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## of the 24th International Congress of Roman Frontier Studies,

Belgrade – Viminacium, Serbia, 2nd September – 9th september 2018

## VOLUME II

# LIMES XXIIII

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**Viminacium – Belgrade, Serbia**

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***These proceedings are dedicated to the memory of***
***C. Sebastian Sommer,***
***dear friend and colleague,***
***man who dedicated his entire life to the Roman limes.***

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# Settlement size, site history, and mortality at Roman Viminacium: Testing the urban graveyard hypothesis

## ABSTRACT

It is a widely held view that ancient cities were unhealthy environments. Some scholars have gone so far as to suggest that larger pre-Industrial cities were so lethal as to be unable to sustain their population levels without constant immigration from rural hinterlands. The present study therefore examines mortality at the ancient city of Viminacium on the Danube frontier in an attempt to test the Urban Graveyard Hypothesis using skeletal remains from a provincial Late Roman context. Given the known trajectory of urban development at Viminacium, which began as a small military outpost on the Roman Limes during the 1st Century and evolved into a large, regionally important political and economic center persisting into the 5th century, it was possible to study changes in health as settlement size and density increased through examination of skeletons from the graveyards surrounding the city. The results suggest that local, historically-specific conditions – namely the Third Century Crisis known from ancient documentary sources – were far more influential upon general public health than increasing population size at Viminacium.

**Key Words:** provincial roman urbanism, urban graveyard effect, third century crisis, paleodemography, event history analysis, survival analysis, transition analysis

It is a long and widely held view that ancient cities were decidedly unhealthy environments for humans relative to open rural settings. This has often been attributed to a purported intensified infectious disease environment brought on by increased population density and the associated sanitation issues[1]**.** Some demographers have, in fact, gone so far as to proclaim an 'iron law' in which pre-Industrial cities with larger populations were fundamentally unable to sustain their numbers without constant immigration from the rural hin-

[1]See Cohen 1989; Larsen 1997; Steckel, Rose 2002; Storey 2006 for numerous case studies supporting this position.

terlands due to excessive levels of mortality[2], though it has also been pointed out that this excess mortality was experienced primarily by the immigrants themselves[3]. Similar views have been advanced for cities of the ancient Mediterranean world, particularly Rome itself [4]. Still, the question remains as to whether this 'Urban Graveyard Effect' is an intrinsic universal of human settlement ecology, or instead a variable characteristic of cities under some conditions – but not others[5]. In the present work, we empirically investigate the question of whether the Urban Graveyard principle is appropriately applied to smaller provincial Roman cities of the Danube *limes*.

## Death and the city

Since as early as the 17th century, demographers have noted that deaths recorded in vital records exceeded births in many early modern European cities[6]. Migration to cities from rural hinterlands was intense during this period and it was perceived that many, if not most, European cities would not have been able to maintain their population size and economic viability if not for this constant influx of persons. E.A. Wrigley perhaps most clearly articulated this notion of an 'Urban Graveyard Effect' in 1967 in his analysis of early modern London. In his view, excess mortality created a constant need of inward migration from a city's hinterlands in order to maintain the urban population and, in turn, its economic stability. Subsequent researchers following Allan Sharlin – while recognizing that this Urban Graveyard phenomenon is reflected in vital records from across Europe – pointed out that it was in fact the immigrants themselves who were contributing disproportionately to the excess mortality. Yet other critics have further argued against the Urban Graveyard Effect as any sort of universal principle, pointing out that some pre-industrial northern Dutch cities did not experience any such excess of deaths over births[7]. In most current research, discussions of Urban Graveyard Theory focus on what subset of the population is primarily responsible for excess numbers of urban deaths[8].

The present paper, however, is specifically focused upon the excess mortality phenomenon itself and its relationship to population size – as opposed to whether the deaths are coming predominantly from natives or migrants. An estimated population threshold of some 10,000 persons has been advanced as the point at which urban environments tend to become exceedingly lethal[9]. This 'Urban Graveyard' principle has also worked its way into models of the ancient Roman World, where some exceeding grim pictures of urban living conditions have been painted, particularly for the city of Rome itself[10]. Ancient documentary evidence details the many plagues and other endemic health risks facing the occupants of Rome and the residents themselves –especially the educated wealthy elites – clearly recognized the health benefits to escaping the confines of the Eternal City during the malarial summers[11]. It is therefore our intention to scientifically test for the existence of the Urban Graveyard Effect in a provincial Roman context.

As far as previous empirical investigations of ancient Roman urban conditions and its effect on general public health, data have been scarce and equivocal in their implications. Epigraphic evidence from tombstones has suggested a significant seasonal impact of endemic malaria and occasional episodes of epidemic mortality in Roman Italy[12], but the fickleness of the 'epigraphic habit' has limited the effectiveness of applying information obtained from mortuary monuments

[2]Wrigley 1967; De Vries 1974; Finlay 1981; Flinn 1981.

[3]Sharlin 1978; Van der Woude 1982.

[4]Morley 1996, 2005; Sallares 2002; Jongman 2003; Scheidel 2003; Paine, Storey 2006; *but see* Lo Cascio 2006, 2015 for a different opinion.

[5]Woods 2003, Shaw 2006.

[6]Graunt 1662; Sussmilch 1775; Malthus 1798.

[7]Van der Woude 1982.

[8]Puschmann *et al* 2013; Hin 2016.

[9]de Vries 1974; Sharlin 1978.

[10]Yavitz 1958; Brunt 1966; Champlin 1982; Ramage 1983; Scobie 1986; Syme 1986; Pleket 1993.

[11]Cicero, *De re Publicum* 2.11; Hippocrates, *On Epidemics*; Celsus, *De Medicina*; Galen, *De Morborum Temporibus.*

[12]Sallares 2002; Shaw 2006.

