VILNIUS UNIVERSITY
LITHUANIAN INSTITUTE OF HISTORY

ŠARŪNAS JATAUTIS

PALEODEMOGRAPHY OF LITHUANIA

ACCORDING TO PALEOOSTEOLOGICAL DATA

Summary of doctoral thesis
Humanities, History (05 H)

Vilnius, 2018

The dissertation was prepared at Vilnius University in 2012-2016.

Scientific supervisor: prof. dr. Rimantas Jankauskas (Vilnius University, Biomedical Sciences, Medicine – 06 B).

Scientific consultant: dr. Artūras Dubonis (Lithuanian Institute of History, Humanities, History – 05 H).

The doctoral thesis is being defended at the public meeting of the Dissertation Defence Board:

Chairman: doc. dr. Gintautas Vėlius (Vilnius University, Humanities, History – 05H).

Members:

dr. Laurynas Vytis Kurila (Lithuanian Institute of History, Humanities, History – 05H).

prof. dr. Zenonas Norkus (Vilnius University, Social Sciences, Sociology – 05S).

prof. dr. Rimvydas Petrauskas (Vilnius University, Humanities, History – 05H).

prof. dr. Vladislava Stankūnienė (Vytautas Magnus University, Social Sciences, Management – 03S).

The dissertation will be defended at Vilnius University, Faculty of History (room 211) at 3 PM, 2nd of March, 2017.

Address: Universiteto 7, LT- 01513, Vilnius, Lithuania.

The dissertation is available at Vilnius University Library, Lithuanian Institute of History Library, and online*: www.vu.lt/lt/naujienos/ivykiu-kalendorius*

VILNIAUS UNIVERSITETAS

LIETUVOS ISTORIJOS INSTITUTAS

ŠARŪNAS JATAUTIS

LIETUVOS PALEODEMOGRAFIJA

(REMIANTIS OSTEOLOGINIAIS DUOMENIMIS)

Daktaro disertacijos santrauka

Humanitariniai mokslai, istorija (05 H)

Vilnius, 2018

Disertacija rengta 2012-2016 m. Vilniaus universitete.

Mokslinis vadovas - prof. dr. Rimantas Jankauskas (Vilniaus universitetas, biomedicinos mokslai, medicina – 06B).

Mokslinis konsultantas - dr. Artūras Dubonis (Lietuvos istorijos institutas, humanitariniai mokslai, istorija – 05 H).

Disertacija ginama viešame disertacijos gynimo tarybos posėdyje:

Pirmininkas – doc. dr. Gintautas Vėlius (Vilniaus universitetas, humanitariniai mokslai, istorija – 05H).

Nariai:

dr. Laurynas Vytis Kurila (Lietuvos istorijos institutas, humanitariniai mokslai, istorija – 05H);

prof. dr. Zenonas Norkus (Vilniaus universitetas, socialiniai mokslai, sociologija– 05S);

prof. dr. Rimvydas Petrauskas (Vilniaus universitetas, humanitariniai mokslai, istorija – 05H);

prof. dr. Vladislava Stankūnienė (Vytauto Didžiojo universitetas, socialiniai mokslai, vadyba – 03S).

Disertacija bus ginama 2018 m. kovo mėn. 2 d. (penktadienį) 15 val. Vilniaus universitete, Istorijos fakultete, 211 auditorijoje.

Adresas: Universiteto g. 7, LT-01513, Vilnius, Lietuva.

Disertaciją galima peržiūrėti Vilniaus universiteto, Lietuvos istorijos instituto bibliotekose *ir VU interneto svetainėje adresu:* www.vu.lt/lt/naujienos/ivykiu-kalendorius

SUMMARY OF DOCTORAL DISSERTATION

Introduction

In Lithuania, paleodemographic research regarding prehistoric and historic populations began to draw more interest thanks to the initiative of G. Česnys, with R. Jankauskas largely contributing later, as well as L. Kurila. Thanks to these scientists, a huge sample of skeletons (on European scale) was collected and preserved from archaeological burial sites, dated to various time periods, while the analysis of this material allowed the academic society to become familiar with the demographic parameters of past Lithuanian populations and their importance in historical studies. Such research is important even for historical times - despite the available data from written demographic sources, Lithuanian historians paid very little attention to the analysis of the demographical processes in populations of the recent past, especially to mortality and fertility.

However, essential **problems** with Lithuanian paleodemographic studies can be distinguished, which have had an influence on this doctorate thesis, the goals set forth and the tasks that emerged. The beginning and development of paleodemographic research in Lithuania is associated with the emergence and establishment stages of this discipline in North America and Europe. That is, goal formulation and methodological choices in Lithuania were and still are being formulated with regard to the works of major paleodemography theoreticians published up to and in the 1970s - a period, when anthropologists and archaeologists were barely familiar with the basics of formal demography and did not assess the reliability of the results provided by paleodemography with sufficient criticism. Over the past 30 and more years it has been proven that the "traditional" method of paleodemographic analysis, formed in the 1970s, is not suitable for transforming osteological data into demographic parameter values of the past population that is being analysed, as they systematically provide very questionable results. This is why modern paleodemography has gone through significant changes and continues to change compared to what it has been in the previous century. Due to processes taking place within the society, fascination with a relatively new discipline and the possibilities it provides for seeing many centuries or even millennia into the past, courageous and all-encompassing demographic conclusions, and observations arising from them, have been replaced with strict critique of the traditional methods used, and with attempts to solve methodological problems based on exact sciences. Moreover, the previously mentioned Lithuanian paleodemography researchers applied different methods for recording osteological material, i.e. when collecting information about people's ages at the time of death. This means that in Lithuania, no paleodemographic analyses have been carried out that would be both systematic and based on contemporary methodology. Therefore, the reliability of available Lithuanian paleodemographic knowledge, its interpretation and conclusions drawn from it must be newly studied and critically analysed.

With that in mind, the main **goal** of this thesis is to conduct a paleodemographic analysis of Lithuanian historical and prehistoric times using the contemporary Rostock Manifesto (RM) modelling method (Wood et al., 2002), and interpreting in the contexts of archaeological and historical data. The main **source of data** in the research presented here is the rich paleo-osteological material collected in the Laboratory of Anthropology, Department of Anatomy, Histology and Anthropology at the Faculty of Medicine of Vilnius University (AHAAL) (skeletal remains of adult individuals), found in archaeological sites in the territory of current Lithuania. The **chronological period** being analysed: from 1st millennium AD through the end of 18th c., as the majority of skeletal remains kept in Lithuania date to this period. Since a study of such a wide scale was being attempted using such a unique but indirect and fragmented source of data, four main **objectives** were set for the thesis:

1. Review the development of the discipline of paleodemography in order to highlight the essential research issues and tendencies characteristic to this field.
2. Prove (or disprove) whether, and in what conditions, the chosen paleodemography RM modelling methodology is effective in reconstructing demographic processes of past populations. In order to do that, controlled experiments have to be conducted using knowledge of statistics and computer modelling.
3. Critically assess the reliability of earlier Lithuanian paleodemographic studies: considering the results achieved with the second objective of this thesis, analyse the empirical osteological material kept in AHAAL in order to evaluate whether the demographic findings are significantly different from

earlier paleodemographic studies due to the pre-formed demographic image of Lithuania in prehistoric and historical times.

4. Evaluate, based on the analysis of osteological material, and archaeological and historical data, whether in interpreting the long-term dynamics of Lithuanian population's demographic processes and indicators, the population-resources model can be applied, which is based on the ideas of T. Malthus and is one of the most important models in European and Asian historical demography research, and which links demographic, economic and biological elements of human life.

The **novelty and significance** of the thesis is first of all in the application of the concept of modern paleodemography research on the numerous osteological material available, the results of which should be important for a number of reasons. First of all, we believe that after achieving the goals and objectives set in the thesis, the findings will be a useful contribution, providing a systemic basis for researching demographic and sociocultural processes in past Lithuanian populations, as well as modelling and interpreting them. At the same time, we hope that unique paleo-osteological data and the significance of paleodemographic research will be better acknowledged by researchers of the history and demography of Lithuania. Until now, paleodemographic studies were either too little-known or treated in a rather sceptical manner by specialists from other fields. However, we also hope that this study will encourage researchers who are going to analyse Lithuanian bioarchaeological data and conduct paleodemographic analyses in the future to dedicate much more attention to the basics of demography and methodical problems of paleodemography. Thirdly, the results of the study should interest interdisciplinary researchers of the past from various countries, as in the process of writing the thesis, close collaborations with highly qualified specialists from various fields took place and their advice was noted.

In conclusion, it can be said that the thesis defends the following main **statements**:

1. Demographic results calculated according to an osteological analysis of remains are highly dependent on the principles of the methodology applied, as although this source of data is unique, it is still only an indirect source of demographic

data. Therefore, paleodemographic results (at least so far) can provide valuable information about certain long-term past demographic tendencies but not about specific numeral expressions that reliably reflect them.

2. Therefore, paleodemographic results diverge into two currently rather separate areas: raising technical-methodical issues and solving them, which receives the most attention from the main specialists in this field, as well as attempts to explain the obtained results in a wider historical (in the broad sense) context.

3. Due to limited data, today the largest benefit of paleodemographic research lies in answering questions related to *how* and *why* the demographic indicators of past populations changed and what influence that has on their standard of living or development of the society, one should rely not on "more reliable" or "more precise" methods of calculating demographic numeric expressions, which would allow drawing substantiated inductive conclusions, but on inspecting the theoretical models and working hypotheses that describe how aspects of the lives of past people in question worked.

Part 1. Review of Paleodemographic Research and Related Issues

In our opinion, the history of paleodemographic research, the main developers of which were specialists of biological anthropology, and later bioarchaeology, can be divided into four stages. These stages, created based on the works of the most prominent specialists in this field, briefly show how this area developed into its current stage, as well as the possibilities and limitations of the field, and are important in bringing forth the issues with paleodemographic research in Lithuania.

- First stage: 1920s-1970.
- Second stage: 1970-1982.
- Third stage: 1982-2002.
- Fourth stage: 2002-…

Certain roots of paleodemographic studies can already be noted in the 1920s-1930s in the works of biological anthropology specialists (first stage). However, only from around 1960s and the beginning of the 1970s (second stage) the "traditional" paleodemographic methodology were created, which allowed researchers to use the bioarchaeological data as unique source of demographical information to study demographic issues (mostly related to mortality), concerned to populations from more ancient past, that have not left any written demographical data behind them. But rather quickly (especially since the beginning of the 1980s, the third stage) researchers have noticed that paleodemographic results systematically differ from the information obtained through analysing alternate demographic sources of information on past populations. Therefore, the majority of the main paleodemographic theses from the past three decades were and still are being dedicated to solving methodological problems, the most important of which are errors in estimating the age of adults at the time of death, issues with samples being non-representative, as well as problems with a mismatch between the models used and the empirical data. The Rostock Manifesto work published in 2002 (Hoppa and Vaupel, 2002), which includes guidelines set forth by the most prominent specialists in this field, is currently a certain consensus, which at least in theory helps to avoid some of the main paleodemographic problems (fourth stage). However, despite the fact that the application of RM methodology for analysing paleo-osteological data has become wide-spread, one of the most important gaps in such research remains the lack of attention to inspecting the RM methodology and its formal testing, i.e. evaluating whether what is said to be possible to calculate theoretically is also possible in practice.

Part 2: Testing the Rostock Manifesto (RM) under Controlled Conditions

The main idea in RM is estimating the distribution of ages-at-death within the framework of a stable population based on recorded values of skeletal characteristics, when no data is available regarding the age of the deceased at the time of death. The RM method requires 5 main prerequisites to be fulfilled:

1. The target sample is representative of the target population.

2. The fitted regression model properly describes the conditional relationship of skeletal trait values at given ages in a reference sample.
3. The estimates of the fitted regression of trait values on age from a reference sample are valid for the corresponding relationship in a target population (the uniformitarianism assumption).
4. The mortality model for the target population is chosen with the aim of ensuring that the actual age-at-death distribution is contained.
5. The parameters describing the parametric model can be reliably calculated using the maximum likelihood method.

In past paleodemographic studies, the least attention was given to testing the following two RM assumptions: 1) can the probability distribution of the age of the deceased be estimated in a non-stationary population? 2) is the uniformitarian hypothesis, so essential to paleodemographic research, according to which, changes in the skeleton of modern humans occur the same way as they did in the past, - reasonable, and if not, what effect does that have on the results of paleodemographic studies? Only after assessing this situation can one begin to analyse the paleo-osteological material on Lithuania. This is why the main goal of this part is to assess the reliability of the RM methodology used in this thesis and to ascertain in what conditions one can expect to reliably estimate demographic results by analysing paleo-osteological material.

Methods

Osteological Analysis

In this thesis, only one of the four osteological age indicators was studied, the auricular surface of the ilium, the changes in which were registered in accordance with the C.O. Lovejoy et al. (1985) classification. After considering the suggestions of D. L. Osbourne et al. (2004), one modification was made to the Lovejoy et al. (1985) classification in this thesis: the eight stages were brought down to a six-stage classification system, i.e. stages II and III, and IV and V were pooled. The modified system was used in order to decrease the risk of incorrectly assigning a certain stage; it is an often-cited problem, characteristic to the Lovejoy et al. (1985) method (Murray and Muray, 1991; Saunders et al., 1992; Buckberry and Gowland, 2002; Osbourne et al., 2004; Hens et al., 2008; Hens and Belcastro, 2012). The thesis analyses the auricular surface on the right side of the ilium; left side if the right side was not preserved or too abraded to score.

The biological sex of the remains was determined according to sex-based morphological differences in the pubic bone and the greater sciatic notch (White & Folkens, 2005).

Statistical Analysis

Application of the Rostock Manifesto Methodology

Provided below are the three main RM calculation stages, with the specific steps taken to implement them in this thesis described after each stage.

1. *Estimate probabilities of observing age-related osteological trait values at given ages and other important covariates. This information is obtained through analysing documented skeleton collections (DSC), or reference samples.*

To achieve this goal, the thesis uses data from three DSC's (Table 2):

1) The skeletons are stored in the State Forensic Medicine Service under the Ministry of Justice of the Republic of Lithuania (abbr. LORC, *Lithuanian osteological reference collection*). The absolute majority of the deceased are of Lithuanian descent and had autopsies conducted due to legal reasons (unclear death circumstances, possible victim of crime etc.). The autopsies have been conducted between 1979 and 1988 (Garmus, 1996). Information about the age and sex of the deceased is known from legal documents of that time. Additional information about the deceased has not survived. The sample consisted of 381 skeletons.

2) Coimbra collection (*Coimbra Identified Skeletons Collection*, Portugal) comprises skeletons of people who died between 1904 and 1938. The deceased persons are local Portuguese, whose remains were taken from Coimbra city cemetery (Rissech et al., 2006). The sample consisted of 264 skeletons.

3) Spitalfields collection (*Spitalfields Coffin Plate Collection*, London, United Kingdom) comprises human remains found in the crypts of the Church of Christ in London, deceased between 1729 and 1859. According to historical data, the cemetery holds graves of prosperous Londoners (merchants, craftsmen, etc.) (Lewis, 2002). The sample consisted of 239 skeletons.

LORC pelvic bones were analysed by the author of this thesis (in autumn 2014). Meanwhile, corresponding information from two benchmark DSC's in Western Europe, Coimbra and Spitalfields, was collected by R. Gowland (Durham University, United Kingdom). R. Gowland kindly agreed to share her data for this work. In total, 618 skeletons from three DSC's had a well-preserved auricular surface of either side suitable for registering age changes according to C. O. Lovejoy et al. classification.

