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THE DEMOGRAPHY OF IRON AGE GRAVES IN ESTONIA

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Cremated and non-cremated human remains from fourteen Estonian Iron Age burial grounds were analysed in order to estimate the number of burials in the graves as well as the age at death and sex of the individuals in these burials and to model the demographic figures for some Estonian Iron Age communities. Three graves (Rõsna I, Rõsna II, Suure-Rõsna) in South-eastern Estonia and two in Western Estonia were suitable for palaeodemographic analyses. Five of the graves were used by communities with 3–9 individuals, which usually corresponds to a single family or household. Rõsna-Saare I barrow cemetery in South-eastern Estonia indicated a somewhat larger community of 10–15 individuals, which could have been an extended family, a larger household, or two nuclear families. The estimated crude death rate during the Middle Iron Age at Rõsna varied between 49.2 and 62.1‰ (52.4‰ on average). The estimated crude death rate was somewhat lower (39.0‰) in Late Iron Age Maidla and was extremely high (86‰) in Middle Iron Age Maidla.

Keywords: Iron Age, cremations, palaeodemography.

Sudeginti ir nesudeginti žmonių palaikai, rasti 14-oje Estijos geležies amžiaus kapaviečių, buvo analizuoti siekiant nustatyti kapų skaičių kapavietėje, palaidotųjų amžių mirties metu, lytį ir pateikti kelių Estijos geležies amžiaus bendruomenių demografinę statistiką. Trys kapavietės (Rõsna I, Rõsna II, Suure-Rõsna) Pietryčių ir dvi – Vakarų Estijoje tiko paleodemografiniam tyrimui atlikti. Penkiose kapavietėse buvo palaidotos 3–9-ių asmenų bendruomenės, galinčios būti šeima ar ūkinis vienetas. Rõsna-Saare I pilkapynas Pietryčių Estijoje rodo buvus didesnę bendruomenę, kurią sudarė 10–15 asmenų ir kuri galėjo būti išplėstinė šeima, didesnis ūkinis vienetas arba dvi porinės šeimos. Bendras mirtingumo rodiklis viduriniajame geležies amžiuje Rosnoje svyravo nuo 49,2 iki 62,1‰ (vidurkis – 52,4‰). Vėlyvajame geležies amžiuje Maidloje bendrasis mirtingumo rodiklis buvo mažesnis (39,0‰), o viduriniajame geležies amžiuje – labai didelis (86‰).

Reikšminiai žodžiai: geležies amžius, degintiniai kapai, paleodemografija.

INTRODUCTION

The cremated human remains from Estonian Iron Age graves have mainly been studied since the 1990s. The cremated bone analyses have mostly been macroscopic, the main goal being the identification of the number of interred individuals and the determination of their biological sex and age at death (Kalling 1993; Mägi *et al.* 1998; Kalman 2000b; Allmäe 2003). These anthropological data have then been combined with the archaeological data to interpret the grave goods and burial customs of the period and/or cultural area (Mandel 2003; Allmäe, Maldre 2005; Aun 2005; Allmäe *et al.* 2007; 2009; Aun *et al.* 2008). Sometimes analyses include the fragmentation, colour, and cremation temperature of the bones (Valk, Allmäe 2009; 2010; Allmäe 2013). Less attention has been paid to palaeodemographic analyses as there are some requirements for the material and data, e.g. the whole burial site should be excavated, migration should be excluded, the skeletal material should be complete, accurate data for the burial chronology and its start should be available, etc. (Acsádi, Nemeskéri 1970; Alesan *et al.* 1999).

The first attempts to analyse the demography of Estonia's ancient populations were made on the basis of the archaeological data (Lang, Ligi 1991; Lang 1996). The authors used the types and number of artefacts to calculate the size of the community, which used the burial site, and made assumptions on population density and size based on the burial grounds in different Estonian districts.

The first palaeodemographic calculations based on osteological research from prehistoric graves were made for the Roman Iron Age Viimsi I *tarand* grave in Northern Estonia (Lang 1993) and for the Pre-Roman Poanse *tarand* grave in Western Estonia (Kalman 2000a). Ken Kalling (1995; 1997) performed the first known palaeodemographic study based on archaeoanthropological material from the Medieval and Early Modern town of Tartu while the author analysed the 13th–14th century skeletal population in Tartu's Jaani Church. The author also demographically analysed a skeletal sample from the 14th–18th century Tääksi village cemetery (Southern Estonia) (Allmäe 1998); this material contained some 15th–16th century cremations (Соколовский 1990; Allmäe 1998). The author also demographically analysed skeletal material from Maidla II (Western Estonia) (Allmäe 2006), which contained 10th–11th century cremations and 12th–13th century inhumations (Mandel 2003). Leiu Heapost (in 2007) analysed the demography of 11th–15th century Kalmetemägi in Siksälä, South-eastern Estonia. The study concerns mostly inhumations, but also includes some cremations.

During 1997–2011, the author analysed several cremation graves in Western and South-eastern Estonia, collecting various descriptive and metric data on cremated bones, including, of course, estimations of the minimum number of buried individuals, the plausible number of interred individuals, the biological sex, and the age. The studied material included five completely excavated burial sites, which are a good source for demographic calculations. The new radiocarbon dating methodology (Lanting *et al.* 2001) also allows cremated bone material to be dated, which helps in dating cremations where artefacts are rare and archaeochronological dating is difficult. This paper presents radiocarbon dates (AMS method) for cremated human bones from six investigated graves. The goal of these analyses was to determine the timespan when the communities used these graves.

The goal of the present study is to systemise the results of the age at death and sex estimations for the inhumations and cremations in Western and South-eastern Estonia from the Middle and Late Iron Ages, to calculate some demographic figures, and to draw some conclusions about ancient burial practices and grave use.

