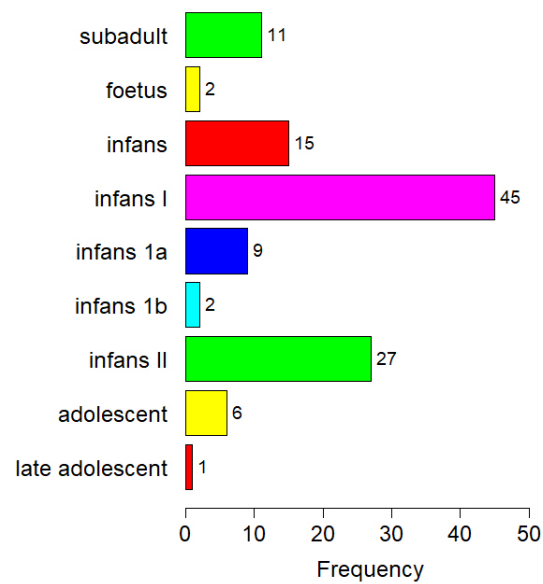


Figure 6: Frequencies of individuals falling into subadult age groups

In young individuals (0–12 years), the mortality rate is high (approx. 14%; Figure 7). The rate dropped in puberty to 4% and increased again in adult individuals. A second peak is visible in the age group “late adult” (34–40 years) with a mortality rate of 15.1%. Female and male adult individuals showed very similar mortality rates. Due to many adult individuals without successful sex determination, the estimated mortality rates in males and females were low and measured approx. 2.5 at maximum. Table 8 shows the mortality table for Inzersdorf. The life expectancy in Inzersdorf was 23 years, and the median age at death was 19 years. The life expectancy for females was 41 years, and for males 39 years. Based on an occupancy range of 465 years based on C14 dating (1366–901 BC), on average, the living population in Inzersdorf contained 12.3 individuals.

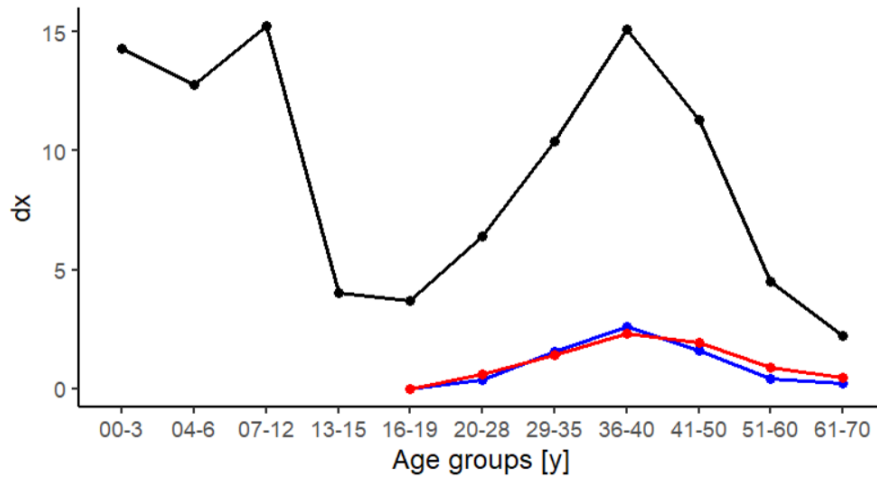


Figure 7: Mortality rates (d_x [in %]) per age group (ranges in years). The black line represents the mortality rate over the whole population in Inzersdorf. Adult individuals were further separated by sex (female: red, males: blue).

Table 8: Mortality table: n : number of individuals per age group; d_x : relative fraction of deceased individuals per age group (in ‰); l_x : relative fraction of survivals per age group (in ‰); q_x : death probability per age group; p_x : survival probability per age group; L_x : sum of survived years of all individuals within one age group; T_x : sum of expected years to survive of all individuals within one age group; e_x : average life expectancy at the entry of one age group.

