

Universidad Autónoma de Madrid Departamento de Biología

Doctoral dissertation

"A study of the lifestyle and health parameters of nuns from convents on the Iberian Peninsula in modern times"

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Universidad Autónoma de Madrid

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Tesis doctoral

"Estudio del modo de vida y los parámetros de salud de mujeres en conventos de clausura de la Península Ibérica en época medieval y moderna"

Natasa Sarkic



Director: Dr. Jesús Herrerín López Madrid, 2017



I Abstract

The purpose of this thesis is to gain an understanding of the daily lives of nuns from convents on the Iberian Peninsula in modern time $(16^{th} - 20^{th} \text{ century})$ by examining their skeletal remains. A study of female monastic communities does not mean just "filling the gap", but expending and enriching the knowledge of the most crucial chapter of female history in Christianity. It is important to remember that nuns were the only women who were able to live an independent life and acquire education, which was denied even to the women of the highest class, and that some of the most significant female poets, writers, painters, philosophers, composers... spent their life behind convent walls. Also, it was the only community of women, run by women, where they were free to make their own decision on administration, to take care of documentation, and even more important – finances. For that reason, many historians and theoreticians see in nunneries the origin of feminism.

Therefore, the idea of this study is to investigate not only the basic aspects of physical anthropology (such as osteology, anthropometry, paleodemography), but also the nutrition, the change of their health and diet before and after entering the monastery, traumas, degenerative diseases, dental health, occupational stress, infectious diseases, as well as possible differences in the way of life between monasteries. Obtained results were compared to the secular female population of the same period and the same region, in order to determine in which way their lifestyles difference.

For the purposes of this study, three monastic and three secular populations, from Spain and Portugal, were analysed.



II Resumen 🖾

El objetivo de esta tesis es conocer la vida cotidiana de monjas de conventos de la Península Ibérica en los tiempos modernos (siglos XVI - XX) examinando sus restos esqueléticos. Un estudio de las comunidades monásticas femeninas no supone sólo "llenar la brecha", sino ampliar e enriquecer el conocimiento del capítulo más importante de la historia femenina en el cristianismo. Es importante recordar que las monjas eran las únicas mujeres que podían vivir una vida independiente y adquirir una educación que se negaba incluso a las mujeres de la clase más alta, y que algunas de las poetisas, escritoras, pintoras, filósofas o compositoras más significantivas... pasaron su vida detrás de los muros de un convento. Además, se trata de la única comunidad de mujeres, dirigida por mujeres, en la que eran libres de tomar decisiones sobre la administración, cómo cuidar la documentación y, aún más importante, sobre las finanzas. Por esta razón, muchos historiadores y teóricos ven en los monasterios el origen del feminismo.

Por lo tanto, la idea de este estudio es investigar no solo los aspectos básicos de la antropología física (como la osteología, la antropometría, la paleodemografía), sino también la nutrición, los cambios de la salud y dieta antes y después de entrar en el monasterio, los traumas, la salud dental, el estrés ocupacional y las enfermedades infecciosas, así como las posibles diferencias en el modo de vida entre los diferentes monasterios. Los resultados obtenidos se compararon con la población femenina secular del mismo período y de la misma región, con el fin de determinar de qué modo sus estilos de vida eran diferentes.

Para los propósitos de este estudio se analizaron tres poblaciones monásticas y tres poblaciones seculares desde en España y Portugal.



III Acknowledgment

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V List of abbreviations in the dissertation

Monastic populations:

POB MON 1 - The necropolis of the convent of Santa Catalina de Siena, Belmonte, (Spain) 16th-18th century
POB MON 2 - The necropolis from the choir of the convent of Santa Catalina de Siena, Belmonte, (Spain) 19th-20th century
POB MON 3 - The necropolis of the convent Nossa Senhora de Aracoeli, Alcacer do Sal

(Portugal) 16th-19th

Control populations:

POB CIV 1 - The necropolis from the church of El Salvador in Toledo (Spain), 16th-18th century

POB CIV 2 - The civil necropolis from the church of Santa Catalina de Siena, Belmonte, (Spain), 19th century

POB CIV 3 - The necropolis from the convent São Francisco, Santarém (Portugal), 15th-19th century



We rejoice that we have children, we ought rather to shed tears of blood when those children are girls.

The Abbess of Castro, Stendhal

We are arrant knaves, all. Believe none of us. Go thy ways to a nunnery.

Hamlet, Shakespeare



Illustration by Sanja Blagojević



1. INTRODUCTION

1. 1. Historical introduction

During the late Middle Ages and Early Modern times women made a half (Herlihy, 1985), and later even three-quarters of the total population in Catholic monasteries (Lynch&Adamo, 2014). However, in various general histories of the Church, nuns and nunneries hold not more than a couple of pages¹.

Female monasteries had a very important role in society. Not only were they the centre of spirituality, but also the centre of education, and they often provided shelter and food for beggars, medical care for the sick and home for orphans and the elderly poor. The lifestyle of nuns, their purity, asceticism and erudition represented the ideal manifestation of Christian virtues and contemporaries praised their goodness to the skies, admitting they lived the most sacred form of life that was possible to people.

Nuns lived in communities under vows of poverty, chastity and obedience, dedicating their time to prayer, contemplation, intellectual and physical work. Many of female monasteries produced their own food, wine and olive oil, so in that way they were completely self-sustainable.

Spain was always one of the countries with the highest number of female monasteries. Even nowadays, according to the latest data published in 2003 by Conferencia Episcopal Española², one fourth of the total number of nunneries in the world are located in Spain. Nuns in cloisters, who spend their whole lives hidden behind thick walls, have always aroused curiosity. Up to now many novels, history books and essays were written about the life of nuns in Spain, but by now, only a few studies, have been published focusing on skeletal remains:

¹ See for example Lynch and Adamo (2014) The medieval church: a brief history, where only 5 out of the total of 345 pages were dedicated to female monasticism. ² Retrieved from <u>http://www.conferenciaepiscopal.es/base-documental/</u>



1. 2. Previous studies

1. 2. 1. Spain

- The first study was performed by De la Rúa, dating from 1992, analysing a skeletal collection of nuns from 20th century convents in the Basque country. The focus was on craniofacial factors of Basque skull in general, so there was no any other kind of study performed on the postcranial skeletal remains and unfortunately the skulls were returned to their tombs in convents, and are not available for further work.
- In 2012 Delgado Malagón studied Markers of Occupational Stress (MOS) of 30 individuals from a cloister in Belmonte (16th-18th century) for her master thesis "Patrones de actividad física en la Necrópolis del Antiguo Alcázar del Infante Don Juan Manuel, Belmonte (Cuenca, S.XVI)" defended at University Autonoma de Madrid (Universidad Autónoma de Madrid). After reviewing the study and processed material, it became clear that the methodology applied did not correspond to the one used in this study, and thus those results were not taken into account.
- In 2013 Montes Salas preformed a study of human skeletal remains from the monastery of Santa Maria de Vallsanta (Guimerà), for her master thesis "Artrosi i canvis a les entesis com a marcadors d'estrès ocupacional en la comunitat cistercenca de Santa Maria de Vallsanta" defended at University Autonoma de Barcelona, and later published in the conference proceedings Actes del V Congrés d Arqueologia Medieval i Moderna a Catalunya (Montes & Subirà, 2014). The study was focused on osteoarthrosis (OA) and MOS, but the sample was very small only 17 individuals belonged to the female monastic population.

So, all in all, there were not enough studies of skeletal remains of nuns in Spain, and moreover, there has never been a detailed one published, which would include all aspects



of general health and activities patterns, with a review of historical sources and all the work done to date.

1. 2. 2. Portugal

Unlike Spain, in Portugal several female monasteries have already been studied. Convent Santa Clara-a-Velha in Coimbra (Portugal) represents an example of a very detailed study with a multidisciplinary approach including archaeological and historical data and bioarchaeological, paleopathological, zooarchaeological and DNA analysis. This study has yielded in numerous publications and one master's thesis:

Cunha, E., Cardoso, F. (1997). Oral pathology in a religious community of Coimbra (Portugal) preliminary results. In: La enfermedad en los restos Humanos arqueológicos. Actualizacion Conceptual y metodologica. Macias López; Sánchez (ed.). Universidad de Cadiz: 439-440.