MATERIALS AND METHODS

Investigated materials

The *Western Estonian stone-graves* (Table 1; Fig. 1) were mainly investigated during 1974–1991 by archaeologist Mati Mandel (2003), the grave at Keskvere during 2001–2002 (Mandel 2003), and Uugla III stone grave in 2008 (Mandel, Allmäe 2009). The bone material was collected using 2x2 m grid squares. The Western Estonian graves were all irregular stone constructions while the graves at Maidla, Kirbla, and Uugla contained areas with a thick charcoal layer, which were probably pyre sites (Mandel 2003). Most of the graves contained scattered cremations, although some also had inhumations, for example, from the 5th–7th centuries in Lihula, from the 5th–7th/10th–13th centuries in Ehmja, and from the 5th–6th/10th–13th centuries in the stone-graves at Maidla (Mandel 2003). Both Maidla stone-graves were completely excavated, the second being the biggest ever investigated archaeologically and

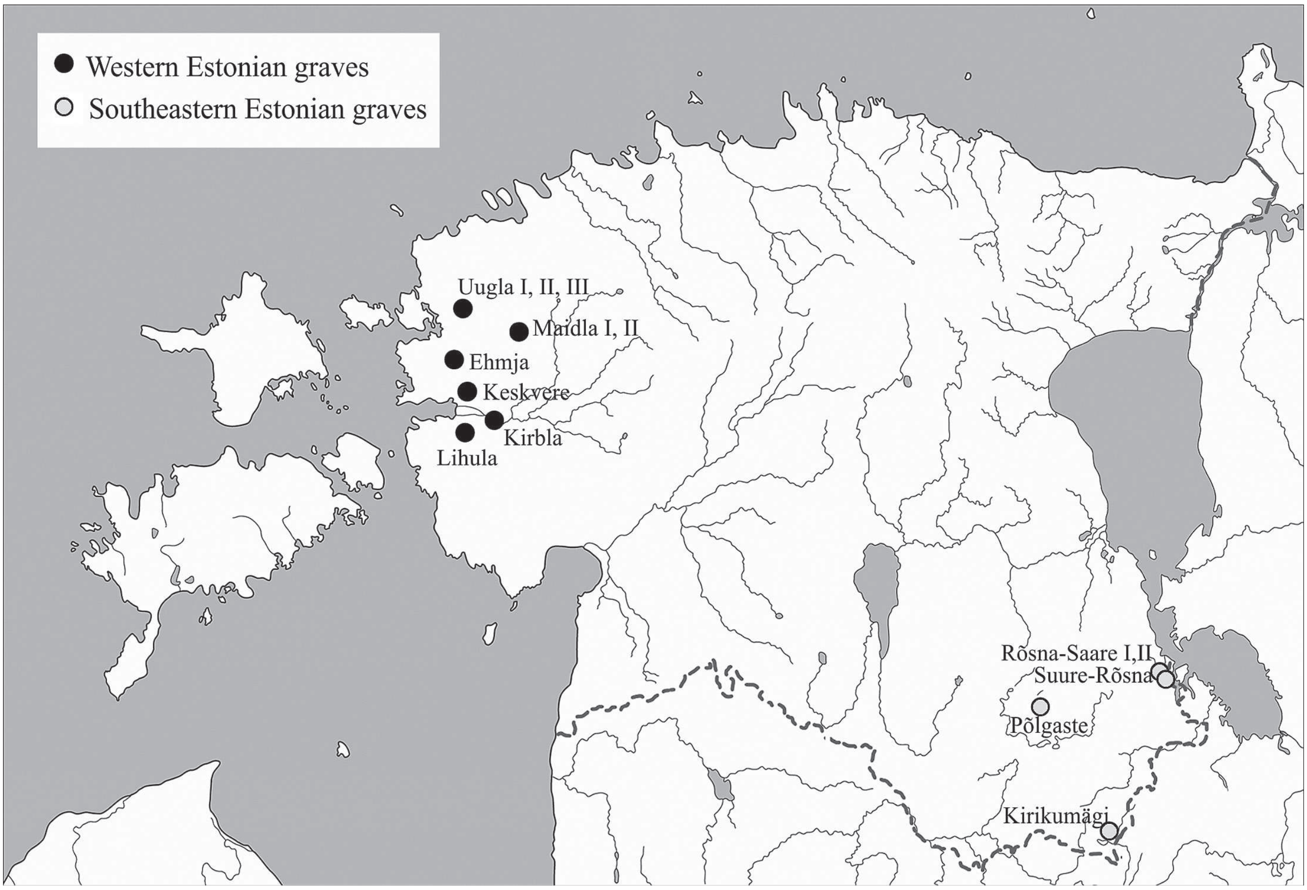

Fig. 1. Locations of the investigated Estonian Iron Age graves. *Map by R. Allmäe.*

osteologically (Allmäe 2003; 2006; Maldre 2003; Mandel 2003). In recent years new excavations have been conducted in the area, the main purpose being to screen the mounds for additional archaeological and osteological finds. This has resulted in an interesting discovery of a double inhumation below one mound; this is probably a secondary burial or the reburial of the remains of an adult female and a child (Mandel, Allmäe 2013).

A total of 1927 bone finds from nine Iron Age Western Estonian graves were analysed.