Age group [in y]	n	d_x	l_x	q_x	p_x	L_x	T_x	e_x
0–3	35.23	142.91	1000.00	0.143	0.857	2785.63	23301.46	23.30
4–6	31.45	127.61	857.09	0.149	0.851	2379.86	20515.83	23.94
7–12	37.58	152.45	729.48	0.209	0.791	3919.53	18135.97	24.86
13–15	10.00	40.59	577.03	0.070	0.930	1670.20	14216.44	24.64
16–19	9.18	37.24	536.44	0.069	0.931	2071.29	12546.23	23.39
20–28	15.79	64.05	499.20	0.128	0.872	4204.59	10474.95	20.98
29–35	25.62	103.94	435.15	0.239	0.761	2682.27	6270.35	14.41
34–40	37.24	151.06	331.21	0.456	0.544	1789.76	3588.08	10.83
41–50	27.81	112.82	180.15	0.626	0.374	1237.42	1798.32	9.98
51–60	11.07	44.91	67.33	0.667	0.333	448.79	560.90	8.33
61–70	5.53	22.42	22.42	1.000	0.000	112.12	112.12	5.00

Pathological lesions

Two subadult individuals and ten adult individuals exhibited pathological lesions. Both subadult individuals (graves 152 & 171) exhibited endocranial lesions. At the endocranial surface of the 3–9-year-old individual from grave 152, a netlike hypervascularization and microporosity were visible. Additionally, this individual exhibited healed cribra orbitalia. The individual of grave 171 fell into the age category infans II and showed porosity and periosteal new bone formation endocranially, and cribra cranii ectocranially. In adults, metabolic disease was observed in five cases (two females, three males). Among them, one female and two male individuals showed a healed cribra cranii. The female individual of grave 178 showed porosity at the greater wings of the sphenoid. Two male individuals (both older than 30 years) developed porosity at the zygomatic bones. These pathological lesions are consistent with vitamin C deficiency and anaemia. Three adult individuals exhibited pathological lesions associated with occupation and ageing: one female individual (older than 40 years) showed a lesion measuring 10.4 mm in diameter and 2.5 mm in depth at one femoral condyle. This lesion is likely osteochondritis dissecans, a disease induced by overloading of the knee joint and a partial rip of the cartilage covering the condyle from the bone surface which later became necrotic. Additionally, this individual presented several Schmorl's nodes and osteophyte formation at the lumbar spine, suggesting this individual executed physically demanding labour for a long time. Two male individuals showed osteoarthritis at

the spine with osteophyte formation and inflammatory signs at one vertebral body (grave 181 & 184). One female (age 30–50 years) showed an enthesopathy of the flexor pollicis longus muscle at the first distal hand phalange.

Two female individuals developed periodontal disease with periosteal new bone formation and porosity. Two males showed signs of healed sinusitis (one case of maxillary sinusitis, one of sphenoidal sinusitis). A summary of all individuals with pathological lesions is present in Table 9.

Table 9: Observed pathological conditions in the individuals of Inzersdorf.

Grave	Sex	Age at death	Pathological lesions
152_Ind 1	female??	20+	Cribra cranii
152_Ind 2	–	3–9	Endocranial lesions: netlike hypervascularization, microporosity Healed cribra orbitalia
163	male	30–50	Healed max. sinusitis
171	–	7–12	Endocranial lesions: porosity and periosteal new bone formation Cribra cranii
173	female??	40+	Periodontal disease
174	female??	30–50	Periodontal disease
178	female	40+	Sphenoidal bone: porosity Lumbar vertebra: Schmorl's nodes & osteophytes Femoral condyle: Osteochondritis dissecans
181	male??	30–50	Zygomatic bones: porosity Osteoarthritis at spine
184	prob. male	40+	Osteoarthritis at spine
197	prob. male	20+	Cribra cranii
212	male	40–69	Zygomatic bones: periosteal new bone formation and porosity Cribra cranii healed sphenoidal sinusitis
314	female??	30–50	1st distal hand phalange: enthesopathy (M. flexor pollicis longus)

Discussion

Taphonomic processes

Bone colouration is affected not only by heat but also by the time of heat exposure and oxidational processes, which makes it difficult to assess the burning temperature based on solely colouration (WALKER et al. 2008; ELLINGHAM et al. 2015). Nevertheless, some observations were possible:

Although male individuals biologically have more muscle mass than females, which burns off harder, this effect can hardly be seen in the data as all male and most female individuals fell into the burning stage III corresponding to burning temperatures of around 550°C on the mean. Only three females were burnt at higher temperatures (650–700°C).