While modelling the relationship between the stages of the auricular surface and known data on the deceased in three DSC's, the auricular surface stages were considered the dependent variable, while age, gender and DSC - the independent variables. The relationship between dependent and independent variables was calculated by applying these multinomial logistic regression models: 1) the proportional odds model (abbr. PO), 2) the multinomial logistic regression (abbr. MLR) and 3) a non-parametric MLR model (Yee, 2015). These three models offer a different tradeoff between parsimony and complexity. Hypotheses on whether or not the relationship between age and the rate of change in the auricular surface significantly differs among sexes and (or) DSC's, were tested using analysis of deviance. The chosen the level of significance was 0.05. The Akaike Information Criteria (abbr. AIC) was used to draw relative comparisons on how well different regression models fit to the empirical DSC material studied. The models were fitted using "VGAM" R-package (Yee, 2015).

Knowing the estimates of regression models, deterministic equations (Yee, 2015) allowed calculating the probability that the person has a certain stage of the auricular surface at a specific age, i.e. the first component necessary for Rostock Manifesto calculations.

2. *Choose a parametric probability density function that would represent the probability distribution of the age of the deceased in a stable past population that is being studied.*

Usually, in modern-day paleodemographic research, only one model is used for modelling the probability distribution of adult cohort age at the time of death - the Gompertz model. The Gompertz death risk/mortality model is defined by two parameters: α – initial level of mortality, and β – rate of ageing. According to this model, an assumption is made that the risk of death *h(t)* grows exponentially over time (or the relationship between age and risk of death logarithm is a linear one) (Wood et al., 2002):

$$h(t) = \alpha e^{\beta t} \qquad (1)$$

Accordingly, the probability distribution of the cohort's age-at-death, *f(t)*:

$$f(t) = \alpha e^{\beta t + \frac{\alpha}{\beta\left(1 - e^{\beta t}\right)}} \qquad (2)$$

This model has two significant advantages. Firstly, it is defined by just two parameters. This is especially important when analysing small samples, characteristic to paleodemographic studies. Second, demographic studies show that the Gompertz model is a good approximation when defining a person's risk of death in a large age interval: approximately between 30 and 80 years (Gage, 1989; Wood et al. 2002). However, the Gompertz model does not take into account the two main aspects characteristic to the mortality of adults both in modern day and historical populations: a) risk of death that is not age-dependent, characteristic to the beginning of adult age (especially for males between approximately 15 to 30 years old), and b) the fact that for persons above 90, the risk of death does not grow exponentially anymore and slows down (Wood et al., 2002). This means that using the Gompertz model for modelling the whole adult period will cause a partial over-estimation of the risk of death for young adults while the changes in the rate of risk of mortality for elder people is not properly taken into account. The second aspect (risk of death in older ages) is less problematic, as it is not expected that in prehistoric and historic populations such old age (90 years and older) would have a large effect on the calculations. Meanwhile, a larger problem is modelling the mortality of younger adults. One of the simple solutions is applying the Gompertz-Makeham model, which has one additional parameter (c), used in mortality analysis to evaluate mortality that is not dependent on age (Wood et al., 2002):

$$h(t) = c + \alpha e^{\beta t} \qquad (3)$$

$$f(t) = (c + \alpha e^{\beta t}) e^{-ct + \frac{\alpha}{\beta(1 - e^{\beta t})}} \qquad (4)$$

However, when attempting to apply the Gompertz-Makeham model on the osteological material from Lithuanian burial sites (in parts 3 and 4 of this thesis), parameter c could not be successfully calculated, i.e., the estimates of parameter c values were particularly small (<1E-08), while standard margins of error were huge. In other words, the achieved results were essentially not different than the Gompertz model. Therefore, when modelling the probability distribution for the age of the deceased of a cohort in this thesis, only the Gompertz model was used.

Since in a stable population the probability distribution of the age of the deceased, $f_r(t)$ depends not only on the risk of death but also on the population's natural growth indicator, r, $f_r(t)$ can be defined by modifying the age-at-death distribution of the cohort's deceased, $f(t)$ (Wood et al., 2002):

$$f_r(t) = \frac{f(t)}{\int_z^w f(a) e^{-ra} da} \qquad (5)$$

In a stationary population, the equation (5) is simplified: the age-at-death distribution for the deceased of the population is the same as the probability distribution for the cohort's deceased, $f(t)$.

3. *Estimate the parameters of the fitted age-at-death distribution for a sample with skeletal traits from the target population by maximising the log-likelihood of the multinomial distribution, which can be expanded as suggested by the Rostock Manifesto protocol* (Konigsberg and Herrmann, 2002):

$$lnL(\theta|c_i) = \sum_i n_i \ln P(c_i) = \sum_i n_i ln\left[\int_z^w P(c_i|\ln t) f_r(t|\theta) dt\right] \qquad (6)$$

where $n_i$are the number of individuals observed to be in the i^{th} of the I phases of the selected age indicator. In addition, the log-likelihood was slightly modified to take into account the absence of deaths between zero and 15 years in target populations: 15 years were substracted from all of the ages entered into the estimation procedure. Having estimated the parameters it was possible to obtain estimates of various demographic measures, such as risk of mortality, life expectancy, etc.

Testing the RM under Controlled Conditions

Testing the Reliability of the Age-at-Death Probability Distribution Estimation Procedure in a Stable Population using RM Methodology

Is it possible to reliably calculate mortality and natural population change indicators using the RM methodology under ideal conditions (i.e. when all RM prerequisites are fulfilled)? To answer this question, the Monte Carlo simulation method was employed, which is a statistical approach that is commonly used to validate the properties of an estimation procedure (Gelmann and Hill, 2007; Carsey and Harden, 2015). The approach can the form of an controlled experiment in which multiple samples are generated under the conditions determined by a researcher, and then the correspondence between results produced by the estimation procedure applied to each of the generated samples and expected values under the known "true" conditions are inspected (Carsey and Harden, 2015). To implement this approach and test the question of interest, a hypothetical stable population was chosen with the Gompertz model and population change parameter values set by me; then 100 samples were generated with *s* number of observations (auricular surface stage values) in each of them.

Testing the Uniformitarian Hypothesis and an Analysis of the Consequences of not Fulfilling this Hypothesis on Paleodemographic Calculations.

Could it be reasonable to accept the essential assumption of paleodemography that the rate of age-related changes in the auricular surface in studied DSC samples and Lithuanian prehistoric and historic populations was the same? If not, what effect does that have on the results on the age-at-death distribution in the studied past sample (and thus the derivative demographic indicators of the studied past population)? Answering both questions directly is impossible as we lack the appropriate data (age of the deceased and their auricular surface stages) from Lithuanian historic and prehistoric times. However, since DSC data was available for me on deceased persons from various periods and geographic areas, it allows testing the significance of the uniformitarian hypothesis on paleodemographic calculations. It was done by modifying the previously mentioned Monte Carlo simulation study. That is, the mentioned hypothetical stationary population was being analysed, but this time featuring a relative relationship between age and the auricular surface that was the same as the one calculated in LORC. In further application of the RM calculation method, results were taken from LORC, Coimbra and Spitalfields DSC’s. It was expected that the uniformitarian hypothesis will be grounded and will only have a minimal effect on the calculated probability distribution of the age the deceased in the skeleton sample being studied.

Main Results and Conclusions

The estimated simulation results, which are are presented in Tables 1-2 and Figures 1-4, greatly reduce the previously described theoretical RM possibilities (Wood et al., 2002). The most important observation is that it is not possible to reliably calculate both mortality and natural population growth parameter values within the framework of a stable population model.

Table 1. *Testing the applied Rostock Manifesto methodology by analysing generated samples from two hypothetical stable populations: simulation results.*

Parameter	**True value**	**Estimated values (mean and standard error)**	**e(15)**	**Estimated values (mean and standard error)**	**e(15)**
α	0.01	0.0094 (0.0054)	27.0 (21.9 – 30.9)	0.0103 (0.0015)	27.0 (25.7 – 28.3)
β	0.06	0.0721 (0.0311)		0.0598 (0.0074)	
r	0.00	-			
α	0.01	0.0963 (0.1399)	19.4	0.0460	23.4 (22.2 – 24.8)

			(18.7 – 29.9)	(0.0661)	
β	0.06	0.1317 (0.1664)		0.0869 (0.0776)	
r	0.02	-0.0071 (0.2879)		0.0088 (0.1441)	

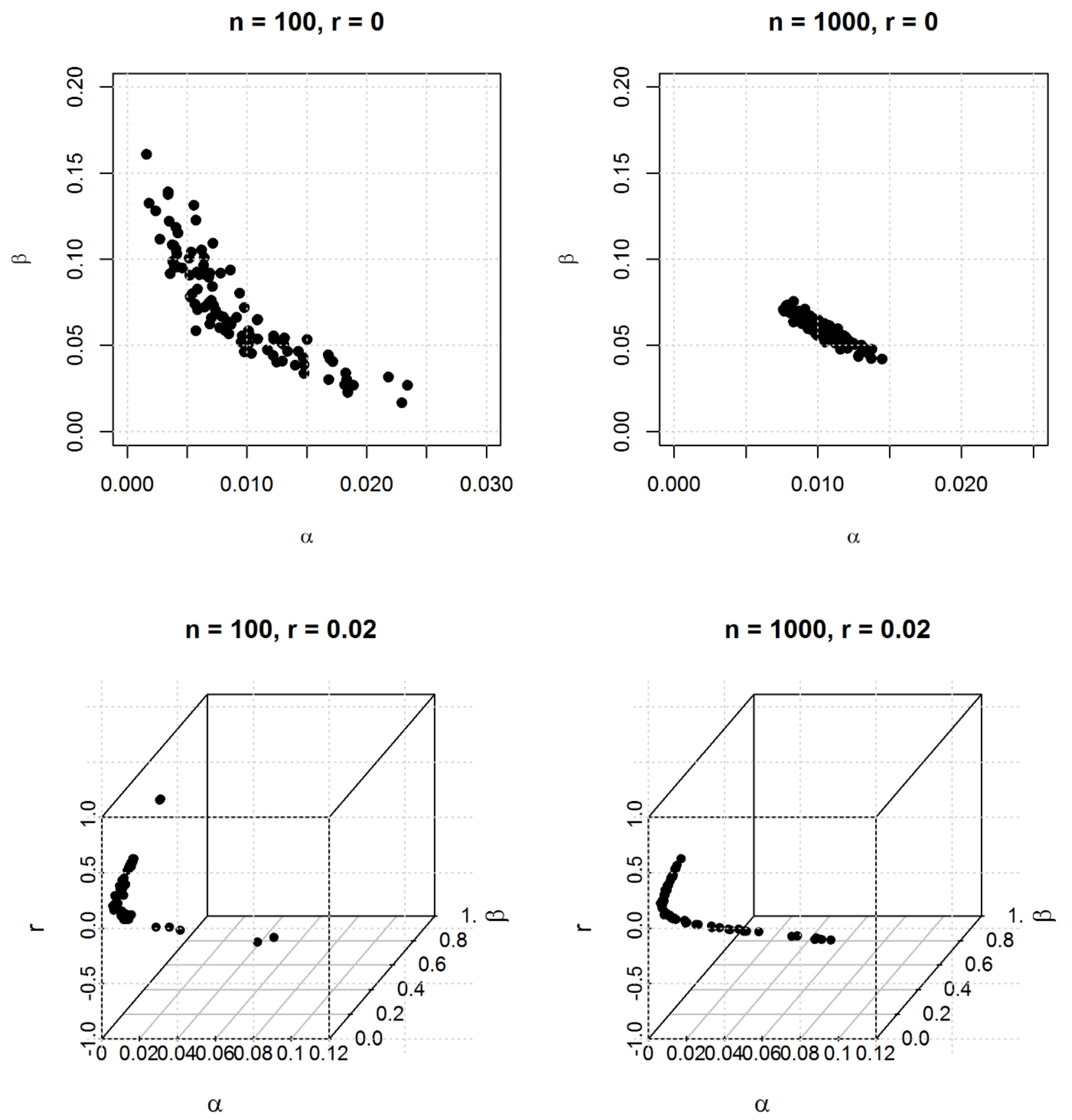

***Fig. 1.** Testing the applied Rostock Manifesto methodology by analysing generated samples from two hypothetical stable populations: estimates of parameters of age-at-death distributions (α, β) and natural population growth indicator (r).*

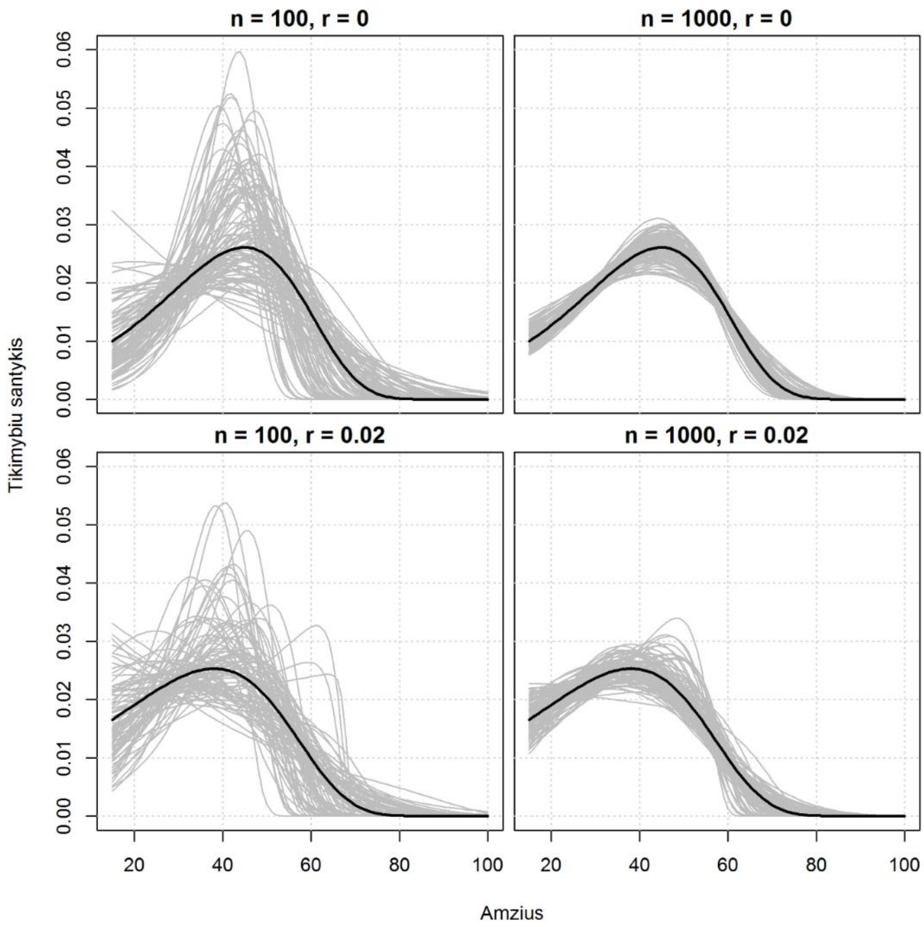

Fig. 2. *Testing the applied Rostock Manifesto methodology by analysing generated samples from two hypothetical stable populations: estimated age-at-death distributions. The black lines represent the actual age probability distributions in stable populations, grey lines represent the estimated distributions. * "Amzius"-"Age"; "Tikimybiu tankis"-"Density".*