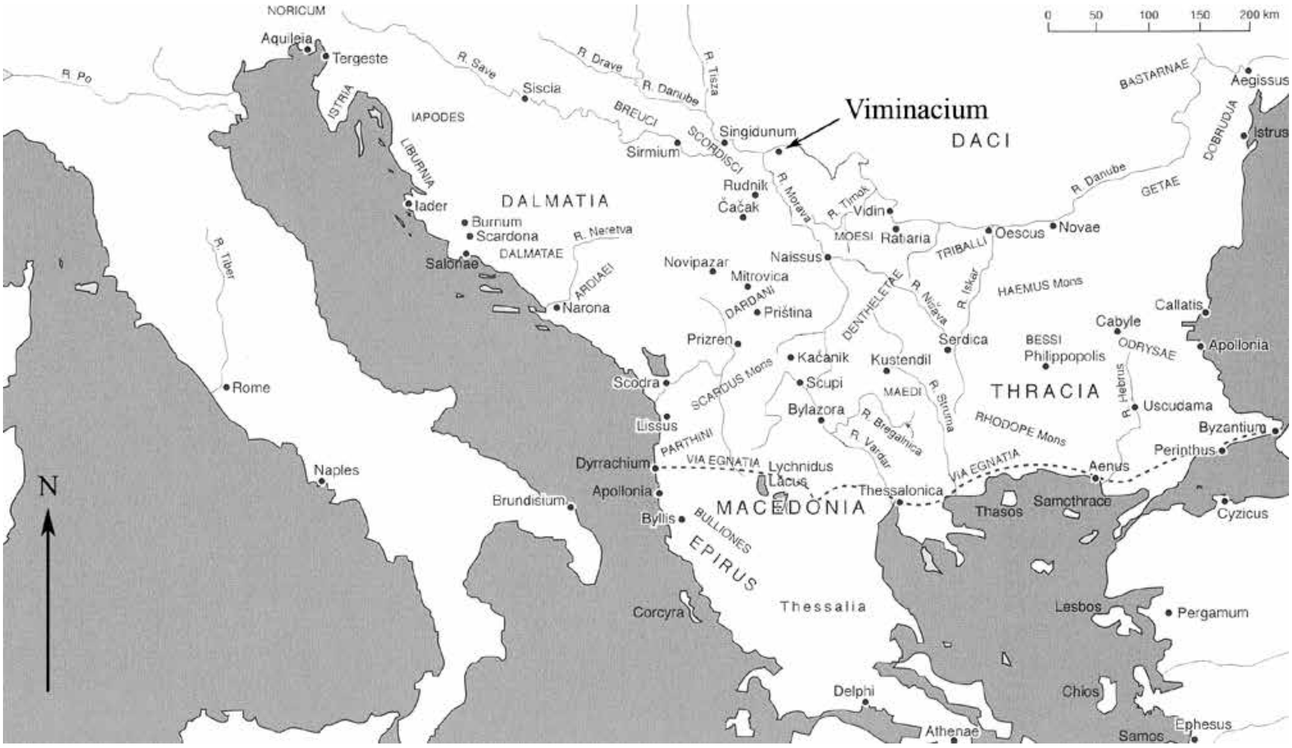


Fig. 1 - Location of Viminacium within the Roman Balkans

to detailed demographic problems[13]. Skeletal evidence from the city of Rome itself has likewise been difficult to come by and lacking in consistency of documentation[14]**.** A few previous attempts have been made to investigate urban and rural health distinctions in other parts of the Roman Empire – mostly Roman Britain – on the basis of skeletal remains[15], but local circumstances and sample constitution have rarely been conducive to investigating the Urban Graveyard Effect in a systematic manner. This has not, however, prevented some scholars from advancing generalized life tables purported to be representative of the ancient Empire as a whole – thereby implying a homogeneity in the mortality experience between city and countryside[16]. A direct test of the Urban Graveyard principle in the context of a Roman urban center from which abundant, quality skeletal data are available therefore seems long overdue.

## Sample description and framing the hypothesis

Consider then if you will the Late Roman provincial city of Viminacium (Fig. 1). Situated on the middle Danube in modern Serbia, this frontier legionary outpost was founded during the 1st Century and became a provincial capital on the Danube Frontier at least by the 2nd Century. The settlement accrued a civilian element and increased in political stature when it became a *municipium* under Hadrian in AD 117[17]. During this period, Viminacium is thought to have consisted of perhaps 5000 soldiers in the military encampment surrounded by several thousand locals in the supporting town. Viminacium rose to political and economic prominence during the late 2nd and early 3rd Century, especially during the Severan dynasty with Septimus Severus visiting on multiple occasions and proclaiming Caracalla his successor here in AD 196[18]. By then the settlement itself was surrounded by defensive walls,

[13]Hopkins 1966–67; Parkin 1992; Schiedel 2001.

[14]Killgrove 2018.

[15]Waldron 1989; Redfern *et al.* 2015; Rohnbogner and Lewis 2017; but see also Šlaus 2004 for treatment of the Danube *limes* and cities of the hinterland to some degree.

[16]*e.g.* Frier 1982, 1983.

[17]Mirković 1968, 63.

[18]Mirković 1968, 64.