Three-quarters of all subadult individuals were cremated at temperatures of around 650 to 700°C, which was significantly higher in comparison to adult individuals. The reason for this is the smaller body mass which can be quickly cremated with a smaller amount of fuel. Interestingly, many individuals showed wedged bone fragments. Here, a black or grey layer is visible in the cross sections of bone fragments, with the cortical bone surface completely calcined. This suggests that in many cremations, the burning temperature reached high temperatures, but only for a short time.

In Inzersdorf, 18 double and six triple graves were identified. As the three grave types contained a significantly different amount of bones, the average bone weight per individual in each type is similar, and assuming that taphonomic processes may have affected all individuals in the same grave similarly, this suggested that most double and triple burials contained intentionally burnt individuals and no admixture of different individuals because bones of an earlier cremation were collected later on with the remains of another individual. After RÖSING 1977, in prehistoric burial grounds, 5% of all graves can be expected to be double burials. Inzersdorf contained over 8% double burials.

Preservation of graves

Based on the bone weight and degree of fragmentation, many graves seemed to have been disturbed. The bone weights significantly differ from the expected bone weight in comparison to modern

cremations. On average, each adult grave contained approximately 400 g of bone fragments, which is approximately 20% of the expected bone weight of modern cremations (WAHL 1981; MCKINLEY 1989). Although male individuals have a higher bone mass, which is published in other studies (WAHL 1981), there were no sex differences in bone weight and the stage of preservation. Only graves containing adult individuals which could not be assigned to a sex due to a lack of diagnostic elements contained much less cremated bones in comparison to graves where a detailed osteological analysis was possible. The remains of subadult individuals were much less preserved. Only 50 g could be recovered per grave on average.

Taphonomic processes, modern disturbance by ploughing, and bone composition are likely the largest causes for the loss of bone fragments. The soil in the Traisen-valley is very pebble-rich, which allows rain to quickly drain into the ground, and is known to affect buried bone (NIELSEN-MARSH, HEDGES 2000). Furthermore, many graves, especially the ones of children, were shallow (FRITZL 2017). Ploughing sometimes even completely destroyed graves so that no bones were recovered, only some ceramic fragments. Another finding suggests that the treatment of the bone fragments after recovery also was destructive. In comparison to other sites, where urns were micro-excavated and carefully washed in fine sieves (WALTENBERGER et al. 2023), the remains of Inzersdorf significantly lack tiny bone fragments of less than 2 mm. Subadult individuals also contain a high number of immature bones with incomplete calcification because they are still growing. If burnt, less mineralized bones fragment more readily than bones of adult individuals. Most graves in Inzersdorf contained bone fragments of all body regions. This suggests that there was no intentional selection of certain elements, and a prehistoric manipulation was unlikely.

Demography

Inzersdorf contained approximately as many adults as subadults, which is extraordinary and close to expected age ratios. In prehistoric times, every second individual died in childhood (ANGEL 1969). Often there is a lack of subadult individuals in prehistoric cemeteries due to taphonomic processes, but also potentially due to different funerary rites for adults and subadults (SCHWIDETZKY 1965; GROSSKOPF 2004). This suggests that in Inzersdorf, deceased children were treated similarly to adults and buried at the same location. Differences in pyre and grave goods between age groups have to be analysed in the future. Over 80% of all children died before puberty. The mortality rates were similar in the age groups *infans I* and *infans II* and in total very low during puberty. However, the data may contain a bias based on age estimation methods: adolescent individuals are predominantly identified based on the pattern of epiphyseal fusion. Epiphyses contain a high degree of cancellous bone with a thin layer of cortical bone, which makes them fragile if burnt. Therefore, it is likely that individuals after the growth spurt were misclassified as adult individuals if no epiphyses could be recovered. Interestingly, two graves contained remains of fetal remains. Grave 32 was a triple burial containing two adults (male and female) and a fetal petrous bone. The second grave (grave 40) contained an adult male and long bone fragments which were fetal based on the size. It cannot be excluded that these fetal bones were an admixture with the other individuals. Especially the grave containing the male individual and the fetal remains are difficult to explain. Options were a misclassified male individual, although by the size of the dens axis, this individual fell into the male category with a 98% probability, a miscarriage that was burnt with the male individual, or an imprecise age at death estimation of the fetal remains due to a strong shrinkage effect of the immature bones and no metric age estimation methods for subadults developed for subadult remains. The petrous bone from grave 32 was clearly fetal based on its shape.