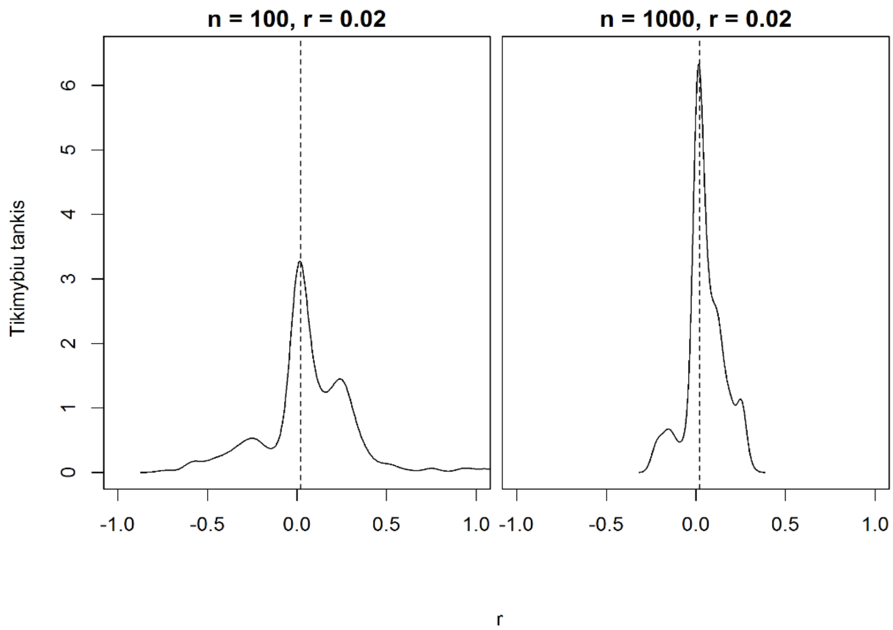

Fig. 3. *Testing the applied Rostock Manifesto methodology by analysing generated samples from a hypothetical increasing stable population: realisations of the natural population growth value r. Vertical dashed lines show the actual natural population growth value (r = 0.02). *"Tikimybiu tankis"-"Density".*

Table 2. *Testing the applied Rostock Manifesto methodology by analysing generated samples from two hypothetical stable populations: estimated parameter realisations of age-at-death distribution (α, β) and natural population growth indicator* (*r*)*.*

Parameter	n = 100			**Parameter**	n = 1000		
	α	β	*r*		α	β	*r*
α	1.00	-	-	α	1.00	-	-
β	-0.50	1.00	-	β	-0.61	1.00	-
r	-0.85	0.87	1.00	*r*	-0.88	0.91	1.00

The simulation results showed that the analysis of paleo-osteological data can only be performed within the framework of a stationary population model or when choosing/knowing in advance the values of natural population growth. The stationary population model greatly oversimplifies the reality being studied, which is why in the future, a further development of the paleodemographic method in this field is necessary in order to avoid those limitations.

Another noted aspect was that the dynamics of skeletal changes in studied DSC's were not the same. Skeletal changes in the auricular surfaces of the people who lived in 17th-19th century London (the rate of transitions between morphological age-related stages of the auricular surface) were notably faster compared to corresponding changes in Portugal in the beginning of the 20th c. and in Vilnius by the end of the 20th c. The slowing-down of the rate of changes in various skeletal areas was also registered by other skeletal biologists and anthropologists. It is likely that such results could be an answer of the skeletal system to the modern changes in the diet, altering types of illnesses and healthcare, physical activity, mortality rate etc. These results suggest that the prerequisite essential to the consistency of paleodemographic research, the rate of human skeletal changes, is not being fulfilled. If the results of the samples studied are representative and skeletal changes truly were slower in the past than in the majority of modern DSC's that are available for paleodemographic analysis, failure to give it enough attention could lead to highly erroneous paleodemographic conclusions about the past population being studied: the more the uniformitarian hypothesis is being violated, the more the estimated age distribution of the deceased will be dominated by overly young deceased persons. Correspondingly, it will have an effect on other realisations of demographical parameter evaluations, e.g. the calculated expected life expectancy will be shorter than it actually was.

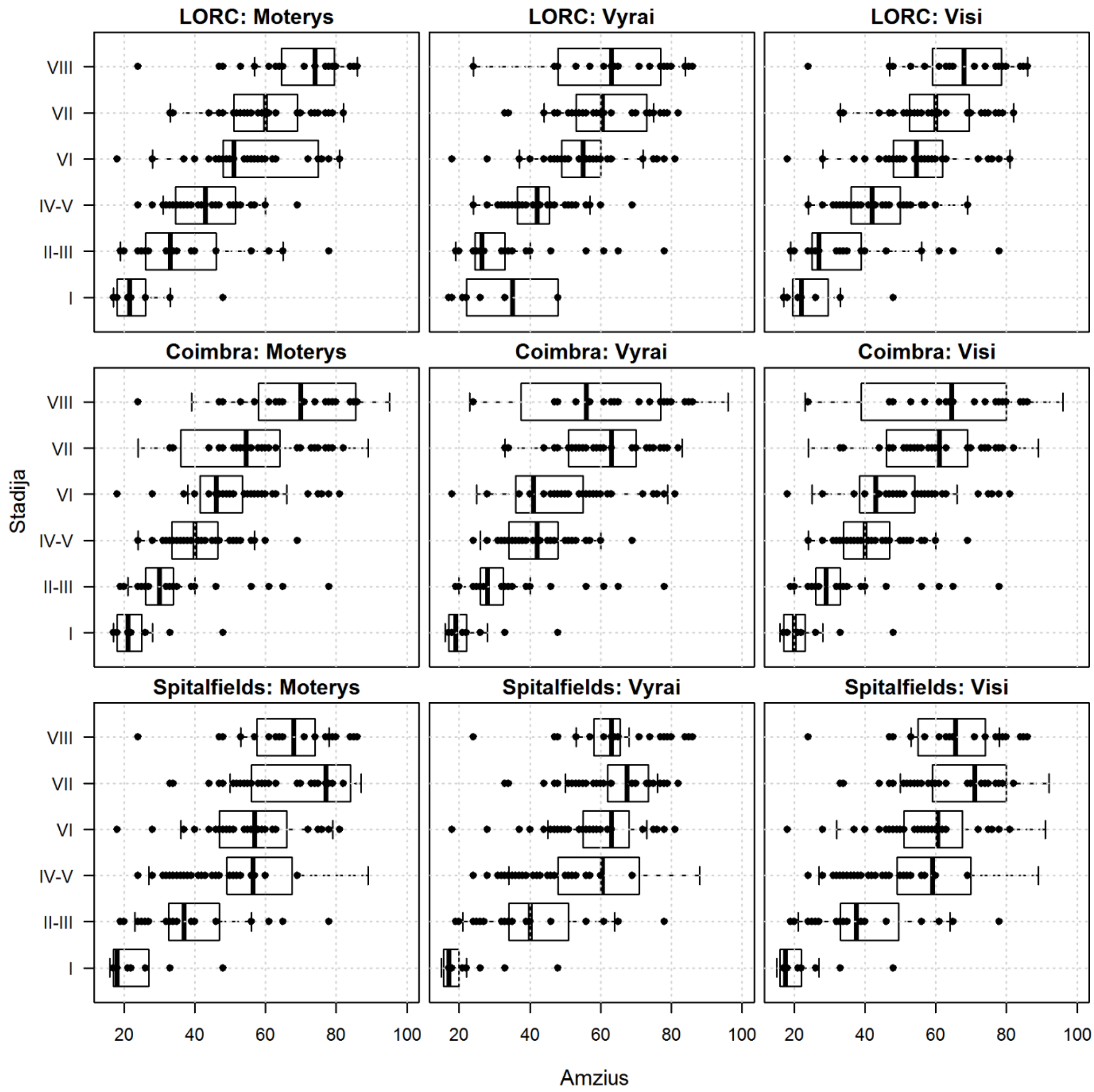

Fig. 4. *Box-plots representing the relationship between age at the time of death and auricular surface stages described by Lovejoy et al. (1985) in LORC, Coimbra and Spitalfields DSC's by sex. Black dots represent the registered empirical data. *"Moterys" – "Females"; "Vyrai" – "Males"; "Visi"-"Both sexes".*

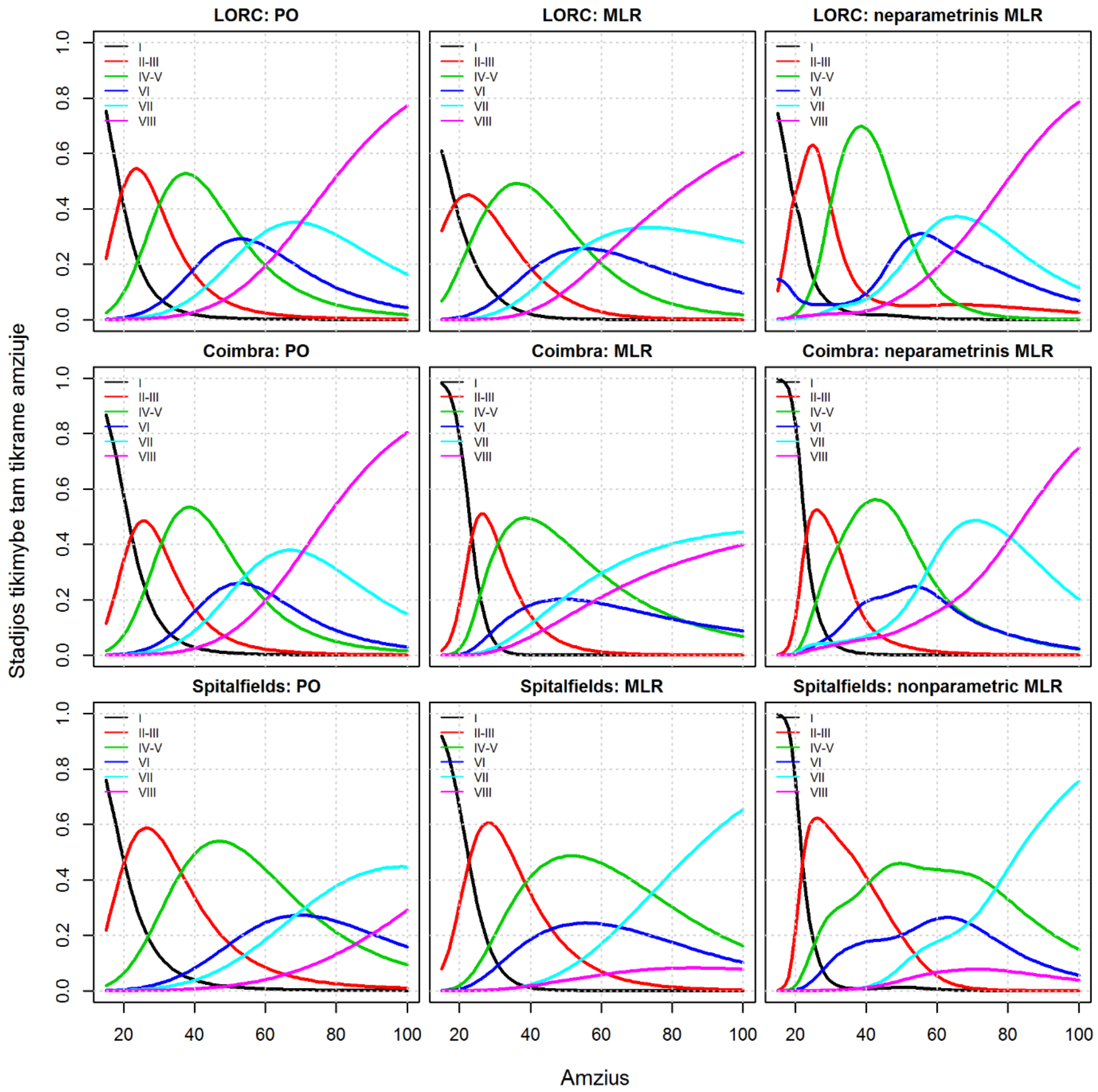

Fig. 5. *Probabilities to observe a particular stage of the auricular surface (as described by C. O. Lovejoy et al. (1985)) at a particular age according to LORC, Coimbra and Spitafields DSC data. The conditional probabilities were estimated by applying different regression models: proportional odds (PO), multinomial logit regression (MLR) and nonparametric multinomial logit regression (neparametrinis MLR). *"Amzius" – Age; "Stadijos tikimybe tam tikrame amziuje"* - *Probabilities to observe a certain stage at a particular age".*

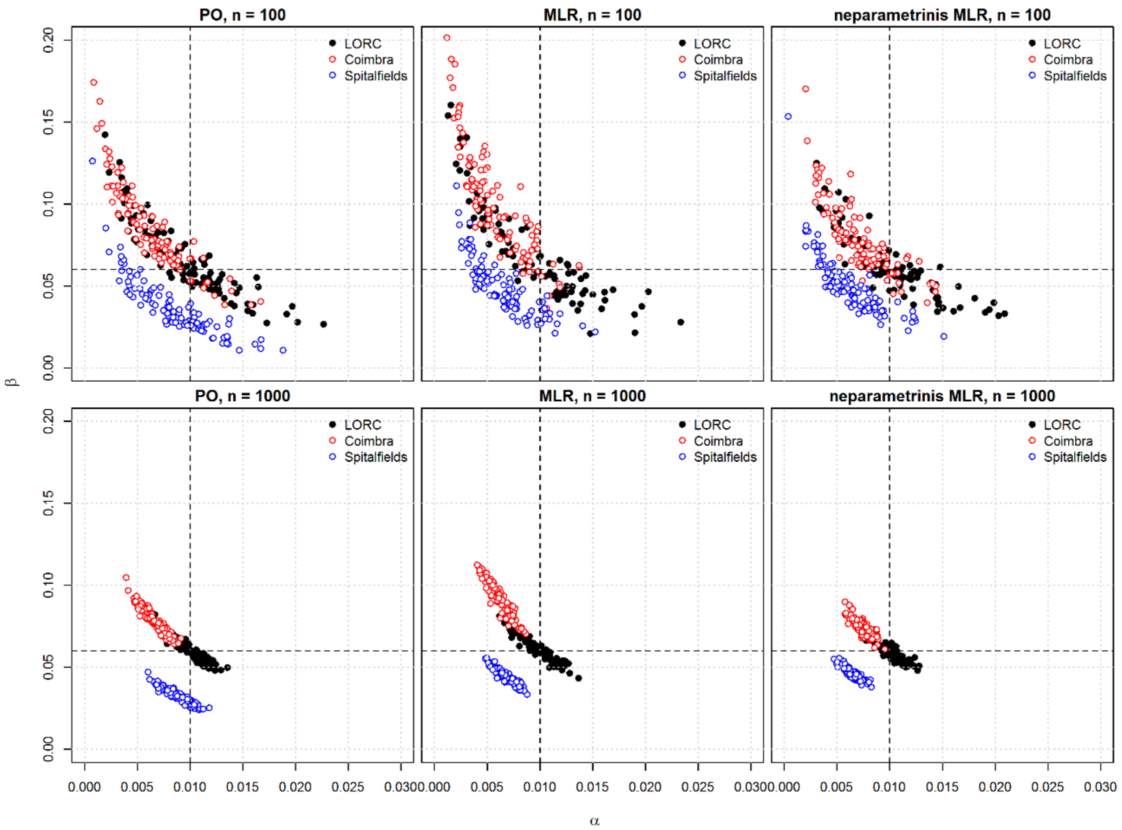

Fig. 6. *Testing the consequences of violating the uniformitarian hypothesis on paleodemographic research: calculated parameter value realisations of age-at-death distributions (Gompertz mortality model parameters). The results are obtained by analysing generated samples from a hypothetical stationary population (in which a conditional relationship between age and auricular surface stages is the same as in LORC), by applying results from different DSC's, regression models and sample sizes n.*