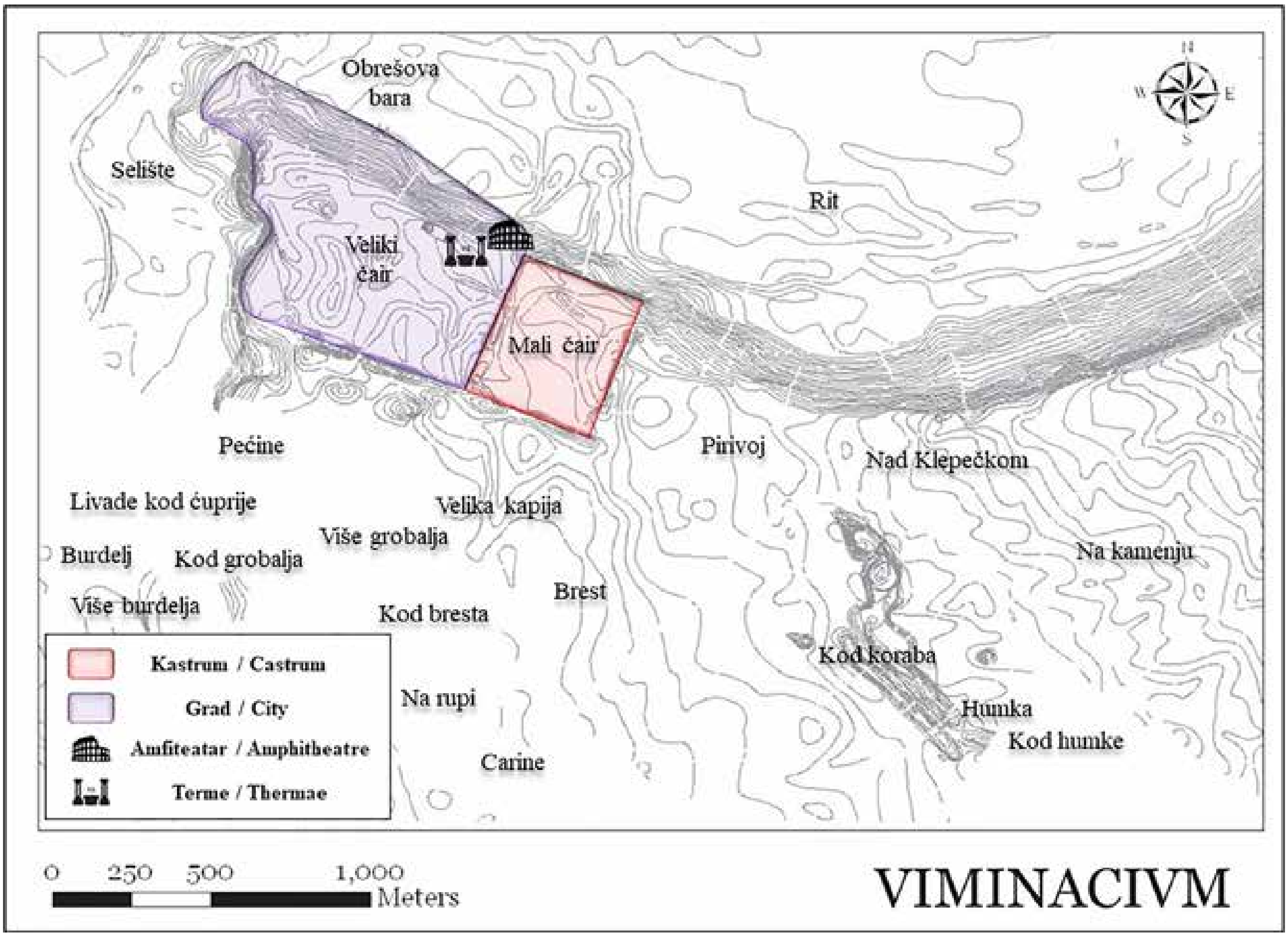


Fig. 2 - Map of Viminacium with Location of Key Contributing Cemeteries

contained an amphitheater, multiple public baths, and a system of aquaducts bringing a public water supply[19]. Viminacium reached the highest possible level of municipal standing under the Empire during the 3rd Century when proclaimed *colonia* in the reign of Gordian III. The city eventually reached a maximum extent of some 220 hectares, and is thought to have attained a population peak of some 30 to 40,000 persons. Viminacium remained a large, heavily populated settlement into the 4th Century, and became an Epsicopal seat of the newly legitimized Christian church[20]. The city was sacked by the Huns in AD 441, with most of the inhabitants reportedly enslaved[21], and the site was rapidly depopulated soon thereafter.

The present study is based upon a sample of 297 skeletal individuals analyzed from 254 graves recovered from 4 spatially distinct cemeteries surrounding the ancient city (Fig. 2)[22]. Chronologically sensitive grave inclusions – predominantly coins and metal fibulae – allowed the date of interment to be estimated for many of the individuals in this sample. It was thereby possible to group individuals by time period in order to examine changes in mortality and other indicators of general health, such as pathological skeletal lesions, through time. Sufficient chronological information was received to attribute time frame of burial to a total of 93 individuals from the overall sample[23]. Individuals were thereby assigned to one of three sequential periods: Period 1 (1st and 2nd Centuries CE), Period 2 (3rd Century CE), or Period 3 (4th Century CE).

[19]See Spasić-Djurić 2002 for general overview of the history and known features of the ancient city.
[20]Mirković 1968, 72.
[21]Priscus, *Historia Byzantium.*
[22]Speal 2015.
[23]See *ibid:* Table 3 for more detailed treatment of sample consistency.

Assuming a typical pre-industrial human population growth pattern – in which demographic increase is rather slow initially but eventually approaches exponential as a settlement becomes more nucleated and fertile – Viminacium should have crossed the "urban" demographic threshold of around 10,000 persons sometime during the 3rd Century or so and theoretically become subject to the Urban Graveyard Effect. Using this premise, we can call Period 1 "pre-urban", Period 2 "proto-urban", and Period 3 "fully urban" Viminacium. The operational hypothesis here then is: if the Urban Graveyard Model applies to middle-sized provincial Roman cities of Late Antiquity, then evidence of elevated mortality – and morbidity – should be most apparent among the fully urban 4th Century (Period 3) skeletons at Viminacium relative to those dating to the earlier pre- and proto-urban 1st through 3rd Centuries (Periods 1 and 2).

## Methodology

Assessment of age-at-death for the skeletons used in this study was accomplished using Transition Analysis – a recently developed technique that examines individualized aspects of change in the pubic symphysis, auricular surface, and cranial sutures of each individual[24]. This aging method employs Bayes' theorem and posterior probabilities to compute both a confidence interval and a maximum likelihood point estimate for each individual's age-at-death, thereby facilitating broader demographic analysis. A supplemental system of obtaining point estimates from sternal rib ends – personally devised by the first author based upon Iscan and Loth's widely-known scoring technique[25] – was used to complement the Transition Analysis in order to increase sensitivity and precision for each individual age estimate[26]. For sub-adults, age-at-death was estimated using standard methods of dental development, epiphyseal closure, and long bone metrics[27]. These methods were combined to obtain the narrowest age range possible, from which a midpoint was calculated in order to obtain an age point-estimate. A single, specific age-at-death point estimate was thereby created for each skeletal individual in the study.

