

# The mass grave in the Schottenstift – an anthropological approach to an unknown urban burial pit of historic Vienna (Austria)

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(with 8 figures)

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## Abstract

Nowadays, most lost and forgotten cemeteries and burial sites in Vienna are re-discovered by accident during the course of building works. This was the case at the Schottenstift in central Vienna, where in 2002 (during construction work in the courtyard of the monastery) a previously unknown burial site was discovered. The individuals were placed in ten tightly packed layers, suggesting this was a mass grave. At least 388 individuals and a small number of artifacts related to the clothing of the individuals were recovered, but the origin and date of the burial site remained unclear due to the lack of written sources. Thus, in 2017 an interdisciplinary project of the Austrian Archaeological Institute of the Austrian Academy of Sciences, the Natural History Museum of Vienna (Anthropological Department), as well as the Forschungsgesellschaft Wiener Stadtarchäologie, and the Schottenstift Archive began, focusing on the reappraisal of the mass grave. In order to clarify the origin of the burial site, the project combined historical and archaeological research as well as modern bioarchaeological methods. Because the historical and archaeological analyses are still largely pending, this paper presents the results of the anthropological examination of a selected sample of 100 individuals. The analysis revealed that predominantly males and infants were present, all of which show skeletal evidence of poor health and living conditions. The lack of perimortem trauma, indicating an act of warfare or violence, suggests that an epidemic plague is the most reasonable cause for this mass interment. Although there is no direct written source within the Schottenstift Archive, the mass grave may be linked to the Great Plague of Vienna in 1678, confirmed with radiocarbon of skeletal and archaeological remains between 1650 and 1725 AD. Despite the limited sample size, the anthropological research within this project has enabled new insights in the socio-cultural background and the evolution of disease of the Early Modern Period, contributing to the urban development of Vienna, as it is known today.

**Keywords:** palaeopathology, mass grave, epidemics, plague, bioarchaeology.

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## Zusammenfassung

Obwohl die Geschichte der Stadt Wien durch eine Vielzahl historischer Quellen und umfangreicher Forschung belegt ist, kommen vor allem durch Bauprojekte immer wieder archäologische Fundstellen zu Tage, deren Existenz und Hintergründe oftmals in Vergessenheit geraten sind. Ein derartiges Beispiel stellt das Wiener Schottenstift dar. Bereits im Jahr 2002 wurde während Bauarbeiten zur Anlage eines Kollektorgangs im Hofe des Klosters ein Massengrab angeschnitten, dessen Bergung die menschlichen Überreste von mindestens 388 Individuen zum Vorschein brachte. Aufgrund fehlender schriftlicher Quellen, blieben jedoch die Umstände der Massenbestattung weitgehend unbekannt. Diesem Rätsel sollte erst im Jahr 2017 mithilfe moderner naturwissenschaftlich-bioarchäologischer Forschungsmethoden und im Rahmen eines, durch die Stadt Wien geförderten, Projekts in Kooperation zwischen dem Österreichischem Archäologischen Institut (ÖAI), der Forschungsgesellschaft Wiener Stadtarchäologie, der Anthropologischen Abteilung des Naturhistorischen Museums und dem Archiv des Schottenstifts auf den Grund gegangen werden. Die Ergebnisse der anthropologischen Untersuchung der Skelettüberreste ergaben eine hohe Präsenz von Männern und Kleinkindern. Zudem fanden sich an Knochen und Zähnen vermehrt Anzeichen chronischer Mangelernährung sowie allgemein schlechter Umwelt- und Lebensbedingungen. Die unübliche Lage innerhalb der Stadtmauern und direkt auf Klosterareal, sowie die hohe Anzahl der Toten deuten auf ein zeitlich begrenztes Ereignis als Ursache hin. Aufgrund fehlender Gewaltspuren, die auf ein kriegerisches Ereignis deuten würden, erscheinen Seuchen und Epidemien als wahrscheinlichster Grund für eine solche Massenbestattung. Obwohl diesbezüglich keine direkten Schriftquellen im Archiv des Schottenstifts gefunden wurden, liegt unter Anbetracht der Datierung der Funde zwischen 1650 und 1725 n. Chr., die Vermutung nahe, dass es sich um ein Massengrab im Zuge der großen Pest von 1678 handelt. Die Ergebnisse der anthropologischen Untersuchung liefern, trotz eingeschränkter Stichprobengröße, nicht nur wichtige Erkenntnisse über die gesundheitliche Situation der damaligen Wiener Bevölkerung, sondern leisten auch einen Beitrag zur Rekonstruktion der historischen Stadtentwicklung.