- Cunha, E., Fily, M. L., Clisson, I., Santos, A. L., Silva, A. M., Umbelino, C., Paulo, C., Corte-Real, A., Crubezy, E., & Ludes, B. (2000). Children at the convent: comparing historical data, morphology and DNA extracted from ancient tissues for sex diagnosis at Santa Clara-a-Velha (Coimbra, Portugal). *Journal of Archaeological Science*, 27(10), 949-952.
- Lopes, C., Cardoso, F., & Cunha, E. (2000). Comments on a diet based on oral pathology. The case of the Median Order of the Clarissas in Coimbra (Portugal). In: T. Varela (Ed.) Proceedings Book *Investigaciones en Biodiversidad humana*. *Sociedade Española de Antropologia Biologica* (pp. 276-281). Santiago de Compostela: Universidad de Santiago de Compostela.
- Lopes, C., Cardoso, F., & Cunha, E. (2002). Patologia oral nas Clarissas de Coimbra entre os séculos XIII e XVII. In: V. Oliveira Jorge (Ed.) *Proceedings Book* Contributos das ciências e das tecnologias para a arqueologia da Península *Ibérica. 3º Congresso de Arqueologia Peninsular* (pp. 431-440). Porto: ADECAP



- Leal, C. C., & Ferreira, M. A. (2007). Cuidados de higiene e de saúde em uma comunidade monástica do século XVII: o caso do Mosteiro de Santa Clara-a-Velha de Coimbra. *Portugalia*, (27-28), 89-117.
- Curate F., Lopes C., & Cunha, E. (2010). A 14th-17th century osteoporotic hip fracture from the Santa Clara-a-Velha Convent in Coimbra (Portugal). *International Journal of Osteoarchaeology*, 20: 591–596.
- Moreno-García, M., & Detry, C. (2010). The dietary role of hens, chickens and eggs among a 17th century monastic order: The Clarisse of Santa Clara-a-Velha, Coimbra (Portugal). *Groningen Archaeological Studies*, 12, 45-55.
- Cleia Detry, L. I. G. & Corte-Real, A. (2012). At table with the nuns: the mammals of 17th century Santa-Clara-a-Velha Monastery (Coimbra, Portugal) In: C. Detry & R. Dias First (Eds.) *Proceedings Book First Zooarchaeology Conference in Portugal.* (pp. 117-128) Oxford: Archaeopress
- Lopes, C. (2001). As Clarissas de Coimbra dos séculos XIV a XVII: paleobiologia de uma comunidade religiosa de Santa Clara-a-Velha. Master's thesis. Departamento de Antropologia da Faculdade de Ciências e Tecnologia, Universidade de Coimbra

The skeletal remains from the convent of Nossa Senhora de Aracoeli, in Alcácer do Sal (Portugal), whose female monastic population was analysed and included in this dissertation, had been previously studied by several researchers, including master and bachelor students, but only one short report about brucellosis and oral communication from congress were published:



- Curate, F. (2006). Two possible cases of brucellosis from a Clarist monastery in Alcácer do Sal, southern Portugal. *International Journal of Osteoarchaeology*, 16(5), 453-458.
- Carvalho, C., Cunha, E., & Silva, A. M. (2000). Contribuição para o conhecimento da comunidade religiosa das Clarissas do Convento de Aracoelli (sec. XVII-XIX). In: V. Oliveira Jorge (Ed.) Proceedings Book *Contributos das ciências e das tecnologias para a arqueologia da Península Ibérica*. 3º Congresso de Arqueologia Peninsular. (Vol IX: pp. 441-448) Porto: ADECAP

Master thesis:

In 1996, Marrafa in her master thesis: Vida e norte no convento de Aracoelli (Alcácer do Sal) – sec. XVII a XIX, defended in Instituto de Ciências Sociais, Universidade do Minho, Braga, analysed skeletal remains of 35 individuals. Analyses focused on robustness, stature, dental health and osteoarthrosis.

In 2001, Curate defended his master thesis: Ad memoriam custodiam ossium, Osteobiografia de uma amostra esquelética proveniente do convento de N^a. Sr.^a de Araceli in Faculdade de Ciências e Tecnologia, Universidade de Coimbra. The study was based on skeletal remains from the ossuary.

Bachelor's thesis:

In 2001, Lourenço defended his Bachelor's thesis: O quotidiano numa comunidade religiosa in Faculdade de Ciências e Tecnologia, Universidade de Coimbra. The study was based on skeletal remains from ossuary.

A recent excavation (2015-2016) of the Convento de Jesus, in Setúbal (Portugal), performed by Antunes-Ferreira, is also worth mentioning. It brought to light 13 individuals – the nuns from the convent, but at the moment of writing there were no



analyses performed on those individuals (N. Antunes-Ferreira, personal communication, 10 of January, 2016 and 2 of May, 2017). Another necropolis of this convent was excavated previously, but according to Cardoso (2004) mixed bone remains found were of both sexes and probably belonged to inhabitants of the surrounding area of the city.

After a review of all the previous studies on the Iberian Peninsula it became clear that our knowledge about female monastic population was insufficient. It was mainly based on written sources, such as historical data, monastic books and rules of orders. But history can often be a subject of manipulation and it provides only general facts, monastic books are mostly focused on expenses and rarely talk about everyday life, while the existence of rules does not necessarily mean that everyone followed them.

A study of female monastic communities does not mean just "filling the gap", but expending and enriching the knowledge of the most important chapter of female history in Christianity. It is important to remember that nuns were the only women who were able to live an independent life and acquire education, which was denied even to the women of the highest class, and that some of the most significant female poets, writers, painters, philosophers, composers... spent their life behind convent walls. Also, it was the only community of women, run by women, where they were free to make their own decisions on administration, and to take care of documentation, and even more important - finances. For that reason, many historians and theoreticians (such as Hamburger, 2005; Kostroun, 2011; Nochlin, 2014; Pick, 2014; Segura, 2000; to name a few) see origins of feminism in nunneries.

Therefore, the idea of this study is to investigate not only the basic aspects of physical anthropology (such as osteology, anthropometry, paleodemography), but also the nutrition, the change of their health and diet before and after entering the monastery, traumas, degenerative diseases, dental health, occupational stress, infectious diseases, as well as possible differences in the way of life between monasteries. Obtained results were compared to the secular female population of the same period and the same region, in order to determine in which way their lifestyles difference.

Moreover, two necropolises from Belmonte – one dating from 16th to the late 17th century and the other from the 19th to the early 20th century, offer a unique opportunity to study



the effect of the transition to industrialization on the population which almost entirely preserved their way of life over the centuries.

The work contains information obtained from various sources:

- Historical data, based on chronicles of that period, monastery rules and expenses books, provide a historical frame and give us a general idea of how monastic life looked like.

- Archaeological data provide information about the architecture of monasteries, the presence of artefacts, but also about burial customs and grave goods.

- A basic bioarchaeological analysis provides paleodemographic information on the size of the population, the life expectancy, the presence of children, the presence of male individuals etc. The age estimation of sub-adults tells us an important information about the age of entering a convent. The presence of male individuals can shed a light to customs of these communities.

- Stable isotopes analysis (for δ^{13} C and δ^{15} N), zooarcheological analysis, recipes and metabolic diseases visible on bones provide information on diet, contact with animals and use of their products (both primary and secondary). These data are very useful to confirm if nuns followed the rules on food restriction and fasting.

- Analysis of traumas on skeletal material, as a highly revealing indicator of the lifestyle of an individual or community. It can tell much about tasks that those individuals performed, accidents that might have occurred, interpersonal relations, etc. But even more important - it reveals medical knowledge and skills of a certain community.

- The presence of osteoarthrosis, occupational stress markers and musculoskeletal stress markers are connected to repetitive movements and habitual activity patterns.

- Presence and frequency of infection inform about conditions of life, contact with animals, medical knowledge and hygiene in general.

- Indicators of dental health, such as dental caries, periodontitis, calculus and *antemortem* tooth loss, can provide quantifiable measures of dental hygiene, but it can also indicate changes in diet.



- Dental enamel hypoplasia is a defect in the enamel formation process that indicate the existence of a period of physiological stress experienced by the individual during the formation of the dental crown. This process can last from the prenatal period up to 12 months in deciduous teeth, from the birth to 7 years for permanent teeth (Hillson, 2008), and up 16.5 years for third molars (AlQahtani, Hector & Liversidge, 2010), which makes it a good indicator of non-specific stress in childhood.

- The frequency of congenital deformation and early childhood pathologies – various traumas, rickets, chronical diseases etc. - that affected health, physical appearance or mobility, could maybe influence a possibility of getting married and/or having children, and therefore to present one of the important reasons for sending girls to a monastery.

1. 3. Research questions and justification of the study

In order to get the most of these skeletal collections, an interdisciplinary approach was applied. Collaboration with radiologist Dr. Rosa Dinarès and Dr. Rosa Gaspar, for radiography and CT scanning, were carried out in order to clarify the aetiology and get an expert opinion in the cases of fractures and other diseases noted in individuals, when that was necessary. An isotopic sample from two necropolises was studied by Dr. Aurora Grandal-d'Anglade and Dr. Olalla Lopez-Costas for δ^{13} C and δ^{15} N analysis. The results of analysis enriched our knowledge of the diet of a female monastic community, and helped to detect a possibility of access to different resources of food. An analysis of the presence of mercury in the case of one individual that was suspected to have had syphilis was performed by Dr Goran Žebić.

Questions:

Maybe the most important question about nuns in past is: did they use to freely choose to commit they life to religion?



Of course, this dissertation does not pretend to offer an answer to this question, nor the answer can be a simple and a uniform one, but in this thesis various factors that could have affected that decision will be presented and considered.

The next important question is: how did the lives of nuns and secular women differ?

In order to answer this question, various anthropometric and quantifiable pathological changes have been compared between the monastic and the secular populations, using a computer program SPSS Statistics 20.0.

And there were many more questions, concerning everyday life in a nunnery:

What kind of tasks did they perform? Did they respect the rules of diet, behaviour, manual work? Were there any important changes in their health status before and after entering the monastery? What was their nutrition? Did the diet change with aging of an individual? Did individuals with chronic pathologies differ in the type of food that they could access? Were there any differences between monasteries and monastic orders? How was their hygiene? What diseases did they suffer from? What was the life expectancy? Did they have close contact with animals? Did the kneeling position during prayers leave any trace on bones? Was there any division of work that would leave clear patterns on bones or all the nuns performed similar kind of work? How frequent fractures and other kinds of traumas were? Did the transition to industrialization affect the monastic population?