The resulting age point estimates were then subject to event-history survival analysis using the STATA Version 8 statistical package[28]. The individual age-at-death point estimates were first processed using STATA's non-parametric Cox logistic regression function to compute a composite life table and produce mortality hazard and survivorship curves for the overall assemblage[29]. Differences in survivorship between specific variables of research interest were then calculated, graphed, and tested for statistical significance using the Kaplan-Meier product limit estimator technique[30]. As we are most interested here in the variable of chronology of interment for purposes of evaluating the Urban Graveyard Hypothesis, those are the only results presented in this paper.

## Results

For those who may be unfamiliar, survivorship graphs depict the surviving proportion of a population or subset of the population at each age relative to the population as a whole implied by a set of observed mortality data. The more gradual the decline of the curve becomes as one proceeds to the right along the x-axis, the greater the 'survivorship'. The steeper the decline as one moves to the right, and the earlier the point at which it meets the x-axis, the more severe the mortality experience. As one can see from Fig. 3, the most severe mortality regime at Viminacium – reflected in the sharpest dropping survivorship curve and earliest point of reaching the x-axis – is observed NOT for the Period 3, 4th Century maximum urban cohort (shown in green here) as expected if the Urban Graveyard Effect was in operation, but instead that representing Period 2, the 3rd Century sample (shown in red). The Period 1 (1st and 2nd Century) survivorship curve, shown in blue, is found to generally follow a more intermediate course.

[24]Boldsen *et al.* 2002; Milner *et al.* 2008.
[25]Iscan, Loth 1986.
[26]Speal 2008.
[27] Buikstra, Ubelaker 1994, Bass 2005.
[28]Cleves *et al.* 2008.
[29]*ibid.* pp. 129–145.
[30]*ibid.* pp. 93–96.

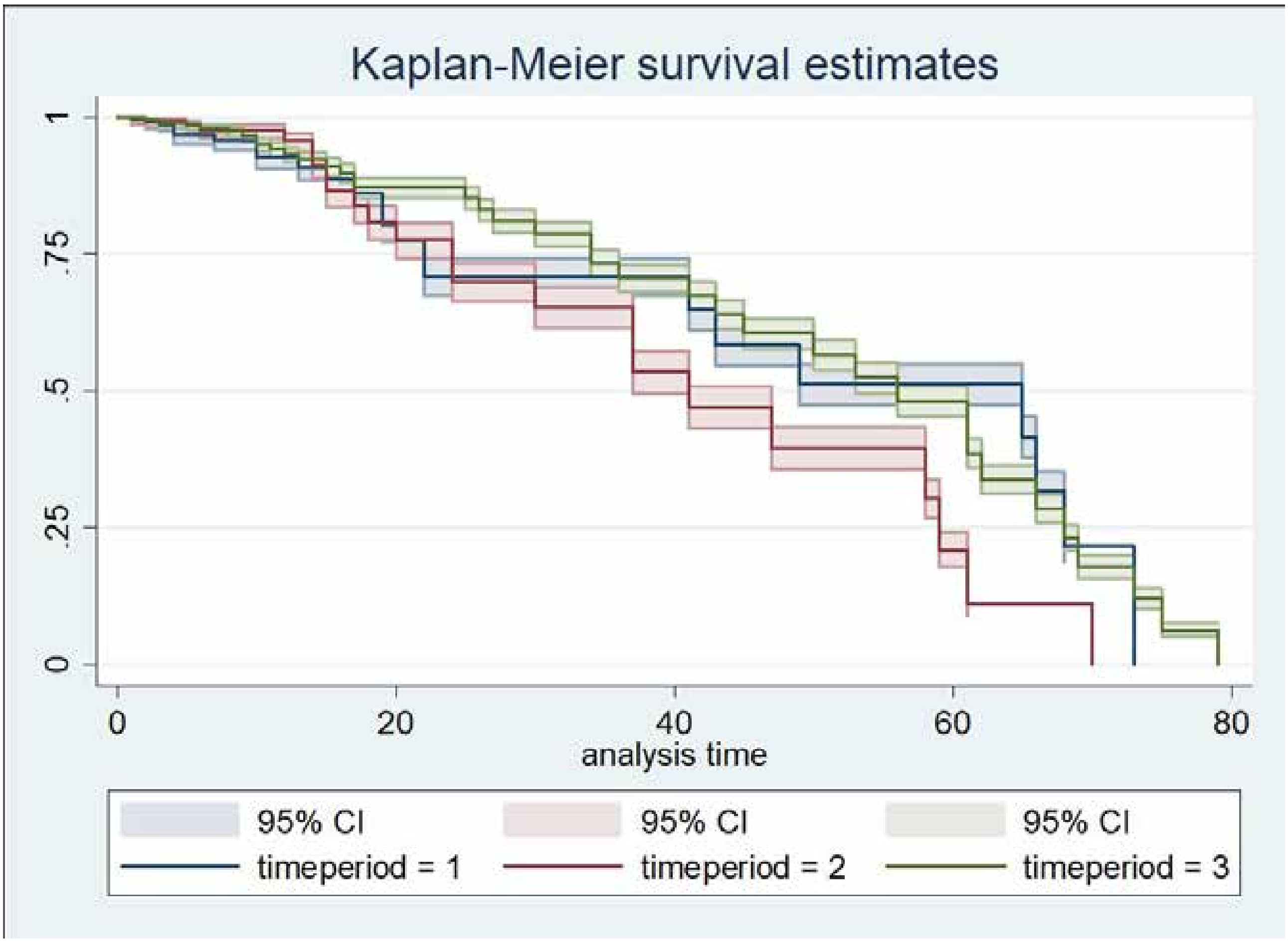


Fig. 3 - Survivorship by Time Period at Viminacium

A mortality hazard curve represents the estimated age-specific risk of death in the population from which the sample was collected. It is essentially a graph of the probability that death will occur at any given age – conditional upon having survived up until that age. In the following hazard graph produced from the Viminacium skeletal data (Fig. 4), the curves do not extend all the way to birth, nor beyond 70 or so years of age, because of the graph smoothing process and because there are too few representatives from these age groups in the skeletal sample to produce a coherent estimate. Nonetheless, it is apparent from the graph that risk of death is substantially greater at almost all adult ages in the Period 2, 3rd Century sample as opposed to either of the other two chronological periods.

