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Children in 14th–16th-century Vilnius – demographics and lifestyle on the basis of urban and burial site data synthesis

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The article presents an approach to analysing data, both from the burial and urban sites, which may help us learn more about the demographics and lifestyle of the past. The analysis compares leather shoes and other remains of footwear from the 14th–16th century found in the Vilnius Castle and the size of feet of people buried in the 13th–15th-century cemetery at 6 Bokšto Street in Vilnius, presenting estimations on the number of children and their role in Vilnius' urban society at the time.

KEY-WORDS*:* childhood history, demographics, social structure, medieval archaeology, osteology

INTRODUCTION

So far the research of urban archaeological features has produced relatively little evidence of the remains related to children and these materials have received relatively little attention. The forms children's of entertainment and work activities are somewhat reflected in the toys that have been discovered by archaeologists (Blaževičius 2011) as well as the fingerprints on ceramic artefacts (Sarcevičius *et al.* 1999). However, the identification and study of the children who lived in the prehistoric and historic times is best made by analysing their remains from burial grounds. Another important source of information are shoe remains. Archaeological children's footwear is not a novelty in Lithuania; small shoes or their parts have been found at various archaeological sites (Navickas 1964; Puškorius 2004; Bračiulienė 2011; Masiulienė 2012), however, usually these artefacts are examined separately, without making any attempt to relate the find to the individual who may have worn it.

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We are certain that the research of footwear could be more comprehensive. Having determined the indicators based on the feet sizes of the people from different age groups from a particular period, and examining the footwear found during archaeological excavations, we were able to achieve a better understanding of the society from that period. This type of data has the potential to reveal the demographic, social, and even socio-cultural information about the inhabitants of the cities or their neighbourhoods.

The special focus of this article is children and the main purpose of this publication is to answer a rather specific and narrow demographical question: can the study of footwear offer us useful data on the estimated relative number and age structure of children who lived in a particular zone?

Traditionally, without appropriate written sources, these and related demographic questions are answered on the basis of the human paleo-osteological data. However, such analysis is complicated and the results may be questionable due to the fragmentary nature of the empirical data (Gage 2010). A marked lack of children is one of the most characteristic features of the majority of burial sites examined by archaeologists (cf. e.g. Jatautis and Mitokaitė 2013). This is caused by two main reasons. Studies from various fields have shown that until modern times (before the 20th century) the child mortality rate was very high (Weiss 1973; Stone 1977; Bideau *et al.* 1998). Without effective protection against the inhospitable living conditions, the risk of death amongst the youngest members of the population was significantly greater than amongst those already a decade or two older. That is why this age group should make up the largest relative part of the deceased population. However, due to various factors such as the taphonomical reasons, the influence of cultural traditions, low-quality of archaeological examinations or incomplete examination of archaeological sites (Milner *et al.* 2000), the number of children's remains discovered near archaeological burial sites is often very small. Even in the ideal conditions of discovering all the buried children and precisely establishing their age at death, we are left with the second fundamental problem: the distribution of ages at death depends not only on the mortality but also on two other demographical processes – birth rates and migration (Moore *et al.* 1975; Sattenspiel and Harpending 1983). Unfortunately, there is not much reliable data on these processes, so it is difficult to establish their impact on the distribution of ages at death. There are two main ways in which these problems can be resolved: modelling based on mathematical-statistical demographic theory and more complex methods adapted to paleo-osteological material, or finding additional empirical data sources. This paper concentrates on the second solution and checks the hypothesis whether, basing on the study of footwear, we can learn significantly more about the relative number of children who lived in the past and about their age structure in medieval Vilnius, and offer additional data on the children's lifestyles in the past.

How can the study of footwear found during archaeological excavations help to identify the demographic situation of the children's population from the past? First of all, the foot of a growing person gives a direct and strong correlation with that person's age. If we also presume that every growing person had worn shoes, that a person from a particular period had worn shoes of their size, and that unsuitable shoes had been discarded (i.e. no one else had worn them), this would suggest that a footwear analysis should to a certain extent reflect the number of children from a certain age group within the population. However, there is evidence that the above-mentioned presumptions are not completely valid for the prehistoric and historic populations. In addition, for various reasons, archaeologists do not find the total number of shoes worn by a certain population. Still, there are grounds to believe that there should be a meaningful link between footwear research and the relative number of younger members of society and their distribution in the population. If this is confirmed, it will prove to be a very important source for the analysis of traditionally vaguely identifiable children in the past populations.

We have chosen for this study two different comprehensively examined archaeological monuments in the city of Vilnius: the burial ground at 6 Bokšto St., which dates to the second half of the 13th–early 15th century, and the Vilnius Castle complex (Fig. 1). We analysed the foot sizes of the people found at the Bokšto St. burial ground and then tried to relate them to footwear fragments from the 14th–early 16th century found within the Vilnius Castle territory, thus obtaining source material on the children who lived at the castle. In this way we are going to determine the number and age of children who could have lived in a relatively enclosed fortress, the Vilnius Castle, in the 14th–early 16th century. Using the results of the analysis, we hope to 'discover' the children hidden in the urban archaeological material, and at the same time present the scientific community with a potential tool and/or method which can facilitate the research of human communities that lived at an archaeological site.