The sample that was studied for this dissertation differs a lot from a typical picture of the population in the past. Relaying on skeletal evidence, the mortality of children in secular populations in the past was high, presenting around 35% of total sample according to Acsádi and Nemeskéri (1970), Coale and Demeny (1966), Ledermann (1969) and Djurić and colleagues (2010), or even 40-45% according to Buchet (1983) and Souich and colleagues (1995). Demographic data for Italy from 17th till late 19th century show a similar picture, with the frequency of sub-adult mortality between 200 and 300 per 1 000 births, but in epidemic and famine periods those numbers could go up to 450 per 1 000



(Bideau & Brignoli, 1997)³. The sex distribution in the secular population should be approximately equal, although many factors can influence it⁴. In monastic populations that were the object of this study there were no children under 10-12 years and there was only one individual who was determined to be possibly a male. Another important difference between monastic and secular populations is the assumed lack of social class, as all of the nuns were supposed to live under the same life conditions and preformed same or similar physical activities. Also, women from monastic populations did not have children, or at least they were not supposed to have. Maternal mortality was very high in pre-industrial populations (and still is today in developing countries, according to WHO⁵), and the highest peak of mortality in women usually corresponded with their most fertile period (Acsádi & Nemeskéri, 1970; Porčić, 2016). A study of skeletal remains from three different medieval populations in Spain show similar results: the mortality of adult females was the highest at the age of 20-39 years (Maroto, 2004). Pregnancy is a period of physical and emotional stress that can have a significant impact on the wellbeing of an expectant mother (Hueston & Kasik-Miller, 1998) and the effect is even stronger with multi-pregnancy, especially if they happen in a short time span (Weyesa, Tadesse, Eba, Minta & Gudu, 2015). Assuming that most of the nuns entered monasteries before being in a fertile period, and that they did follow the vow of chastity, differences in length of life and general health, compared to secular women, can be expected.

It is also important to keep in mind that the study of an exclusively female population requires special caution. There are several reasons for that: first of all, a female body is under a strong influence of hormones, the status of which is changing during the lifetime. Secondly, in the period of menopause woman experience strong decay of health, the porosity of bone structure and the lack of calcium, so their bones are more fragile and fractures can occur more frequently (Lindsay, 1987; Gambacciani et al., 1997; Gambacciani, Spinetti & Taponeco, 1994; Spector et al., 1995). Females are more often

³ High children mortality rate is presented even nowadays in developing countries. Under-five mortality rate in Angola, from 1980 till 2015, has always between 25% and 29%, according to UNICEF (data retrieved from <u>https://data.unicef.org/topic/child-survival/under-five-mortality/</u>). Even if this fact is very deficient, from the humanistic standpoint, these data can help us to get a more accurate picture of the population in the past, as well as insight to the most common cause of death in children when medical care and antibiotics are denied.

⁴ In human populations frequency of livebirths of male children is slightly higher than female, but the sex ratio can vary greatly between populations for different reasons (e.g., wars, the dangers of pregnancy, gender division of labour, cultural norms related to behaviour), that are affecting this relationship (Porčić, 2016).

⁵ Data retrieved from http://www.who.int/mediacentre/factsheets/fs348/en/



exposed to anaemia, for both cultural and biological reasons: in many cultures due to son preference, a male would be given more meat (hence proteins and iron) and larger portions (Lukacs, 2011; Lukacs 2012), but also due to menstrual periods (Cybulski, 1977; Cook, 2005). Genetic influence on the presence of osteoarthritis is higher in females than in males, probably due to the role that oestrogen receptor genes have in osteoarthritis (Wilson, Michet, Ilstrup, & Melton., 1990; Bergink et al., 2003; Spector & MacGregor, 2004), so it is a less precise indicator of activity. Women tend to have more caries and tooth loss than men due to hormonal, reproductive, social and religious factors (Lukacs, 2011).

<u>1. 4. The populations in the study</u>

For the purposes of this study, three monastic and three secular populations were analysed. For comparative (secular) populations, the criterion applied was that they had to belong approximately to the same time period and they had to be located not more than 150 km in radius from the monastic population they were compared with.

Monastic populations:

- The necropolis of the convent of Santa Catalina de Siena, Belmonte, (Spain) 16th-18th century - POB MON 1
- The necropolis from the choir of the convent of Santa Catalina de Siena, Belmonte, (Spain) 19th-20th century - **POB MON 2**
- The necropolis of the convent of Nossa Senhora de Aracoeli, Alcacer do Sal (Portugal) 16th-19th - POB MON 3

Control populations:

- The necropolis from the church of El Salvador in Toledo (Spain), 16th-18th century
 POB CIV 1
- The civil necropolis from the church of Santa Catalina de Siena, Belmonte, (Spain), 19th century - POB CIV 2



The necropolis from the convent São Francisco, Santarém (Portugal), 15th-19th century - POB CIV 3

In order to avoid repetitions and longer, descriptive names of the populations, and also to avoid possible confusion, as 3 of 6 populations were found in the same monastery (two monastic and one civil population), in the rest of this work the short names will be used: **POB MON 1-3** (from Spanish "población monástica") for monastic populations and **POB CIV 1-3** (from Spanish "población civil") for the control populations.



Figure 1- Map of the populations in study

1. 4. 1. Historical and archaeological background of monastic populations

The convent of Santa Catalina de Siena⁶

During the restoration work on the fortress Infante Don Juan Manuel in Belmonte (Spain) two monastic and one civil necropolis were found. It is well known from historical

⁶ All information about history of the convent, architecture, artefacts, burials and burial goods found within has been taken from an archaeological report written by Caballero & Sánchez (2013)



sources that the old fortress was converted to the Dominican convent of Santa Catalina de Siena in 16^{th} century⁷ and that it was in use until the middle of 20^{th} century.



Figure 2- Convent of Santa Catalina de Siena before the restoration work

Don Juan Manuel founded in La Alberca de Záncara a convent of Dominican nuns in 1335. At the end of 15th century Don Diego López Pacheco, II Marques de Villena, sent a petition to pope Alexander VI to move those Dominican nuns from that convent to the old fortress of Belmonte. It took some more years since that permission was obtained for finishing all the work of adaptation necessary for converting the fortress to Dominican convent, but since the middle of 16th century nuns inhabited the convent and stayed there uninterruptedly until 1960, when the last 3 nuns moved to a convent in Olmedo, leaving the building abandoned.

In total, the convent with the outdoor areas that belonged to it had the surface of more than 7,000 m2. On the ground floor there were a choir, an antechoir, a church, kitchens, a refectory, a nursing station, rooms for wine and olive oil production, a storeroom and warehouses. On the upper floor there were cells for nuns, rooms for work, a library and some other rooms which use is still undetermined. In 18th and 19th century stables were added to the main building.

⁷ The Archive of Dominicans Convent of Olmedo, Libro Becerro. Fols. 5 and 6



Various artefacts were found in the convent:

- coins from the period of the Catholic Monarchs (ruling during 15th and 16th century) to Philip IV of Spain (17th century), together with some Portuguese coins;

- ceramic remains: fragments of handles and bottoms of glass lamps (16th-17th century), fragments of dishes (plates, bowls, jugs, pitchers) of different origin (Talaveran, Levantine, Andalusian, Aragonian ...);

- metal objects: bronze belt buckles, crosses, a medal of Pope Innocent IX (1591), rosaries, silver and bronze pins;

- glass material: both crystal pieces and some pieces of "lapis Specularis"

- stone and derived material: remains of church vases and tondos, as well as ornamental gypsum elements (roof plaster);

- remains of fauna: bones of hens, lambs, pigs, fish and egg shells;

- wood remains: mainly remains of coffins and wooden beams.



Figure 3 – simple tombs from cloister area

The necropolis in cloister – POB MON 1

The burials seem to correspond to the period prior to the important reforms of the convent in 1732. It is not clear when the first burial occurred. The earliest artefact that could help dating was the medal of Pope Innocent IX from 1591. In total, there were 25 simple tombs carved in rock with at least 85 individuals (Fig. 3). All the tombs, except one, were reutilized. In some cases, there were up to 7 individuals in the same tomb. As for burial goods, only parts of clothes (buckles and pins), rosaries and in one case the cross of Caravaca, typical for the



area of Murcia, were found (Fig. 4). Only one individual had jewellery - a small golden earring.

Individuals were buried in the supine position, with hands on their chest and, in some cases, with fingers crossed.



Figure 4 - cross of Caravaca found in tomb 5, POB MON 1



Figure 5 – rosary found in one pf the graves from POB MON 1



The necropolis in chorus - POB MON 2

Even before the excavation started it was clear that the chorus was used for burials of the religious community, as the floor was covered with simple plaques with the year of death, sometimes followed with "R. I. P." inscription. The dates ranged from 1850 to 1921, when the last burial took place. A total of 45 tombs were identified, with 31 individuals, as some of the tombs were empty. There were no important changes in terms of burial customs, between POB MON 1 and 2. In both necropolises the individuals were buried in simple pits and in wooden coffins. In POB MON 2 some of the tombs were quite shallow, while others were more than 5 meters deep.

Like in the case of POB MON 1, those individuals too were buried in the supine position, with hands on their chest or on the abdominal area.

Footwear was still preserved on most of the individuals (simple shoes made of rubber), and in some cases pieces of cloths and shrouds too. Also, all deceased were buried with two rosaries, the first at the height of the hip, possibly tied to a belt, while the second was placed to the height of the chest, sometimes along with crucifixes and medals. Most of the rosaries were made of glass paste. In a few cases, the coffins were still preserved. The coffins were very simple, or rather modest, and even in two cases boxes for candles were used instead of a coffin (the logo was still recognisable at the moment of excavation).