The South-eastern Estonian osteological material comes from five different graves (Table 1; Fig. 1). Põlgaste *tarand* grave was excavated by Silvia Laul in 1970–1973 and dates to the Early Iron Age, i.e. the 3rd–5th centuries (Laul 2001, pp.40–43). *Tarand* graves are burial sites with characteristic quadrangular stone enclosures, commonly with N–S orientations (Jaanits *et al.* 1982, p.207; Lang 2007, pp.170, 192). The bone material of Põlgaste *tarand* grave, all of it cremated, was collected in 1x1 m grid squares (Laul 2001, p.42). The cremains were analysed in 2010–2011. This grave was chosen for comparative analyses for several reasons. The first was its archaeochronological dating, i.e. the 3rd–5th centuries (contemporaneous with Maidla I grave). The second was its stone construction, i.e. *tarand* grave. It also has other intriguing characteristics (Laul 2001, pp.27, 40–41), e.g. the underground Bronze Age cremation burial discovered under it (the charcoal among the bones had a 68.2% probability of being from 1260–920 BC) and the three sand barrows that lay partially atop it. Laul (2001, pp.40–43) also detected differences in the cremated bone material, the bones in the grave's older part being less burnt than those in

Table 1. Investigated Estonian graves

	Western Estonia									South-eastern Estonia				
Name of the grave	Maidla I	Maidla II	Keskvere	Lihula	Ehmja	Uugla I	Uugla II	Uugla III	Kirbla	Rõsna-Saare I	Rõsna-Saare II	Suure-Rõsna	Kirikumägi	Põlgaste
Type of the grave	stone-grave	stone-grave	flat grave	stone-grave	stone-grave	stone-grave	stone-grave	stone-grave	stone-grave	sand barrow	sand barrow	sand barrow	flat grave	*tarand* grave
Period (centuries)*	5–6	10–13	7–8	5–7	5–7, 10–13	11–13	11–13	11–13	11–13	6–8	7–8	6–8	10–12	3–5
Number of bone units	268	674	10	144	248	157	30	326	70	159	97	164	69	59
Archaelogically determined nested bone units**	–	–	–	–	–	–	–	–	–	65	53	41	–	–
MNI	19	51	1	10	5	4	1	7	1	34	22	26	4	18
PNI	20	74	3	21	10	4	1	11	2	61	46	40	4	23
Cremations	17	42	3	10	5	4	1	11	2	61	46	40	3	23
Inhumations	3	32	–	9	5	–	–	–	–	–	–	–	1	–
Subadults (0–15)	8	22	1	4	5	0	0	1	1	21	18	15	1	4
Adults (over 15)	12	52	2	17	5	4	1	10	1	40	28	25	3	19
Males	5	13	–	2	2	–	–	2	–	14	10	8	2	12
Females	5	16	–	4	–	1	1	3	1	15	8	8	1	6
Undetermined	2	32	2	11	3	3	0	5	0	11	10	9	1	1

the later part. A secondary burial custom, i.e. the cremation of human skeletal remains, was probably observed in the older part (Allmäe 2013). The complete bone material would have been good source for observing possible changes in the burial practices, but unfortunately the osteological materials collected from Põlgaste *tarand* grave in South-eastern Estonia were only partly available in the depository and came from the grave's older part.

During the 1970s–1980s archaeologist Mare Aun (Аун 1992) investigated several Long Barrow Culture sand-barrow cemeteries in North Setumaa from the second half of the 1st millennium AD. The present paper analyses three sand-barrow cemeteries (Suure-Rõsna, Rõsna-Saare I, and Rõsna-Saare II), which were selected because they have been completely excavated. The sand barrow cemeteries in North Setumaa consist of long, round mounds of piled sand that reveal various burial customs. The cremated bones were commonly buried in fairly compact assemblages or in different containers under and in the mounds (Аун 1992; Aun 2005). The human bone material collected from the barrows had all been cremated (Allmäe, Maldre 2005; Allmäe *et al.* 2007; Allmäe 2013).

During 2003–2004 and 2007, Heiki Valk

* Dates from Aun 1992; Laul 2001; Mandel 2003; Valk, Allmäe 2010.

** After Aun *et al.* 2008.

excavated Kirikumägi flat cemetery from the late 10th–12th centuries. Scattered cremation burials were discovered under the base. The bones had mainly been cremated, with the exception of some teeth and temporal bones of a 3–4 year-old child (Valk, Allmäe 2010).

A total of 548 bone finds from five Iron Age graves in South-eastern Estonia were osteologically analysed.

The total material analysed during the study consisted of 2475 bone finds.

Criteria and methods used to estimate the minimum and probable number of individuals

The Western Estonian stone-graves

It is known that some parts of a skeleton are more resistant to heat-induced changes and survive better among cremated bones (Holck 1997/2008). Thus, the minimum number of individuals (MNI) among the examined cremains is very often determined using the recurrent bone fragment method. Several different bone fragments were counted during analyses, but in most cases the *pars petrosa* of the *os temporale* was the best unit for estimating the MNI. In some cases, where recurrent fragments did not occur, the individuals were distinguished on the basis of biological age estimations (e.g., if the bone assemblage included adult cranial vault fragments as well as an unfused long bone epiphysis or deciduous tooth crowns, etc.).

The probable number of individuals (PNI) was estimated on the basis of the fragments (20 or more) of cranial vault combined with at least one determined fragment of human skeleton. The cranial part of the skeleton was preferred because the fragments are easily distinguished among cremated bones and mean that complete corpses were probably cremated. The distances between bone units were also taken into account in estimating the PNI, which is an important unit for graves with scattered or disturbed cremations (Maidla I–II, Ehmja, Kirbla, Uugla I–III, Lihula). On the one hand, in most cases the bone fragments are collected using fairly large grid squares: 2x2 m. On the other hand, there is no way to know how much material was carried from the pyre to the burial site. The material was analysed and the PNI was determined using the criteria described above.

The South-eastern Estonian sand barrow cemeteries

The material from the barrows was also collected as bone assemblages, which were bigger here (except Siksäla flat cemetery). The MNI was estimated for each barrow in all of the analysed sand barrow cemeteries. Many different recurrent bone fragments were recorded, but here also the *pars petrosa* of the *os temporale*, as the most frequently found element, was the best unit for calculating the MNI. Unfortunately the number of cranial fragments was not counted because it initially seemed that the bone assemblages were well-defined units, i.e. archaeologically distinguished burials. The collected and deposited units were named main and additional assemblages. It was not always possible to decide whether or not the additional bone assemblage(s) were part of the main one and sometimes it seemed that numbered main bone assemblages did not equal one burial. The discrepancy between the MNI and the archaeologically determined number of burials/assemblages is obvious; the osteologically estimated MNI is usually smaller than the archaeologically estimated number. There are two reasons for this. First, the burial criteria are not clearly distinguishable during excavations. It is nearly impossible to decide whether an assemblage belongs to an adjacent main assemblage or constitutes a separate burial. Second, as always, the percentage of the cremains collected from the pyre and buried in the barrows remains unknown.