MATERIAL, METHODS AND PROBLEMS WITH THE DATA

We employed different methods at the respective stages of our research. The primary database of archaeological finds was compiled from probably the richest Lithuanian archaeological complex from the Late Middle Ages: the Lower and Upper Castles in Vilnius. These castles were intensively investigated from the mid-20th century. The archaeological examinations at the castle territory have revealed cultural layers of up to 7–8 m in height where even rapidly decaying organic materials have survived due to the high level of groundwater. The resulting favourable anaerobic environment preserved leather footwear remains from the 14th–early 16th century that are so crucial

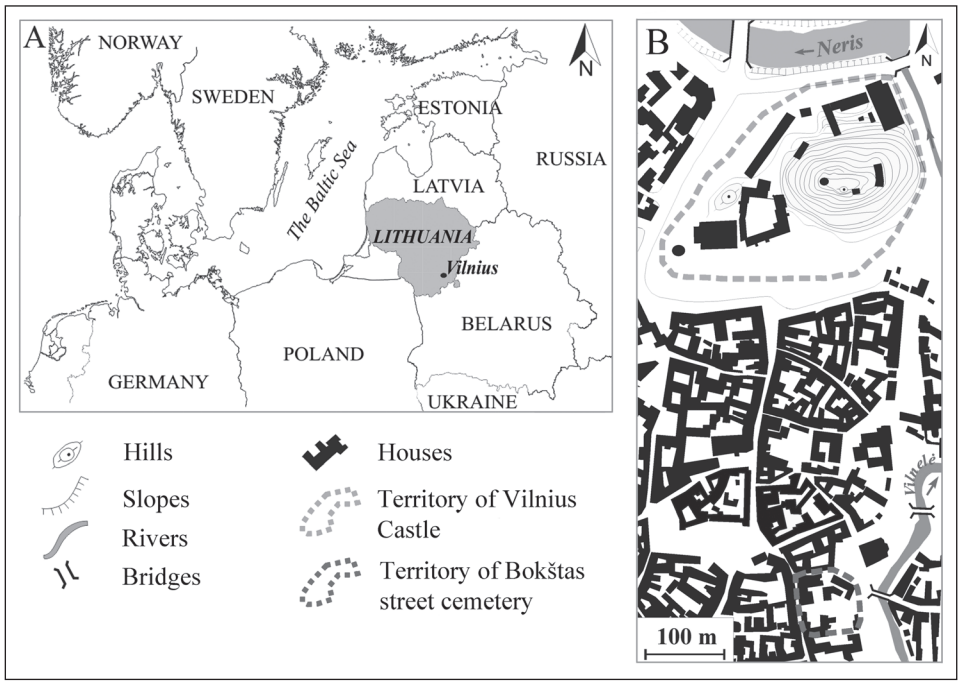

Fig. 1. Study area location

for our research. Having examined all the material collected by the archaeologists between 1959 and 2010[1], which is now kept at the National Museum Palace of the Grande Dukes of Lithuania and the National Museum of Lithuania, we selected only those footwear fragments for which the entire length of the sole could be measured. It appeared that less than 4% of the finds met this requirement. Out of the selected 739 shoes or shoe parts, only 581 were suitable for our research because they came from the chronological period we were interested in[2]. The main measurement which was included into the database, besides the circumstances of the discovery and chronology, was the total length of the sole. In addition, we took note of the supplementary

[1] Approx. 20 000 finds.

[2] Sadauskaitė 1959; Tautavičius *et al.* 1960; Tautavičius 1961; Lisanka 1982; Urbanavičius *et al.* 1992; Kuncevičius *et al.* 1993; Sarcevičius 1994; Tautavičius and Urbanavičius 1995; Steponavičienė 1997; Steponavičienė 1998; Steponavičienė 1999; Katalynas 2000; Ožalas 2001; Ožalas 2002; Ožalas 2003; Rackevičius 2003; Ožalas 2004; Steponavičienė *et al.* 2006; Striška 2007; Blaževičius and Žvirblė 2009; Blaževičius *et al.* 201X; Blaževičius and Bugys 201X; Montvilaitė *et al.* 201X; Ožalas 201Xa; Ožalas 201Xb; Ožalas and Montvilaitė 201X; Ožalas *et al.* 201X; Striška 201Xa; Striška 201Xb.

information on the sole shape, shoe style, its completeness, decor, etc. (Blaževičius 2013). The summary of the technical measurements revealed that the shortest sole length was 97 mm, whilst the longest was 310 mm. 75% of the soles fall into the interval between 252 mm and 310 mm, and the difference between the first quartile and third quartile of the set of data (IQR) is 54 mm (Fig. 2).

It is noteworthy that the sample of finds that were measured included intact footwear, soles, inner soles, as well as other leather pieces which, although fragmented, represented the full length of a sole (Blaževičius 2013). Footwear size analysis by age group was based on the assumption that both small and large shoe sizes are represented by the same number of remaining and/or discovered fragments. Thus, even if we failed to find full sets of pieces that could constitute a single shoe sole, we maintain that the data at hand should adequately represent the proportion of shoes of different sizes.