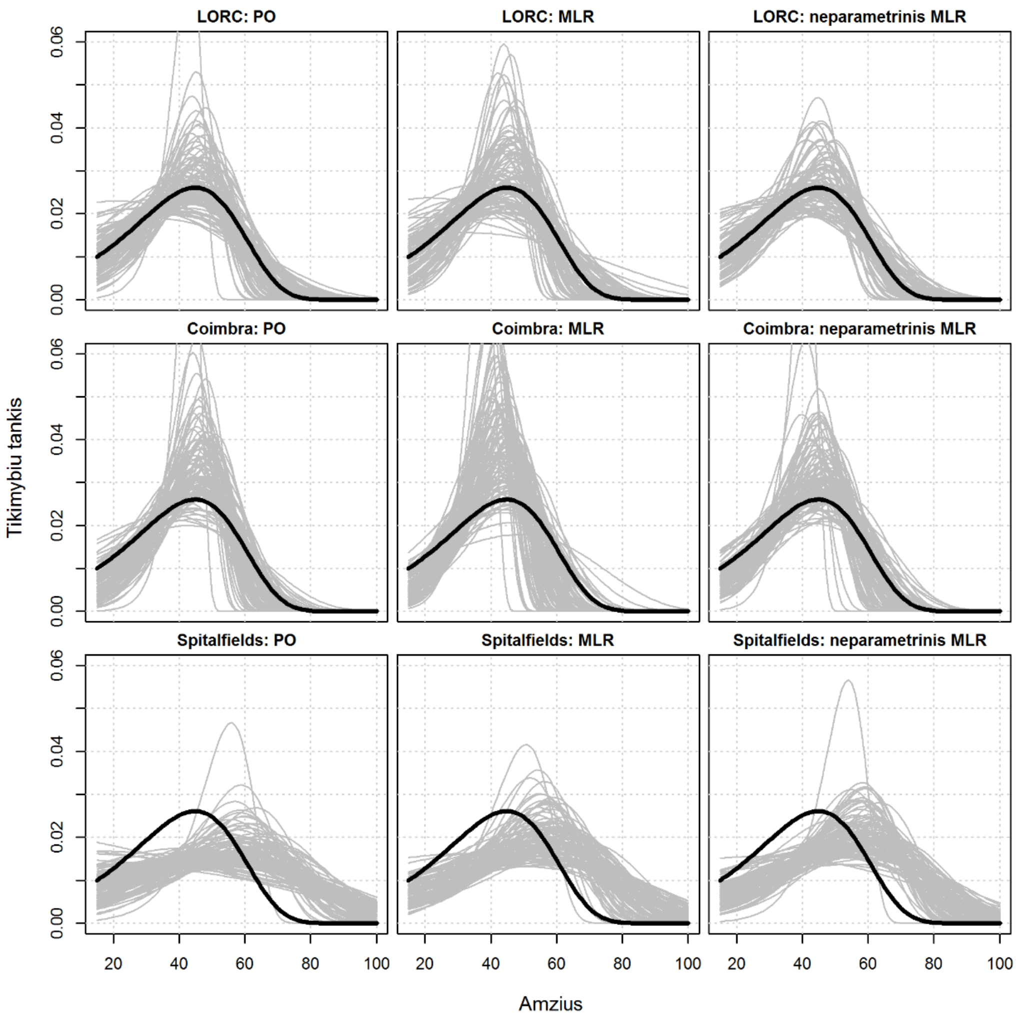

Fig. 7. *Testing the consequences of violating the uniformitarian hypothesis on paleodemographic research: estimated age-at-death distributions. The results are obtained through analysing generated samples from a hypothetical stationary population (in which a conditional relationship between age and auricular surface stages is the same as in LORC), by applying results from different DSC's and regression models; the size of one sample is equal to 100 generated values of auricular surface. The black line represents the actual age-at-death distribution of a stable population, grey lines represent the calculated distributions based on an analysis of generated samples. * "Amzius"-"Age"; "Tikimybiu tankis"-"Density".*

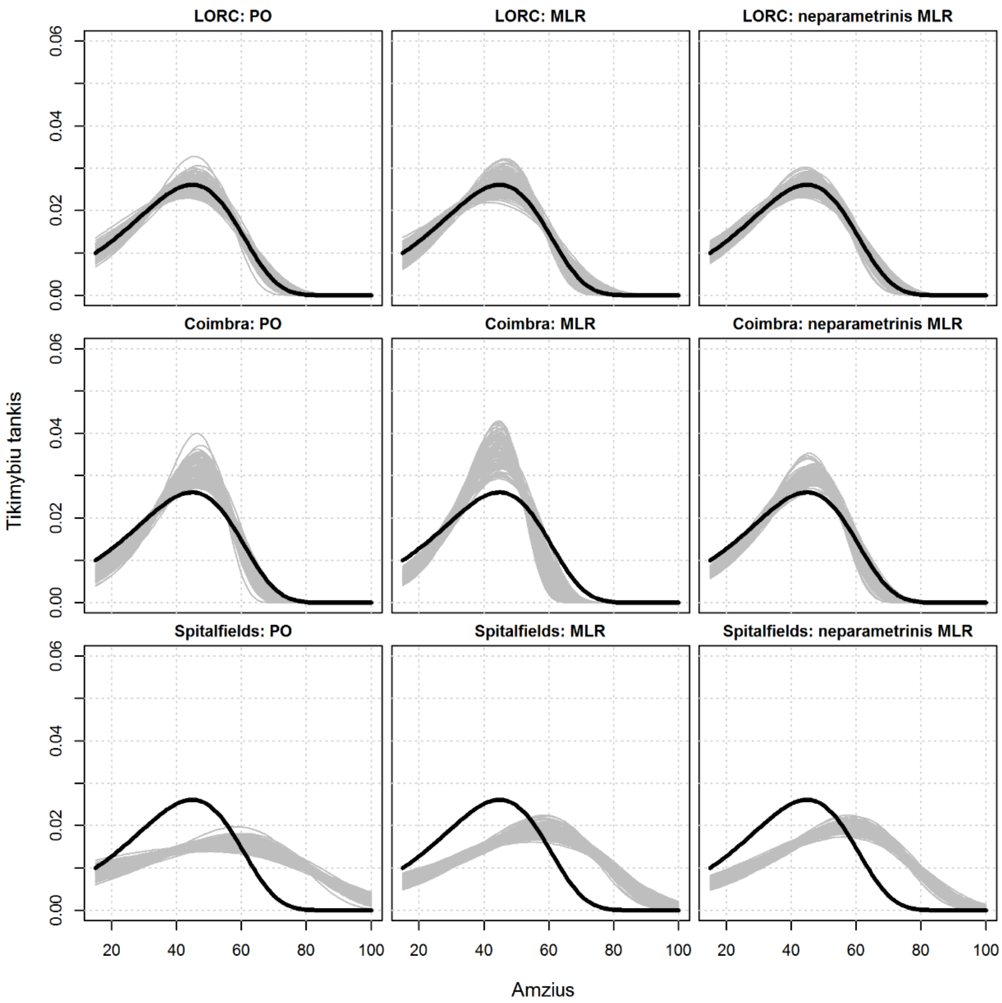

Fig. 8. *Testing the consequences of violating the uniformitarian hypothesis on paleodemographic research: calculated age-at-death distributions. The results are obtained by analysing generated samples from a hypothetical stationary population (in which a conditional relationship between age and auricular surface stages is the same as in LORC), by applying results from different DSC's and regression models; the size of one sample is equal to 1000 generated values of auricular surface. The black line represents the actual age-at-death distribution of a stable population, grey lines represent the calculated probability distributions based on an analysis of generated samples. * "Amzius"-"Age"; "Tikimybiu tankis"-"Density".*

And this observation leads to a particularly important question: which DSC to choose for further analysis of empirical material in this research? This choice has an enormous influence on describing the demographic situation of the Lithuanian population in further research. It was decided to base further paleodemographic analysis only on Spitalfields: if indeed skeletal changes in the auricular surface used to be slower in the past, Coimbra and LORC data are not suitable for analysing Lithuanian osteological material from historical and prehistoric times. Of course, at the same time, it remains unclear whether Spitalfields DSC that represents people who lived in late 17th to 19th c. London can be applied to the geographical and chronological period being studied. We can only base our research on the assumption, that the rate of auricular surface changes in prosperous citizens of late 17th to 19th c. London was closer to that of people who lived in Lithuania in historic and prehistoric times rather than the Portuguese and Lithuanians of the 20th c. On the other hand, other researchers advise ignoring the differences and, if possible, using large DSC samples, i.e. collecting data from different DSC's (Konigsberg et al., 2008). Thus, for comparison, part of the Lithuanian paleo-osteological data was analysed using information from all three DSC's.

Part 3. Assessment of Lithuania's Paleodemographic Situation: Differences between Results Achieved Using "Traditional" and RM Paleodemographic Methodologies

Review of Lithuanian Paleodemographic Research and Related Issues

Researchers G. Česnys (1973; 1978; 1981; 1987; 1988; 1993; Česnys and Balčiūnienė, 1988; Česnys and Urbanavičius, 1978), R. Jankauskas (1997; 1999; 2001; 2002; 2003) and L. Kurila (2009; 2014; 2015) have made the largest contribution in analysing the demographic situation of Lithuanian past populations based on osteological data. The first two researchers concentrated on researching skeletal remains, while the third was focused on analysing cremated remains. Based on the principles of "traditional" paleodemography methodology, formed in stage II, as mentioned in the review of paleodemography studies in this work, mostly the general mortality situation was analysed and, on a smaller scale, possible causes of death, as well as attempting to calculate what relative part of the reproduction potential was realised by the populations that left burial objects, and also their age structure, size and speed of generation renewal. The chronological period analysed was limited by the available paleo-osteological material to a period from the beginning of the 1st millennium AD to the beginning of the 19th c., since osteological material from earlier periods is scarce.

In summarizing previous researches, 7 main paleodemographic observations about the demographic situation that used to be predominant in Lithuania can be distinguished from ones registered up to this day. The first five are related to mortality. That is, during a period of almost two millennia in Lithuania, very high (1) child and (2) adult mortality rates were predominant, so the chances for an average person to reach an older age (over 50 years) was very low. (3) For adult males, mortality level was lower than for females (during the fertile period for women), but in older age, the sex differences in mortality diminished. (4) The size of the living place was an important indicator of mortality level - in the Medieval and Early Modern ages, mortality level positively correlated with the size of the settlement. Way less is known about the changes in mortality based on another important factor, the time period, except that in the Early Iron Age, a mortality crisis may have taken place compared to earlier times. Calculation of mortality level according to other important characteristics, like social and economic status or, even more so, family composition, has not yet been studied in detail. (5) It is claimed that the main causes of death were infectious diseases and poor nutrition, which directly or indirectly (by reducing the body's resistance to negative effects) had an influence on the mortality level. Other observations are related to attempts to calculate the sizes of communities who have left burial sites (6), as well as the (7) realisation of reproduction potential and rate of generation renewal. Results show that the analysed communities had to grow faster or at an extremely fast pace because, despite high mortality, a large part of the reproduction potential was being reached.

However, since the previously mentioned demographic discoveries were made by applying methodical principles established in stage II, said paleodemographic problems and controversies encourage reassessing how well they are grounded. At least some of the paleodemographic problems distinguished in the second paleodemographic stage could apply to practically all published Lithuanian paleodemographic studies. For example, the reliability of the age determination methods and other derivative calculations (population age structure, size or dynamic) is highly questionable. This goes on to raise reasonable doubts regarding the reliability of the view on Lithuania’s past demographic situation drawn by these results: can we trust these results, or are they merely an artefact created by the sample representativeness and methodical problems? Thus, one of the most important objectives of this thesis was to compare the findings made by G. Česnys, R. Jankauskas and myself, i.e. results obtained by applying different methods of skeleton analysis and (or) demographic methods in analysing the same burial sites. Attention was focused on assessing the mortality situation according to the main variables: age, sex and habitat, and based on the mortality estimation, the general population birth rates were calculated. The links between mortality and the development Lithuanian population on the whole with another important factor, the time period, were analysed in more detail in the fifth chapter of this thesis.

Material and Methods

All skeletons analysed in this thesis were from archaeological burial monuments found in the territory of current Lithuania are kept in the Laboratory of Anthropology of the Faculty of Medicine, Department of Anatomy, Histology and Anthropology at Vilnius University (AHAAL). Only skeletons which had a sufficiently well-preserved auricular surface were included in the analysis, and analysed applying the RM methodology described in chapter 2.

Besides materials previously studied and published by G. Česnys or R. Jankauskas, to expand the comparison material, we have included data on adult individuals from the AHAAL database, which stores previously established information about the age of the remains at the time of death, as well as the burial sites and dating. This information was mostly collected by R. Jankauskas (or his students) after performing a paleo-osteological analysis. Therefore, analysis of this data, based on traditional paleodemographic methodology, could be considered equivalent to a comparison with R. Jankauskas's study findings. AHAAL database was only used for data on adult skeletons where the post-cranial skeleton was preserved; this was done considering the previously mentioned doubts regarding the relationship between age and the tendencies of skull sutures calcification. Selected sites: Plinkaigalis cemetery (3rd-7th c.) (Česnys, 1988), all Iron Age burial monuments (2nd-12th c.; AHAAL data), Alytus burial monument (end of 14th c.-17th c.) (Jankauskas, 1995), Kernavė church burials (15th-18th c.; AHAAL data), four 14th-18th c. rural burial monuments (Jakštaičiai, Skrebinai, Gėluva and Liepiniškiai burial monuments) (Česnys, 1983), all larger rural burial sites from 14th-18th c. (AHAAL data) and all burial sites in Vilnius from the end of 13th c. up to 18th c. (AHAAL data).

A separate discussion should be dedicated to the main methodological differences between R. Jankauskas, G. Česnys and applied in our study: the principles for calculating the mortality of children and adults differed. Let us begin from the three main methodical differences in calculating the mortality of adults. Firstly, the osteological analysis of the remains differed, when collecting information about the age of adults. G. Česnys collected the data based on skull suture closure, R. Jankauskas analysed the whole skeleton (skull and postcranial skeleton), while we only registered the age-related changes in the auricular surface of the pelvic bone. This is why the number of remains was different in samples from corresponding burial monuments. For example, sample sizes used by R. Jankauskas from the same burial sites are larger compared to the ones we collected. However, if we make an assumption that the preservation of skull and the auricular surface is not age-dependent, the differences in demographic results (excluding confidence intervals for estimated mortality indicators) should not significantly influence sample size differences. To our knowledge, no published studies show the preservation of skull or the auricular surface to be dependent on age. Therefore, we believe that said assumption is justified. The second difference is the nature of data in demographical analysis. G. Česnys and R. Jankauskas, in analysing skeletons, would ascertain the likely interval of age at the time of death for each of them according to chosen osteological indicators and, based on this information, would conduct demographic analysis; meanwhile the applied RM methodology did not require converting osteological information into the age of the deceased. Thirdly, the demographic methods used for analysing mortality also differed. G. Česnys and R. Jankauskas analysed empirical data using life tables, while we opted for the parametric Gompertz model. For comparison, we analysed the AHAAL data using both life tables and Gompertz model. The mortality situation in all said samples was described based on the following mortality indicators: life expectancy at a certain age, probability of reaching a certain age and modal age of the deceased adults (age at which most adults die). All calculations, as in papers published by G. Česnys and R. Jankauskas, were performed based on a stationary population model.

In order to calculate child mortality rates, G. Česnys and R. Jankauskas used empirical data analysis, applying traditional paleodemographic methodology. However, in this thesis, it was decided to only analyse adult persons (15+ years). That is why it was necessary to come up with a way for indirectly calculating information about child mortality. We used a simple and often-used method in historical demography, where the issue of the lack of children is also present (e.g. Woods, 1993; Bagnall & Frier, 1994; Hinde, 2003). That is, based on the assumption that the relationship between adults and younger individuals is strong and stable between different populations. After calculating e(20) in such way and identifying the Coale-Demeny (1966) model life table ("Western Families") with the closest e(20) value, it was possible to ascertain mortality indicators, characteristic to children, as well as the whole population. Based on the same principle, population birth rates were also estimated, i.e., an assumption was made that a strong relationship between birth rates and adult mortality existed.