The sex ratio in Inzersdorf (males : females = 1 : 1.12) showed a similar sex ratio to two earlier cemeteries nearby (Early Bronze Age: Franzhausen 1: BERNER 1988, Gemeinlebarn: SZOMBATHY 1934. In Inzersdorf, the mortality rates and life expectancy of males and females were very similar, thus a detailed age at death estimation and sex determination was not possible for most adults.

The life expectancy for the population in Inzersdorf was 23 years. 50 % of the total population died before 19 years, which was strongly affected by the high mortality rate in children. Once they reached puberty, the chances were high to live at least to the mid-thirties. Less than one fifth of the population in Inzersdorf reached more than 40 years. In comparison to the Early and Middle Bronze Age sites Franzhausen (BERNER 1988) and Pitten (TESCHLER-NICOLA 1985), the life expectancy is two years lower in Inzersdorf. Based on an occupation range of 465 years for the cemetery Inzersdorf, the living

population measured only 12–15 individuals on average, suggesting that this area was occupied by an extended family.

Pathological lesions

Pathological lesions could be observed in the remains of twelve individuals. Two subadult individuals exhibited endocranial lesions caused by haemorrhage, infectious meningitis, traumata, or metabolic diseases (LEWIS 2004; JANOVIC et al. 2015; ROHNBÖGNER, LEWIS 2017). Endocranial lesions may develop during rapid growth phases of babies and toddlers in normal development, while in older individuals, a pathological origin is more likely (LEWIS 2004; ROHNBÖGNER, LEWIS 2017). In six individuals, signs for metabolic diseases were present (cribra orbitalia or cribra cranii). These pathological lesions are commonly associated with malnutrition, scurvy, rickets, anaemia, and respiratory diseases (LEWIS 2007; WALKER et al. 2009; O'DONNELL et al. 2020). Cribra cranii in adult individuals was always healed, suggesting these lesions developed many years ago, most likely in childhood. Two individuals showed healed sinusitis. These pathological lesions are associated with infections (CASNA et al. 2021; RICCOMI et al. 2021). Further pathological lesions in adults are associated with ageing, but also heavy occupation (VILLOTTE 2009; VIKATOU et al. 2017; KARAKOSTIS et al. 2021).

Acknowledgements

This research was funded in the framework of the projects “The value of mothers to society: responses to motherhood and child rearing practices in prehistoric Europe” by the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No 676828) and “Unlocking the secrets of cremated human remains: temporality, gendered mobility and family relations in Late Bronze Age Austria” by the Austrian Science Fund (Grant-DOI 10.55776/P33533).