**Schlüsselwörter:** Paläopathologie, Massengrab, Seuchen, Pest, Bioarchäologie.

## Introduction

During the Early Modern Period, Vienna held a place of great importance in both the economy and politics of Europe. Its hegemony led to rapid urban development and at the end of the 18<sup>th</sup> century, the city was one of the biggest in Europe (WEIGL 2003) with a population of 250,000 (KUCIREK 2001). However, the increasing population size due to immigration from all parts of the Habsburg Empire led to a decrease of access to resources and living space. Consequently, the majority of the citizens constituted a broad social lower class, facing very poor health and living conditions, resulting in one of the highest mortality rates within Early Modern Period in Europe (WEIGL 2003: pp. 109–131). The Viennese physician Zacharias WERTHEIM (1810) portrayed the unfavorable urban climate of dust and heavy traffic, as well as an insufficient sanitary system and small, poorly-aired flats, which provided the foundation for recurring epidemics and the spread of infectious diseases. Besides outbreaks of cholera, typhus and plague, a large number of deaths at that time were from syphilis and tuberculosis. Further, the high mortality



Fig. 1: An outline of the excavation site 2002 (Photo: E. H. HUBER, FWS).

of infants, reaching 43.6% in 1791 and the increasing poverty, bear witness to the poor living conditions in the city (VOCELKA 2001).

Finally, in 1784, in order to prevent further contamination, and to re-purpose urban space for new living areas, Emperor Joseph II, the oldest son of Maria Theresa, passed a reform, which banned burials within the city wall. As a result, former cemeteries were built over and forgotten to the present day. The mass grave at the Schottenstift represents only one example of numerous re-discovered urban burial sites from the Late Medieval and Early Modern Period. As in the majority of cases, the human skeletal remains were revealed by chance during modern construction works within the monastery.

The Schottenstift (Helferstorferstraße 4) is centrally located in the first district of Vienna and is still functioning as a religious and educational institution. In 2002, construction works in the courtyard of the monastery revealed hundreds of human skeletal remains. Archaeologists from the Forschungsgesellschaft Wiener Stadtarchäologie, directed by Elfriede Hannelore HUBER, conducted the subsequent rescue excavation between August 30<sup>th</sup> and October 30<sup>th</sup> 2002 (see Fig.1).

Limited by truncations by later walls on the northern side, as well as the extent of the construction site in the south, the burial site could only be partially documented within an area of 25 m<sup>2</sup> (10 × 2.5 m); and a maximum depth of 3.5 meters. The topmost layer of the feature was disturbed by architectural structures related to stables of the monastery (HUBER 2003). In the excavated area, a minimum of 380 individuals were buried in ten layers. Most bodies were placed parallel to each other, on their back, and orientated

alternatingly head to feet in a north-south direction. Both the size and the dimension of the burial site suggest a mass grave related to a mass fatality event, such as an epidemic or act of violence as the most likely interpretation. Differences in the positioning and spacing of the bodies, and burial layers may provide further information regarding the nature and sequence of the event (HUBER 2003). Whereas the skeletal remains of the bottom layer seem to be buried less closely together and are covered with a thick layer of soil, the middle layers revealed closely spaced bodies which are only lightly covered, and finally the upper layers again show a less dense distribution of the human skeletons. The absence of wooden remains or coffin nails surrounding the bodies indicates that the dead were buried without coffins. Nails and wooden slats occasionally recovered in the spaces left between bodies were interpreted as boardwalks, used to deposit the dead more efficiently.

Personal adornments as well as religious items made of metal, such as buttons, rosaries and pendants were frequently recovered with the bodies, suggesting that the individuals were buried fully clothed (see Fig. 2). Rows of buttons recovered with seven male adult individuals may be attributed to monks' habits, leading to the preliminary interpretation that at least some of the individuals buried in the mass grave had been members of the Catholic clergy of the Schottenstift (E. H. HUBER, pers. comm. 2019). The excavation also revealed small knives, mostly found in the thoracic region of the bodies. In one case, small iron fragments were recorded with a total length of 30 to 40 cm, reflecting a cutting or thrusting weapon, indicating a higher social status of the individual (HUBER 2003). Common to all individuals was the prayer position of the arms, with the hands folded in the pelvic region.