Such findings are decidedly not in accord with the Urban Graveyard model, which predicts that mortality should be at its highest during the latest period of occupation – when the city's population was presumably at its greatest. In fact, the Viminacium survival analysis data instead suggest that mortality was instead at its *lowest* during the peak 4th Century population, which directly contradicts the notion that larger provincial Roman cities were inherently more unhealthy than the smaller communities from which they arose.

Furthermore, a survey of pathological lesions from the same skeletal sample tells a similar story. Four of the ten lesion categories examined at Viminacium – including active periostitis, multiple linear enamel hypoplasia, active cribra orbitalia, and lytic erosive lesions – were found to occur with a steadily declining relative frequency through time with the lowest crude prevalence during the urban 4th Century (Fig. 5). Four other classes of pathology – linear enamel hypoplasia, cribra orbitalia, porotic hyperostosis, and long bone curvature – were found to peak during Period 2 – the 3rd Century. Only one type of lesion, undifferentiated periostitis, was found to reach maximum prevalence during the 4th Century urban height of Viminacium, and there are reasons to believe that this lesion class was in fact behaving in a 'paradoxical' manner at the site – meaning that its elevated prevalence may be an indication that greater numbers of people were surviving

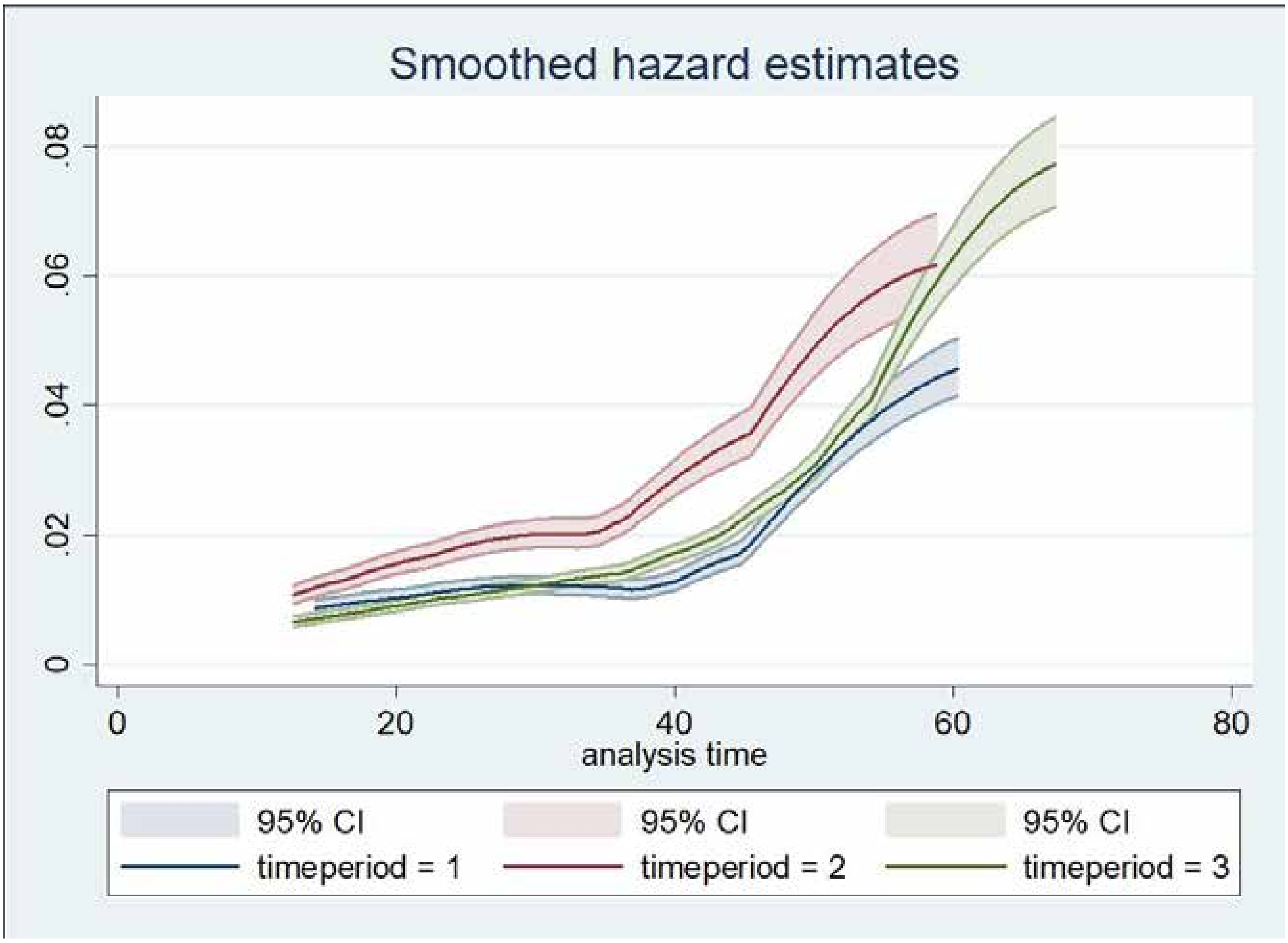


Fig. 4 - Mortality Hazard by Time Period at Viminacium

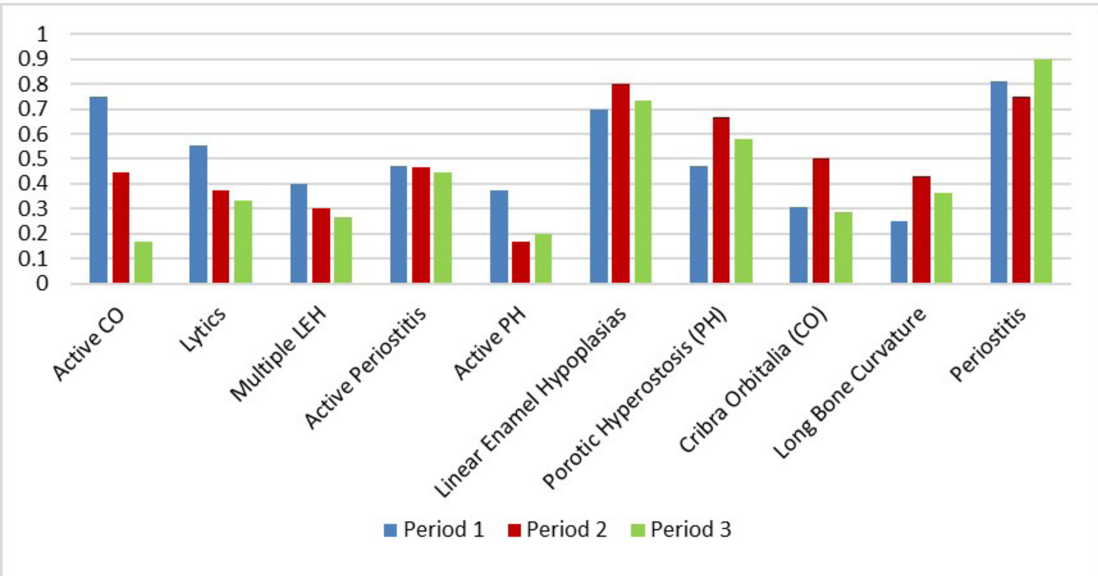


Fig. 5 - Crude Prevalence of Various Classes of Skeletal Lesions by Time Period

the conditions that caused the lesion, making it more a marker of biological resilience than of systemic stress.

## Discussion

The present study has yielded fairly strong evidence to reject any notion of an Urban Graveyard Effect at Viminacium. If anything, the skeletal data suggest that mortality and most indicators of morbidity decreased at the site as the city surpassed the demographic 'urban' threshold and reached its population peak in the 4th Century. The elevated mortality and morbidity observed in Period 2 – the 3rd Century – was unexpected, however, and does merit further discussion. Ancient textual sources are, in fact, replete with descriptions of the 3rd Century CE as a time of great disruption and crisis across the Roman Empire[31]. This period is generally recognized as a time of social upheaval characterized by incursions by Germanic populations from northern Europe and Eurasia, increased internal political strife with contested imperial successions, and widespread economic malaise especially in the northern border regions of the western Empire[32].

While ancient primary sources noted the onset of a general decline after the reign of Marcus Aurelius between 161 and 180 CE, the crisis truly arose around the time of Severus Alexander and Maximinus Thrax between 222 and 238 with an onslaught of Germanic peoples across the Danube and Rhine frontiers. With the defeat of Decius at the hands of the Goths and the capture of Valerian by the Persians in 260, the Empire was in complete disarray. In the year 272 the province of Dacia was completely abandoned by the Roman state, which only increased the pressure on the northern frontier communities through resettlement and increased proximity to hostile populations. Some stability was reportedly achieved by Claudius II, Aurelian, and Probus, but it was only under the intense reforms of Diocletian between 284 and 305 CE that the Empire regained any kind of political and economic normalcy.