Finally, the PNI was determined by taking into account the distances of the collected bone units, the MNI, the colour of the cremains, the size and composition of the collected bone unit, and the results of age and sex determinations. Compared to the previously published studies (Allmäe, Maldre 2005; Allmäe *et al.* 2007; Aun *et al.* 2008), this paper uses some PNI and MNI recalculations for the sand barrow cemeteries.

The tarand graves and flat cemeteries

In both cases the osteological material was collected using grid squares. The bone assemblages in Kirikumägi flat cemetery at Siksälä are smaller than those in Põlgaste *tarand* grave. The MNI and PNI were estimated for both cemeteries. Unfortunately, the materials represent only part of these burial sites: Kirikumägi has been only partially excavated and part of the bone material is missing from Põlgaste *tarand* grave.

Radiocarbon dating

Nine samples of cremated human bones from six investigated graves were dated. Cremated bone fragments from Maidla I (Hela-2403) and Maidla II (Hela-1958) and non-cremated bone (Hela-1919) from the stone-graves, Rõsna-Saare I (Hela-1959, Hela-1960) and II (Hela-1961) barrow cemeteries, Suure-Rõsna (Hela-1962) barrow cemetery, and Põlgaste *tarand* grave (Hela-2404, Hela-2405) were radiocarbon dated in 2009 and 2010 at the Dating Laboratory of the Finnish Museum of Natural History, University of Helsinki. The ^{14}C concentration was measured using the AMS method. The results were calibrated using an Intcal09 curve (Reimer *et al.* 2009) and OxCal 4.1 software (Bronk Ramsey 2009).

Methods and criteria used for sex and age at death determination

The sex and age at death of the individuals were determined using common osteological standards (Miles 1963; Workshop 1980; Brothwell 1981; Buikstra, Ubelaker 1994; Bass 2005; Mays 2006). If applicable, other criteria were used to estimate or determine a cremated individual's age at death: cranial vault morphology (Gejvall in Sigvallius 1994) and tooth root morphology, i.e. the roots of the teeth of older individuals become more rounded due to the deposition of cementum. Hypercementosis is quite common in older individuals (Acsádi, Nemeskéri 1970; Soames, Southam 1993). Age-related pathologies on cremated bones, e.g., osteoarthritis on vertebrae or anywhere on skeletal elements, were also used. It must be emphasized that age at death and sex determinations made for cremated human remains are less reliable than those for inhumations. The incompleteness of the cremated remains due to high bone fragmentation means that only a few skeletal elements are available for determinations.

Demographic estimations

The demographic estimations were made using several different methods. Our model assumes that the population is stationary and that the birth and death rates are equal (growth = 0) because the Estonian populations under study are all too small to model a positive or negative natural increase.

The life table method proposed by G. Acsádi and J. Nemeskéri (1970) was initially used to estimate the life expectancy at birth (e^0_0). The natural data obtained from the skeletal samples was used for this.

The life tables were then corrected in accordance with F. W. Rösing and R. Jankauskas (1997) by increasing the proportion of small children (0–4 years) in the population to 45% of the total skeletal population under study. This means that 45% of population died before they reached the age of 5.

J.-P. Bocquet and C. Masset (Bocquet, Masset 1977; Bocquet-Appel, Masset 1982) established a third model for estimating the demographic figures of past populations. The ratio of subadults to adults (juvenility index) was also calculated for every population under study:

number of children deceased between 5 and 15 / number of adults deceased at 20 and later:

$\boldsymbol{D_{5-14}/D_{20+}}$

The model was adjusted to overcome the problem that the number of small children (0–4 years) is often underrepresented in the burials.

The formula (Bocquet, Masset 1977; Bocquet-Appel, Masset 1982) to estimate the newborn life expectancy from the juvenility index is:

$\mathbf{e^0_0=78.721*log_{10}\sqrt{1/x}-3.384\pm1.503}$,

where $\mathbf{x=D_{5-14}/D_{20+}}$.

The newborn life expectancy, crude death rate ($1/e^0_0$), and size of the living populations were calculated using all three models. In these models it was assumed that the population was stationary and that the birth and death rates were equal (growth = 0).

The size of the living population was calculated using D. Ubelaker's (1989) formula:

$\mathbf{P=N*e^0_0/T}$,

where P – population size,

N – number of burials in the cemetery,

e^0_0 *– life expectancy at birth (in years),*

T – timespan during which the burial site was used (in years).

The model made an assumption concerning the timespan for the cemetery's use. In order to model the population size, the 68.2% probability dates (interval) of the cremated bones from each grave were equated with the grave's usage period (T) with the exception of Maidla II, where 250 years of grave usage was established by Mandel (2003) and was used in the present calculations.

Reproduction was estimated according to two different models. The first model estimated the fertility rate, i.e. the number of female offspring born per woman (gross reproduction rate or GRR), from the juvenile indices of J.-P. Boquet-Appel and C. Masset (1982) and calibrated it in accordance with R. McCaa (1998; 2000). It then calculated the total number of offspring per woman (total fertility rate or TFR): **GRRx2.05=TFR**.

M. Henneberg (1975) established the second model used here to estimate reproduction from archaeological human remains. The approach is somewhat different from that used in conventional palaeodemography. Henneberg (1975) combined the demographic (mortality structure) and biological characteristics of human fertility to construct a reproduction model for human palaeopopulations. In order to estimate a population's reproduction rate, the following definitions and calculations were used: the potential gross reproduction rate (R_{pot}) or the average number of births per adult couple during their lifetime, the net reproduction rate (R_o) or the average number of adult descendants per adult parent, and the absolute number of offspring born to an average adult couple (C). The calculation of the last figure required the hypothetical value U_c (the total number of births achievable throughout the full reproductive period). The U_c closest to reality is about eight (Acsádi, Nemeskéri 1970), but the number could be lower or higher. In the present study the number of offspring born to an average couple (C) was calculated using the value of U_c=7.45 (Lorimer 1954 in Henneberg 1975).