Figure 6 - preserved footwear from POB MON 2



Figure 7 - a coffin made of candle box

Figure 8 - Individual with partially preserved robe



Nossa Senhora de Aracoeli - POB MON 3

The old fortress in Alcácer do Sal was converted into the convent of Nossa Senhora de Aracoelli in Alcacer do Sal, in 1573. The convent belonged to the order of Poor Clares and it was founded by D. Ruy Salema. It was abandoned shortly after the extinction of the religious order in Portugal, which took place in 1832 (Carvalho, 1994).

An archaeological excavation of the convent was conducted in 1994 by the team from the Department of Anthropology, University of Coimbra. The burials were found in various parts of the convent: in the Cloister, the chapter house, the choir and the church, including individual burials and ossuaries. The ossuaries were found with great frequency in the superior levels in all the areas that were excavated, while individual interments prevailed in the inferior stratigraphic levels (Cunha, Santos, Silva & Umbelino, 1994). The sample studied was composed of more than 200 individuals (Curate, 2006) of both monastic and secular population, but separated in different areas of the convent.

Most of the individuals were buried in the supine position, with hands on the chest, at 50 - 80 cm of depth (Marafa, 1996). Various artefacts were found buried with individuals, mostly beads, rings, tiaras and other types of jewellery (Marafa, 1996). In some burials of the cloister, beneath the individuals, vestiges of wood were found, suggesting that the individuals were buried in wooden coffins (Marafa, 1996). This fact is also supported by the various nails that were found in the graves (Cunha et al., 1994).

During the analysis of the remains from the cloister, performed by the author of this dissertation, in the areas reserved for the burial of the nuns, a lot of animal bones mixed with human skeletal remains were found. The bones belonged to sheep/goats (both adult animals and lambs), pigs (adult, female), cows (adult), and even to a carnivore, most likely a dog. On some of the bones chop-marks and cut-marks were visible⁸. An astragal bone of sheep, with a very polished surface, that could suggest frequent use, was found in one of the tombs. Knowing that "knucklebones" was a very popular game⁹, often represented in art, it is possible that nuns also played it in their pastime. Nevertheless, an additional microscopic analysis is required.

⁸ The identification of animal species and cuts on bones, based on photos, was performed by archaeozoologist Dr. Sonja Bogdanović (May 26, personal communication)

⁹ "Knucklebones" is a game of ancient origin, usually played with five small objects, or ten in the case of jacks. Originally the "knucklebones" were astragal of a sheep, which were thrown up and caught in various manners.



1. 4. 2. Historical archaeological background of civil populations The Church of El Salvador in Toledo - POB CIV 1

El Salvador is a church in Toledo, Spain, dating back from 1041 or possibly earlier. Initially, it was a mosque and therefore it is oriented south-east, in the direction of Mecca. It survived the conquest of Toledo by Christian armies in 1085, to be turned into a church in 1159 (Aparicio, 1993). It became one of the richest churches in the city "of noble people, (that) has many houses of nobles and officers" (Kagan, 1994). Visigoths' architectural elements were reused for its construction.

The restoration work carried out in 2008 brought to light a cemetery that occupied a great part of the outdoor patio and the floor of the church. The remains of the burials dated from medieval and modern times, 15th to 18th century, but it should be pointed out that the majority of the tombs from this site originate from 16th - 18th century. Only four individuals belong to 15th century, but those individuals were not included in the study.

The excavation was ordered by the consortium of Toledo, conducted by the company ARTEMON, and led by an archaeologist Sanchez Garcia. The burials were in cists, in the supine position, some of them with a coffin, while others were just placed down in pits. The distance between the tombs was about 50 - 60 cm. The rests from the aisle were badly damaged by fire and due to the moisture produced by a well. The remains located on the west side of the church were also poorly preserved due to moisture, because the level of the street was higher, and water was leaking. The best preserved rests are those from the central nave.

In total 79 individuals, of both sexes, were found.

According to the historical data available to us, this population made their living directly or indirectly from agriculture (Lerma-Lluch, 2011). The majority of the population was vassal population, although the number of artisans in Toledo was quite high.



The civil necropolis from Santa Catalina de Siena – POB CIV 2¹⁰

Human remains were found in the interior of the church, outside the cloister, in simple graves and modest coffins. Those were the burials of the people from the village, who would pay for their tomb in the sacred place. Probably all of them correspond to 19th century. There were individuals of both sexes, as well as children.

Just like monastic population, those individuals were also buried in the supine position, with hands on their chest. Only few burial objects were found, including one very luxury shroud, one pair of shoes, several pins, buttons made of metal, handles and wood pieces from a coffin. One of the female individuals buried in POB CIV 2, Individual 2, had similar kind of shoes and a belt buckle like those found with the nuns from POB MON 2, suggesting her possible relationship with the monastic community.



Figure 9 - shoes and a belt buckle find with Individual 2

The necropolis from the convent São Francisco - POB CIV 3¹¹

The convent of São Francisco was founded in 1242, while the necropolis found inside of the convent date from 15th - 19th century. During the archaeological excavation in 1996, 93 burials with 99 individuals were found. Most of the burials were dug directly into the ground, but there were also tombs that were carved into a rock, and those with a coffin.

¹⁰ Information taken from the archaeological report written by Caballero & Sánchez (2013)

¹¹ All information about the necropolis were taken from the archaeological report written by Gama da Silva (1996)



The position in which individuals were buried was, in most of the cases, the supine with hands on the chest or in the coxal area.

There were no distinctions in burial customs between different kind of tombs. There were also various cases of reutilisations of tombs, as well as plenty of decontextualized bones found in the area of the convent.

Of 99 individuals, 82 were adults of both sexes and 17 were children.

<u>1.5. The social status of the populations in the study</u>

In the moment when a young girl gives her vows of chastity, poverty and obedience she becomes a nun, and therefore "dead to the world". She would remain in an enclosure until the end of her life without any social contacts apart from other nuns. She would spend her life praying, meditating and performing manual labour. Such a blessing for those who yearn to dedicate their lives to God's service! ... and such a terrible punishment for those who do not. Historical texts are full of both: beautiful descriptions that praise monastic life, as well as a melancholic lament. One thing is for sure - such a life was certainly not easy, and the decision to step into a monastery was almost irreversible.

Throughout history, women were rarely allowed to express their will. Their future was decided by a father, a brother or another male relative. And the higher the social status was, the less was the freedom of decision for a girl. For wealthy families, marriage was a very important way to make social connections and alliances. Giving a daughter to a monastery for good, meant losing an opportunity to strengthen the position of the family (Ariès & Duby,1988).

With this in mind, knowing what average marriage dowries were and comparing it with dowries given to a monastery, is of a great importance. If giving a daughter to a monastery was more financially efficient that marrying her to someone, that could have been solution for the poorest. On the other hand, if monastery dowries were higher than the one for marriage, then it could have been a privilege of the richest families.

1.5.1.Spain



Marriage dowry

According to historic sources from 17th and 18th century the quantity of a marriage dowry varies greatly, depending on the wealth of the family, and it could have been paid in money or in trousseau, silver, gold or jewellery (Hernández, 1997). The same source mentions a few examples: Don Pedro López de Arrieta who married Doña Francisca Cabezón has received a house and bequest in the total value of 7,000 ducats; Don Juan Antonio de Larrumbe paid 8,000 ducats for one and 11,000 for another daughter. Some fathers would give different amount of dowries, depending on how rich a future husband was, so there is an example of a rich merchant Eugenio de Yepes, who gave 4,000 ducats to one daughter, 10,000 to another, 80 "tahúllas"¹² to the third and 3,000 ducats to the forth (Irigoyen & Perez, 2002). But those examples can be understood as extreme cases of very rich families. Comparing various cases from 1690-1710 in Murcia only 39 of 194 (20%) paid more than 1,000 reales (91 ducats) (Irigoyen & Perez, 2002). The size of a dowry depended on various factors, as a number of daughters, social position and the professions of parents. In 18th century in Granada, most of the dowries were between 1,000 and 3,000 reales (91-272.72 ducats) (Gómez, 1997), while in Santiago de Compostela average dowries for craftsman were less than 5,000 reales (454.54 ducats), and for merchants and bourgeois the average was less than 6,000 reales (545.45 ducats) (Burgo, 1984).

Religious dowry

Because of its analogy with the dower that a woman brings to her husband when she marries, the name "religious dower" was given to the sum of money or the property that a religious woman, or a nun, brought for her maintenance into the convent¹³.

The size of a dowry differed from a monastery to a monastery, depending on its status and wealth, but in 16^{th} – 18^{th} century, in most of the cases they were no less than 600 ducats (Aniz & Callejo de Paz, 1994), but they could go up to 1,200 (Gómez, 2004) or even

¹² An agricultural area which size is 1118 m2

¹³ retrieved from http://www.catholicity.com/encyclopedia/d/dower,religious.html



1,500 (Torres, 1991). It seems that those amounts did not change in the 19th century, as historical sources are mention amounts between 800 and 872 ducats (Cabañas, López-Yarto & Rincón, 2008).

Information about habitual dowry for the convent of Santa Catalina de Siena in Belmonte could not be obtained, but there is a record in the monastic book of a rich widow that gave a donation of 600 ducats and in return spent her last days in the convent (Caballero & Sanchez, 2013).

After analysing historical data, it is possible to conclude that religious dowry in Spain was way above of what common people could pay, and therefore giving a child to a monastery was probably the privilege of the richest.

1.5.2. Portugal

Marriage dowry

In Portugal, an average marriage dowry in 17th century varied from 800,000 to 300,000 réis (Fialho, 2014), while the highest amount registered was 16,000,000 réis (Fialho, 2013).