This partial collapse of the Roman state is thought to have manifested itself in different ways across the Empire, but the Danubian provinces seem to have experienced the sharpest economic decline – as well as the brunt of much of the conflict brought on by outside military incursions[33]. Trade was repeatedly interrupted, particularly in the frontier provinces, and inflation ran rampant. A shortage of peasants was reported in the countryside, leading to a consequent decline in agrarian food production as well. The results of the present study tend to confirm that this "Third Century Crisis" was very real, and it very much affected public health at Viminacium in a manner that overwhelmed any kind of general Urban Graveyard Effect.

This is not to say that the 4th Century was without difficulties. The beginning of this era has generally been characterized as a period of stabilization across the Empire, and a series of political, military, and economic reforms allowed the Roman state to survive for another century or so[34]. Nevertheless, new incursions of foreign peoples, religious conflicts, and wars between pretenders to the Imperial throne would again shake the Empire in the middle to late 4th Century CE – culminating in the defeat of a Roman army by insurgent Goths at Adrianople in 378. Though the crux of these events took place in relative geographic proximity to Viminacium, the present study suggests that they were nowhere near as immediately consequential for general public health as were the crises of the 3rd Century.

There are, of course, a number of other possible explanations for the failure of the Urban Graveyard hypothesis in the present study. Perhaps Viminacium never actually reached the population threshold that would incur an Urban Graveyard Effect. This seems unlikely given the magnitude of architectural development and economic complexity observed archaeologically at the site, as well as the description of its importance in ancient documents, but should be entertained as a possibility. It is also possible that the purported Urban Graveyard threshold of 10,000 persons is simply set too low for significant levels of excess mortality to be incurred. That explanation would, of course, also imply that a number of 30,000 is too low as well – since that is what most archaeological estimates suggest for Viminacium at its peak.

[31] Marcus Aurelius, HA, 17.2; *Epit. de Caes.* 16.2; Dio 71.36.4, 80.7.2; Cyprian, *Ad Demetr.;* Tertullian*, Apol 20.2*

[32] Mócsy 1974; Alföldy 1975.

[33] Alfoldy 1975 (1988 trans. ed.) pp. 157–159).

[34] Mirković 2006, 73.

Or perhaps Viminacium reached the demographic threshold at an earlier, 3rd Century date, and the results therefore do actually reflect the early onset of an Urban Graveyard Effect. In that case, it would become necessary to explain the subsequent rebound in survivorship and apparent increased skeletal health during the 4th Century. No such explanations are immediately forthcoming. Short of a major depopulation of the site during the 4th Century, which is not generally supported by the archaeology – nor the ancient literary sources – such an argument would be difficult to make.