The exact date and historical background of the mass burial remains unclear because no written sources seem to exist, even within the archive of the Schottenstift. While historical and archaeological documents represent important sources for reconstructing past environments, the bioarchaeological analysis of human skeletal remains contextualized within historical, archaeological, environmental, and social data has taken on greater scientific significance in the last decades (*e. g.*, LARSEN 2015). Human bones and teeth provide a significant amount of information about health and living conditions from early childhood, throughout adulthood until death. Hence, skeletal remains represent the most important and direct link to the past, particularly in the absence of further sources, as in the case the mass grave at the Schottenstift. Therefore, in 2017 a new research project of the Austrian Academy of Sciences, funded through a "Stadt-Wien-Förderung", was started and directed by M. BINDER, then at the Austrian Archaeological Institute of the Austrian Academy of Sciences (ÖAI). The project was accomplished in collaboration with the Anthropological Department of the Natural History Museum Vienna (NHM), the Forschungsgesellschaft Wiener Stadtarchäologie (FWS), and the archive of the Schottenstift. Because a detailed assessment of the archaeological context and further historic research is yet pending, this paper solely presents the results of the anthropological examination of the human skeletal remains focusing on indicators of diseases and injuries, as well as possible causes of death. Furthermore, the analyses of demographic and palaeopathological data are used to reconstruct general health and living conditions in Vienna in the 17<sup>th</sup> and beginning of 18<sup>th</sup> centuries.

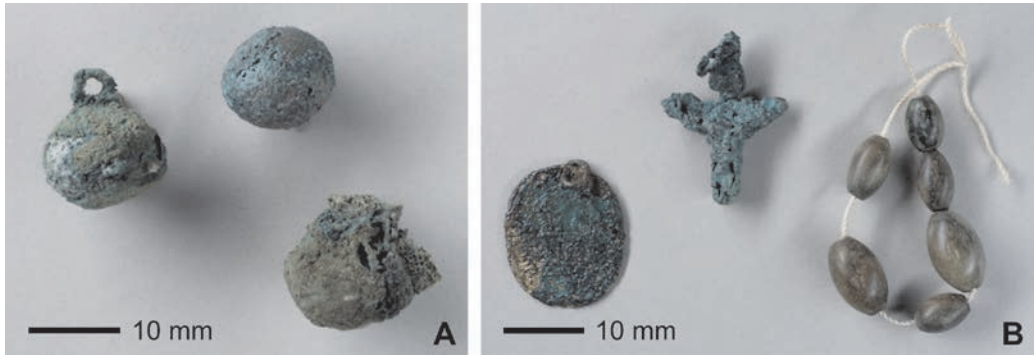


Fig. 2: Common grave goods: buttons (A), rosaries and other pendants (B) (Photo: E. H. HUBER, FWS).

### Material and Methods

All of the skeletal remains recovered during the excavations in 2002 were deposited with the Anthropological Department of the NHM for further examination and inclusion into the osteological collection. The present project focuses on a selected sample of 100 individuals<sup>4</sup>, based on the archaeological documentation and chosen for their good level of preservation, both with and without associated artefacts. Despite great efforts by the archaeologists to excavate and document well, the complexity of the grave, with at least 8 to 10 different layers of bodies, as well as the time pressure, meant that a certain degree of commingling of body parts could not be avoided. In addition, due to taphonomic conditions, the majority of the bones were fragmented and the bone surfaces were, to some extent, in a poor state of preservation.

The anthropological analysis was based on standards adapted from BUIKSTRA & UBELAKER (1994) and comprised the collection of both demographic and palaeopathological data. The examinations were conducted macroscopically; additional measurements were taken with an osteometric board and sliding calipers. During the investigation, each individual was checked systematically for anatomical completeness. The gathered data was stored in a digital database using MS Access and statistically analyzed using MS Access and Statistic Package for Social Scientists (SPSS).