The masculinity index for every population was calculated by dividing the number of males by the number of females in the population.

The available data on contemporaneous Latvian and Lithuanian communities were used to discuss the demographic figures of the studied Estonian Iron Age communities (Jankauskas 2002; Zariņa 2009). The demographic figures were calculated according to the juvenile/adult ratio (Boquet-Appel, Masset 1982) with the GRR calibrated in accordance with R. McCaa (1998; 2000).

RESULTS

The studied graves are of different sizes and from different periods; the composition of the bone material also varies (Table 1) due to the burial practice (cremation, inhumation). In many Western Estonian graves (Maidla I and II, Ehmja, Lihula), both cremations and inhumations were found (Allmäe 2003; Mandel 2003). Cremation predominated (Аун 1992; Laul 2001; Allmäe 2013) in the studied South-eastern graves, except in Kirikumägi flat cemetery at Siksälä where the unburnt fragments of the skeleton of a 3–4-year old child were found (Valk, Allmäe 2010). In Suure-Rõsna barrow cemetery, some unburnt human vertebrae were found in one bone assemblage; this could have been due to an unsuccessful cremation where the temperature and oxygen flow were insufficient for proper burning of the corpse. The MNI and the PNI differ in most cases, the discrepancy, as expected, being bigger in the larger graves (Table 1).

The radiocarbon dates of cremated bones from six investigated graves indicate some discrepancies compared to the archaeochronological dates (Tables 1, 2). The number of AMS dates is small, but they help to identify the timespan when the grave was in use. According to AMS dates, Maidla I is from the 4th–5th centuries. The cremations in Maidla II are from the 10th–12th centuries as Mandel (2003) has already suggested. The radiocarbon dating of one infant inhumation from this grave showed that in addition to the 12th–13th century inhumations (Mandel 2003), the infant inhumation(s) could even be from the Middle Ages (Table 2). The sand barrows from South-eastern Estonia were radiocarbon dated to the 4th–6th centuries, indicating a somewhat earlier establishment of the grave compared to the archaeochronological dates (Tables 1, 2). The dating also confirms the suggestion that the barrows were created over a short period (Аун 1992; Aun 2005). The flat cemetery at Siksälä was radiocarbon dated using the charcoal found amongst the cremains (Valk, Allmäe 2010), which yielded 10th–11th century dates (Table 1). The Põlgaste *tarand* grave was archaeochronologically dated to the 3rd–5th centuries (Laul 2001, pp.27, 40–41). The radiocarbon dating of cremated bones from the older part of the grave indicates a somewhat earlier establishment of the burial site, i.e. in the late Pre-Roman Iron Age or early Roman Iron Age (Tables 1, 2).

The phenomenon that the radiocarbon dating of cremated bone could yield a somewhat older age is supported by experimental evidence (Hüls *et al.* 2010; Olsen *et al.* 2013). Hüls and his co-workers (Hüls *et al.* 2010) found that depending on the cremation temperature, its duration, the composition of the burning atmosphere, and the composition/age of the fuel, an aging effect of 50–100 years may be possible. Therefore the possibility cannot be excluded that the relatively old AMS dates are due to the employed burial techniques. For example, in the case of the Põlgaste *tarand* grave it is highly likely that bare human bones were cremated rather than corpses (Allmäe 2013).

The biological sex of the individuals was often undeterminable, especially in graves with scattered cremations, but masculinity indexes were still calculated (Table 3). In the sand barrows, the index was slightly above 1.0, indicating a balanced sex ratio in the community. At Maidla II, it was 0.81; a masculinity index below 1 may signify turbulent times, for example, when men often died away from home.

The proportion of subadults in the graves is 40% or below (Tables 1, 3). The proportion has, of course, less importance in small graves (Uugla I–III, Kirbla), where only a few individuals were buried and/or burned at the site (Allmäe 2003; 2013; Mandel 2003). In partially investigated graves (Ehmja, Keskvere, Põlgaste, Kirikumägi), the age structure can be distorted because only part of the osteological material was available for anthropological study. Therefore the proportion of subadults is significant in graves, which have been completely excavated: Maidla I–II, Rõsna-Saare I–II, and Suure-Rõsna. The proportion of subadults (under 15 years of age) is apparently very similar for these graves: from 34.4% to 40.0%. The only exception is Maidla II, where the proportion of subadults is slightly lower at 29.7%. Even then the proportion of subadults could be overestimated here, because it is highly probable that the infant burials or at least some of them are from the Medieval period (Table 2).

Table 2. Radiocarbon dating

Burial place	**Const-ruction**	**Bone sample**	**Location in grave**	**Lab no.**	$d^{13}C$ (‰)	**BP**	**95.4%**	**68.2%**
Maidla I	stone-grave, irregular	adult, left ulna, proximal, cremated	104/F	Hela-2403	-22.4	1675±30 BP	258–427 AD	341–413 AD
Maidla II	stone-grave, irregular	adult, cranial vault, cremated	96N–96O	Hela-1958	-22.2	1000±30 BP	980–1160 AD	990–1120 AD
Maidla II	stone-grave, irregular	infant, *os temporale*, *pars petrosa*, uncremated	75S	Hela-1919	-20.7	440±30 BP	1410–1610 AD	1430–1465 AD
Rõsna-Saare I	long sand barrow	adult, axis, cremated	bone set 1, under barrow 7, cremated	Hela-1959	-27.2	1565±35 BP	410–570 AD	430–540 AD
Rõsna-Saare I	round sand barrow	subadult, long bone fragment, cremated	bone set 3, in the centre of barrow 9, cremated	Hela -1960	-26.7	1595±35 BP	390–550 AD	420–540 AD
Rõsna-Saare II	long sand barrow	adult, cranial vault, cremated	bone set 3, in the centre of barrow 7, cremated	Hela-1961	-24.4	1620±35 BP	340–540 AD	390–540 AD
Suure-Rõsna	round sand barrow	adult, cranial vault, cremated	bone set 7, in the centre of barrow 6, cremated	Hela-1962	-22.5	1535±35 BP	420–600 AD	430–580 AD
Põlgaste	*tarand* grave	adult, cranial vault, cremated	8B–8C	Hela-2404	-23.9	1959±30 BP	40 BC – 122 AD	5–74 AD
Põlgaste	*tarand* graves	adult, cranial vault, cremated	10F	Hela-2405	-20.9	1977±30 BP	45 BC – 80AD	20BC – 65AD