It is also possible that the study sample sizes were simply not adequate to resolve the true ancient demographic patterns. Unfortunately, the final sample size of 93 total individuals was smaller than originally intended. Still, the collection is substantial and both mortality and morbidity outcomes are in general agreement, which suggests that the results are robust. Nonetheless, one would hope that future research will at some point further test these findings at Viminacium and elsewhere. By far the most plausible present conclusion then, seems to be that smaller provincial Roman cities really were organized and managed well enough to avoid the major public health failings evident at the larger urban centers across the ancient Mediterranean world and later pre-Industrial Europe.

## Conclusions

The widely recognized, historically specific 'Third Century Crisis' then seems to have had the greatest influence on the diachronic pattern in mortality and morbidity stress observed at Viminacium. The general implication is that culturally and historically particular developments had much more influence on overall public health than any broader Urban Graveyard Effect in the provincial Roman case. In fact, urban life – at least on the Danube Frontier – appears to have brought more health benefits than risks to the local populace. As population reached its peak levels, indicators of public health seem to have improved, not declined. Perhaps this is a reflection of the economic vitality of upstart urban centers and/or the hygienic efficiency of late Roman planning and design engineering.

To conclude, the present study yields fairly strong evidence that we should reject any notion of an Urban Graveyard Effect at Viminacium. If anything, the skeletal data indicate that overall mortality – and most indicators of morbidity – decreased at the site as the population peaked in the 4th Century. The results of this study suggest that universal characterizations of ancient cities as putrid death traps or perpetual population sinks are not defensible. Apparently, there are limits to the Urban Graveyard principle even within the confines of pre-modern Europe itself. The realities of urban life and health were evidently much more historically specific and variable than has been generally accounted for. Moreover, if local demographics were anywhere near as generally dynamic at individual Roman provincial cities as the present study suggests, the notion that there ever was any single coherent, unitary Roman mortality program is also an untenable assumption.

## Bibliography

**Alföldy 1975**
G. Alföldy, *Romische Sozialgeschichte* (Wiesbaden 1975).

**Bass 2005**
W. M. Bass, *Human Osteology: A Laboratory and Field Manual* (Columbia 2005).

**Boldsen *et al.* 2002**
J. L. Boldsen, G. Milner, L. Konigsberg, J. Wood, Transition Analysis: A New Method for Estimating Age from Skeletons, in: R. Hoppa, J. Vaupel, *Paleodemography: Age Distribution from Skeletal Samples* (Cambridge 2002) 73–106.

**Brunt 1966**
P. Brunt, The Roman Mob, *Past and Present* 35 (1966) 3–27.

**Buikstra, Ubelaker 1994**
J. E. Buikstra, D. Ubelaker, *Standards for Data Collection from Human Skeletal Remains* (Fayetteville 1994).

**Champlin 1982**
E. Champlin, The Suburbium of Rome, *American Journal of Ancient History* (1982) 97–117.

**Cleves *et al.* 2008**
M. Cleves, W. William, G. Gutierrez, U. Marchenko, *An Introduction to Survival Analysis Using STATA, 2nd Edition* (College Station 2008).

**Cohen 1989**
M. N. Cohen, *Health and the Rise of Civilization* (New Haven 1989).

**de Vries 1974**
J. de Vries, *The Dutch Rural Economy in the Golden Age, 1500–1700* (New Haven 1974).

**Finlay 1981**
R. Finlay, Natural Decrease in Early Modern Cities, *Past and Present* 92, 1981, 169–174.

**Flinn 1981**
M.W. Flinn, *The European Demographic System, 1500–1820* (Baltimore 1981).

**Frier 1982**
B. Frier, Roman Life Expectancy: Ulpian's Evidence, *Harvard Studies in Classical Philology* 86 (1982) 213–251.

**Frier 1983**
B. Frier, Roman Life Expectancy: The Pannonian Evidence, Phoenix 37(4) (1983) 328–344.

**Graunt 1662**
J. Graunt, *Natural and Political Observations and Conclusions Made Upon the Bills of Mortality* (London 1662).

**Hin 2016**
S. Hin, Revisiting Urban Graveyard Theory: Migrant Flows in Hellenistic and Roman Athens, in: L. de Ligt, L.E. Tacoma (eds.) *Migration and Mobility in the Early Roman Empire* (Leiden 2016) 234–263.

**Hopkins 1966–67**
K. Hopkins, On the Probably Age Structure of the Roman Population, *Population Studies* 20 (1966–67) 245–264.

**Iscan, Loth 1986**
M. Y. Iscan, S. Loth, Estimation of Age and Determination of Sex from the Sternal Rib, in: K.J. Reichs (ed.) *Forensic Osteology: Advances in the Identification of Human Remains* (Springfield 1986) 68–89.

**Jongman 2003**
W. Jongman, Slavery and the Growth of Rome, in C. Edwards, G. Woolf (eds.) *Rome the Cosmopolis* (New York 2003) 100–122.

**Killgrove 2018**
K. Killgrove, Using Skeletal Remains as a Proxy for Roman Lifestyles: The Potential and Problems with Osteological Reconstructions of Health, Diet, and Stature in Imperial Rome, in: P. Erdkamp, C. Holleran (eds,) Routledge Handbook of Diet and Nutrition in the Roman World (London 2019) 245–258.

**Larsen 1997**
C. S. Larsen, *Bioarchaeology: Interpreting Behavior from the Human Skeleton* (Cambridge 1997).

**Lo Cascio 2006**
E. Lo Cascio, Did the Population of Imperial Rome Reproduce Itself?, in: G.R. Storey (ed.) *Urbanism in the Preindustrial World: Cross-Cultural Approaches* (Tuscaloosa 2006) 52–68.

**Lo Cascio 2015**
E. Lo Cascio, The Impact of Migration on the Demographic Profile of the City of Rome: A Reassessment, in: L. de Ligt, L.E. Tacoma (eds.) *Migration and Mobility in the Early Roman Empire* (Leiden 2016) 23–32.

**Malthus 1798**
T. Malthus, *An Essay on the Principle of Population As It Affects the Future Improvement of Society* (London 1798).