χ^2 statistical test was applied to test the hypothesis for whether the realisations of the most likely results of applied models based on RM methodology are compatible with the empirical material. I.e. χ^2 statistics and its *P* value was estimated to assess whether the empirical probability distribution of auricular surface stages is compatible with the calculated most likely probability distribution of auricular surface stages.

Results and Conclusions

The main calculated results are provided in Tables 3-5.

Table 3. *Estimated values of various mortality and fertility indicators in Plinkaigalis, rural and Alytus populations according to different researchers.*

Researcher and method	**Indicator**	**Plinkaigalis, 3–7 c.**	**Four villages, 14–18 c.**	**Alytus, 14 – 17 c.**	**Vilnius, 13 – 18 c.**
G. Česnys (using life tables and traditional paleodemographic methodology)	Number of males | females | children	156 | 85 | 93	403 | 269 | 332	-	0 | 614 | 827
	Ratio of adult males to adult females	1.09	1.23		1.35
	l(15) (%)	57.8	63.8		-
	e(0)	23.1	28,4		-
	e(20)	17.7 | 20.8	21,4 | 25,9		17.2 | 20.7
	e(50)	4.3 | 5.0	6,0 | 5,6		5.1 | 4.6
	Modal age-at-death for adults	20-24 | 45-50	55+ | 55+		20-24 | 45-49
	l(50|20) (%)	21.2 | 23.7	32.7 | 46.2		20.9 | 24.3
R. Jankauskas (using life tables and traditional	Number of males | females | children	-	-	533 | 412 | 400	-

paleodemographic methodology)	Ratio of adult males to adult females			0.97	
	l(15) (%)			64.9	
	e(0)			27.8	
	e(20)			17.5 | 23.2	
	e(50)			5.2 | 5.2	
	Modal age-at-death for adults			20-24 | 50+	
	l(50|20) (%)			18.8 | 17.8	
Š. Jatautis (using Gompertz model and RM methodology)	Number of males | females | children	0 | 42 | 70	0 | 36 | 54	0 | 276 | 285	0 | 263 | 392
	Ratio of adult males to adult females	1.67	1.50	1.03	1.49
	l(15) (%)	43.5 | 49.3	50.4 | 57.2	55.0 | 67.7	39.4 | 44.9
	e(0)	22.4 | 25.2	27.9 | 31.1	31.7 | 38.9	19.1 | 21.9
	e(20)	29.1 (23.1-54.0) 30.5 (25.0-45.1)	31.9 (24.0-55.2) 33.5 (27.2-54.9)	33.8 (30.5-38.9) 37.5 (34.2-42.6)	27.4 (24.3-32.2) 28.8 (26.2-32.6)
	e(50)	11.2 (5.7-41.8) 17.2 (10.6-37.1)	20.5 (11.1-43.8) 17.6 (10.7-44.2)	18.7 (14.8-25.5) 19.7 (16.1-25.8)	13.1 (9.6-20.2) 15.9 (12.6-21.4)
	Modal age-at-death for adults	52.4 (32.5-70.5) 42.1 (7.8-66.5)	29.3 (5.2-82.2) 53.1 (16.6-76.4)	50.9 (33.8-59.5) 60.3 (54.3-66.5)	44.3 (26.4-52.1) 39.6 (17.3-49.2)

	$l(50\|20)$ (%)	48.7 (29.1-83.5) 47.6 (36.1-70.1)	48.0 (33.2-80.4) 55.1 (42.3-83.0)	54.5 (48.7-62.4) 63.0 (57.6-70.4)	42.3 (35.2-51.4) 44.2 (38.9-50.7)
	χ^2 (df, P-value)	17.4 (5; 0.004) 1.1 (5; 0.955)	29.7 (5; < 0.001) 4.4 (5; 0.497)	59.1 (5; < 0.001) 130.1 (5; < 0.001	91.7 (5; <0.001) 12.4 (5; 0.0293)
	Total fertility rate	5.3	4.5	4.0	5.9

Table 4. *Estimated values of various mortality and fertility indicators using different paleodemographic methodology and between different researchers.*

Researcher and method	Indicator	Iron Age (2–12 c.)	Many villages (14–18 c.)	Kernavė (15–18 c.)	Vilnius (13–18 c.)
AHAAL database data (using life tables and traditional paleodemographic methodology)	Number of adult males | adult females	297 | 412	309 | 380	83 | 113	278 | 428
	Ratio of adult males to adult females	1.39	1.23	1.36	1.54
	e(20)	21.0 | 23.4	23.3 | 26.0	23.4 | 25.6	21.6 | 22.5
	e(50)	5.0 | 4.5	4.1 | 5.2	4.7 | 5.8	5.3 | 5.0
	Modal age at death for adults	25-30 | 35-40	40-45 | 40-45	40-45 | 40-45	30-35 | 40-45
	$l(50\|20)$ (%)	16.5 | 16.1	17.4 | 26.8	18.4 | 17.4	14.9 | 17.6

AHAAL database data (using Gompertz mortality model and traditional paleodemographic methodology)	Number of adult males | adult females	297 | 412	309 | 380	83 | 113	278 | 428
	Ratio of adult males to adult females	1.39	1.23	1.36	1.54
	e(20)	18.1 (16.9-19.5) 19.5 (18.7-20.5)	21.3 (19.9-23.1) 22.6 (21.6-24.0)	19.7 (18.0-22.9) 21.2 (20.0-23.1)	18.1 (17.0-19.6) 19.4 (18.4-20.7)
	e(50)	5.9 (4.9-7.4) 4.2 (3.7-5.0)	8.6 (7.0-10.9) 6.1 (5.3-7.2)	4.6 (3.4-6.7) 3.6 (2.9-4.7)	4.6 (3.8-5.9) 5.3 (4.5-6.4)
	Modal age at death for adults	34.9 (29.9-38.7) 41.5 (40.2-43.1)	37.0 (29.4-42.1) 45.3 (43.8-47.2)	41.6 (38.3-46.2) 44.4 (42.9-46.7)	38.3 (35.5-41.1) 40.0 (37.7-42.4)
	l(50|20) (%)	15.7 (12.1-20.1) 15.3 (12.5-18.9)	26.1 (21.7-31.4) 27.7 (23.9-32.4)	16.7 (10.8-27.5) 17.4 (12.2-25.3)	13.3 (9.7-18.1) 17.6 (14.2-21.8)
Š. Jatautis (using Gompertz model and RM methodology)	Number of adult males | adult females	143 | 225	278 | 319	45 | 79	263 | 392
	Ratio of adult males to adult females	1.57	1.15	1.76	1.49
	l(15) (%)	36.4 | 46.9	61.4 | 63.9	64.4 | 67.9	39.4 | 44.9
	e(0)	21.1 | 23.9	25.1 | 28.8	27.1 | 26.9	19.1 | 21.9

	e(20)	25.2 (21.9-35.0) 29.1 (26.0-34.6)	31.4 (28.2-36.3) 36.3 (33.2-40.9)	34.7 (27.4-55.3) 33.7 (28.1-47.9)	27.4 (24.3-32.2) 28.8 (26.2-32.6)
	e(50)	9.4 (5.7-22.5) 12.3 (9.0-19.4)	16.7 (13.0-23.7) 18.5 (15.1-24.3)	21.2 (13.0-44.8) 19.3 (12.9-38.0)	13.1 (9.6-20.2) 15.9 (12.6-21.4)
	Modal age at death for adults	46.6 (31.4-55.1) 51.0 (44.4-57.1)	47.7 (29.2-56.3) 59.1 (56.1-68.5)	44.1 (7.2-79.4) 48.1 (11.7-69.4)	44.3 (26.4-52.1) 39.6 (17.3-49.2)
	l(50|20) (%)	37.5 (25.5-55.9) 47.8 (39.8-58.5)	50.2 (44.1-58.4 61.4 (56.1-68.5))	53.9 (41.0-80.1) 53.6 (43.4-72.9)	42.3 (35.2-51.4) 44.2 (38.9-50.7)
	χ^2 (df, P-value)	19.9 (5; 0.001) 3.5 (5; 0.619)	150.5 (5; <0.001) 72.0 (5; <0.001)	13.5 (5; <0.001) 2.2 (5; 0.827)	91.7 (5; <0.001) 12.4 (5; 0.0293)
	Total fertility rate	6.3	4.3	4.1	5.9

Table 5. *Calculated values of various mortality indicators using alternative estimation methods.*

Researcher and method	**Indicator**	**Plinkaigalis (3–7 a.)**	**Alytus (14 –17 a.)**	**Four villages (14–18 a.)**	**Vilnius (13–18 a.)**
Coale-Demeny (1966) “West-family” model life tables (using e(0) estimated by G. Česnis or R. Jankauskas)	e(0)	23.1 (3-ias lygis)	28.4 (4-as lygis)	27.8 (4-as lygis)	-
	e(20)	31.3 | 29.3	32.6 | 30.1	33.9 | 31.9	
	e(50)	15.6 | 13.9	16.2 | 14.5	16.9 | 15.2	
	Modal age-at-death for adults	60-65 | 40-45	60-65 | 60-65	60-65 | 60-65	
	l(50|20) (%)	53.4 | 48.5	56.3 | 51.2	56.3 | 51.2	
Š. Jatautis (using life tables and traditional paleodemographic methodology)	e(20)	18.5 | 19.4	21.3 | 23.0	20.7 | 21.2	19.1 | 18.8
	e(50)	6.3 | 5.7	6.3 | 6.5	6.7 | 5.8	6.7 | 5.9
	Modal age-at-death for adults	30-35 | 35-40	55+ | 55+	55+ | 45-50	35-40 | 35-40
	l(50|20) (%)	15.4 | 14.2	23.6 |	27.8 | 22.2	18.6 | 14.5
Š. Jatautis (using Gompertz model and traditional	e(20)	23.6 (20.5-31.0)	23.5 (22.2-25.3) 25.8 (24.4-27.7)	25.2 (20.8-36.5) 22.6 (20.3-27.7)	21.9 (20.4-23.9) 20.2 (19.3-21.4)
	e(50)	8.6 (6.0-15.3)	8.4 (7.2-10.1) 9.8 (8.5-11.8)	13.1 (8.1-27.6) 6.3 (4.7-9.7)	9.2 (7.6-11.4) 5.8 (5.1-6.8)

paleodemographic methodology)	Modal age-at-death for adults	43.9 (30.0-55.3)	44.2 (40.9-47.5) 47.3 (44.2-50.5)	35.0 (6.0-59.5) 45.0 (40.8-51.9)	37.3 (29.3-42.7) 40.9 (38.8-43.2)
	l(50|20) (%)	32.5 (22.5-54.9)	32.2 (28.0-37.6) 39.2 (35.0-44.8)	36.5 (25.0-60.6) 27.8 (19.5-45.5)	28.0 (23.7-33.4) 20.5 (17.4-24.4)

Since paleodemographic research is based on fragmented and indirect demographic data, it is hardly possible to avoid the observation that calculated paleodemographic results are more or less questionable. However, in concluding the material addressed in this chapter, several main observations can be put forth. Firstly, analysis of the same material yields very different results about the past population being studied when using traditional and RM paleodemographic methodologies. Results obtained under the RM methodology show that for a long time adult mortality did not need to be as high as suggested by earlier paleodemographic research conducted in Lithuania by G. Česnys and R. Jankauskas, who applied traditional paleodemographic methodology. After surviving the complicated pre-adult period, it is likely that a large part of the past population in Lithuania used to reach at least 50 years of age. Therefore, 50 should not be considered "elderly" or "senior" age neither in the Iron Age, nor the Middle Ages or the Early Modern period. Such demographic mortality/survival numbers are much more compatible with alternate information - ethnographic data from small communities, historic demographical data on European countries, and model table predictions for high mortality countries. Also, earlier results of Lithuanian paleodemographic research contradict the uniformitarian hypothesis, which states that the relationship between the indicators of mortality at various ages and general birth rate in human population is consistent. Meanwhile, results achieved using RM methodology contradict this hypothesis much less. Another difference: gender mortality differences were not as high as earlier research suggests. By the way, this study did not register a tendency for mortality indicators to be less favourable for women only within the reproductive period, an observation that was noted by the majority of paleodemographic, historic and ethnographic demography studies. Finally, the obtained results do not allow confirming that a positive linear dependence existed between settlement size and mortality rate; the only clear differences were found between Vilnius and the rest of the settlements.

On the other hand, the research showed results calculated using the RM methodology significantly differ from the collected empirical material, especially so for female populations. Also, the choice of different DSC samples leads to noticeably different results. Thus, in reviewing the results achieved in this chapter, it is difficult to not draw the conclusion that paleodemographic analysis of osteological data is hardly useful (at least at this time) for finding accurate numeral expressions regarding population mortality, birth rates, age distribution, population dynamics etc., i.e. to provide more or less “accurate” demographic numbers. Unfortunately, a large part of researchers who use the RM methodology and enthusiastically argue for its advantages, essentially give no attention to testing and proofing the reliability of the models used and their compatibility with empirical material. That is why the problem of non-compatibility between results obtained in this thesis and the empirical data is difficult to assess in a larger context of paleodemographic research.

That is why, with regard to problems of the traditional and the RM methodology, we have to return to the words of T. G. Parkin, who said that “researchers of the past should, instead of looking for precise numbers in demography about the studied past populations to answer pressing questions, try to model and understand how and why a population functions. [...] [Researchers] should not limit themselves to collecting and discussing exact numbers obtained by analysing past sources, but instead relate this approximate and indirect data to past economic, social etc. life conditions and general principles of how a population functions” (Parkin, 1992: 68–69).

Part 4: Demographic Development of the Lithuanian Population from the Beginning of the 1st Millennium AD to the 18th c.: The Relationship between Population Numbers, Production, Resources and Living Standard

Demographic analysis of past populations would not be comprehensive if we did not attempt to integrate information about demographic processes and factors that possibly influenced them in order to explain *why the development of the Lithuanian population was the way it was and what effect this development had on the living standard for people.* Attempting to answer such questions based on osteological data has its advantages and disadvantages. On one hand, a huge advantage of paleo-osteological data is that analysing it allows seeing historical events *from below*, and collecting data about "the history of the people", without being limited to the worldview and experience of a small part of society. Human remains discovered by archaeologists are nameless individuals from various social classes, who had faced their particular hardships of life and lived in different regions and differently-sized settlements. Therefore, the samples of data provided by the remains are more representative when researching populations from distant past rather than the often-fragmented, subjective and selective written sources. On the other hand, due to problems with osteological data analysis mentioned earlier, the margins of error in the obtained results are large, which brings one to strongly doubt whether the summarising inductive conclusions about the populations studied can help answer the questions raised. In our opinion, a much more promising way to achieve this goal is by testing models that explain how and why certahin processes of the past took place, related to population development and, by applying a hypothetical-deductive research method, test the proposed hypotheses. Therefore, it is necessary to briefly review the development of Lithuanian population numbers during the studied period, chose the starting positions for the field of interpretation, as well as assumptions and limitations, and to put forth working hypotheses that could be tested against available fragmented empirical osteological data, that way answering the questions raised.

Dynamics of the Lithuanian Population from the Beginning of the 1st Millennium AD to the 18th c.

The main method for detecting tendencies in the changes of the Lithuanian population between the beginning of 1st millennium and the 18th c. is by directly linking the population number to the changes of the number of archaeological monuments (burial sites, settlements, hill forts). The increasing (decreasing) number of archaeological monuments shows a spreading (shrinking) of the settlement, which on its own accord is likely to be related to a decreasing (diminishing) number of residents. Unfortunately, such archaeological data only allows interpreting the general tendencies in the changes to the population size rather than specific numeric values of population size. Some researchers provide population density of this period in Lithuania (e.g.