Monastic dowry

In the same period (17^{th} century) monastic dowries in the municipality of Evora (the municipality to which the convent of Nossa Senhora de Aracoeli belongs) were between 400,000 for San Bento de Cástris, 400,000 – 499,000 for Santa Catarina and 200,000 – 399,000 réis for the convent de Paraíso (Fialho, 2013).

From the mid-eighteenth century the number of novices in Portuguese monasteries decreased, so in order to survive, there were monasteries that chose to increase dowry (the convent San Bento de Cástris increased their dowry to 600,000), while others tried exactly the opposite tactics: to decrease a dowry and to increase food rations (Fialho, 2013).



As we can see from the above mentioned, in Portugal, at least in the municipality of Evora, a marriage dowry did not differ importantly from the religious one. The monastic book of San Bento de Cástris mentioned professions of parents of those admitted to the cloister, and between them there were daughters of the mayor, nobleman of the Royal House, but also of an organist and even peasants (Fialho, 2013).

<u>1. 6. The presence of children</u>

The presence of children in convents was expected, as many historical sources often mentioned very young children in convents. The Council of Trent, in 16th century decided that the minimum age to enter in religion was 14 years for boys and 12 for girls (Bamji, 2016). For young girls that age was considered to be the limit between childhood and adult age, so since that moment they were forbidden to spend time outside playing (Aries & Dubby, 1988). After entering a monastery, a girl had to spend at least one year as a novice (Bamji, 2016), before giving a vow and becoming a nun, but often it would take much longer, in some cases even up to 7 years (Marín, 2009).

However, it seemed that the rule of the minimum age was often disobeyed in Spain. The monastic book (libro de actas) from 17th century of the monastery in Santa Ana in Malaga mentioned two girls, aged 7 and 8 who were accepted in the monastery (Marín, 2009). Gerturudis de Santa Ines entered the monastery at the age of 7 (Barrado, 1995). In 17th century in the monastery of San Clement el Real in Toledo Isabel Bazan Manrique entered when she was only 7 years old, while Isabela de Ayala y Manrique entered when she was 4 (Bravo, López-Yarto & García, 2008). In notarial protocols from Cordoba, it was written that novices needed to be 12 years old, or if a minor, she would need a dispensation of N. Vicar P. Vicario, "and, if possible, to know to read and write¹⁴".

For Portuguese monasteries the data compiled for the area of Evora shows that the average age was 14.5 years; for the convent of Salvador around 19.7 years, in Santa Catarina 16.3 years, in San Bento de Cástris 12.1 years, and in the convent of Paraíso

¹⁴ AHPCO, 1808, notarial protocols of Cordoba, 11, p. 146



there was data for just one individual that indicates the age of 10 at the time when the contract for the dowry was made.

Later, in 20th century, the limit of the minimum age was changed. According to "Normæ", the rules in use by the Sacred Congregation of Bishops and Regulars for the approbation of religious under simple vows, published on 28 June 1901, no person could have been admitted into a new congregation under the age of 15 without a special permission of the Holy See (De Maeyer, Leplae, & Schmiedl, 2004).

1.7. Monastic rules

"The nuns seek God by observing the norms of the purely contemplative life, by maintaining their withdrawal from the world by enclosure and silence, by working diligently, studying the truth eagerly, searching the Scriptures with ardent heart, praying intently, willingly practicing penance, pursuing communion through their manner of government, in purity of conscience and the joy of sisterly concord, "in freedom of spirit." Innocent IV, 11 May 1252¹⁵.

The Constitution of the Nuns gives very detailed rules about every aspect of the life in a monastery. Here only a couple of them will be presented, mostly those that had a direct impact on physical health.

One of the most important aspects of monastic life is fasting. The second rule of the Order of the Clarisses dedicated a whole chapter to fasting and abstinence in which consumption of meat, eggs and dairy products was restrained to special circumstances (Constituiçoens geraes, 1693).

"Fast and abstinence for the sisters with the exception of the sick and the externals, all sisters must fast from Our Lady's Nativity (8th of December) until Easter, except on Sundays and Christmas Day. The rest of the year they should fast only on Fridays.

¹⁵ "Constitutions of the Nuns of the Order of Preachers" retrieved from <u>http://www.op.org/sites/www.op.org/files/public/documents/fichier/nuns_constitutions_020311.pdf</u>



Further, they must restrain from eating meat, except in the case of sickness. The abbess can dispense the weakest, according to their weaknesses. Eggs, cheese and dairy products can be consumed except from Advent to Christmas, (...), on Fridays and during the fasting ordered by the Holy Church. The abbess can dispense the youngest, sick and oldest sisters from fasting, except during Advent and on Fridays."

The period of fasting for the Dominican order was even longer, from the Exaltation of the Holy Cross (14 September) until Easter, and for the rest of the year on all Fridays that were not Solemnities (Hinnebusch, 1975). The only ones excluded from that rule were the sick, children under 14 and people under leech therapy. Even for the rest of days it was suggested to consume food, especially meat, "with fasting and abstinence, so far as your health permits"

The various paragraphs in the Constitution show that sick and weak nuns had a special treatment.

In chapter one, "Purpose and basis of common life" it is written:

"Food and clothing shall be distributed to each of you by your superior, not equally to all, for all do not enjoy equal health, but rather according to each one's need. For so you read in the Acts of the Apostles that "they had all things in common and distribution was made to each one according to each one's need" (4:32, 35)."

In chapter three, "Moderation and self-denial" it is said:

"When someone is unable to fast, she should still take no food outside mealtime unless she is ill."

The difference in the treatment of the ill could be noted in other paragraphs:

"If those in more delicate health from their former way of life are treated differently in the matter of food, this should not be a source of annoyance to the others or appear unjust in the eyes of those who owe their stronger health to different habits of life. Nor should



the healthier sisters deem them more fortunate for having food which they do not have, but rather consider themselves fortunate for having the good health which the others do not enjoy."

"Once in good health, they must not become slaves to the enjoyment of food which was necessary to sustain them in their illness. For it is better to suffer a little want than to have too much."

In chapter five "The care of community goods and treatment of the sick" there is one paragraph that refers the body hygiene, showing that taking a bath was not very popular (and common) among nuns, and was performed only for medical purposes.

"As for bodily cleanliness too, a sister must never deny herself use of the bath when her health requires it. But this should be done on medical advice, without complaining, so that even though unwilling, she shall do what has to be done for her health when the superior orders it."

Work seemed to be very important for monastic communities, since there is a whole chapter IV about it, and also work is mentioned in the article IV about poverty.

"Since poverty imposes on so many people the necessity of working hard for only a meagre livelihood, the nuns should give an effective corporate witness to the world by working diligently, living frugally and gladly sharing their often modest means with the poor."

"It is the Lord who has said to man that he must eat his bread in the sweat of his brow (Gen. 3:19); and the Apostle adds that the one who refuses to work should not eat (2 Thes. 3:10); and the prophet before him: You shall eat from the toil of your hands and that will be good for you (Ps, 127:3)."

"So with the exception of the hours which the sisters ought to consecrate to prayer, to reading, to the preparation of the Divine Office and chant, or to study, they should devote themselves to some manual labour, as shall be judged good by the prioress."

"Because of the effort it demands, work is one of the more common forms of asceticism. In addition, the perseverance and skill which it requires and the benefits it brings foster mental equilibrium and the formation and development of personality."
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Although the importance and the necessity of work were so much emphasized, it is not specified what kind of work it had to be. On contrary, it was taken in a very broad meaning:

"The term "work" refers to any human activity, manual or intellectual, in which the nuns engage."

"According to the economic situation of the region, a type of work should be chosen which supplies the necessities of life for the monastery as far as possible."

"Since idleness is the enemy of the soul and the mother and nurse of all vices, let no sister in the cloister remain idle, but let each be always occupied, as far as possible, at some work; for she is not easily ensnared by temptation who is intent on some worthy employment."

It appears that it was more important to avoid idleness, by doing whatever would keep one busy, than to contribute economically to the community, although any extra income was appreciated.

According to Rey (2009), Spanish monasteries were more centres of consumption than of production. This claim was established on the basis of her study of monasteries' expense books, as well as on the fact that nuns were of noble status and probably not used to work. In Rey's opinion, most of the work was performed by lay sisters, who were employed in the external service of the convent and belonged to lower social status.

This claim, along with other historical data, will be taken into consideration.



1. INTRODUCCIÓN 🖾

1. 1 Introducción histórica

Durante la segunda mitad de la Edad Media y al comienzo de la Edad Moderna las mujeres representaban la mitad (Herlihy, 1985) y, más tarde, incluso tres cuartas partes de la población total de los monasterios católicos (Lynch & Adamo, 2014)¹⁶. Sin embargo, en varias historias generales de la Iglesia, la información referida a monjas y conventos es especialmente escasa. No obstante, los monasterios femeninos tuvieron un papel muy importante en la sociedad. No solo eran el centro de la espiritualidad en sus comunidades, sino también centro de educación y, a menudo, ofrecían refugio y comida a mendigos, atención médica a los enfermos y hogar para los huérfanos y los ancianos pobres. El estilo de vida de las monjas, su pureza, ascetismo y erudición representaban el ideal de las virtudes cristianas y sus contemporáneos atribuían su bondad a lo celestial, admitiendo que vivían la vida más sagrada posible.

Las monjas vivían en comunidades bajo votos de pobreza, castidad y obediencia, dedicando su tiempo a la oración, la contemplación y al trabajo intelectual y el trabajo físico. Un gran número de monasterios femeninos producía su propia comida, vino y aceite de oliva, siendo en ese sentido completamente autosostenibles.