As for the reliability of the archaeological data, it is also noteworthy that approx. 81.5% of all fragments were treated with glycerol or PEG solutions and approx. 18.5% of fragments were dried naturally. Both conservation and drying makes leather shrink,

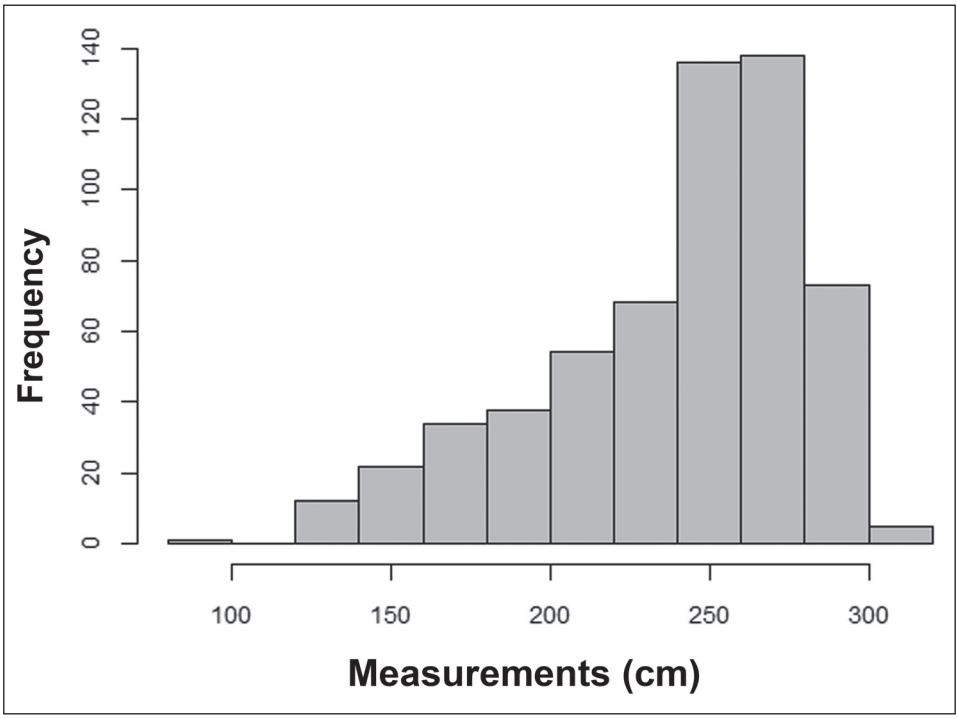

Fig. 2. Histogram of sole measurements

but the degree of shrinkage differs depending on the method, ambient conditions, and the qualities of leather itself. Experiments of British researchers show that conservation in 20% glycerol leads to the shrinkage of 3.92%, conservation in 2% PEG400 leads to the shrinkage of 5.92% and natural drying, to 5.72%. Conservation and drying with the help of other methods and technologies makes archaeological leather shrink by an average of 7.3% (Karsten and Graham 2011: 14–16). Although it is impossible to assess the individual degree of deformation due to conservation, drying or preservation, the average degree of shrinkage is estimated at 7%.

Having established the medieval footwear sole measurements, we faced the problem of applying these parameters to determine the foot size of the wearer. Based on a popular theoretical model, the foot and shoe ratio to a person's height is around 15% to 17% (Robbins 1986; Davis 1990; Jasuja *et al.* 1991; Burke 2006). However, if this model were applied to people and their shoes in the 21st century, does it necessarily mean that it would also suit the 13th–14th-century people? In order to achieve the most accurate possible margin of error, additional experimental measurements were taken. We measured feet sizes of 47 people aged from 5 months to 39 years[3] and the soles of the shoes they wore[4], and compared this data to 24–33 years old Medieval re-enactors' foot and shoe ratio[5] and received almost identical results[6]. Shoes were around 10% larger than the wearer's foot, on average by 12–15 mm (Blaževičius 2013). As the theoretical and practical measurements did not match, the ratio was calculated on the basis of the assumption that footwear in Vilnius in 13th–16th centuries was on average 10% larger than the feet. Since archaeological leather shrinks by approx. 7%, we could further maintain that archaeological footwear was only 3% larger than the feet of its wearers.

However, this is just a hypothetical average ratio, and it is thus important not to forget the other numerous aspects of medieval footwear research. From the 21st-century perspective it is difficult accurately to evaluate the margin of error which depends on the shape of the shoe, natural foot swelling, certain nuances in wearing shoes (puttees, socks or straw in winter), social status, etc. The archaeological footwear measurements themselves are also partially subjective. For example, if the sole is bent and hardened, it cannot be straightened out without damaging the artefact, so during measurement a certain margin of error may also appear. A similar margin of error might also have

[3] Measured in August 2013. Men (aged 32–39) made up 12.75% of the sample, women (aged 26–37) – 46.8%, boys (aged 5 months–10 yrs) – 27.7%, and girls (aged 3–10) – 12.75%.

[4] Measurements were taken both for winter and summer footwear.

[5] Items measured included 6 pairs of ankle boots made by D. Grigonienė and A. Puškorius, and 4 pairs of *karbatina* made by unknown reconstructors of medieval footwear.