The demographic profile of the sample includes the estimation of sex and age-at-death, as well as the reconstruction of living height if long bones of the lower limbs were preserved intact. The estimation of sex followed the recommendations of FEREMBACH *et al.* (1979), including the evaluation of morphological traits of the cranium and pelvic girdle. Additionally, the robusticity of the long bones of upper and lower limbs were taken into

<sup>4</sup> regarding the financial constraints demanding that only a sample of just over ¼ of the whole excavated collection be analysed

account. For further analyses, the sex categories *probably female* and *probably male* were summarized as *female* and *male* respectively, and if sexing was not possible, the individual was considered *indifferent*. The age-at-death estimation was based on both the evaluation of the cranial suture closure adapted from NEMESKÉRI *et al.* (1960) and the scoring of postcranial structures of the pelvis and clavicle based on methods outlined by BROOKS & SUCHEY (1990), LOVEJOY *et al.* (1985), and SZILVÁSSY (1977). Subadult age-at-death was mainly assessed using dental development following UBELAKER (1978) as well as the postcranial epiphyseal fusion by FEREMBACH *et al.* (1979) and SCHEUER & BLACK (2000). In the absence of both indicators, the estimation was considered from the length of the long bones of upper and lower limbs (FEREMBACH *et al.* 1978). For further statistical analysis, all individuals were placed into one of the following age categories: *Neonatus* (X–3 months), *Infans I* (4 months to 6 years), *Infans II* (7–12 years), *Juvenis* (13–20 years), *young adult* (21–35 years), *middle adult* (36–50 years), *senile* (>50 years), *adult undetermined* (21–X years). For the reconstruction of living height, the formula of TROTTER & GLESER (1958) based on the maximum length of the long bones of the lower limbs was used.

The anthropological analysis further focused on skeletal evidence for either general or specific pathological changes, reflecting living conditions or even a possible cause of death. Therefore, the evaluation of traumatic injury patterns followed the protocol of LOVELL (1997), classifying trauma in three categories: during lifetime (ante-mortem), around the time of death (perimortem) or after death (post-mortem). Further, as the occurrence of active or healed bone lesions indicates underlying infectious diseases and/or non-specific inflammatory processes, corresponding new bone formations (NBF) were recorded based on methods and recommendations by ROBERTS & BUIKSTRA (2003), ORTNER (2003), and WALDRON (2009). Lesions and porosities in the orbital cavity were identified as *Cribra orbitalia*. Since their aetiology remains debated (WALKER *et al.* 2009; WAPLER *et al.* 2004), they were recorded as non-specific markers of physiological stress. As the dentition of an individual strongly reflects dietary pattern and developmental disturbances as well, the examination further included the scoring of dental pathologies, such as dental enamel hypoplasia (DEH), carious and periapical lesions, attrition and ante-mortem tooth loss (AMTL), using the schemata of BROTHWELL (1981), SCHULTZ (1988), LUKACS (1989), and HILLSON (2008).

## Abbreviations

AMTL antemortem tooth loss

DEH dental enamel hypoplasia

FWS Forschungsgesellschaft Wiener Stadtarchäologie

NBF new bone formation

NHMW Natural History Museum, Vienna

ÖAI Austrian Archeological Institute

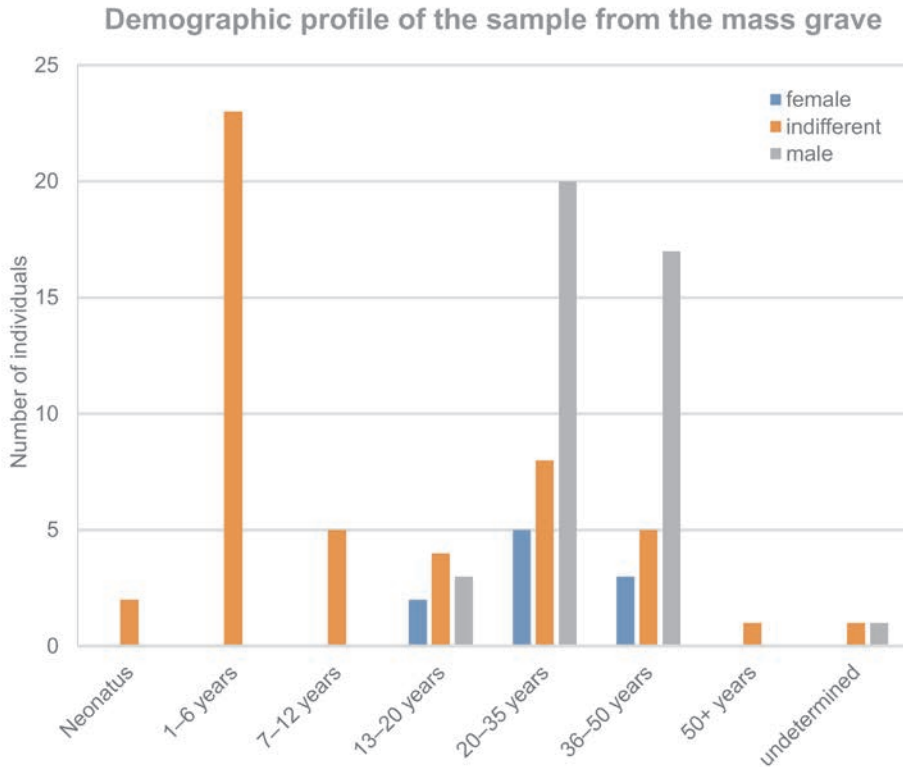


Fig. 3: Demographic profile of the Schottenstift: Sex and age-at-death distribution (Graphic: C. MUSALEK).