The modelled demographic characteristics for the Estonian graves under study are presented in Table 3. Newborn life expectancy, calculated using uncorrected life tables (raw data), shows the highest values for the graves, signifying a relatively low mortality. The data, corrected in accordance with Rösing and Jankauskas (1997) by increasing the proportion of infants and children (0–4 years) to 45% of the total number of individuals under study, yields lower and probably more reliable values for newborn life expectancy (Table 3).

The model based on the juvenile ratio (Bocquet, Masset 1977; Bocquet-Appel, Masset 1982) proposes the lowest newborn life expectancies. The juvenility indices (D_{5-14}/D_{20+}) for the sand barrow cemeteries vary from 25 to 32 (27 on average) and e^0_0 between 16.3 and 20.3 years (19.0 years on average), indicating a mortality between 49.2 and 62.1‰ (52.4‰ on average). These mortality values are much higher compared to those obtained from the uncorrected life tables (31–37‰) and slightly higher compared to the mortality obtained from the corrected life tables (46–57‰).

The stone-graves of Maidla show greater variability in the juvenility indices and newborn life expectancy (Table 3). Maidla I shows a very high

Table 3. Demographic data from the Estonian graves

Name/type of the burial place Type of the grave	Maidla I	Maidla II	Rõsna-Saare I	Rõsna-Saare II	Suure-Rõsna	Three barrow cemeteries, summarised
	stone-grave	stone-grave	sand barrow	sand barrow	sand barrow	
AMS dates 68.2% (range)	341–413 AD	990–1120 AD	420–540 AD	390–540 AD	430–580 AD	390–580 AD
AMS dates 95.4% (range)	258–427 AD	980–1160 AD	390–570 AD	340–540 AD	420–600 AD	340–600 AD
Number of burials	20	74	61	46	40	147
Males	5	13	14	10	8	32
Females	5	16	15	8	8	31
Masculinity index (%)	1.0	0.81	0.87	1.25	1	1.03
Undetermined sex	2	23	11	10	9	30
Proportion of adults (%)	60	70.30	65.60	60.90	62.50	63.27
Proportin of subadults (%)	40	29.70	34.40	39.10	37.50	36.73
T = usage of grave (years)	72	250*	120	150	150	190
Life tables, raw data after Acsádi, Nemeskéri 1970						
e^0_0 (newborn life expectancy)	26.9	28.2	28.42	27.25	32.02	29.03
Crude death = crude birth rate	0.037	0.035	0.035	0.037	0.031	0.034
Corrected life tables after Rösing, Jankauskas 1997						
e^0_0 (newborn life expectancy)	17.5	19.56	19.56	19.89	21.72	20.6
Crude death = crude birth rate	0.057	0.051	0.051	0.050	0.046	0.049
After Boquet, Masset 1982						
Juvenility index (5–14/20+)	0.42	0.18	0.25	0.25	0.32	0.27
e^0_0 (newborn life expectancy)	11.6	25.7	20.3	20.3	16.3	19.0
Crude death = crude birth rate	0.086	0.039	0.049	0.049	0.061	0.053
GRR (gross reproduction rate)	5.5	2.5	3.1	3.1	3.9	3.2
TFR (total fertility rate)	11.3	5.1	6.4	6.4	8.0	6.6
Reproduction after Henneberg 1975						
R_{pot}	0.688	0.668	0.675	0.680	0.776	0.709
R_0 (U_C=7.45)	1.52	1.80	1.53	1.54	1.76	1.61
C – average number of births	5.0	5.1	5.0	5.1	5.8	5.3
Population size (after Ubelaker 1989)	3.2–7.5	7.6–8.7	10.3–14.8	6.2–8.5	4.3–8.7	14.7–22.8

* From Mandel 2003.

crude death rate (88‰) and an extremely low newborn life expectancy (e^0_0=11.6); under these conditions a community is hardly sustainable. At Maidla II, the mortality is the lowest (39‰) and the life expectancy at birth (e^0_0=25.7) is the highest compared to the other studied communities. Bear in mind that Maidla I is a very small grave (only 20 burials) and at Maidla II both infants and older children (over 5 years of age) could be underrepresented, only two cremations of subadults having been detected in the grave (Allmäe 2003). The GRR and TFR obtained from the juvenility indices are also presented in Table 3. According to this model, the women at Late Iron Age Maidla are characterised by the lowest number of offspring, the Middle Iron Age women in Maidla by the highest. The Middle Iron Age women at Rõsna gave birth to 6.6 children on average.

The number of children born per woman was also calculated using the model proposed by Henneberg (1975). The total number of births per woman or adult couple is from 5.0 to 5.8 in the communities under study. The number of offspring varies from 5.0 to 5.8 for the South-eastern Estonian barrow cemeteries and between 5.0 and 5.1 for the Western Estonian stone-graves (Table 3). R_o or the net reproduction rate shows the replaceability of generations; the $R_o>1$ for all of the observed communities suggests a positive increase.