[6] However, we must take into account the fact that according to the data from the anthropologists studying today's children, body proportions are changing due to various reasons (personal information from J. Tutkuvienė, Faculty of Medicine, Vilnius University). That is why today's proportions do not necessarily have to match those of the past populations.

occurred when measuring very pointy and long-nosed shoes, in which case the parameters had to be corrected taking into consideration the foot's imprint or wear-markings on the inner sole, or how much empty space would have remained at the tip of the shoe. For these reasons, the measurement data may fluctuate by several millimetres; however, we believe that this will not have a significant impact on the final results.

At the same time the remains from the burial ground on Bokšto Street, the largest excavated medieval cemetery in Vilnius, were analysed. In 2005–2012, 500 burials dating to the second half of the 13th–early 15th century were found on the upper terrace of the Vilnelė River. The data on 487 individuals have been used for this study. The age and gender of the deceased were determined using traditional osteological methods (Buikstra and Ubelaker 1994). Taking bone data to determine a child's age at death, the average figure was used for the analysis, e.g., having determined that the child died at the age of 3 ± 1 year (i.e. 2–4 years old), the 3 year average figure was used for our calculations.

However, the margins of error for the adults' ages at death are incomparably greater than for the children. So in order to conduct a further comparative analysis, the distribution of adults' ages at death was approximated applying the Gompertz distribution (Wood *et al.* 2002). The likelihood of estimating the Gompertz distribution was obtained by taking into account the fact that the observation scheme for adults was left truncated, interval- and right-censored. The parameters were estimated by maximizing the above-mentioned likelihood.

Due to various reasons, the use of biological data in a demographic analysis is complicated (for more see Hoppa and Vaupel 2002). Without the use of more complex methods, the analysis results in clear deviations in the distribution of ages at death from the expected characteristics which would describe the realistic demographic picture of the past. So, the model suggested by R.R. Paine and his colleagues (Paine 2000; Paine and Boldsen 2002) was used as an expected reference for comparison, as it describes the 'standard' characteristics for mortality typical among pre-industrial populations. That is, we used the Brass logit life table and the birth rate model, where $\alpha=0.65$, $\beta=0.95$ (from a Brass standard model).

The conversion of the distribution of ages at death into the population's age structure was performed within the framework of the stationary population model according to K.H. Weiss (1973). The main assumptions of the stationary population model are: constant mortality and birth rates, inexistent migration and population growth rates equal to 0 (Weiss 1973). Admittedly, this model is not particularly suitable for medieval city populations; however, the application of more complex models can be left for future research, all the more so that we have no reliable data on the possible growth of the Vilnius' population during the research period, whereas the consideration of the influence of migration (the scale of which has also not been reliably determined) on the distribution of ages at death in the paleo-demographical research is especially difficult.

The length of adult feet was calculated using heel measurements based on R. Povilaitis' determined regression equations (Povilaitis 1995). The foot length of younger individuals was calculated in two stages. First, by measuring the long bones based on regression equations by A. Telkkä *et al.* (1962), the person's height was calculated. Second, taking the height data and using regression equations made by T.B. Grivas *et al.* (2008), the foot length was calculated. An assumption was made that individuals' left and right foot lengths were equal.

Some obvious problems arise when the results are compared quantitatively in terms of children's footwear and children's burial sites from a defined period. If we consider a quantitative analysis of only one of these components, no problems appear to arise: the percentage simply states how many shoe fragments of a particular size there were amongst the total number of shoes found. The same applies to burial sites.

However, this becomes problematic when comparing the data groups amongst themselves. On the one hand, one shoe is just half of a pair which one child could have worn at a given moment. So, theoretically, in ideal conditions one child had two shoes. However, the data show that finding two shoes of the same pair during archaeological excavations is not the rule but rather an exception. If we consider the differences in the children's social status, we should also keep in mind that some children might not even have had leather footwear (they might have walked barefoot, worn woven straw shoes or something else). And, conversely, during the course of their life, children could and almost certainly would have outgrown more than one pair of shoes.

Looking even deeper, we understand that the scope of the data reflects completely different events: shoes reflect the growing process, which is continuous (child development and foot size at a certain age); burial sites are non-continuous and reflect the end of the process (the end of a child's development and the loss of a member of the community). So how should this data be handled? Is it possible to make a quantitative comparison of these bodies of data? Without a doubt, the data are not completely adequate, but their contrast nevertheless gives us some additional information. The comparison of data intervals from one group and the assessment of these results can be supplemented with the equivalent data from the second group, as some quantitative trends related to age are visible and are in part repeated in both data bodies.

Interesting problems arise also in the chronology studies, as during the several hundred years of its existence the city's society and structure could have changed; the same applies to the burial traditions. The particularities of wearing leather footwear or its value could have changed as well as its prevalence. However, these are classical problems that are encountered in the analysis of burial monuments and archaeological finds and there are no clear solutions. That is why the collected and analysed data must nevertheless be treated as maximally accurate, quantitatively and qualitatively equal, and similarly representative of narrow intervals in time.