## Results

### Anthropological results

#### *Demographic profile of the sample*

The statistical analysis of the sex and age-at-death assessments revealed a predominance of male and subadult individuals within this collection (see Fig. 3). 62% of all adult individuals were classified as male ( $n=41$ ), while only 13% are female ( $n=10$ ) and for 25% ( $n=15$ ) sex could not be determined. According to age-at-death, the majority of adults were assessed as having died between the ages of 20 and 35 years (54%) and respectively 36–50 years (41%). Only one individual, with undetermined sex, was estimated to be older than 50 years-at-death. Further, the reconstruction of the adult living height indicated an average height of 167.7 cm irrespective of sex. Sex-specific analyses revealed a mean of 170.5 cm among male and 160.9 cm among female individuals. Regarding the sample of subadults ( $n=39$ ), the results revealed a majority of 59% with



Fig. 4: Postcranial pathologies in non-adults as possible evidence of rickets (Photo: W. REICHMANN, NHMW).

an estimated age-at-death between 1 and 6 years ( $n=23$ ) as well as adolescents between 13 and 20 years ( $n=9$ ), infants aged between 7 and 12 years ( $n=5$ ) and two neonates. Sex estimation of infants was not considered due to undeveloped sexually dimorphic traits.

### Palaeopathological profile of the sample

Among all observed pathological changes, new bone formation represents the most common group, affecting both cranial and postcranial skeleton. On the skull, these lesions appeared on both the inner and outer lamina, whereas postcranial changes mainly occurred on the long bones of the upper and lower extremities and the visceral surface of the ribs. Children displayed high frequencies of cranial lesions, including a prevalence of *Cribra orbitalia* of 39% of the preserved subadult orbital cavities. On the postcranial bones, new bone formation among children mostly affect the upper and lower extremities, which also show, in two cases, an increased curvature of the diaphysis. Additionally, they displayed flaring sternal ends of the ribs as well (see Fig. 4). With regard to childhood health, the analyses further revealed frequent findings of moderate to severe dental enamel hypoplasia. Of all the teeth preserved, 16% of the non-adults and 60% of the adults, including 24% of the mature individuals, displayed moderate to severe enamel defects, appearing as grooves and pits on the surface of the tooth.

Among the adult individuals, cranial new bone formations predominantly affected the maxillary sinus with a prevalence of 86% of the preserved bones. About 67% of the adult sample further displayed endocranial meningeal lesions, and 54% exhibited scattered porosities on the ectocranial vault. In comparison, *Cribra orbitalia* was observed in 27% of the adult sample. On the postcranial skeleton, 70% of the periosteal reactions





Fig. 5: Marked bone activities as possible indicators of septic arthritis or skeletal tuberculosis (Photo: W. REICHMANN, NHMW).

occurred on the long bones of the lower extremities, especially the tibiae. One male individual displayed marked bone growth activities on the proximal tibia and distal femur, implying an ankylosis of the knee joint, most likely due to septic arthritis or skeletal tuberculosis (see Fig. 5). Moreover, new bone formations affected the ventral surface of about 33 % of all preserved ribs.

The analysis further revealed an age-related difference of bone growth activity (Fig. 6), where pre-adolescent individuals, with an estimated age under 20 years, displayed higher frequencies of active, woven bone formations, in contrast to the corresponding lesions on adult skeletal remains, which mostly occurred as healed, lamellar new bone growth.

About one-third (33 %) of the preserved teeth were affected by carious lesions and 13 % by periapical lesions. Further, about 9 % of the dentition was absent due to ante-mortem tooth loss (see Fig. 7). Whereas periapical lesions occurred quite consistently across age and sex, the analysis also revealed an age-related increase of caries lesions as well as ante-mortem tooth loss, as would be expected. Furthermore, several individuals showed brown staining of the teeth, frequently seen in tobacco consumption. One male individual additionally displayed specific tooth abrasion associated with pipe smoking.