España siempre ha sido uno de los países con mayor número de monasterios femeninos. Incluso hoy en día, según los últimos datos publicados en 2003 por la Conferencia Episcopal Española, una cuarta parte del número total de monasterios femeninos en el mundo se encuentra en España¹⁷. Las monjas enclaustradas, quienas pasan toda su vida recluidas detrás de gruesas paredes, siempre han despertado curiosidad. Hasta hoy se han escrito muchas novelas, libros de historia y ensayos sobre la vida de las monjas en España, pero se han publicado pocos estudios centrados en restos esqueléticos.

¹⁶ Ver por ejemplo Lynch & Adamo (2014) "The medieval church: a brief history", donde en total solo 5 páginas de 345 se dedicaban a la vida monástica femenina

¹⁷ Información encontrada en: <u>http://www.conferenciaepiscopal.es/base-documental/</u>

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1. 2. Estudios previos

1.2.1 España

- El primer estudio fue realizado por De la Rúa en 1992 y analiza una colección esquelética de monjas de conventos del siglo XX en el País Vasco. El estudio se centra en los elementos craneofaciales del cráneo vasco en general, por lo que no hubo ningún otro tipo de estudio realizado sobre los restos esqueléticos postcraneales. Lamentablemente, los restos fueron devueltos a sus tumbas en los conventos, no estando disponibles para posteriores trabajos.
- En el año 2012, Delgado Malagón estudió los Marcadores de Estrés Ocupacional (MOS) de 30 personas de un claustro en Belmonte (siglos XVI-XVIII) para su trabajo fin de máster "Patrones de actividad física en la Necrópolis del Antiguo Alcázar del Infante Don Juan Manuel, s. XVI)" defendida en la Universidad Autónoma de Madrid. Después de revisar el estudio y el material procesado, se observó que la metodología aplicada no correspondía con la utilizada en este estudio, así que los resultados no se tuvieron en cuenta.
- En 2013 Montes Salas realizó un estudio de los restos óseos humanos del monasterio de Santa María de Vallsanta (Guimerà) para su tesis de maestría "Artrosi i canvis a les entesis com a marcadores de estrés ocupacional en la comunidad cisterciense de Santa María de Vallsanta" defendida en la Universidad Autónoma de Barcelona, y posteriormente publicada en las Actas de la Conferencia Actes del V Congrés d Arqueología Medieval y Moderna a Catalunya (Montes & Subirà, 2014). El estudio se centró en la osteoartrosis (OA) y MOS, pero la muestra era muy pequeña - solo 17 individuos pertenecían a la población monástica femenina.



Por lo tanto, se puede afirmar que no hay suficientes estudios de los restos óseos de monjas en España. Además, nunca se ha publicado un estudio detallado que incluya todos los aspectos de la salud general y modelos de actividades con una revisión de las fuentes históricas y todo el trabajo realizado hasta ahora.

1.2.2. Portugal

A diferencia de España, en Portugal se han estudiado varios monasterios femeninos. El Convento de Santa Clara-a-Velha en Coimbra (Portugal) representa un ejemplo de estudio muy detallado con una propuesta multidisciplinaria que incluye datos arqueológicos e históricos, análisis bioarqueológico, paleopatológico, zooarqueológico y análisis de ADN. Este estudio ha derivado en numerosas publicaciones y una tesis de maestría:

- Cunha, E., Fily, M. L., Clisson, I., Santos, A. L., Silva, A. M., Umbelino, C., Paulo, C., Corte-Real, A., Crubezy, E., & Ludes, B. (2000). Children at the convent: comparing historical data, morphology and DNA extracted from ancient tissues for sex diagnosis at Santa Clara-a-Velha (Coimbra, Portugal). *Journal of Archaeological Science*, 27(10), 949-952.
- Lopes, C., Cardoso, F., & Cunha, E. (2000). Comments on diet based on oral pathology. The case of the Median Order of the Clarissas in Coimbra (Portugal). In: T. Varela (Ed.) Proceedings Book *Investigaciones en Biodiversidad humana*. *Sociedade Española de Antropologia Biologica* (pp. 276-281). Santiago de Compostela: Universidad de Santiago de Compostela.
- Lopes, C., Cardoso, F., & Cunha, E. (2002). Patologia oral nas Clarissas de Coimbra entre os séculos XIII e XVII. In: V. Oliveira Jorge (Ed.) *Proceedings Book* Contributos das ciências e das tecnologias para a arqueologia da Península *Ibérica. 3º Congresso de Arqueologia Peninsular* (pp. 431-440). Porto: ADECAP



- Leal, C. C., & Ferreira, M. A. (2007). Cuidados de higiene e de saúde em uma comunidade monástica do século XVII: o caso do Mosteiro de Santa Clara-a-Velha de Coimbra. *Portugalia*, (27-28), 89-117.
- Curate F., Lopes C., & Cunha, E. (2010). A 14th–17th century osteoporotic hip fracture from the Santa Clara-a-Velha Convent in Coimbra (Portugal). *International Journal of Osteoarchaeology*, 20: 591–596.
- Moreno-García, M., & Detry, C. (2010). The dietary role of hens, chickens and eggs among a 17th-century monastic order: The Clarisse of Santa Clara-a-Velha, Coimbra (Portugal). *Groningen Archaeological Studies*, 12, 45-55.
- Cleia Detry, L. I. G. & Corte-Real, A. (2012). At table with the nuns: the mammals of 17th century Santa-Clara-a-Velha Monastery (Coimbra, Portugal) In: C. Detry & R. Dias First (Eds.) *Proceedings Book First Zooarchaeology Conference in Portugal*. (pp. 117-128) Oxford: Archaeopress
- Lopes, C. (2001). As Clarissas de Coimbra dos séculos XIV a XVII: paleobiologia de uma comunidade religiosa de Santa Clara-a-Velha. Trabajo fin de master. Departamento de Antropologia da Faculdade de Ciências e Tecnologia, Universidade de Coimbra

Los restos óseos del convento de Nossa Senhora de Aracoeli, en Alcácer do Sal (Portugal), cuya población monástica femenina fue analizada e incluida en esta disertación, habían sido estudiados previamente por varios investigadores, incluso estudiantes de maestría y bachillerato, pero solo fueron publicados un informe corto sobre la brucelosis y una comunicación oral del congreso:

Curate, F. (2006). Two possible cases of brucellosis from a Clarist monastery in Alcácer do Sal, southern Portugal. *International Journal of Osteoarchaeology*, *16*(5), 453-458.



Carvalho, C., Cunha, E., & Silva, A. M. (2000). Contribuição para o conhecimento da comunidade religiosa das Clarissas do Convento de Aracoelli (sec.XVII-XIX). In: V. Oliveira Jorge (Ed.) Proceedings Book *Contributos das ciências e das tecnologias para a arqueologia da Península Ibérica. 3º Congresso de Arqueologia Peninsular* (pp. 441-448). Porto: ADECAP

Trabajos fin de máster

En 1996, Marrafa en su tesis de maestría: Vida e norte no convento de Aracoelli (Alcácer do Sal) – sec. XVII a XIX, defended in Instituto de Ciências Sociais, Universidade do Minho, Braga, analizó los restos esqueléticos de 35 individuos. Los análisis se centraron en la robustez, estatura, salud dental y artrosis.

En 2001, Curate defendió su tesis de maestría: Ad memoriam custodiam ossium, Osteobiografia de uma amostra esquelética proveniente do convento de N^a. Sr.^a de Araceli in Faculdade de Ciências e Tecnologia, Universidade de Coimbra. El estudio se basó en restos óseos del osario.

Trabajo fin de grado:

En 2001, Lourenço defendió su tesis de licenciatura: O quotidiano numa comunidade religiosa in Faculdade de Ciências e Tecnologia, Universidade de Coimbra. El estudio se basó en restos óseos del osario.

También hay que mencionar una excavación reciente (2015-2016) del Convento de Jesús, en Setúbal (Portugal), realizada por Antunes-Ferreira. La excavación descubrió 13 individuos, monjas del convento, pero a la terminación de esta tesis no existía aún ningún análisis sobre los restost encontrados (N. Antunes-Ferreira, comunicación personal, 10 de enero de 2016 y 2 de mayo de 2017). La segunda necrópolis de este convento fue excavada previamente, pero, según Cardoso (2004), se encontraron restos óseos mixtos



de ambos sexos que probablemente pertenecían a los habitantes del area circundante a la ciudad.

Después de revisar todos los estudios previos sobre la Península Ibérica, queda claro que nuestro conocimiento sobre la población monástica femenina es insuficiente. Éste se basa principalmente en fuentes escritas, tales como datos históricos, libros monásticos y reglas de órdenes. Pero hay que tener en cuenta que la historia a menudo puede ser manipulada y proporcionar solo datos generales, los libros monásticos se centran principalmente en los gastos y no nos dicen mucho sobre la vida cotidiana, mientras que la existencia de reglas no significa necesariamente que todos las siguieran.

Un estudio de las comunidades monásticas femeninas no significa sólo "llenar la brecha", sino ampliar e enriquecer el conocimiento del capítulo más importante de la historia femenina en cristianismo. Es importante recordar que las monjas eran las únicas mujeres que podían vivir una vida independiente y adquirir la educación que se negaba incluso a las mujeres de la clase más alta, y que algunas de las poetias, escritoras, pintoras, filósofas o compositoras más significantes... pasaron su vida detrás de los muros de conventos. Además, se trata de la única comunidad de mujeres, dirigida por mujeres, en la que eran libres de tomar decisiones sobre la administración, de cómo cuidar la documentación, y aún más importante - sobre las finanzas. Por esta razón, muchos historiadores y teóricos (como Hamburger, 2005; Kostroun, 2011; Nochlin, 2014; Pick, 2014 y Segura, 2000, por nombrar algunos) ven en los monasterios el origen del feminismo.