ANALYSIS AND INTERPRETATION OF THE RESULTS

We shall begin by comparing the demographic data determined during the analysed period with the expected results. The actual and theoretical distributions of ages at death (dx) were notably different (Fig. 3). In the comparison graph, three 'traditional' deviations from the expected results typically found in paleo-demographical research are clearly visible. First, there are obviously too few of the youngest members of society. For example, there were only 2.9% of infants under one year of age whereas the expected value was 40%. As a comparison, F. Rösing and R. Jankauskas (1997) in their analysis of Lithuania's paleo-osteological material (which consisted of over 3000 skeletons, mostly from burial features dating to the 14th–17th centuries) calculated that the percentage of children under 5 at a burial ground should be around 45%. Meanwhile, our particular burial ground had a figure of around 15% of children who died aged under 5. So, the relative number of infants' and young children's skeletons in the researched plot of the Bokšto Street burial ground is obviously too small to reflect the actual child mortality rate of this community or the population structure from the 13th–early 15th century.

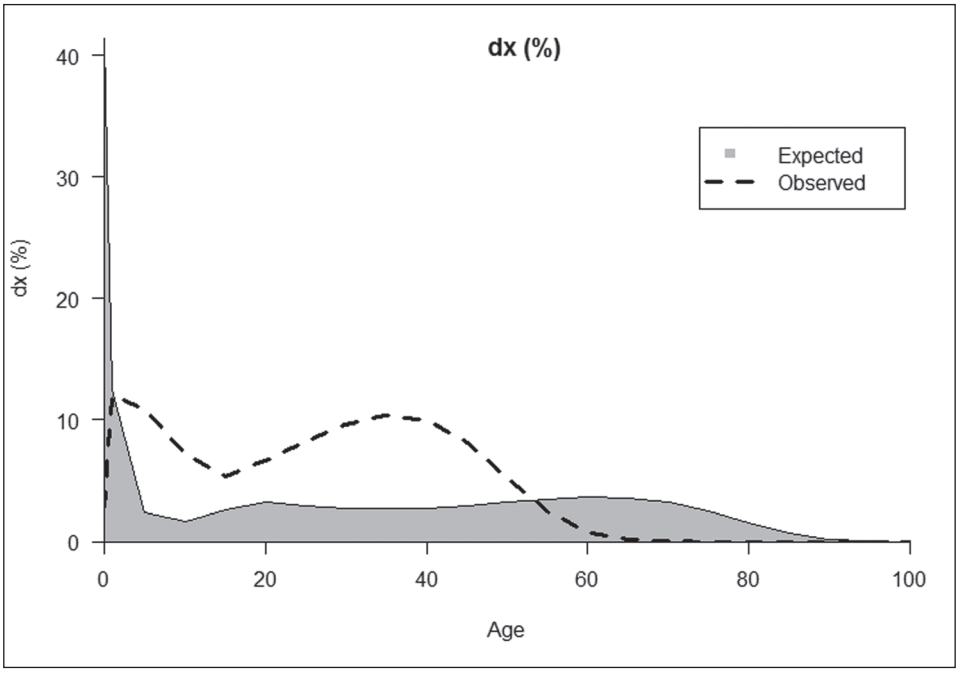

Fig. 3. Estimated and expected age-at-death distributions

There are two more inconsistencies: there were too many deceased adults aged up to 50 and no older individuals (aged 50+). That is why it should not be surprising that the reconstructed population's age structure (Cx) is markedly different when compared to a stationary population, namely, the observed population was much younger than expected (Fig. 4). Therefore, the Cx component, based on the anthropological analysis is not suitable for comparison with the prevalence of footwear. For that reason, to test this paper's hypothesis the data from the expected model were used.