The analysis of trauma revealed evidence of traumatic events in 23 of 100 individuals, out of which 75 % of the 23 recorded fractures were classified as ante-mortem. Healed rib fractures comprised 29 % of all fractures and 26 % of fractures affected the vertebral bodies. In comparison, evidence of perimortem injuries was recorded in only one individual. The skull of a probable female individual displayed a blunt force trauma to the right parietal and a sharp force trauma transversal on the occipital bone (see Fig. 8).

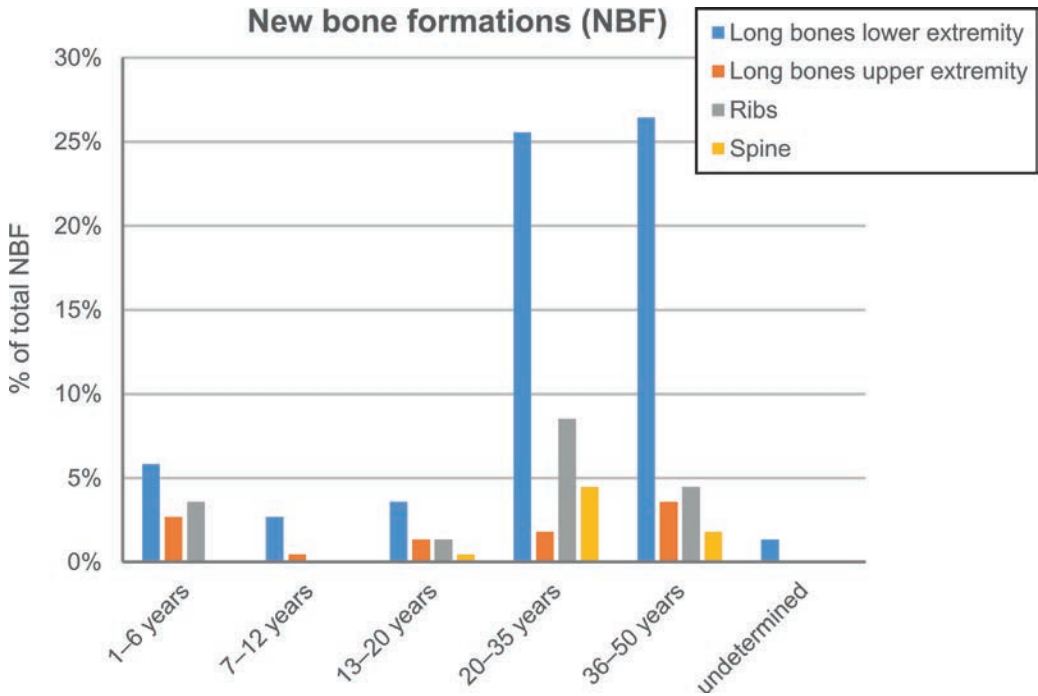


Fig. 6: Distribution of postcranial new bone formation at Schottenstift (Graphic: C. MUSALEK).

### Bioarchaeological results

The burial site could be roughly dated through archaeological, historical and stratigraphic information. As mentioned before, the excavation revealed architectural structures related to horse stables of the monastery built in 1725, which also provide a terminus ante quem for the use of the burial site (HUBER 2003). The archaeological research within this project further revealed that “Benedictus” medals, recovered with several individuals in the sample, only appear in the archaeological record after the middle of the 17<sup>th</sup> century (unpublished manuscript HUBER 2019; FASSBINDER 2002). Concurrently, the macroscopic examination of the skeletal remains revealed evidence of tobacco consumption, also limiting the dating to at least the 16<sup>th</sup> century, related to the discovery and distribution of tobacco plants after the discovery of the New World in 1492. The dating is further supported by two <sup>14</sup>C-dates<sup>5</sup> car-

<sup>5</sup> <sup>14</sup>C-dates of the two samples from Schottenstift. All analyses were carried out at the CEZ Mannheim.

Labornr MAMS	Probenname	<sup>14</sup> C Alter [yrs BP]	±	δ <sup>13</sup> C AMS [‰]	Cal 1-sigma	Cal 2-sigma	Material
35995	Schottenkloster 1/33	229	22	-18.1	cal AD 1651–1795	cal AD 1644–1950	bone
35996	Schottenkloster 203/366	230	23	-19.3	cal AD 1650–1795	cal AD 1643–1950	bone



Fig. 7: Mandible displaying dental diseases such as abrasion of the front teeth, severe caries lesions of premolars and molars and ante mortem tooth loss of the first and second molars (Photo: W. REICHMANN, NHMW).

ried out on bone samples from two individuals, one from the top-most layer and one from the bottom layer. Corresponding to these results, the use of the mass grave can be dated to between the mid-17<sup>th</sup> century and 1725.