References

- ANGEL 1969
J. L. ANGEL, The bases of paleodemography, *American Journal of Physical Anthropology* 30/3, 1969, 427–437. doi: 10.1002/ajpa.1330300314
- ASCADI, NEMSKÉRI 1970
G. ASCADI, J. NEMSKÉRI, *History of the Human Life Span and Mortality*. Budapest 1970.
- BERNER 1988
M. BERNER, *Das frühbronzezeitliche Gräberfeld von Franzhausen I: demographische und metrische Analyse*. Dissertation, Universität Wien 1988.
- BOLDSSEN et al. 2002
J. L. BOLDSSEN, G. R. MILNER, L. W. KONINGSBERG, J. W. WOOD, Transition analysis: a new method for estimating age from skeletons. In: R. D. HOPPA, J. W. VAUPEL (eds.), *Paleodemography: Age Distributions from Skeletal Samples*. Cambridge Studies in Biological and Evolutionary Anthropology 31, Cambridge 2002, 73–106.
- BRICKLEY, MCKINLEY 2004
M. Brickley, I. McKinley (eds.), *Guidelines to the Standards for Recording Human Remains*. Southampton – Reading 2004.
- BUCKBERRY, CHAMBERLAIN 2002
J. L. BUCKBERRY, A. T. CHAMBERLAIN, Age estimation from the auricular surface of the ilium: a revised method, *American Journal of Physical Anthropology* 119/3, 2002, 231–239. doi: 10.1002/ajpa.10130
- CASNA et al. 2021
M. CASNA, C. L. BURRELL, R. SCHATS, M. L. P. HOOGLAND, S. A. SCHRADER, Urbanization and respiratory stress in the Northern Low Countries: a comparative study of chronic maxillary sinusitis in two early modern sites from the Netherlands (AD 1626–1866), *International Journal of Osteoarchaeology* 31/5, 2021, 891–901. doi: 10.1002/oa.3006

- CAVAZZUTI et al. 2019
 C. CAVAZZUTI, B. BRESADOLA, C. D'INNOCENZO, S. INTERLANDO, A. SPERDUTI, Towards a new osteometric method for sexing ancient cremated human remains: analysis of Late Bronze Age and Iron Age samples from Italy with gendered grave goods, *PLOS ONE*, 14/1, 2019, e0209423.
- ELLINGHAM et al. 2015
 S. T. D. ELLINGHAM, T. J. U. THOMPSON, M. ISLAM, G. M. TAYLOR, Estimating temperature exposure of burnt bone: a methodological review, *Science and Justice* 55, 2015, 181–188.
- FEREMBACH et al. 1979
 D. FEREMBACH, I. SCHWIDETZKY, M. STLOUKAL, Empfehlungen für die Alters- und Geschlechtsdiagnose am Skelett, *Homo* 30, 1979, 1–32.
- FRITZL 2017
 M. FRITZL, Die mehrfach belegten Gräber des Gräberfeldes von Inzersdorf ob der Traisen, NÖ. Eine Studie zu sozialen, religiösen und rituellen Implikationen von mehrfach belegten Gräbern der Urnenfelderkultur. Master thesis, University of Vienna 2017.
- FRITZL et al. 2024
 M. FRITZL, L. WALTENBERGER, H. F. JAMES, C. SNOECK, K. REBAY-SALISBURY, Over the river and into the hills: locals and non-locals at Inzersdorf, a late Bronze Age cemetery in the Traisen Valley (Austria), *Archaeological and Anthropological Sciences* 16, 2024, 151. doi: 10.1007/s12520-024-02054-w
- GROSSKOPF 2004
 B. GROSSKOPF, Leichenbrand: Biologisches und kulturhistorisches Quellenmaterial zur Rekonstruktion vor- und frühgeschichtlicher Populationen und ihrer Funeralpraktiken. Dissertation, Universität Leipzig 2004.
- HERRMANN, BENNETT 1999
 N. P. HERRMANN, J. L. BENNETT, The differentiation of traumatic and heat-related fractures in burned bone, *Journal of Forensic Sciences* 44/3, 1999, 461–469.
- INSKIP et al. 2019
 S. INSKIP, C. L. SCHEIB, A. W. WOHNS, X. GE, T. KIVISILD, J. ROBB, Evaluating macroscopic sex estimation methods using genetically sexed archaeological material: The medieval skeletal collection from St John's Divinity School, Cambridge, *American Journal of Physical Anthropology* 168/2, 2019, 340–351. doi: 10.1002/ajpa.23753
- JANOVIC et al. 2015
 A. JANOVIC, P. MILOVANOVIC, J. SOPTA, Z. RAKOCEVIC, V. FILIPOVIC, D. NENEZIC, M. DJURIC, Intracranial arteriovenous malformations as a possible cause of endocranial bone lesions and associated neurological disorder, *International Journal of Osteoarchaeology* 25/1, 2015, 88–97. doi: 10.1002/oa.2266
- KARAKOSTIS et al. 2021
 F. A. KARAKOSTIS, J. E. BUIKSTRA, E. PREVEDOROU, E. M. HANNIGAN, J. HOTALING, G. HOTZ, H. LIEDL, K. MORAITIS, T. J. SIEK, L. WALTENBERGER, K. J. WIDRICK, K. HARVATI, New insights into the manual activities of individuals from the Phaleron cemetery (Archaic Athens, Greece), *Journal of Archaeological Science* 131, 2021, 105415. doi: 10.1016/j.jas.2021.105415
- LEWIS 2004
 M. E. LEWIS, Endocranial lesions in non-adult skeletons: understanding their aetiology, *International Journal of Osteoarchaeology* 14, 2004, 82–97.
- LEWIS 2007
 M. E. LEWIS, *The Bioarchaeology of Children: Perspectives from Biological and Forensic Anthropology*. Cambridge 2007.
- LOVEJOY et al. 1985
 C. O. LOVEJOY, R. S. MEINDL, T. R. PRYZBECK, R. P. MENSFORTH, Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of adult skeletal age at death, *American Journal of Physical Anthropology* 68, 1985, 15–28. doi: 10.1002/ajpa.1330680103
- MCKINLEY 1989
 J. I. MCKINLEY, Cremations: expectations, methodologies and realities. In: C. A. ROBERTS, F. LEE, J. BINTLIFF (eds.), *Burial Archaeology: Current Research, Methods and Developments*. Oxford 1989.