Pakštas, 1968). However, such attempts are either based on a methodology that is not clearly described or are a derivative of consistent assumptions that is difficult to either substantiate or deny. Meanwhile, the population number and changes of it in 13th-18th c. Lithuania is defined by extrapolating and interpolating findings made by analysing the surviving army and resident censuses conducted by economic units (dūmas), and church registers.

To summarise this archaeological and historical data, it can be said that the number of people in Lithuania had been growing since the 1st millennium AD up to the 12th c., then began to diminish, ceased, or rose very slowly until the 15th c., at which point it began to rise again. From the middle of the 16 c. up to the middle of the 17 c., growth was particularly fast, with two major demographic crises taking place in the middle of the 16th c. and in the beginning of the 17th c., the demographic losses of which were later compensated by the particularly fast population growth starting with the 1630s.

Theoretical Assumptions

Why was the population development described earlier such as it was? Let us begin from the fundamental demographic equation according to which the population size can only change due to three demographic processes: birth, mortality and migration. When analysing the development of population numbers in pre-industrial populations, usually an assumption is made that the natural change of people (the difference between the newly born and the deceased) was a far more important factor than net migration (the difference between emigrants and immigrants). This assumption is also made in this thesis.

In the historiography of Lithuanian population development, the more important role of mortality is stressed, and especially the importance of crisis mortality compared to the role of fertility. It seems that the role of fertility is based on the attitude that births happened as often as "God's will allowed". Unfortunately, there is a lack of empirical demographic research data on families that would allow avoiding guessing how closely the formation of families (and, by extension, birth rates) depended on demographic and economic conditions. Even though a lot is known about the attitude towards families in legal terms; for example, according to the Statute of Lithuania, the age permitting marriage was 13 for women and 18 for men (Andriulis, 1996). However, the registered bottom age limit does not indicate how people actually reacted to hardships of the environment. Since paleo-osteological data does not permit independently estimating mortality and birth rates, it is important to take into consideration the previously mentioned general regional tendencies and take on the assumption that the development of the Lithuanian population was first of all regulated through changes in mortality rates.

Further on, it needs to be answered why the population figure was changing and what influence that had on the lives of people. First, the position of cultural materialism was employed, according to which, in the process of societal development, priority is given to production and demographic powers. That is, an assumption is being made that the societal framework and the main reasons behind changes to it lie somewhere between the demographic development of the population, production, and natural environment that is available for exploitation.

Further on, let us assume that the relationship between infrastructure components (demographic development of production and population) and material standard of living can be described using a model of static resource (or population-resource) model, which is based on the ideas of T. Malthus (Livi-Bacci, 1997). The model is based on three assumptions:

1. Food is necessary to human existence and is the most important resource.
2. If the needs for nutritional energy are satisfied, the population constantly grows, because “the passion between genders is necessary and shall always remain so”.
3. Population reproduction potential is higher than the possibilities to maintain corresponding food production per person. Eventually that causes an imbalance between the population number and food resources, which causes the issue of poverty.

In conclusion, it can be stated that according to this model, the population number depends on the living standard which is related to possibilities to acquire food products; meanwhile, the changes of the population number affect the development of domestic affairs and the economy in general. The influence of population development can be expanded into other important aspects of public life - social organisation and relationships, law, political organisation etc. According to M. Livi-Bacci, the "model is especially applicable to societies, which: a) have agriculture dominating in their economy, therefore are limited by the land available for exploitation, and b) spend most of their income on food products. Before T. Malthus and the industrial revolution, almost all countries in the world met these two criteria; a lot of poor countries in modern times also fall under these categories" (Livi-Bacci, 2001: 83).

The application of the population-resources model to Eastern Europe has not been studied as much, in our opinion, for two main reasons - relatively low density of people that was characteristic of this region and (or) the widespread tendency to interpret the development of this region using Marxist (or Neo-Marxist) theory. For example, M. Mollat et al. (1955) claimed that the eastern part of Europe (Russia, Baltic states, Poland), as opposed to the rest of Europe, was left untouched by the 14th-15th c. agriculture crisis due to its low population density. Meanwhile, M. Dygo (1990) who analysed the development of Polish economy in the Middle Ages suggested that said crisis when production per person decreased or stayed the same was characteristic to the whole of Europe but only reached Poland in the 15th c. (Table 21), when eventually production per person diminished or remained the same, i.e. 100-150 years later than in England, France or Germany. According to the author, it relates to the fact that in Poland economic growth began later (12th c. instead of 11th c.) and the effects of the crisis were lesser and shorter. However, according to M. Dygo, contrary to Western Europe, crisis was caused not by a lack of land (density in the eastern part of Europe is greatly lower than in Western Europe), but by the lack of innovations that could cover the basic needs of the population, i.e. the applied production method reached its peak of capability in regard to the population numbers. T. Malthus's ideas were also the basis for the German historian W. Conze (1940) in interpreting the agricultural and population development of Lithuania and Belarus in 16th-20th c. His point of reference was the Malthusian idea that any society has a "limited number of vacancies" and any ability to increase the amount of available resources (e.g. by working a larger area of land or organising social life more effectively) would only create conditions for population growth which would later cause turmoil and conflicts. The main force behind all social processes were political factors, caused by both upper and lower social layers. According to W. Conze, in 17th-18th century in this region the increasing population was not being satisfied by its increasing production volume (due to the inherited German tradition in the institute), nor by a more effective social organisation. Therefore, only social conflicts and turmoil could be the cause of population growth. S. H. Rijgby (2007), who criticised the universality of Malthus's model in all European regions, used Poland and Lithuania as an example. According to him, the growing population in the 16th c. not always followed the population-resources model: a) population growth the previously mentioned Languedoc region in France, as predicted by the population-resource model, caused diminishing farmsteads, increasing prices, decreasing living standard and eventually a demographic crisis due to inability to satisfy the need for food by the growing population; b) the growth of English population encouraged progress in manufacturing and the development of capitalism; c) meanwhile, growth in Poland and Lithuania caused a shift in the relationship between land and work, which gave landowners advantage over the peasants, while the latter had to submit to increasing control and burden of obligations in monetary form and in kind, i.e. population growth here encouraged serfdom relationships. In any case, the T. Malthus’s population-resources model is possibly the most important model in explaining the population dynamics in pre-industrial times (or at least when choosing the model as a point of reference and (or) object of critique), therefore its compatibility with Lithuanian empirical material is indeed to be encouraged.

Hypotheses, Material, Methods

In order to check whether the population-resources model can be applied to the area of Lithuania between the beginning of the 1st millennium and the 18th c., the following working hypotheses need to be assessed. First hypothesis: in long-term perspective, a negative relationship existed between the population size and living standard, and thus also body height. That is, as the population quickly increased, the height of the people decreased; as the population size decreased, height increased. Second hypothesis: in long-term perspective, agricultural progress had no effect on the living standard of the average person. Third hypothesis: in long-term perspective, increasing population size would cause an increased death rate.

To achieve this goal, information was needed regarding three variables: the development of population size, mortality and living standard. Information about population development was gained from archaeological and historical data. Skeletons stored by AHAAL supplied information about mortality and were analysed using the RM methodology (as described in the second chapter of this thesis). Only this time the likely value of the natural population increase during a specific period was taken into account. The height of adults was used as an indicator of life standard. In order to assess population height, maximum right (left, if the right one was not surviving) femur bone length (MFL), which on average comprises approximately 26% of the maximum height reached by a human being (Steckel, 1995). However, it was decided to not transform MFL values into the maximum reached height of the person due to issues similar to age ascertainment (for more see Konigsberg et al. 1998), i.e. MFL was used as an approximate indicator of height and thus also the living standard. Also, it was decided to only include data from male skeletons into the analysis, considering that a) the RM methodology and demographic models used so far suited female populations less than male and b) male bodies react to changes in the environment more sensitively compared to females (Jankauskas & Kozlovskaya, 1999). In this thesis, it was decided to categorise periods according to the surviving paleo-osteological material compared to more notable population developments: 2nd-7th c., 7th-12th c, 13th-15th c., 15th-16th c., 16th-17th c., 17th-18th c.

Review of the Results

The most significant findings are presented in Tables 6-10 and discussed below.

Table 6. *2nd-12th and 13th-18th c. average values of male maximum femur length (MFL) with a 95% confidence intervals (CI).*

Period	**Sample size**	**MFL**	**95 % CI**
2–12	209	470.6	467.5–473.7
13–18	619	450.4	448.6–452.3
13–18 (without Vilnius)	396	452.8	450.6–455.0

Table 7. *2nd-10th c. and 13th-18th c. male life expectancies at age 20 (e(20)) at different values of the population natural increase indicator (r). The values in bold are the most likely values at specific periods in comparison to other values provided in the table.*

Period	**Sample size**	**e(20), r = -2 %**	**e(20), r = -1 %**	**e(20), r = -0.5 %**	**e(20), r = 0 %**	**e(20), r = 0.5 %**	**e(20), r = 1 %**	**e(20), r = 1.5 %**	**e(20), r = 2 %**
2–12	225	24.4	26.7	27.9	**29.1**	**30.2**	31.4	32.5	33.6
13–18	1284	26.4	30.0	32.0	34.0	**36.1**	**38.2**	**40.3**	42.3
13–18 (without Vilnius)	892	28.8	32.1	34.2	36.3	**38.5**	**40.6**	**42.8**	44.8

Table 8. *Calculated 2nd-18th c. average values of male maximum femur length (MFL) with a 95% confidence intervals (CI) at different periods. Results provided on the right side of the table do not include skeletons from Vilnius burial monuments. The values in bold are the most likely values at specific periods in comparison to other values provided in the table.*

Period	**Sample size**	**MFL**	**95 % CI**	**Sample size (without Vilnius)**	**MFL**	**Sample size (without Vilnius)**
2–8	154	471.4	468.2–474.6	10	471.4	468.2–474.6
9–12	9	470.6	461.5–479.7	154	470.6	461.5–479.7
13–15	22	458.1	448.0–468.3	105	450.5	445.4–455.6
15–16	25	453.8	443.4–464.1	52	445.3	438.6–451.9
16–17	243	451.2	448.5–453.9	269	451.2	448.5–453.9
17–18	106	454.8	450.8–458.7	193	450.7	447.5–454.0

Table 9. *Calculated 2nd-18th c. male life expectancies at age 20 (e(20)) at different values of the population natural increase indicator (r) at different time periods. The values in bold are the most likely values at specific periods in comparison to other values provided in the table.*

Period	**Sample size**	**e(20), r = -2 %**	**e(20), r = -1 %**	**e(20), r = -0.5 %**	**e(20), r = 0 %**	**e(20), r = 0.5 %**	**e(20), r = 1 %**	**e(20), r = 1.5 %**	**e(20), r = 2 %**
2–8	187	24.7	27.4	28.8	**30.2**	**31.7**	33.1	34.5	35.9
9–12	9	23.9	26.4	28.1	**29.6**	**30.9**	32.6	33.8	35.3
13–15	141	28.3	31.1	**32.6**	**34.0**	**35.4**	36.8	38.2	39.5
15–16	64	19.9	22.5	23.9	25.5	**27.1**	**28.8**	30.5	32.3
16–17	236	25.4	28.8	30.7	32.6	**34.5**	**36.5**	**38.5**	40.4
17–18	235	27.2	**31.3**	**33.5**	**35.8**	**38.2**	**40.6**	**42.9**	45.3

Table 10. *Calculated 2nd-18th c. male life expectancies at age 20 (e(20)) at different values of the natural increase indicator (r) at different time periods. Skeletons from Vilnius burial monuments not included in the analysis. The values in bold are the most likely values at specific periods in comparison to other values provided in the table.*

Period	**Sample size**	**e(20), r = -2 %**	**e(20), r = -1 %**	**e(20), r =-0.5 %**	**e(20), r = 0 %**	**e(20), r = 0.5 %**	**e(20), r = 1 %**	**e(20), r = 1.5 %**	**e(20), r = 2 %**
2–8	187	24.4	27.4	28.8	**30.2**	**31.7**	33.1	34.5	35.9
9–12	9	23.9	26.4	28.1	**29.6**	**30.9**	32.6	33.8	35.3
13–15	20	31.1	36.8	**40.0**	**43.4**	**46.9**	50.3	53.8	57.1
15–16	39	20.1	22.6	23.9	25.3	**26.8**	**28.3**	29.9	31.4
16–17	197	25.3	28.8	30.7	32.6	**34.6**	**36.6**	**38.7**	40.7
17–18	121	32.0	**37.5**	**40.4**	**43.4**	**46.5**	**49.6**	**52.5**	55.4

Changes of mortality tendencies in Iron Age Lithuania are difficult to assess since empirical material is rather scarce, and archaeological burial monument functioning periods are very much overlapping. Therefore, the paleo-osteological data is not sufficient for answering the question of whether at a certain time in the Iron Age (from ancient to late Iron Age) Lithuanian population was caught in a “Malthusian trap”. Judging from other archaeological data, it is likely that progress in manufacturing and low population numbers during the Iron Age could have allowed avoiding the preventive and positive limitations described by T. Malthus, i.e. a sufficient amount of food was being produced, which allowed avoiding an imbalance between population growth and resources claimed and required for feeding the growing population.

Meanwhile, the obtained results showed that in the period between 13th and 18th centuries the first and third hypotheses are compatible with empirical data: height, living standard and population development tendencies match the predictions of the population-resources model well. However, the development of mortality rates was not strongly related to the standard of living. That is, the available data does not allow accepting the third hypothesis. Therefore, it is likely that a large part of the causes of death could be explained by different factors. At the same time, the findings show that long-term developments in the population numbers were not caused exclusively by changes in the mortality rates but we can also guess that a much more important role was played by changes in birth rates.

Conclusions

Calculating the parameters describing the demographic development of past population of Lithuania and conclusions drawn from them regarding the influence of demographic processes on the people's standard of living and development of societies according to the analysis of osteological data is only possible within the framework of applied models and are very dependent on the method of data analysis. In order to significantly contribute to the knowledge collected in this field, this thesis discussed three main issues: a) the reliability and limitations of the Rostock Manifesto (RM) methodology in paleodemographic research, b) compatibility of earlier Lithuanian paleodemographic research findings with the findings made using the RM methodology, and c) the interpretation of paleodemographic research findings within the framework of the population-resources model, at the same time employing archaeological and historical data. Some new, unexpected conclusions were made during the study, which at the same time also confirm some of the previously known paleodemographic knowledge:

1. While analysing the RM methodology, the following two major observations were made on the limits of the theoretical capabilities of the method:

    a. RM methodologies, described by Wood et al. (2002), Konigsberg et al. (2002), do not allow for a reliable calculation of the age-at-death distribution of the deceased within the framework of a stable population. Even if all other necessary prerequisites of RM are satisfied, one can only expect to be able to reliably calculate the age-at-death distribution in a stationary population (one with a permanent, unchanging size) or a stable population, but only when the natural population growth value is chosen in advance. Therefore, the theoretical capabilities laid out by said authors are not entirely grounded.

    b. The analysed empirical data shows that the biological uniformitarian hypothesis in the analysed skeleton collections (DSC) with known age, necessary for converting paleo-osteological information into population-defining demographic parameter values, is not substantiated. In the historical Spitalfields DSC, where 17th-19th c. London residents are buried, age-related changes in the auricular surface were substantially slower compared to corresponding skeletal changes in residents of Coimbra (Portugal) in the beginning of the 20th c. and Lithuania in the end of the 20th c. Therefore, choosing which DSC data regarding skeletal age indicators should be used in paleodemographic research has a huge effect on the calculated values about the past populations being studied.