Por lo tanto, la idea de este estudio es investigar no solo los aspectos básicos de la antropología física (como la osteología, la antropometría, la paleodemografía), sino también la nutrición, los cambios en la salud y la dieta antes y después de entrar en el monasterio, los traumas, salud dental, estrés ocupacional y enfermedades infecciosas, así como las posibles diferencias en el modo de vivir entre monasterios. Los resultados obtenidos se compararon con la población femenina secular del mismo período y de la misma región, con el fin de determinar de qué modo sus estilos de vida eran diferentes.

Además, dos necrópolis de Belmonte - una que data del siglo XVI al fin del siglo XVII y otra del siglo XIX al principio del siglo XX - ofrecen una oportunidad única para estudiar



el efecto de la transición a la industrialización en la población que conserva casi completamente su modo de vivir a través de los siglos.

La tesis contiene información obtenida de varias fuentes:

 Datos históricos, basados en las crónicas de este período, en las reglas del monasterio y en los libros de gastos, que proporcionan un marco histórico y nos dan una idea general de cómo era la vida monástica.

- Datos arqueológicos, que proporcionan información sobre la arquitectura del monasterio, la presencia de artefactos, pero también sobre las costumbres funerarias y los objetos funerarios.

- Un análisis bioarqueológico básico, que proporciona información paleodemográfica sobre el tamaño de la población, la esperanza de la vida, la presencia de niños, la presencia de individuos masculinos, etc. La estimación de la edad de los sub-adultos nos da una información importante sobre la edad en el momento de ingreso a un convento. La presencia de individuos masculinos puede arrojar la luz sobre las costumbres de estas comunidades.

- Los análisis de isótopos estables (δ 13C y δ 15N), análisis zooarqueológicos, recetas de cocina y enfermedades metabólicas visibles en los huesos proporcionan información sobre la dieta, el contacto con los animales y el uso de productos de origen animal (tanto primario como secundario). Estos datos son muy útiles para confirmar si las monjas siguieron las reglas sobre la restricción de alimentos y el ayuno.

- El análisis de los traumas en el material esquelético es un indicador del estilo de vida de un individuo o una comunidad. Nos puede revelar mucho sobre las tareas que esos individuos realizaron, accidentes que pudieron haber ocurrido, relaciones interpersonales, etc. Pero aún más importante - revela las habilidades y conocimientos médicos de dicha comunidad.

- La presencia de osteoartrosis, marcadores de estrés ocupacional y marcadores de estrés musculoesquelético están relacionados con movimientos repetitivos y patrones de actividades habituales.



- La presencia y frecuencia de enfermedades infecciosas informan sobre las condiciones de vida, contacto con los animales, conocimientos médicos e la higiene en general.

- Los indicadores de salud dental, tales como los procesos patológicos como caries, periodontitis, cálculo y pérdida de piezas dentales *antemortem*, pueden proporcionar medidas cuantificables de salud y de higiene dental, pero también pueden indicar los cambios en la dieta, nutrición y salud durante los últimos años de vida

- La hipoplasia del esmalte son defectos en el proceso de formación del esmalte que indican la existencia de un período de estrés fisiológico vivido por el individuo durante la formación de la corona dental, que abarca desde el período prenatal hasta los 12 meses en dientes deciduos y desde el nacimiento hasta los 7 años para dientes permanentes (Hillson, 2008), extendiéndose hasta los 16.5 años para los terceros molares (AlQahtani *et al.*, 2010), lo que la convierte en buen indicador de estrés no especifico en la infancia.

- La frecuencia de deformaciones congénitas y las patologías de la infancia temprana - varios traumas, raquitismo, enfermedades crónicas, etc. - que afectaron a la salud, la apariencia física o la movilidad, podrían influir en la posibilidad de casarse y/o tener hijos y así ser una de las razones importantes para enviar niñas a un monasterio.

1. 3. Preguntas de investigación y justificación del estudio

Se aplicó un enfoque interdisciplinario se aplicó con el fin de aprovechar al máximo estas colecciones esqueléticas. Se ha condato con la colaboración de la radióloga Dra. Rosa Dinarès y la Dra. Rosa Gaspar, para radiografía y tomografía computarizada, con el fin de aclarar la etiología y obtener una opinión de expertos en el caso de las fracturas y otras enfermedades observadas en individuos, cuando fuera necesario. Una muestra isotópica de dos de las necrópolis fue estudiada por la Dra. Aurora Grandal-d'Anglade y la Dra. Olalla López-Costas para el análisis de $\delta 13C$ y $\delta 15N$. Los resultados del análisis enriquecieron nuestro conocimiento sobre la dieta en una comunidad monástica femenina y ayudaron a detectar la posibilidad de acceso a diferentes recursos alimenticos. El análisis de la presencia de mercurio en el caso de un individuo que se sospechaba que tenía sífilis fue realizado por el Dr. Goran Žebić.

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Preguntas:

Quizás la pregunta más importante, cuando se trata de monjas en el pasado, fuera la siguiente: ¿Eligieron libremente dedicar la vida a la religión?

Por supuesto, esta tesis no pretende ofrecer la respuesta a esa pregunta, tampoco la respuesta podría ser simple o uniforme, si bien en esta tesis se presentarán y considerarán varios factores que podrían haber afectado a dicha decisión.

La siguiente cuestión importante es: ¿cómo era de diferente la vida de las monjas y la de mujeres seculares?

Con el fin de responder a esta pregunta, se han comparado varios cambios patológicos antropométricos y cuantificables entre las poblaciones monásticas y seculares, utilizando el programa informático SPSS Statistics 20.0.

También se plantean muchas más cuestiones en relación con la vida cotidiana en un convento:

¿Qué tipo de tareas realizaron? ¿Respetaron las reglas de la dieta, del comportamiento y del trabajo manual? ¿Hubo cambios importantes en su salud antes y después de entrar en el monasterio? ¿Cómo era su nutrición? ¿Cambió la dieta con el envejecimiento de un individuo? ¿Hubo diferencia en el tipo de alimento al que podían acceder los individuos con patologías crónicas? ¿Hubo diferencias entre los monasterios y las órdenes monásticas? ¿Cómo era su higiene? ¿Qué enfermedades sufrían? ¿Cuál era la esperanza de la vida? ¿Tenían contacto cercano con animales? ¿Dejó algún rastro en los huesos la posición arrodillada durante las oraciones? ¿Hubo alguna división del trabajo que dejara patrones claros en los huesos o todas las monjas hicieron un tipo de trabajo similar? ¿Fueron frecuentes las fracturas y otros tipos de traumas? ¿Cómo afectó la industrialización afectó a la población monástica?



La muestra que se estudió para esta disertación difiere mucho de una imagen típica de población en el pasado. egún en evidencias esqueléticas, la mortalidad de niños en las poblaciones seculares en el pasado fue alta, siendo alrededor del 35% de la muestra completa según Acsádi y Nemeskéri (1970), Coale y Demeny (1966), Ledermann (1969) y Djurić y col. (2010), o incluso del 40-45% según Buchet (1983) y Souich y col. (1995). Los datos demográficos de Italia desde el siglo XVII hasta finales del siglo XIX muestran una imagen similar, con una tasa de mortalidad de subadultos entre 200 y 300 por cada 1.000 nacimientos, con excepción de períodos de hambruna y epidemia, cuando la cifra podría alcanzar el 45% (Bideau y Brignoli, 1997)¹⁸.

La distribución por sexo dentro una población secular ha de ser aproximadamente igual, aunque muchos factores pueden influir en ésto (Porčić, 2016). En las poblaciones monásticas, que fueron el objeto de este estudio, no hubo niños menores de 10-12 años y solo hubo un individuo que se determinó como posible masculino. Otra diferencia importante entre las poblaciones monásticas y las seculares es la falta de clase social. Se supone que todas las monjas vivían bajo las mismas condiciones de vida y que realizaban las mismas o similares actividades físicas. Además, las mujeres de las poblaciones monásticas no tenían hijos, o al menos no debían tenerlos. La mortalidad materna era muy alta en las poblaciones preindustriales (y sigue siendo alta hoy en dia en países en desarrollo, según la WHO), y el pico de mortalidad en las mujeres concuerda con su período más fértil (Acsádi&Nemeskéri, 1970; Porčić, 2016). El embarazo es un período de estrés físico y emocional que puede tener un impacto significativo en el bienestar de una mujer embarazada (Hueston & Kasik-Miller, 1998) y el efecto es aún más fuerte con el embarazo múltiple, aún más si ocurren en un plazo de tiempo corto (Weyesa et al., 2015). Suponiendo que la mayoría de las monjas entraron en el monasterio antes de estar en el período fértil y que siguieron el voto de castidad, se pueden esperar diferencias en cuanto a la duración de vida y la salud general en comparación con las mujeres seculares.

¹⁸ Incluso hoy en día existe una alta tasa de mortalidad infantil en los países en desarrollo. La tasa de mortalidad de menores de cinco años en Angola, desde 1980 hasta 2015, se sitúa siempre entre el 25 y el 29%, según UNICEF (información encontrada en <u>https://data.unicef.org/topic/child-survival/under-five-mortality/</u>). Aunque este hecho es muy deficiente, desde el punto de vista humanitario, estos datos pueden ayudarnos a obtener una imagen más precisa de la población en el pasado, así como una visión de la causa más común de muerte en los niños cuando se les niega atención médica y los antibióticos se les niega .