The living population sizes calculated using different life expectancies indicate that in most cases one household or family used the graves under study. The model also suggests that Rõsna-Saare I cemetery was used by a somewhat larger household or extended family or two nuclear families (Table 3). The calculated living population size is sensitive to the estimated period of the grave's use; as the timespan decreases, the calculated population size will increase in these models (Table 3).

DISCUSSION

The earlier demographic studies of the Estonian prehistoric and historic periods have been based on different assumptions and modelled using various methods. The first demographic model to calculate community sizes for the prehistoric period was based on the number of artefacts in *tarand* graves and a presumed mortality rate of 40‰. The suggested average estimated size of the community that used one *tarand* grave was 5–9 individuals in North-eastern, South-eastern and Central Estonia and 3–4 individuals in North-western Estonia (Lang, Ligi 1991, pp.224–225). Later on Valter Lang (1996, p.375) corrected the aforementioned numbers to 7–13 and 3–8 individuals, respectively. A community size of 8–10 individuals was obtained from the skeletal remains from the Roman Iron Age Viimsi I *tarand* grave in Northern Estonia (Lang 1993, p.56), which corresponds well with the artefact-based calculations.

The osteological research of skeletal material from the Pre-Roman Iron Age *tarand* graves at Poanse (Western Estonia) indicated a community of 4–6 individuals depending on the period of the grave's use (Kalman 2000a; Lang 2007, p.224). The community at Tandemägi (Võhma, Northern Estonia) consisted of 6 individuals (Lang 2000, p.206). Lang (2007, pp.224–225) pointed out that a single family used the *tarand* graves for centuries and that custom of burying only nuclear family members and sometimes only some of them in stone-graves was practiced during the Pre-Roman and Roman Iron Ages.

The first stone-grave of Maidla in Western Estonia was most likely established in the late Roman Iron Age or early Middle Iron Age. At most, a single family used the grave; the crude death rate was very high (e^0_0=11.6) and the community was probably not sustainable. The same pattern characterises the Pre-Roman Iron Age *tarand* graves at Poanse (Kalman 2000a; Mandel 2000). The newborn life expectancy was extremely low (10.8 and 14.4 years), thus the crude death rates are very high and the calculated community sizes very small (3.5 people at Maidla I, 2.0 at Poanse I, and 3.4 at Poanse II). The period these graves were used is 72, 250, and 150 years, respectively. The timespan assumptions are probably wrong and the graves were possibly used for a shorter period. Population size estimation is highly dependent on the period of a grave's use and the estimated life expectancy at birth. Our idea that graves, especially *tarand* graves, were used for several centuries could be somewhat overestimated. For example, if the use period for Poanse I is reduced from 250 to 100 years and for Poanse II from 150 to 50 and a newborn life expectancy derived from the juvenile ratio (e^0_0=10.8; e^0_0=14.4 years) is used, another reality is seen. The community size for Poanse I *tarand* grave is then 5 and for Poanse II 10.

During the Late Iron Age a community of 7–10 individuals, probably a single family or household, used Maidla II in Western Estonia (Allmäe 2006). The estimated family size is in accordance with the earlier results of various authors on the average Estonian family size in the 13th century and later (Blumfeldt 1937; Ligi 1961; Tarvel 1972; Palli 1996). The present study also suggests that a single family or household (7–9 individuals) probably had its own burial ground at Maidla during the 10th–13th centuries. The newborn life expectancy was 25.7 years, the crude death rate was 39‰, and women gave birth to 5.1 children on average in Maidla during the 10th–13th centuries. The newborn life expectancy shows low child mortality and favourable living conditions or underrepresentation of the subadult (older than 5 years of age) burials in the grave. There are many possible reasons for child underenumeration in the graves: segregation in the subadult burial practice is plausible (Allmäe 2010), the crushing of the cremains before burial, and the excavation techniques. For example the crushing of burnt bones before burial in Late Iron Age Western Estonia is probable (Allmäe 2013); in this case, the fragile cremains of children become invisible in graves (Sigvallius 1994, p.32; Holck 1997). Insufficient excavation techniques are less plausible since the number of subadults in Maidla I is representative.

In respect to community size, the results of the osteological analyses of the cremains from the Middle Iron Age barrow cemeteries at Rõsna (South-eastern Estonia) show the same pattern of one family or household using one barrow cemetery. The community size assumptions based on the archeologically determined number of burials (Rõsna-Saare I and Rõsna-Saare II) and a mortality rate of 40‰ yield similar results (Лиги 1989; Lang, Ligi 1991, p.227). Similar results have been obtained from Iron Age East Lithuania: communities of 5–15 individuals usually buried their dead in one barrow cemetery, the number of individuals corresponding to a group of people the size of the average nuclear family over several generations (Kurila 2009). The newborn life expectancy at Rõsna during the Middle Iron Age was 19.0 years, the crude death rate was 49–53‰ on average, and women gave birth to 5.3–6.6 children (Table 3), indicating relatively unfavourable living conditions compared to Late Iron Age Maidla.

The present study shows that the demographic figures depend on the selected model or sample. The overall variability in the proportion of adults and subadults in the graves is not striking, but when the skeletal samples are very small, any minor change in the proportions of the age groups has a significant impact on the demographic figures.