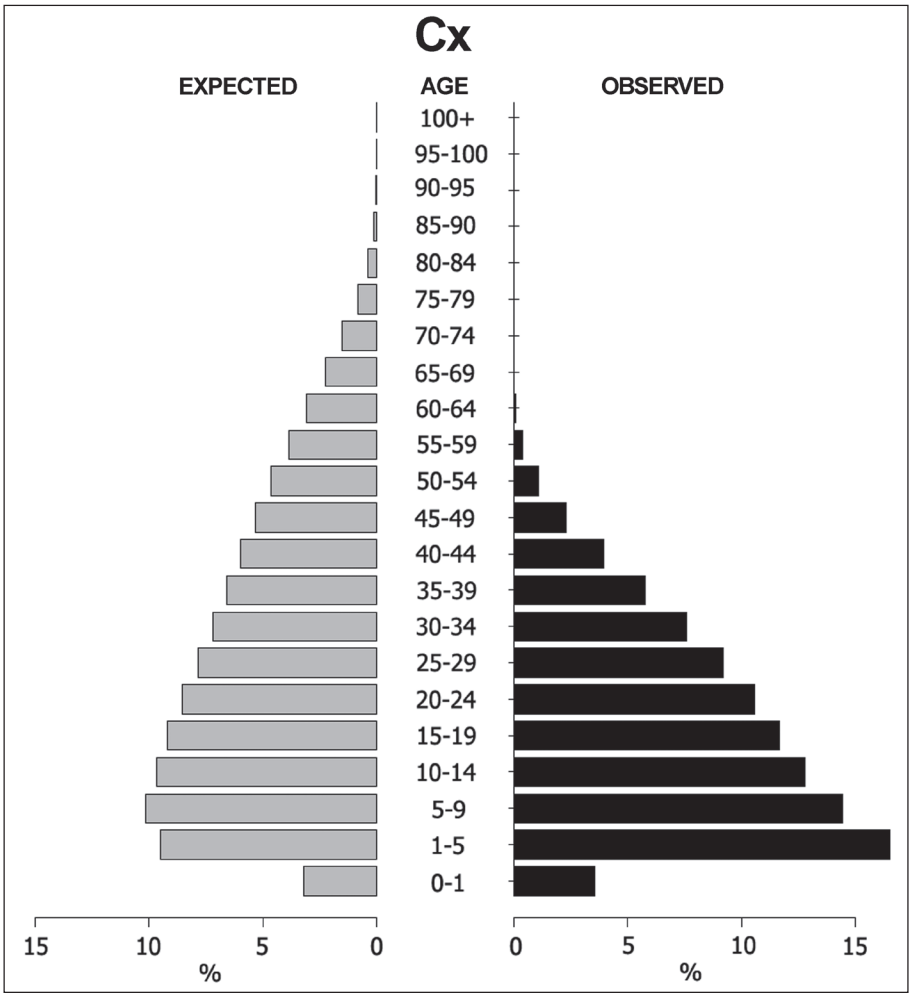

Fig. 4. Estimated and expected age structures, assuming the stationary population model

In order to achieve this, all the age groups were divided into six segments (0–1, 1–5, 5–10, 10–12, 15–20, and 20+) and the sixth segment (20+) was also divided according to sex. The 13–15 age group was left out on purpose, as this interval could not be properly assessed due to the lack of data. The above six age groups and the minimum and maximum foot sizes of the individuals falling into these groups served as the point of reference for allocating footwear to a particular age group. The results of the anthropological analyses demonstrated that the foot of a teenager older than 15 could be the same size as that of a petite woman, making it clear that it was not possible to attribute shoes longer than 220 mm to a distinct age group. Due to this reason, we did not distinguish six but only five groups where shoe size was related to an individual's age and foot size. By multiplying the detailed footwear measurement results by the set coefficient (1.03) we received the following age-related parameter intervals: up to 81.4 mm (0–1), 95.6–140 mm (1–5), 141–184.6 mm (5–10), 185.4–211.9 mm (10–12), and >212 mm (15+). Thus, children's shoes of the greatest interest for our study fell into the first four inter-correlating age, foot and shoe size intervals (Fig. 5).

Table 1 shows the distribution of footwear as well as the deceased and living individuals according to age groups. However, as there is very little material reflecting the number of children in terms of one aspect (the skeleton parts required to determine foot length were in poor condition), we rejected the idea of using statistical tests for equal proportionality in age groups. The conclusions presented below are to be considered as general observations which attempt to grasp and explain the expected trends.

Table 1. Percentage of age groups determined by distribution of shoes, estimated and expected dx, Cx (assuming the stationary population model) as well as the number of individuals for whom foot size was determined.

Age groups	dxobserved (%)	dxexpected (%)	Cx according to observed data (%)	Cx according to expected data (%)	Footwear (%)	Number of individuals for whom foot size was determined
0–1	2.9	41.4	3.6	3.2	0	5
1–5	12.1	12.5	16.5	9.5	2.4	10
5–10	10.9	2.4	14.4	10.2	23.06	11
10–12 (10–15)	6.2 (7.2)	<1.7* (1.7)	7.7 (12.8)	<9.7* (9.7)	15.83 (?)	8 (?)
15+	66.9	42	52.7	67.5	58.71	59