## Discussion

The bioarchaeological analysis revealed a number of additional new insights related to the identity of the interred but also to the living conditions in 17<sup>th</sup> century Vienna. The demographic composition of the sample, consisting of mainly male and infants, suggests that this is indeed a specific group and not a typical portion of the urban population. As this may attribute to a monastic setting, the demographic profile still has to be debated as an artefact of the limited sample size within this project. Hence, analyses of the rest of the skeletal remains are suggestive in order to confirm or reject the presented sample of 100 individuals as being representative of the population. According to the palaeopathological profile, analyses indicate a population facing substantial poor living conditions



Fig. 8: Perimortal trauma: The skull of a young adult female shows blunt and sharp force injuries (Photo: W. REICHMANN, NHMW).

causing physiological stress and metabolic disturbances from childhood through to adulthood, which can be seen in the frequencies of healed lesions, such as *Cribra orbitalia* and periostitis, in the adults and the number of active new bone formations in children within this sample. According to the results, no group was apparently afforded special treatment and all individuals faced physiological assaults, resulting in a poor health status. This is also indicated by the frequencies of dental pathologies such as carious lesions (33%), periapical lesions (13%), and ante mortem tooth loss (9%), which are mainly caused by inadequate dental hygiene but also relate to food consumption and dietary composition as well as to a depressed immune system of the individual. These results coincide with previous examinations of urban burial sites in Vienna (BINDER 2008; BINDER & KRAUSE 2010). The notion of poor childhood health further corresponds with the frequent finding of evidence of rickets, a disease resulting from chronic Vitamin D deficiency caused by either insufficient dietary intake or restricted exposure of the skin to sunlight (BRICKLEY & IVES 2010). As Vitamin D is essential for bone growth, chronic shortage during childhood causes deformities of the long bones of both upper and lower limbs and the sternal ends of the ribs (see Fig.4), as well as inflammation and new bone formations. In general, inflammatory processes are the most common form of pathological changes displayed in both children and adults within this sample. As

there are many different reasons for these changes, including chronic infectious diseases, malnutrition such as scurvy or rickets, and trauma (ORTNER 2003; WESTON 2008), identification of the exact cause of the inflammatory response is difficult. Specification of the underlying disease requires additional differential diagnostic markers, which are not often present; consequently, the interpretation of the lesions remains problematic. Thus, almost every individual from the sample displayed new bone formations associated with unspecific inflammatory processes. Among adults, these changes occurred mostly on the postcranial skeleton, particularly affecting the long bones of the lower extremities and the ventral surface of the ribs. According to LARSEN (2015), new bone formations on the diaphysis of tibia and fibula number among the most common pathological changes in human skeletal remains. The observations of new bone formations with this sample are in agreement with data from other contemporary samples from Vienna (BINDER *et al.* 2016; BINDER & KRAUSE 2010; KRAUSE *et al.* 2013) and indicate that, regardless of the individual's background, urban living conditions were detrimental to people's health. New bone formations on the ventral surface of the ribs and in the maxillary sinus in this sample further attest to a relatively high degree of respiratory diseases such as chronic sinusitis and unspecific pulmonary infections. These results are not surprising, considering the various contemporary literature sources, which blame high mortality rates on the miserable environmental conditions in Early Modern Period Vienna (VOCELKA 2001; WEIGL 2003; WERTHEIM 1810). Another cause for the observed examples of new bone formation in the ribs may be tuberculosis, which was endemic in post-medieval Vienna and, due to the high prevalence within the 19<sup>th</sup> century, even called "*morbus Viennensis*", the Viennese disease, at that time (DIETRICH-DAUM 2007). Within the Schottenstift sample, two adult individuals displayed pathologies, suggesting a differential diagnosis of skeletal tuberculosis. These pathological markers included unilateral joint lesions with both marked destructive and proliferative bone growth in the affected area. In one individual, pathological changes occurred in the left elbow joint, while the other adult individual displayed similar, but more severe changes, on the right knee, indicating an ankylosis of the joint. According to ORTNER (2003: pp. 227–263), tuberculosis of the knee joint occurs about as often as, or even more frequently than, an inflammation of the hip; whereas tuberculosis of the elbow is the most frequent joint affected of the upper extremity. Nevertheless, septic arthritis has to be considered as differential diagnosis in both cases, considering the unilateral affliction of the joint and the fact that most manifestations of skeletal tuberculosis may also be attributed to other infectious diseases (ORTNER 2003: pp. 227–263).