NIELSEN-MARSCH, HEDGES 2000

C. NIELSEN-MARSH, R. E. M. HEDGES, Patterns of diagenesis of bone I: the effects of site environments, *Journal of Archaeological Science* 27, 2000, 1139–1151.

O'DONNELL et al. 2020

L. O'DONNELL, E. C. HILL, A. S. A. ANDERSON, H. J. H. EDGAR, Cribra orbitalia and porotic hyperostosis are associated with respiratory infections in a contemporary mortality sample from New Mexico, *American Journal of Physical Anthropology* 173/4, 2020, 721–733. doi: 10.1002/ajpa.24131

OSBORNE et al. 2004

D. L. OSBORNE, T. L. SIMMONS, S. P. NAWROCKI, Reconsidering the auricular surface as an indicator of age at death, *Journal of Forensic Sciences* 49/5, 2004, 1–7.

PHENICE 1969

T. W. PHENICE, A newly developed visual method of sexing the os pubis, *American Journal of Physical Anthropology* 30/2, 1969, 297–301. doi: 10.1002/ajpa.1330300214

RICCOMI et al. 2021

G. RICCOMI, J. CASACCIA, S. MINOZZI, C. FELICI, S. CAMPANA, V. GIUFFRÀ, Maxillary sinusitis as a respiratory health indicator: a bioarchaeological investigation into medieval central Italy, *International Journal of Paleopathology* 35, 2021, 40–48. doi: 10.1016/j.ijpp.2021.09.001

ROHNBOGNER, LEWIS 2017

A. ROHNBOGNER, M. E. LEWIS, Poundbury Camp in Context-a new Perspective on the Lives of Children from urban and rural Roman England, *American Journal of Physical Anthropology* 162/2, 2017, 208–228. doi: 10.1002/ajpa.23106

RÖSING 1977

F. W. RÖSING, Methoden und Aussagemöglichkeiten der anthropologischen Leichenbrandbearbeitung, *Archäologie & Naturwissenschaften* 1, 1977, 53–80.

SCHAEFER et al. 2009

M. SCHAEFER, S. BLACK, L. SCHEUER, Juvenile osteology: A laboratory and field manual. Burlington, MA 2009.

SCHWIDETZKY 1965

I. SCHWIDETZKY, Sonderbestattungen und ihre demographische Bedeutung, *Homo* 16, 1965, 230–247.

ŠIKANJIĆ et al. 2024

P. RAJIĆ ŠIKANJIĆ, D. LOŽNJAK DIZDAR, M. FRITZL, H. SKERJANZ, L. WALTENBERGER, K. REBAY-SALISBURY, Traces of disease in cremated children's bones: age and health in Bronze and Iron Age communities north and south of the Alps, *Interdisciplinaria Archaeologica: Natural Sciences in Archaeology* 15/2, 2024, 133–146.