2. An even larger effect on the paleodemographic findings is had by the choice of paleodemographic methodology. When comparing the findings of mortality analysis on paleo-osteological material from the same Lithuanian archaeological burial monuments using RM methodology with the findings of earlier studies that were based on the "traditional" paleodemographic methodology that developed before the 1970s, the following observations were made:

    a. Contrary to what earlier research suggests, the majority of adults that lived in Lithuanian territory would have had to at least live to be 50. That means that these findings are much closer to the information provided by alternative data - the historical demography of European countries in the Middle Ages and contemporary history, and ethnographic research findings on small hunter-gatherer and early-farmer populations.

    b. Lesser differences between male and female mortality were noted than suggested by earlier research. Also, no tendency for convergence of mortality between sexes in older age (in the post-reproductive age of women, i.e. in the age period after 45-50) was registered.

    c. The findings made using the RM methodology do not allow confirming that a positive linear dependency existed between settlement size and mortality rate: the differences between cities (Alytus and Kernavė) and villages where insignificant. This contradicts the conclusions made earlier. The only distinct differences in mortality were detected between Vilnius and all other settlements, i.e. the age-at-death distribution of the deceased in Vilnius burial monuments from 13th-18th c. is noticeably "younger".

    d. Earlier Lithuanian paleodemographic research findings clearly indicate the fact that the relationship between child and adult mortality was fundamentally different compared to census data that began to be collected in the 18th century in European countries and later other continents. Meanwhile, findings made using the RM methodology are much more compatible and do not contradict the assumption that the mortality of adults and children is stable.

e. However, this study showed that results estimated using the RM methodology within the framework of a stationary population model significantly differ from the collected empirical material, especially so for females. Also, the choice of different DSC samples causes noticeably different results. Thus, in reviewing the results, it is difficult not to draw the conclusion that mere paleodemographic analysis of osteological data is hardly useful (at least at this time) for finding accurate numeric expressions regarding population mortality, birth rates, age distribution, dynamics etc.

3. After applying T. Malthus's population-resources model to analyse the development of the Lithuanian population size, its mortality and standard of life, the following observations were made:

   a. Changes in the body height and mortality trends in the Iron Age (beginning of the 1st millennium - 12th c.) in Lithuania are difficult to assess, since empirical material is rather scarce, and archaeological burial monument functioning periods are very much overlapping. Therefore, paleo-osteological data is not sufficient for answering the question of whether at a certain time in the Iron Age (from ancient to late Iron Age) the Lithuanian population was caught in a "Malthusian trap".

   b. In the period between 13th and 18th centuries two of three tested hypotheses (the first and second hypotheses) are compatible with empirical data: height, living standard and population development tendencies coincide well with the predictions of the population-resources model. Periods from the 13th c. to the beginning of the 15th c. and 15th-16th c. were the worst for Lithuanian residents. However, the development of mortality rates was not strongly related to the standard of living. That is, the available data does not allow accepting the third hypothesis. Therefore, it is likely that a large part of the causes of death could be explained by different factors. At the same time, the findings show that long-term developments in the population numbers were not caused exclusively by changes in the mortality, but we can also guess that a much more important role was played by changes in fertility.

References

1. Bagnall R. S., Frier B. W., 1994. *The demography of Roman Egypt*. Cambridge University Press.
2. Buckberry J. L., Chamberlain A. T., 2002. Age estimation from the auricular surface of the ilium: a revised method. *American Journal of Physical Anthropology*, 119: 231-239.
3. Carsey T. M., Harden J. J., 2014. *Monte Carlo simulation and resampling methods for social sciences*. Sage.
4. Coale A. J., Demeny P., 1966. *Regional model life tables and stable populations*. Princeton university press.
5. Conze, W. 1940. *Agrarverfassung und Bevölkerung in Litauen und Weißrussland, Vol. 1*. S. Hirzel.
6. Česnys, G., 1973. Jakštaičių XIV–XVII a. gyventojų paleodemografija ir antropologija. *Lietuvos Archeologija*, 1: 152–170.
7. Česnys G., 1981. Lietuvos didžiosios kunigaikštystės demografiniai rodikliai 1790 m. gyventojų surašymo duomenimis. *Lietuvos istorijos metraštis (1980 metais*): 5-17.
8. Česnys G., 1987. Paleodemography of Iron Age man in Lithuania. *Historicka demografie*, 11: p-20.
9. Česnys, G., 1988. Paleodemografija ir antropologija. *Lietuvos Archeologija*, 6: 89–99.
10. Česnys, G., 1993. Plinkaigalio gyventojų paleodemografija, antropologija ir populiacinė genetika. *Lietuvos Archeologija*,10: 82–196.
11. Česnys, G., Balčiūnienė, I., 1998. *Senųjų Lietuvos gyventojų antropologija*. Mokslas.
12. Dygo M., 1990. Was there an economic crisis in late medieval Poland? VSWG: *Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte*, 77: 305-322.
13. Gage T. B., 1989. Bio-mathematical approaches to the study of human variation and mortality. *Yearbook of Physical Anthropology*, 32: 185-214.

14. Gelman A., Hill A., 2006. *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press.

15. Garmus A., 1996. *Lithuanian forensic osteology*. Baltic Medico-Legal association.

16. Hens S. M., Belcastro M. G., 2012. Auricular surface aging: a blind test of the revised method on historic Italians from Sardinia. *Forensic Science International*, 214: p. e1-5.

17. Hens S. M., Rastelli E., Belcastro M. G., 2008. Age estimation from the human os coxa: a test on a documanted Italian collection. *Journal of Forensic Science*, 52: 21-23.

18. Hinde A., 2003. A history since the domesday survey England‘s population. Cambridge University Press.

19. Hoppa R. D., Vaupel J. W. (sud.), 2002b. *Paleodemography: age distributions from skeletal samples*. Cambridge University Press.

20. Yee T. W., 2015. *Vector generalized linear and additive models: with an implementation in R.* Springer.

21. Jankauskas R., 1995. Vėlyvųjų viduramžių Alytaus antropoekologija. *Lietuvos Archeologija*, 11: 129–142.

22. Jankauskas R., 2001. Lietuvos gyventojų antropologija: nuo seniausių laikų iki XIII a. *Istorija*, 49/50: 38-45.

23. Jankauskas R., 2002. Anthropology of the Iron Age inhabitants of Lithuania. In: Bennike P., Bodzsar B.É., Susanne C. (sud.) *Ecological aspects of past human settlements in Europe (=Biennieal books of EAA, 2)*. Eötvös University Press: 129–142.

24. Jankauskas R., 2003. Lietuvos gyventojų antropologija iki XIII amžiaus. In: Butrimas A. (sud.) *Lietuva iki Mindaugo*. Vilniaus dailės akademijos leidykla: 234–248.

25. Jankauskas R., Kozlovskaya M., 1999. Biosocial differentiation in Lithuanian Iron Age population. *Anthropologie*, 37: 177-185.

26. Jankauskas R., Urbanavičius A., 1997. Paleodemography and population biology studies relating to the Marvelė burial ground (2nd – 7th centuries AD). *Acta Biologica Szegediensis,* 42: 67-73.
27. Jatautis Š., Jankauskas R., spaudoje. Eastern Baltic region vs. western Europe: modelling age related changes in the pubic symphysis and the auricular surface. *Anthropologischer Anzeiger*.
28. Konigsberg L. W., Hens S. M., Jantz L. M., Jungers W. L., 1998. Stature estimation and calibration: Bayesian and maximum likelihood perspectives in physical anthropology. *American Journal of Physical Anthropology*, Supplement 27: 65-92.
29. Konigsberg L. W., Hermann N. P., Wescott D. J., Kimmerle E. H., 2008. Estimation and evidence in forensic anthropology: age-at-death. *Journal of Forensic Sciences*, 53: 541-557.
30. Kurila L., 2007. Geležies amžiaus Rytų Lietuvos gyventojų demografija. *Istorija*, 66: 3–11.
31. Kurila L., 2014. Apgyvendimo tankumas geležies amžiaus Lietuvoje: Žeimenos baseino mikroregionas. *Lietuvos Archeologija*, 40: 181-204.
32. Kurila L., 2015. Cremation as limitation? A paleodemographic inquiry into the accuracy of macroscopic analysis of cremated human remains based on an East Lithuanian sample. *Papers on Anthropology*, 24: 67-85.
33. Lewis M.E., 2002. Impact of industrialization: comparative study of child health in four sites from medieval and postmedieval England (A.D. 850 – 1859). *American Journal of Physical Anthropology* 119: 211 – 223.
34. Livi-Bacci M., 1997. *A concise history of world population (2nd ed.).* Blackwell.
35. Lovejoy C. O., Meindl R. S., Pryzbeck T. R., Mensforth R. P., 1985. Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of adult skeletal age. *American Journal of Physical Anthropology*, 68: 15-28.

36. Mollat M., Jahansen P., Postan M., Sapori A., Verlinden C., 1955. L'economie europeenne aux deux derniers siecles du Moyen Age. In: Congresso Internazionale di Scienze Storiche, Relazioni, 6, Florence: 803-957.

37. Murray. K.A., Muray T. 1991. A test of the auricular surface aging technique. *Journal of Forensic Sciences*, 36: 1162-1169.

38. Osbourne D. L., Simmons T. L., Nawrocki S. P., 2004. Reconsidering the auricular surface as an indicator of age at death. *Journal of Forensic Sciences*, 49: 905-911.

39. Pakštas K., 1968. Lietuvių tautos plotai ir gyventojai. *Lietuvių enciklopedija*, t. 16: 434.

40. Parkin T. G., 1992. *Demography and Roman society.* Johns Hopkins University Press.

41. Rigby S. H., 1998. *Marxism and history: a critical introduction (2nd ed.).* Manchester University Press.

42. Rissech C., Estabrook G. F., Cunha E. Malgosa, A., 2006. Using the acetabulum to estimate age at death of adult males. *Journal of Forensic Sciences*, 51: 213 – 229.

43. Saunders S. R., Fitzgerald C., Rogers T., Dudar C., McKillop H., 1992. A test of several methods of skeletal age estimation using a documented archaeological sample. *Canadian Society for Forensic Science Journal*, 25: 97-118.

44. Steckel R. H., 1995. Stature and standard of living. *Journal of Economic Literature*, 33: 1903-1940.

45. White T. D., Folkens P. A., 2005. *The human bone manual*. Academic Press.

46. Wood J. W., Holman D. J., O'Connor K., Ferrell R. J., 2002. Mortality models for paleodemography. In: Hoppa R. D., Vaupel J. W. (sud.) *Paleodemography: age distributions from skeletal samples*. Cambridge University Press: 129-168.

47. Woods R., 1993. On the historical relationship between infant and adult mortality. *Population Studies*, 47: 195-219.

DAKTARO DISERTACIJOS SANTRAUKA

Tyrimo objektas ir problemos

Lietuvoje ankstyvųjų populiacijų paleodemografiniais tyrimais susidomėta G. Česnio iniciatyva, vėliau daugiausiai prisidėjo R. Jankauskas, taip pat ir L. Kurila. Šių mokslininkų dėka buvo surinkta ir išsaugota didžiulė Europos mastu skeletų imtis iš skirtingais laikotarpiais datuojamų archeologinių laidojimo objektų, o šios medžiagos analizės dėka akademinė visuomenė supažindinta su Lietuvos praeities populiacijų demografiniais parametrais bei jų reikšme praeities tyrimuose. Šie tyrimai yra svarbūs netgi istoriniams laikams – nepaisant turimų rašytinių demografinių šaltinių duomenų, Lietuvos istorikai skyrė labai mažai dėmesio vėlyvųjų laikų praeities žmonių populiacijų demografinių procesų analizei, ypač dviems iš jų - mirtingumui ir gimstamumui.

Tačiau galima išskirti esmines Lietuvos paleodemografinių tyrimų **problemas**, dariusias įtaką šiam doktorantūros darbui, iškeltiems tikslams ir uždaviniams atsirasti. Paleodemografinių tyrimų pradžia ir plėtojimas Lietuvoje yra sietinas su šios disciplinos atsiradimu ir įsitvirtinimo stadija Šiaurės Amerikoje ir Europoje. Tai yra tikslų formulavimas ir metodiniai sprendimai Lietuvoje buvo ir yra formuluojami atsižvelgiant į pagrindinių paleodemografijos teoretikų darbus, publikuotus iki XX a. 8-ojo dešimtmečio (imtinai) – laikotarpiu, kai antropologai ir archeologai buvo per mažai susipažinę su formaliosios demografijos pagrindais ir per mažai kritiškai vertino paleodemografijos teikiamų rezultatų patikimumą. Per paskutinius 30 ir daugiau metų buvo įrodyta, kad aštuntajame dešimtmetyje susiformavusi „tradicinė“ paleodemografinės analizės metodika nėra tinkama transformuoti osteologinius duomenis į tiriamos praeities populiacijos demografinių parametrų reikšmes, nes sistemingai suteikia labai abejotinus rezultatus. Todėl šiuolaikinė paleodemografija labai pakito ir toliau keičiasi nuo tos, kokia ji buvo praeitame šimtmetyje. Susižavėjimas sąlyginai nauja disciplina dėl galimybės žvelgti daug šimtmečių ar tūkstantmečių atgal į praeitį, drąsios ir visaapimančios demografinės išvados bei iš jų išplaukiantys pastebėjimai dėl praeities visuomenėse vykusių procesų buvo pakeisti griežta taikomų tradicinių metodų kritika ir tiksliaisiais mokslais grįstais bandymais spręsti metodines problemas. Dar daugiau, anksčiau minėti Lietuvos paleodemografijos tyrėjai taikė skirtingą metodiką osteologinei medžiagai registruoti, pavyzdžiui, renkant informacija apie asmenų amžių mirties metu. Tai reiškia, kad Lietuvoje nėra atliktos šiuolaikine metodika paremtos ir kartu sisteminės paleodemografinės analizės. Dėl to turimų Lietuvos paleodemografinių žinių patikimumas, jų interpretacija ir jomis paremtos išvados turi būti tiriamos ir kritiškai analizuojamos iš naujo.

Tyrimo tikslas, uždaviniai, chronologijos ribos ir tirta medžiaga

Atsižvelgiant į tai, šio darbo **tikslas** yra Lietuvos priešistorės ir istorinių laikų paleodemografinė analizė, taikant šiuolaikinę „Rostoko Manifesto" (RM) modeliavimo metodiką (Wood ir kt., 2002), bei interpretavimas archeologijos ir istoriniame kontekste. Pagrindinis pristatomo tyrimo **duomenų šaltinis** yra Vilniaus universiteto Medicinos fakulteto Anatomijos, histologijos ir antropologijos katedros Antropologijos laboratorijoje (AHAAL) sukaupta gausi Lietuvos paleoosteologinė medžiaga (griautiniai suaugusiųjų asmenų skeletai), rasti dabartinės Lietuvos teritorijoje esančiuose archeologiniuose paminkluose. Nagrinėjamas **chronologinis laikotarpis**: nuo I tūkstantmečio po Kr. pr. iki XVIII a. pab. imtinai – šiuo laikotarpiu yra datuojama didžioji dalis Lietuvoje saugomų griautinių skeletų. Kadangi buvo bandoma įgyvendinti tokio plataus masto studiją, remiantis unikaliu, bet netiesioginiu ir fragmentišku duomenų šaltiniu, keliami keturi pagrindiniai darbo **uždaviniai**:

1. Apžvelgti paleodemografijos disciplinos raidą, kad būtų išryškintos šiai sričiai būdingos esminės tyrimų problemos ir tendencijos.
2. Įrodyti (arba paneigti), ar ir kokiose sąlygose pasirinkta paleodemografijos RM modeliavimo metodika yra veiksminga rekonstruoti praeities populiacijų demografinius procesus. Tam reikia atlikti kontroliuojamus eksperimentus, taikant statistikos ir kompiuterinio modeliavimo žinias.
3. Kritiškai įvertinti ankstesnių Lietuvos paleodemografinių tyrimų rezultatų patikimumą: atsižvelgiant į gautus šio darbo antro uždavinio rezultatus, išanalizuoti AHAAL saugomą empirinę osteologinę medžiagą tam, kad galima būtų įvertinti, ar gauti demografiniai rezultatai reikšmingai skiriasi

nuo ankstesnių paleodemografinių tyrimų dėl suformuoto priešistorinių ir istorinių laikų Lietuvos demografinio vaizdinio.