* Not precisely known, as model data was obtained only for the 10–15 age group

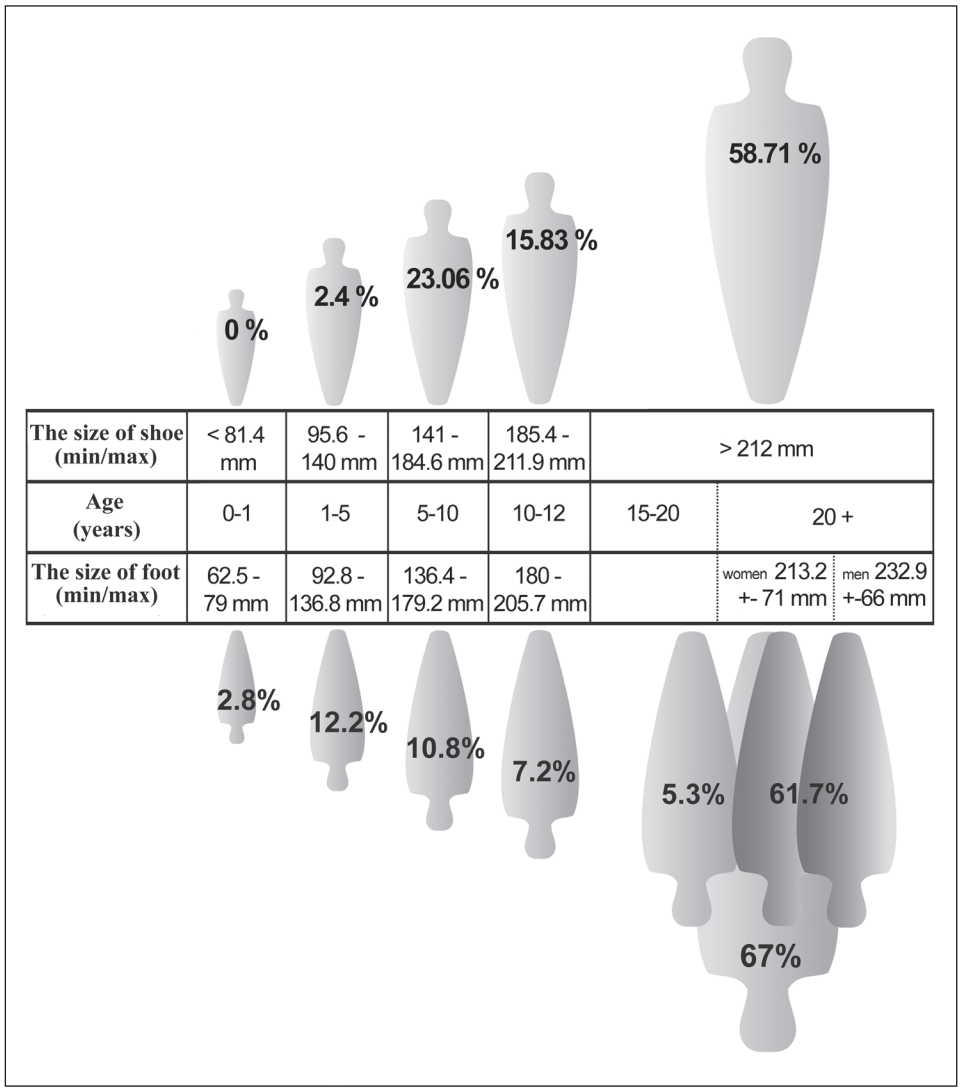

Fig. 5. Inter-relation of clusters representing age, footwear and paleo-osteological material

The summary of the data suggests that footwear research is not a more suitable source for learning about the mortality, age structure, or number of children than anthropological research. Unfortunately, this is also a minimally informative source when it comes to one of the largest gaps in paleodemography – infants. It is rather

obvious that the distribution of footwear amongst children's age groups has little in common with the actual, and especially the expected age-at-death, distribution. That is, a reduced risk of death and the age structure of the deceased do not correlate with the trends in the prevalence of footwear.

On the other hand, it is likely that from the age groups of above 5, the distribution of footwear displays a certain association with the age structure of the children's population within the stationary population. This may potentially confirm the benefit of footwear research when analysing children's age structure and their relative numbers. The research also showed certain consistencies in the distribution of children's footwear, which could reflect the interrelation of demographical phenomena with the socio-cultural aspects in society. Below are our insights which explain the results of our analyses.

Having attributed shoes to the corresponding age groups basing on anthropological data, we determined that, basing on the discovered footwear, children up to the age of 12 made up 41.29 % of the population. On the other hand, it is noteworthy that children may have had no leather shoes (walked barefoot, wore bast-shoes, etc.) or had more than one pair of shoes. In any case, as there is no alternative theory, we maintain that the archaeological footwear which belonged to different social and age groups has survived to a similar extent and the available finds represent these groups proportionately. Comparing this figure with the expected equivalent, i.e., more than 32.6%, we see that they differ quite considerably. What is obvious is that the general percentage value is informative insofar as it demonstrates that in the rather closed fortress in the capital of the Grand Duchy of Lithuania, children up to 12 years of age made up at least 40% of the inhabitants.

The comparison of individual age interval data reveals other significant differences. It is necessary to take account of the inter-relation of these intervals. For the first interval, no shoe fragments which belonged to infants under one year of age were found. Is it realistic to find shoes or their fragments attributed to this age group? Probably not. We can support this argument with the fact that even today, infants who cannot walk usually do not wear real shoes but soft fabric shoes similar to socks. Undoubtedly, there are exceptions, but, most likely, even in the Middle Ages, a child would have received their first pair of shoes once they had started walking. Based on the universal children's development model, we know that when they are around 1–1.5 years old, children start to walk independently, and from the age of 2 they can confidently run, climb and jump. These facts show that the greatest need for shoes comes in at around the ages of 1.5–2. Looking at the 1–5 age interval data, we see that the number of children's shoes does indeed increase. Admittedly, this figure is only 2.4% and is still quite small compared to the expected values in the population.

A significant increase can be seen in the third age interval (5–10 years of age): the number of shoes accounts for 23.06% of the total. This is ten times as many shoe

fragments as in the lower age groups and it should be a reflection of significant socio-cultural changes. Taking into consideration the margin of error and the fact that shoe acquisition would have depended on families' different social status and wealth, we can hypothetically claim that children received their first shoes at the age of 3–5. This would also be influenced by the greater physical activity of older children and the rise of their status within the family as well as in the social hierarchy. From the age of 5 upwards, differences in age group results suggest that footwear research better reflects the age structure of children in any living population than the structure of the dead (influenced also by other external factors).