**Milner *et al.* 2008**
G. R. Milner, J. W. Wood, J. L. Boldsen, Advances in Paleodemography, in: M.A. Katzenberg, S.R. Saunders (eds.), *Biological Anthropology of the Human Skeleton* (2nd Ed.) (New York 2008).

**Mirković 1968**
M. Mirković, *Rimski Gradovi na Dunavu u Gornjoj Meziji* (Beograd 1968).

**Mirković 2006**
M. Mirković, *Sirmium: Istorija Rimskog Grada od I Veka do Kraja VI Veka* (Sremska Mitrovica 2006).

**Möcsy 1974**
A. Mócsy, *Pannonia and Upper Moesia: A History of the Middle Danube Provinces of the Roman Empire* (London 1974).

**Morley 1996**
N. Morley, *Metropolis and Hinterland: The City of Rome and the Italian Economy, 200 B.C.–A.D. 200* (New York 1996).

**Morley 2003**
N. Morley, Migration and the Metropolis, in: C. Edwards, G. Woolf (eds.) *Rome the Cosmopolis* (New York 2003) 147–157.

**Paine, Storey 2006**
R. Paine, G. Storey, Epidemics, Age at Death, and Mortality in Ancient Rome, in: G. R. Storey (ed.) *Urbanism in the Preindustrial World: Cross-Cultural Approaches* (Tuscaloosa 2006) 69–85.

**Parkin 1992**
T. Parkin, *Demography and Roman Society* (Baltimore 1992).

**Pleket 1993**
H. Pleket, Rome: A Preindustrial Megalopolis, In T. Barker, A. Sutcliffe (eds.) *Megalopolis: The Giant City in Prehistory* (New York 1993) 14–35.

**Puschmann *et al.* 2013**
P. Puschmann, R. Donrovich, G. Dekeyser, K. Matthijs, *Migration and Urban Graveyards: Comparing Mortality Risks between Urban In-Migrants and Natives in a Western European Port City: The Case of Antwerp*, 1846–1920, Paper presented at the XXVII IUSSP International Population Conference, Busan, Republic of Korea, 26–31 August 2013.

**Ramage 1983**
E. Ramage, Urban Problems in Ancient Rome, In R.T. Marchese (ed.) *Aspects of Greek and Roman Urbanism: Essays on the Classical City,* B.A.R. International Series 188, (Oxford 1983) 61–92.

**Redfern *et al.* 2015**
R. Redfern, S. DeWitte, J. Pearce, C. Hamlin, K. Dinwiddy, Urban-Rural Differences in Roman Dorset, England: A Bioarchaeological Perspective on Roman Settlements, *American Journal of Physical Anthropology* 157 (2015) 107–120.

**Rohnbogner, Lewis 2017**
A. Rohnbogner, M. 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 (2017) 208–228.

**Sallares 2002**
R. Sallares, *Rome and Malaria* (New York 2002).

**Scheidel 2001**
W. Scheidel (ed.) *Debating Roman Demography* (Boston 2001).

**Scheidel 2003**
W. Scheidel, Germs for Rome, in: C. Edwards, G. Woolf (eds.) *Rome the Cosmopolis* (New York 2003) 158–176.

**Scobie 1986**
A. Scobie, Slums, Sanitation, and Mortality in the Roman World, *Klio* 68 (1986) 399–433.

**Sharlin 1978**
A. Sharlin, Natural Decrease in Early Modern Cities: A Reconsideration, *Past and Present* 79, 1978, 126–138.

**Shaw 2006**
B. D. Shaw, Seasonal Mortality in Imperial Rome and the Mediterranean: Three Problem Cases, in G. R. Storey (ed.) *Urbanism in the Preindustrial World: Cross-Cultural Approaches* (Tuscaloosa 2006) 86–120.

**Spasić-Djurić 2002**
D. Spasić-Djurić, *Viminacium: The Capital of the Roman Province of Upper Moesia* (Požarevac 2002).

**Speal 2008**
C. S. Speal, Evaluating Intercostal Variability in Sternal Rib Ends for Purposes of Skeletal Aging, *Arheologija i Prirodne Nauke* 3 (2008) 31–36.

**Speal 2015**
C. S. Speal, A Paleodemographic / Mortuary Study of Graves from the Eastern Necropolis at Roman Viminacium, *Arheologija i Prirodne Nauke* 11 (2015) 167–186.

**Steckel, Rose 2002**
R.H. Steckel, J.C. Rose (eds.) *The Backbone of History: Health and Nutrition in the Western Hemisphere* (New York 2002).

**Storey 2006**
G. R. Storey (ed.), *Urbanism in the Preindustrial World, Cross-Cultural Approaches* (Tuscaloosa 2006).

**Süssmilch 1761**
J. Süssmilch, *Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts, aus der Geburt, dem Tode und der Fortpflanzung desselben* (Berlin 1761).

**Syme 1986**
R. Syme, *The Augustan Aristocracy* (Oxford 1986).

**Šlaus *et al*. 2004**
M. Šlaus, N. Pecina-Šlaus, H. Brkic, Life Stress on the Roman limes in Continental Croatia, *Homo* 54(3) (2004) 240–263.

**Van der Woude 1982**
A. M. Van der Woude, Population Developments in the Northern Netherlands (1500–1800) and the Validity of the "Urban Graveyard" Effect, *Annales de Demographie Historique* (1982) 55–75.

**Waldron 1989**
T. Waldron, The Effects of Urbanisation on Human Health: The Evidence from Skeletal Remains, in: D. Serjentson, T. Waldron (eds.), *Diet and Craft in Towns: The Evidence of Animal Remains from the Roman to the post-Medieval Periods*, BAR British Series 199 (Oxford 1989) 55–73.

**Woods 2003**
R. Woods, Urban-Rural Mortality Differentials: An Unresolved Debate, *Population and Development Review* 29 (1), 2003, 29–46.

**Wrigley 1967**
E. A. Wrigley, A Simple Model of London's Importance, in: Changing English Society and Economy 1650-1750, *Past and Present* 37, 1967, 44–70.

**Yavitz 1958**
Z. Yavitz, The Living Conditions of the Urban Plebs in Republican Rome, *Latomus* 17 (1958) 500–517.

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