4. Remiantis osteologinės medžiagos analize, archeologiniais ir istoriniais duomenimis įvertinti, ar interpretuojant ilgalaikę Lietuvos gyventojų demografinių procesų ir rodiklių kaitą galima pritaikyti vieną iš svarbiausių Europos ir Azijos istorinės demografijos tyrimuose taikomą „populiacijų–išteklių" modelį, pagrįsta T. Malthus idėjomis, kuriame susiejami demografiniai, ekonominiai ir biologiniai žmogaus gyvenimo komponentai.

Darbo naujumas ir aktualumas

Darbo **naujumas ir svarba** visų pirma slypi modernios paleodemografijos tyrimų koncepcijos taikyme turimai gausiai osteologiniai medžiagai, kurios rezultatai turėtų būti svarbūs dėl kelių priežasčių. Pirma, manau, kad įgyvendinus darbe keliamus tikslus bei uždavinius darbo rezultatai prisidės suteikdami sisteminį pagrindą demografinių ir sociokultūrinių procesų Lietuvos praeities populiacijose tyrimams, modeliavimui ir interpretavimui. Kartu tikimasi, kad unikalūs paleoosteologiniai duomenys ir paleodemografinių tyrimų svarba bus labiau pripažinti Lietuvos praeities ir demografijos tyrėjų. Iki šiol paleodemografiniai tyrimai buvo arba per menkai žinomi, arba gana skeptiškai traktuojami kitų sričių specialistų. Tačiau taip pat tikimasi, kad ši studija paskatins tyrėjus, kurie ateityje analizuos Lietuvos bioarcheologinius duomenis ir atliks paleodemografines analizes, kur kas daugiau dėmesio skirti demografijos pagrindams ir paleodemografijos metodinėms problemoms. Trečia, studijos rezultatai turėtų sudominti įvairių šalių tarpdisciplininių sričių praeities tyrėjus, nes atliekant darbą buvo glaudžiai dirbama su įvairių sričių aukštos kvalifikacijos specialistais, atsižvelgta į jų patarimus.

Pagrindiniai ginami teiginiai

Apibendrinant galima pasakyti, kad darbe yra ginami šie pagrindiniai **teiginiai**:

1. Apskaičiuojami demografiniai rezultatai pagal osteologinę palaikų analizę labai priklausomi nuo taikomos metodikos principų, nes nors šis duomenų

šaltinis yra unikalus, tačiau yra tik netiesioginis demografinių duomenų šaltinis. Todėl paleodemografiniai rezultatai (bent jau kol kas) gali suteikti vertingos informacijos apie tam tikras ir ilgalaikes demografines praeities tendencijas, bet ne patikimai jas atspindinčias konkrečias skaitines išraiškas.

2. Todėl paleodemografiniai tyrimai išsiskiria į dvi ir šiuo metu pakankamai atskiras sritis: techninių-metodinių problemų kėlimas ir jų sprendimas, kuriems yra skiriamas didžiausias pagrindinių šios srities specialistų dėmesys, ir bandymus paaiškinti gaunamus rezultatus platesniame istoriniame (plačiąja prasme) kontekste.

3. Dėl ribotų duomenų, šiandien didžiausia paleodemografinių tyrimų nauda atsakant į klausimus, susijusius su *kaip* ir *kodėl* keitėsi praeities gyventojų demografiniai rodikliai bei kokią įtaką tai turėjo jų gyvenimo lygiui ir visuomenės raidai, reikėtų kliautis ne „patikimesniais ar tikslesniais“ demografinių skaitinių išraiškų skaičiavimo būdais, kurie leistų daryti pagrįstas indukcines išvadas, bet teorinių modelių ir darbinių hipotezių, apibūdinančių pasirinktos praeities žmonių gyvensenos aspektų veikimą, tikrinimą.

Išvados

Praeities Lietuvos gyventojų demografinę raidą apibūdinančių parametrų apskaičiavimas ir jų pagrindu daromos išvados apie demografinių procesų įtaką žmonių gyvenimo lygiui bei visuomenės raidai pagal osteologinių duomenų analizę yra įmanomi tik taikomų modelių rėmuose ir yra labai priklausomi nuo duomenų analizės metodikos. Siekiant reikšmingai prisidėti prie šioje srityje kaupiamų žinių, doktorantūros tyrime buvo nagrinėjamos trys pagrindinės problemos: a) Rostoko manifesto (RM) metodikos patikimumas ir apribojimai paleodemografinuose tyrimuose, b) ankstesnių Lietuvos paleodemografinių tyrimų rezultatų suderinamumas su rezultatais, gautais taikant RM metodiką, ir c) paleodemografinių tyrimų rezultatų interpretacija populiacijos–išteklių modelio rėmuose, kartu pasitelkiant archeologinius ir istorinius duomenis. Tyrime buvo gautos kai kurios naujos, netikėtos, bet kartu ir patvirtinančios kai kurias anksčiau žinomas paleodemografijos žinias, išvados:

1. Analizuojat RM metodiką buvo padaryti šie du svarbiausi pastebėjimai, apribojantys teorines metodo galimybes:

    a. RM metodikos, aprašytos Wood ir kt. (2002), Konigsberg ir kt. (2002), neleidžia patikimai apskaičiuoti mirusiųjų amžiaus skirstinio stabilios populiacijos rėmuose. Net jei yra tenkinamos visos kitos būtinos RM prielaidos, galima tikėtis patikimai apskaičiuoti mirusiųjų amžiaus skirstinį tik iš stacionarios (nekintančio, pastovaus dydžio) populiacijos arba stabilios populiacijos, bet iš anksto pasirinkus populiacijos natūralaus prieaugio reikšmę. Taigi, minėtų autorių išdėstytos teorinės galimybės nėra visiškai pagrįstos.

    b. Analizuoti empiriniai duomenys rodo, kad biologinio pastovumo prielaida (angl. *uniformitarian hypothesis*) tirtose žinomo amžiaus skeletų kolekcijose (DSK), kuri yra būtina norint konvertuoti paleoosteologinę informaciją į populiacijų, apibūdinančių demografinių parametrų įverčių reikšmes, nėra pagrįsta. Istorinėje Spitalfields DSK, kurioje palaidoti XVII–XIX a. gyvenę Londono gyventojai, ausinių paviršių amžinių pokyčių tempas buvo daug lėtesnis, lyginant su atitinkamais XX a. pr. Coimbra (Portugalijos) ir XX a. pab. Lietuvos gyventojų skeletų pokyčiais. Todėl pasirinkimas, kuriuos iš DSK duomenų apie skeleto amžinius rodiklius naudoti paleodemografiniams tyrimams, turi didžiulę įtaką apskaičiuojamoms skaitinėms reikšmėms apie tiriamas praeities populiacijas.

2. Dar didesnę įtaką paleodemografiniams rezultatams turi skirtingos paleodemografinės metodikos pasirinkimas. Lyginant tų pačių laidojimo Lietuvos archeologinių paminklų paleosteologinės medžiagos mirtingumo analizės rezultatus, taikant RM metodiką, su ankstesnių tyrimų rezultatais, paremtais iki XX a. aštuntojo dešimtmečio susiformavusia „tradicine“ paleodemografijos metodika, gauti šie pastebėjimai:

a. Priešingai nei siūlo ankstesni tyrimai, didžioji dalis Lietuvos teritorijoje gyvenusių suaugusiųjų turėjo sulaukti bent jau 50 m. Tokiu būdu, šie rezultatai yra kur kas panašesni į alternatyvią duomenų teikiamą informaciją – viduramžių ir naujųjų laikų Europos šalių istorinės demografijos ir medžiotojų-rankiotojų bei žemdirbių mažų populiacijų etnografinių tyrimų rezultatus.

b. Skirtumai tarp vyrų ir moterų mirtingumo buvo pastebimai mažesni, nei siūlo ankstesni tyrimai. Be to, nebuvo fiksuojamos lyčių mirtingumo supanašėjimo tendencijos vyresniame amžiuje (poreprodukciniame moterų laikotarpyje, t. y. vyresniame nei 45–50 m. amžiaus laikotarpyje).

c. Gauti rezultatai, taikant RM metodiką, neleidžia patvirtinti egzistavus teigiamos ir tiesinės priklausomybės tarp gyvenvietės dydžio ir mirtingumo lygio: skirtumai tarp magdeburginių miestų (Alytaus ir Kernavės) ir kaimų buvo nežymūs. Tai prieštarauja anksčiau gautoms išvadoms. Aptikti tik ryškūs mirtingumo skirtumai tarp Vilniaus ir visų kitų gyvenviečių, t. y. XIII–XVIII a. Vilniaus laidojimo paminklų mirusiųjų amžiaus skirstinys buvo pastebimai „jaunesnis“.

d. Ankstesnių Lietuvos paleodemografinių tyrimų rezultatai liudija, kad ryšys tarp vaikų ir suaugusiųjų mirtingumo buvo fundamentaliai skirtingas, lyginant su nuo XVIII a. pradėtais rinkti Europos ir vėliau kitų žemynų šalių surašymų duomenimis. Tuo tarpu rezultatai, gauti taikant RM metodiką, yra kur kas labiau suderinami ir neprieštarauja prielaidai, kad suaugusiųjų ir vaikų mirtingumas yra pastovus.

e. Vis dėlto šis tyrimas atskleidė, kad apskaičiuoti rezultatai, taikant RM metodiką, stacionarios populiacijos modelio rėmuose reikšmingai skiriasi nuo surinktos empirinės medžiagos, ir ypač tai pasakytina apie moterų populiacijos dalį. Be to, skirtingų DSK imčių pasirinkimas lemia pastebimai skirtingus rezultatus. Todėl apžvelgiant šiame skyriuje gautus rezultatus, sunku nepadaryti išvados, kad tik osteologinių duomenų analizė vargu ar yra naudinga (bent jau šiai dienai) gaunant tikslias skaitines išraiškas apie populiacijos mirtingumą, gimstamumą, amžiaus pasiskirstymą, dinamiką ir kt.

3. Taikydami T. Malthus‘o populiacijų–išteklių modelį, aiškintantis Lietuvos gyventojų skaičiaus, mirtingumo, gyvenimo lygio raidą, užfiksuoti šie pastebėjimai:

    a. Ūgio ir mirtingumo tendencijų kaitą geležies a. (I tūkst. pr. – XII a.) Lietuvoje yra sunku nustatyti, nes empirinės medžiagos nėra daug, o archeologinių laidojimo paminklų funkcionavimo laikotarpiai labai persidengia. Todėl atsakyti į klausimą – ar tam tikru metu geležies amžiuje (nuo senojo iki vėlyvojo geležies amžiaus) Lietuvos populiacija buvo pakliuvusi į „Malthus‘o spąstus“ – paleoosteologinių duomenų nepakanka.

    b. Laikotarpyje tarp XIII ir XVIII a. išsikeltos dvi iš trijų (pirma ir antra) hipotezės, skirtos patikrinti taikytą modelį, derinasi su empiriniais duomenimis: ūgio, gyvenimo lygio ir populiacijos raidos tendencijos gerai sutapo su populiacijos–išteklių modelio prognozėmis. XIII–XV a. pr. ir XV–XVI a. buvo prasčiausi laikotarpiai Lietuvos gyventojams. Tačiau mirtingumo raida nebuvo labai susieta su gyvenimo lygiu. Tai yra turimi duomenys neleidžia priimti išsikeltos trečios hipotezės. Todėl tikėtina, kad didelę dalį mirčių priežasčių reikėtų aiškinti skirtingais veiksniais. O kartu rezultatai rodo, kad ilgalaikės gyventojų skaičiaus raidos nebuvo lemiamos tik mirtingumo pokyčių, bet ir spėtina, kad kur kas svarbesnį vaidmenį vaidino gimstamumo pokyčiai.

CURRICULUM VITAE

Name: Šarūnas Jatautis

Date and place of birth: 1986.12.04, Vilius

Education:

2012–2016 PhD Studies in History, Faculty of History, Vilnius University, Vilnius, Lithuania.

2009–2011. Master degree in Archaeology, Vilnius University, Vilnius, Lithuania.

2005-2009. Bachelor degree in Archaeology, Vilnius University, Vilnius, Lithuania.

Scientific publications:

- Jatautis Š., Jankauskas R. (in press). Eastern Baltic region vs. Western Europe: modelling age related changes in the pubic symphysis and the auricular surface. *Anthropologischer Anzeiger*.
- Blaževičius P., Jatautis Š., 2016. Children in 14th – 16th – century Vilnius – demographics and lifestyle on the basis of urban and burial site data synthesis. *Archaeologia Polona*, 51-52: 143-162.
- Jatautis Š. 2015. Įvadas į paleodemografiją: sąvokos, tyrimai ir problematika. *Lietuvos archeologija*, 41: 111-130
- Blaževičius P., Jatautis Š. 2014. Vaikų pėdsakai viduramžių mieste: naujos avalynės tyrimų galimybės. *Lietuvos archeologija*, 40: 205-220.
- Jatautis Š. 2014. XVI-XVII a. Senojo Panevėžio gyventojų antropologija. In: Gaidelienė J., Juškienė E., Pilkauskas D. (sud.) *Panevėžio patirties: emigracijos patirtys XIX-XX a.*: 104-116.
- Laužikas R., Jatautis Š. 2014. Archeologija ir statistinė analizė: Taikomosios galimybės. In: Merkevičius A. (sud.) *Metodai Lietuvos Archeologijoje*. Vilniaus universiteto leidykla: 443 – 472
- Jatautis Š. 2013. Lietuvos paleodemografiniai tyrimai. *Mes ir demografija*: 7-9.

- Jatautis Š., Mitokaitė I., 2013. “Senojo Panevėžio gyventojai XVI-XVII a. bioarcheologinė analizė (paleodemografija ir paleoepidemiologija. *Lietuvos archeologija, 39*: 97-120
- Jatautis Š., Mitokaitė I., Jankauskas R., 2012. Analysis of *Cribra Orbitalia* in the Earliest Inhabitants of Vilnius. *Anthropological Review,* 74: 57-68.

Presentations presented at conferences

- Jatautis Š., Lynnerup L., 2014. Old age mortality in Medieval Denmark. In: *83rd annual meeting of the American Association of Physical Anthropologists*, April, Calgary, Canada.
- Blaževičius P., Jatautis Š., Jonaitis R. (poster), 2013. Where do Medieval children hide? In: *19th annual meeting of the European Association of Archaeologists*, September, Pilsen, Czech Republic.
- Jatautis Š. 2013. Mortality Statistics of the Earliest Inhabitants of Vilnius, current capital of Lithuania. In: *the XXIV Nordic Medical History Congress*, May, Helsinki, Finland.
- Jatautis Š., 2013. Gyvenimo kokybė ir ūgis dviejų tūkstantmečių po Kr. perspektyvoje (Quality of life and stature in Lithuania during the last two millennia). In: *M. Gimbutienės skaitymai X*, March, Vilnius, Lithuania.