The need for horse rider clothing and shoes for the younger aristocrats is illustrated by an interesting historical fact about how the son of the Grand Duke Kristupas II Radvila, Jonas, received a horse at the age of 5 (Ragauskienė 2013). It appears that it is precisely the children of the aristocracy who can be associated with elegant low boots and unique finds such as children's spurs found during archaeological excavations. Spurs were an attribute of a rider, and were intended not just for handling a horse in an extreme situation, but they were also a symbol of a knight in medieval Europe, often as important as a sword (Hilczerówna 1956: 128–132). Spurs represented knighthood and high social status (Kirpichnikov 1973: 124), and also indicated a degree of experience, as an inexperienced rider could cause great harm to a horse with his spurs. The two miniature spurs found in the Vilnius Castle territory should be considered as indicators of a high social status and/or family wealth. The hoop width of the first spur, dated to the late 14th–early 15th century, is barely 35 mm (Steponavičienė *et al.* 2006: 227), while the second, dated to the 17th century, measures 45 mm (Tautavičius and Urbanavičius 1995: 81). A comparison to the archaeological shoe parameters[7] revealed that the former could have belonged to a child aged 1.5–3, and the latter, to a child of around 5. Such a young age of riders again confirms that it was not the function of the spurs that was most important, but the status they represented.

Returning to the footwear analysis we see that in the fourth interval (10–12), a smaller number of shoes and their fragments was found – 15.83%. The difference is not very big, so we think this can be explained by the narrower cluster as it encompasses only 3 and not 5 years as do the second and third intervals.

Although the focus of our attention in this article is children's footwear and children's burial sites, we would like to draw the readers' attention to another important phenomenon noticed whilst measuring adults' foot and shoe lengths. A comparison of these two parameters has shown that as many as 22% of shoes were larger than the maximum foot length. This can lead to several inter-related assumptions. It could be that the people buried at the Bokšto Street cemetery differed in their height from those who had worn shoes within the castle grounds and that could be related to their quality

[7] Intact low-shoes were measured above the ankle.

of life and social status. The detailed analysis of the skeletons found in Lithuania carried out by the anthropologist R. Jankauskas reveals the great importance the social status had on the average height of adults (Jatautis and Jankauskas 2013). If the average adult heights are markedly different then the question arises whether the calculations made from the burial ground data and the attribution of footwear to the corresponding age groups are correct and accurate. Unfortunately, at present we have no other alternative – there is no other comprehensively examined cemetery in Vilnius that could represent all the age groups of the city's inhabitants in the 13th–15th century. So we remain hopeful that in the future, having collected more data, we will be able to confirm or dismiss the above-mentioned hypotheses.

CONCLUSIONS

In this study, whilst trying to test the hypothesis of how in certain defined conditions footwear research could help scientists get a better insight into the demographical structure of the children in the past and determine their number of children in a given population, we have come up with more questions than answers. First of all, it has become clear that the research had many significant limitations: the size of the sample of the remains from which we could measure foot length in general, the questionable suitability of the stationary population demographic model for medieval Vilnius, the possible inaccurate measurement of the fragmented surviving archaeological artefacts, the reliability of shoe to foot ratio calculations, etc.

Answering the main hypothesis of whether footwear research can give us useful data on the probable relative number and age structure of children living in a certain territory has proved to be difficult not just due to the problems mentioned above, but also because in footwear research results, the demographic processes are intertwined with the socio-cultural aspects. However, the results confirm that this question is worthy of further attention as certain associations between the children's age structure and the distribution of footwear do exist. Basing on footwear research, we established that in the rather closed fortress in the capital of the Grand Duchy of Lithuania, children up to 12 years of age made up around at least 40% of the population. However, it is necessary to take into account the fact that the analysis of the shoes provides very little information about children below 5 years of age, i.e., it underestimates very significantly the expected number of individuals in this age group. It may be very tentatively suggested that around 23.06% and 15.83% of the population were individuals between 5 to 10 and 10 to 12 years of age, respectively.

Our results also helped us formulate another important hypothesis worthy of analysis in future studies. During the research it was determined that using geographically and chronologically close burial ground data and analysing them using suitable methods,

footwear discovered at urban cemeteries may be attributed to certain shoe-wearing age groups. The examined data allow us to state that children in the 13th–early 16th-century Vilnius often received their first pair of shoes at the age of 3–5. In addition, the obvious quantitative leap in shoes attributed to 5–10 year olds is most likely related to the children's position in society. The measurement results also demonstrated that the shoes of children aged over 15 were of the same size or sometimes larger than adults' shoes, which means that they can not be distinguished in the research material.

The preliminary results obtained during the analysis of the available material suggest that it is difficult to obtain reliable demographic information basing solely on footwear research. Paleo-osteological research is more informative in this regard. That is why the hypothesis of whether footwear research could offer useful information on the number and distribution of children in a living population should be postponed to the not-too-distant future. We trust that application of more complex demographic calculation methods giving specific information about individuals over the age of 5 could help clarify the demographic indicators. Thus far, this study has been incapable of thoroughly covering all the complex questions and developing certain guidelines for the future work.

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