STEWART 1979

T. D. STEWART, *Essentials of Forensic Anthropology*. Springfield, IL 1979.

SZOMBATHY 1934

J. SZOMBATHY, Bronzezeitskelette aus Niederösterreich und Mähren, *Mitteilungen der Anthropologischen Gesellschaft in Wien* 64, 1934, 1–101.

TESCHLER-NICOLA 1985

M. TESCHLER-NICOLA, Die Körper- und Brandbestattungen des mittelbronzezeitlichen Gräberfeldes von Pitten, Niederösterreich: Demographische und anthropologische Analyse. In: F. HAMPL, H. KERCHLER, Z. BENKOVSKY-PIVOVAROVA, Das mittelbronzezeitliche Gräberfeld von Pitten in Niederösterreich: Ergebnisse der Ausgrabungen des Niederösterreichischen Landesmuseums in den Jahren 1967 bis 1973 mit Beiträgen über Funde aus anderen urzeitlichen Perioden. Band 2: Auswertung, *Mitteilungen der Prähistorischen Kommission* 21/22, 127–272.

UBELAKER 1979

D. H. UBELAKER, *Human Skeletal Remains: Excavation, Analysis, Interpretation*. 2nd edition, Washington 1979.

VIKATOU et al. 2017

I. VIKATOU, M. L. P. HOOGLAND, A. L. WATERS-RIST, Osteochondritis Dissecans of skeletal elements of the foot in a 19th century rural farming community from The Netherlands, *International Journal of Paleopathology* 19, 2017, 53–63.

VILLOTTE 2009

S. VILLOTTE, Enthesopathies, as occupational stress markers: a reliable and reproducible method based on present medical data. In: A. L. Santos, F. A. Cardoso, S. Assis, S. Villotte (eds.), Workshop in Musculoskeletal Stress Markers (MSM): Limitations and achievements in the reconstruction of past activity patterns. Program – Abstract Book. Coimbra 2009, 41.

WAHL 1981

J. WAHL, Beobachtungen zur Verbrennung menschlicher Leichname: Über die Vergleichbarkeit moderner Krematorien mit prähistorischen Leichenbränden, Archäologisches Korrespondenzblatt 11, 1981, 271–279.

WALKER 2008

P. L. WALKER, Sexing skulls using discriminant function analysis of visually assessed traits, American Journal of Physical Anthropology 136/1, 2008, 39–50. doi: 10.1002/ajpa.20776

WALKER 2009

P. L. WALKER, R. R. BATHURST, R. RICHMAN, T. GJERDRUM, V. A. ANDRUSHKO, The causes of porotic hyperostosis and cribra orbitalia: a reappraisal of the iron-deficiency-anemia hypothesis, American Journal of Physical Anthropology 139/2, 2009, 109–125. doi: 10.1002/ajpa.21031

WALKER et al. 2008

P. L. WALKER, K. W. P. MILLER, R. RICHMAN, Time, temperature, and oxygen availability: an experimental study of the effects of environmental conditions on the color and organic content of cremated bone. In: C. W. SCHMIDT, S. A. SYMES (eds.), The Analysis of Burned Human Remains. London 2008, 129–135.

WALTENBERGER et al. 2023

L. WALTENBERGER, M. D. BOSCH, M. FRITZL, A. GAHLEITNER, C. KURZMANN, M. PINIEL, R. B. SALISBURY, L. STRNAD, H. SKERJANZ, D. VERDIANU, C. SNOECK, F. KANZ, K. REBAY-SALISBURY, More than urns: a multi-method pipeline for analyzing cremation burials, PLOS ONE 18/8, 2023, e0289140. doi: 10.1371/journal.pone.0289140

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