To summarize, the pathological changes, occurring in this sample in both adults and children, predominantly cannot be related to specific diagnoses. As mentioned before, the living conditions in 17<sup>th</sup> century Vienna were notoriously bad; in particular, infectious diseases were widespread through insufficient management of waste and sewage and crowded living conditions (WEIGL 2003). Hence, it is not possible to interpret the large number of inflammatory lesions beyond observing that they represent a high degree of negative environmental influences acting upon the individuals buried in the mass grave

at Schottenstift throughout their lives. Alongside the information obtained about the former health and living conditions of the interred, the bioarchaeological analyses have also revealed some important new insights into the nature of the mass grave itself. As mentioned before, the archaeological context and composition of the burial site strongly suggests a mass fatality event within a short time. Based on VOCELKA (2001), act of wars and recurring epidemics frequently affected Vienna during the Early Modern Period. However, the bioarchaeological analysis of the sample revealed an almost complete absence of evidence of perimortem trauma or violence on the skeletal material. Even though violent trauma can also only affect soft tissue and thus would not be detectable in the skeleton, a total absence of skeletal evidence in such a large sample seems unlikely. Consequently, an attribution to warfare can be excluded as an explanation for the mass grave in the Schottenstift. This leaves an epidemic disease as the most plausible explanation for the burial site. Based on the date of the mass grave to between 1600 and 1725, this period includes one of the most dramatic epidemic events in Viennese history, the Great Plague of Vienna, raging between 1678 and 1680 with an estimated death toll from 7,000 to 16,000 victims. Unfortunately, the majority of infectious diseases leading to epidemics in post-medieval Vienna such as plague, dysentery, typhoid or cholera in the 19<sup>th</sup> century do not leave a visible imprint in bone, because either they kill too quickly or the individual recovers without any skeletal involvement (ORTNER 2003). Even so, historical research supports a possible link between the presented burial site and the Great Plague. According to contemporary written sources (*e. g.*, SCHMÖLZER 2015: p. 108), as a sanitary solution and to avoid further contamination, the dead bodies were loaded on carts and driven to the outer edge of the city, where they were put in large pits, very similar to the mass grave of the Schottenstift. In addition, the preliminary archaeological findings within this project also indicate that religious orders, such as the Benedictines of the Schottenstift, administered sacraments and took care of the sick during the great plague epidemics in Vienna (SCHMÖLZER 2015: p. 190). Consequently, this claimed numerous victims among the clergy as well (unpublished manuscript HUBER 2019; SCHMÖLZER 2015), which further may attribute to the specific demographic profile of the sample. Based on the temporary archaeological report, atypical distributions of male and female adults also occurred within the outbreak of plague in London 1605 and 1624 (SIGNOLI *et al.* 1995) as well as in Martigue, Marseille between 1720 and 1722 (BIRABEN 1975), both referring to a gender-determined differentiation of sanitary labour during these periods. Nevertheless, to clarify pending questions about the distinct nature of the burial site in the Schottenstift, further historical and bioarchaeological research is required.

## Conclusion

With burials and cemeteries regularly being discovered through new building works, the results from Schottenstift highlight the importance of an interdisciplinary approach to these projects. While this paper has shown good preliminary results in regards to elucidating details of life, living conditions, and health challenges in the Early Modern

Period in Vienna, further research is still needed. The analysis of the complete skeletal collection from the Schottenstift mass grave would provide a significant contribution to our understanding of life in Vienna during this period. Further to this, biomolecular analyses of the skeletal material may confirm our hypothesis of this as a plague pit burial, and would further clarify the picture of epidemic disease in historic Vienna.

### Acknowledgements

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### Online Supplementary Material

A catalogue (in German language) of the human skeletal remains studied herein is available with the online version, at [http://www.nhm-wien.ac.at/verlag/wissenschaftliche\\_publicationen/annalen\\_serie\\_a/122\\_2020](http://www.nhm-wien.ac.at/verlag/wissenschaftliche_publicationen/annalen_serie_a/122_2020)

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