The next step looks more closely at two most representative samples from Estonia: the summarised sample of South-eastern Estonian sand barrows from the Middle Iron Age at Rõsna (Rõsna I, II, Suure-Rõsna) and the Western Estonian stone-grave at Maidla II from the Late Iron Age. The demographic figures calculated for these samples and for some Latvian (Zariņa 2009) and Lithuanian (Jankauskas 2002) archaeological ske-

Table 4. Comparative demographic data

Grave	South-eastern Estonian	Lithuania*		
	Rõsna (summarised)	Marvelė	Marvelė	Plinkaigilis
Date (years)	390–580 AD	300–450 AD	450–600 AD	450–600 AD
Usage of grave (years)	190	150	150	150
Number of burials	147	179	223	334
Juvenility index	0.27	0.32	0.27	0.20
Newborn life expectancy	19.1	16.3	18.7	24.0
Crude death rate	0.052	0.061	0.053	0.042
GRR**	3.2	3.8	3.2	2.6
TFR	6.6	7.8	6.6	5.3
Grave	**Western Estonia**	**Latvia*****		
	Maidla II	Leijasbitēni	Čunkāni-Dreņģeri	Laukskola
Date (years/centuries)	980–1230 AD	7th–10th	8th–11th	10th–13th
Usage of grave (years)	250	300	300	275
Number of burials	74	188	233	239
Juvenility index	0.18	0.21	0.11	0.28
Newborn life expectancy	25.7	23.3	34.2	18.3
Crude death rate	0.0390	0.0430	0.0293	0.0546
GRR**	2.5	2.6	1.9	3.4
TFR	5.1	5.3	3.9	6.97

letal materials are presented in Table 4. The juvenility index is lowest in Marvelė during 300–450, showing the highest mortality in the studied communities. Jankauskas (2002) has suggested some kind of crisis, which led to a dramatic decrease in the Marvelė community during this period, but in the following Middle Iron Age period the situation improved. Rõsna in Southern Estonia shows juvenility indexes comparable to those of Middle Iron Age Marvelė, both indicating less suitable living conditions compared to the cemetery in Plinkaigalis (Lithuania). A somewhat better demographic situation is indicated for the Estonian and Latvian communities somewhat later during the Middle Iron Age and Late Iron Age. The exception is Laukskola cemetery from the 10th–13th centuries. The dramatic fluctuation in population size there due to economic and political processes has been thoroughly analysed by Zariņa (2009, pp.180–184). The collective influence of these processes is reflected in the demographic figures of the summarised sample.

The number of offspring (TFR values), as expected, increases with the mortality rate because higher infant mortality reduces the birth intervals. When a nursing child dies, the natural sterility due to the lactation period is interrupted and conception occurs earlier (Wood 1990). The human reproductive strategies may change due to the influence or interaction of several economic,

* Data from Jankauskas 2002.
** Calibrated from McCaa 1998; 2000.
*** Data from Zariņa 2009.

social, and biological factors. Fertility may increase, e.g., during wars, famine and drought periods, even though the mortality rate is high at the same time. The phenomenon is observable in Table 4: low newborn life expectancy is related to a higher number of offspring.

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ABBREVIATIONS

AVE – Arheoloogilised välitööd Eestis = Archaeological fieldwork in Estonia

EAMTAA – Eesti Ajaloomuuseum. Töid ajaloo alalt

EJA – Estonian Journal of Archaeology

ETAA – Eesti Teaduste Akadeemia Ajaloo Instituut

ETATÜ – Eesti Teaduste Akadeemia Toimetised, Ühiskonnateadused

JHE – Journal of Human Evolution

MT – Muinasaja Teadus

ST – Setumaa kogumik = Setumaa symposium = Сетумааский сборник

TÜAKT – Tartu Ülikooli Arheoloogia Kabineti Toimetised

GRR – gross reproduction rate, i.e. the number of female offspring born per woman

MNI – minimum number of individuals

PNI – probable number of individuals

TFR – total fertility rate, i.e. the total number of offspring per woman

ESTIJOS GELEŽIES AMŽIAUS KAPINYNŲ DEMOGRAFIJA

Raili Allmäe

Santrauka

Viduriniojo geležies amžiaus Pietryčių Estijos pilkapynus palikusių bendruomenių (bendri Rõsna I, Rõsna II, Suure-Rõsna duomenys) juveniliškumo indeksai rodo trumpą vidutinę numatomą gyvenimo trukmę gimus (e^0_0=19,0). Bendras šioje teritorijoje mirusiuosius laidojusių bendruomenių dydis buvo 15–23 asmenys. Kiekviena šeima ar namų ūkis greičiausiai turėjo savo kapavietę. Rõsna ir Suure-Rõsna pilkapynai naudoti apie 190 metų. Rõsna-Saare I kapavietę naudojo 10–15-os asmenų bendruomenė (čia laidota apie 120 metų), kuri dydžiu veikiau atitiktų išplėstinę nei porinę šeimą ir yra didesnė už Rõsna-Saare II ar Suure-Rõsna bendruomenes.

Maidla akmenų kapų (Vakarų Estija) medžiagoje pastebimos didesnės juveniliškumo indekso variacijos. Vidutinė numatoma gyvenimo trukmė gimus (e^0_0=25,7) vėlyvojo geležies amžiaus Maidla II kapavietės medžiagoje rodo buvus mažą vaikų mirtingumą ir neblogas gyvenimo sąlygas arba nesuaugusių asmenų kapų trūkumą. Realybės neatspindintį mažą nesuaugusiųjų palaikų skaičių galima paaiškinti įvairiomis priežastimis: vaikų laidojimu atskirai nuo kitų bendruomenės narių, degintinių kaulų sutrupinimu prieš laidojant (tokiu atveju trapių vaikų kaulų archeologiniame kontekste nepastebima) arba archeologinių tyrimų metodikos trūkumais. Pastarąją tikimybę verčia atmesti nemažas nesuaugusiųjų kapų skaičius Maidla I kapavietėje. Vėlyvojo geležies amžiaus Maidla II bendruomenę sudarė 7–9 (laidojimo trukmė – 250 metų); viduriniojo geležies amžiaus Maidla I bendruomenę – 3–7 asmenys (laidojimo trukmė – 72 metai). Maidla I bendruomenėje vidutinė numatoma gyvenimo trukmė gimus buvo labai trumpa (e^0_0=11,6), o bendras mirtingumo rodiklis – labai didelis. Pagal šiuos demografinius rodiklius galima teigti, kad bendruomenė buvo netvari.

LENTELIŲ SĄRAŠAS

ILIUSTRACIJŲ SĄRAŠAS

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