Es importante tener en cuenta que el estudio de una población exclusivamente femenina también requiere una precaución especial. Hay varias razones para eso: en primer lugar, el cuerpo femenino está bajo una fuerte influencia de las hormonas, cuyo estado va cambiando durante la vida. En segundo lugar, en el período de la menopausia, la mujer experimenta decaimiento intneso de la salud, incremento de la porosidad de la estructura ósea y falta de calcio, por lo que sus huesos son más frágiles y las fracturas pueden ocurrir con más frecuencia (Lindsay, 1987; Gambacciani et al., 1997; Gambacciani, Spinetti & Taponeco, 1994; Spector et al., 1995). Las mujeres son más propensas a la anemia, por razones tanto culturales como biológicas: en muchas culturas debido a la preferencia de los hijos, a un varón se le daría más carne (por lo tanto, proteínas y hierro) y porciones más grandes (Lukacs, 2011; Lukacs 2012), pero también debido a los períodos menstruales (Cybulski, 1977; Cook, 2005). La influencia genética en la presencia de artrosis es más alta en individuos femeninos que en masculinos, probablemente debido al papel que juegan los genes receptores de estrógenos tienen en la artrosis (Wilson et al., 1990; Bergink et al., 2003; Spector & MacGregor, 2004), siendo un indicador de la actividad menos preciso. Las mujeres tienden a tener más caries y son más propensas a la pérdida de dientes que los hombres debido a factores hormonales, reproductivos, sociales v religiosos (Lukacs, 2011).

1. 4. Las poblaciones del estudio

Para los propósitos de este estudio se analizaron tres poblaciones monásticas y tres poblaciones seculares. Para las poblaciones comparadas (seculares), el criterio que se aplicó fue que debían pertenecer aproximadamente al mismo período de tiempo y tenían que estar localizadas a no más de 150 km en el radio de la población monástica con la que fueron comparadas.

Poblaciones monásticas:

- La necrópolis del convento de Santa Catalina de Siena, Belmonte, (España) del siglo XVI-XVIII **POB MON 1**
- La necrópolis del coro del convento de Santa Catalina de Siena, Belmonte, (España) del siglo XIX-XX - POB MON 2



La necrópolis del convento Nuestra Señora de Aracoeli, Alcácer do Sal (Portugal) del siglo XVI-XIX - POB MON 3

Población de control:

- La necrópolis de la iglesia de El Salvador en Toledo (España), siglo XVI-XVIII -POB CIV 1
- La necrópolis civil de la iglesia de Santa Catalina de Siena, Belmonte, (España), siglo XIX – POB CIV 2
- La necrópolis del convento São Francisco, Santarém (Portugal), siglo XV-XIX -POB CIV 3

Con el fin de evitar repeticiones y largos nombres descriptivos para las poblaciones, y también para evitar confusiones, ya que 3 de las 6 poblaciones fueron encontradas en el mismo monasterio (dos monásticas y una civil), en el resto de este trabajo serán utilizados los siguientes nombres abreviados:

POB MON 1-3 (del español "población monástica") para las poblaciones monásticas y **POB CIV 1-3** (del español "población civil") para las poblaciones de control.

1. 4. 1. Fondos históricos y arqueológicos de las poblaciones monásticas

El convento de Santa Catalina de Siena

Durante la restauración de la fortaleza Infante Don Juan Manuel en Belmonte (España) se encontraron dos necrópolis monásticas y una necrópolis civil. Se ha podido saber a través de fuentes históricas que la antigua fortaleza se convirtió en el convento dominicano de Santa Catalina de Siena en el siglo XVI y que se utilizó hasta mediados del siglo XX. Don Juan Manuel fundó un convento en La Alberca de Záncara de monjas dominicanas en 1335. A finales del siglo XV Don Diego López Pacheco, II Marqués de Villena, envió una petición al papa Alejandro VI de trasladar las monjas dominicanas de ese convento a la antigua Fortaleza de Belmonte. Después de obtener el permiso, tardaron años en terminar todo el trabajo de adaptación necesario para convertir la fortaleza en el



convento dominicano, pero desde mediados del siglo XVI las monjas habitaron el convento, permanecindo allí ininterrumpidamente hasta 1960, cuando las tres últimas monjas se trasladaron a un convento de Olmedo, abandonando el edificio.

En total, el convento, junto con el área al aire libre que le pertenecía tenía una superficie de más de 7.000 m2. En la planta baja había un coro, un antecoro, una iglesia, cocinas, un refectorio, enfermería, salas de producción de vino y aceite de oliva y los almacenes. En la planta superior había celdas de monjas, habitaciones de trabajar, una biblioteca y varias otras habitaciones de uso indeterminado. En los siglos XVIII y XIX se añadieron caballerizas al edificio principal.

Varios artefactos fueron encontrados en el convento:

monedas de la época de los Reyes Católicos (gobernantes durante los siglos XV y XVI)
a Felipe IV de España (Siglo XVII), junto con algunas monedas portuguesas;

restos de cerámica: fragmentos de asas y fondos de lámparas de vidrio (S.XV-XVII),
fragmentos de platos (platos, tazones, vasas, jarras) de orígenes diferentes (de Talavera,
el Levante, Andalucía, Aragón...);

 - objetos metálicos: hebillas de cinturón de bronce, cruces, medalla del Papa Inocencio IX (1591), rosarios, alfileres de plata y bronce;

- materiales de vidrio: piezas de cristal y varias piezas de "lapis Specularis"

- piedra y materiales derivados: restos de jarrones y tondos de iglesia, elementos decorativos de yeso (yeso de techo);

- restos de fauna: huesos de gallinas, corderos, cerdos, peces y cáscaras de huevo;

- restos de madera: principalmente restos de ataúdes y vigas de madera.

La necrópolis en el claustro – POB MON 1

Los entierros parecen corresponder al período anterior a las reformas significativas del convento de 1732. No está claro cuándo se realizó el primer entierro. El artefacto más antiguo que puede ayudar a datar el enterramiento es la medalla del Papa Inocencio IX de 1591. En total, había 25 tumbas simples con al menos 85 individuos. Todas las tumbas, excepto una, fueron re-utilizadas. En algunos casos había hasta 7 individuos en la misma tumba. En cuanto a objetos funerarios, solo se encontraron partes de ropa (hebillas y



alfileres), rosarios y, en un caso, una cruz de Caravaca, tradicional de la zona de Murcia. Solo un individuo tenía joyas - un pequeño pendiente de oro. Los individuos fueron enterrados en decúbito supino, con las manos en el pecho y en algunos casos, con los dedos cruzados.

La necrópolis en el coro - POB MON 2

Incluso antes de comenzar la excavación estaba claro que el coro fue utilizado para enterramiento de individuos de la comunidad religiosa, ya que el suelo estaba cubierto de placas simples con el año de la muerte, seguido a veces con la inscripción "R. I. P.". Las fechas se encontraban en el intervalo entre 1850 y 1921, cuando tuvo lugar el último enterramiento. Se identificaron un total de 45 tumbas, con 31 individuos (varias tumbas estaban vacías). No hubo cambios importantes en términos de costumbres funerarias, entre POB MON 1 y 2. En ambas necrópolis los individuos fueron enterrados en fosas simples y en ataúdes de madera. En POB MON 2 algunas de las tumbas eran bastante superficiales, mientras que otras eran más profundas de 5 metros.

Como en el caso de POB MON 1, estos individuos también fueron enterrados en decúbito supino, con las manos en el pecho o en el área abdominal.

El calzado todavía se conservaba en la mayoría de los individuos (zapatos simples de goma), y en algunos casos piezas de tela y mortajas. Además, todos los difuntos fueron enterrados con dos rosarios, el primero a la altura de la cadera, posiblemente atado a un cinturón y el segundo colocado a la altura del pecho, a veces junto con crucifijos y medallas. La mayoría de los rosarios eran de pasta de vidrio. En algunos casos, los ataúdes todavía se conservaban. Éstos eran muy simples, o más bien modestos, e incluso en dos casos se utilizaron cajas de velas en lugar de un ataúd (el identificativo era todavía reconocible en el momento de excavación).

Nossa Senhora de Aracoeli - POB MON 3

La antigua fortaleza de Alcácer do Sal se convirtió en el convento de Nossa Senhora de Aracoelli en Alcácer do Sal en 1573. El convento pertenecía a la orden de las Clarisas y fue fundado por D. Ruy Salema. Poco después de la extinción de las órdenes religiosas en Portugal, que tuvo lugar en 1832 (Carvalho, 1994) la fortaleza fue abandonada. La excavación arqueológica del convento fue realizada en 1994 por el equipo del



Departamento de Antropología de la Universidad de Coimbra. Los enterramientos fueron encontrados en varias partes del convento: en el claustro, la sala capitular, el coro y la iglesia, incluyendo enterramientos individuales y osarios. Los osarios se encontraron con mayor frecuencia en los niveles superiores en todas las áreas que fueron excavadas, mientras que las tumbas individuales lo fueron principalmente en los niveles estratigráficos inferiores (Cunha, Santos, Silva & Umbelino, 1994). La muestra estudiada estaba compuesta por más de 200 individuos (Curate, 2006) tanto de la población monástica como de la secular, pero encontrados en diferentes áreas del convento. La mayoría de los individuos fueron enterrados en decúbito supino, con las manos sobre el pecho, a 50-80 cm de profundidad (Marafa, 1996). Se encontraron varios artefactos enterrados junto a los individuos, como rosarios, anillos, tiaras y otros tipos de joyas (Marafa, 1996). En algunos enterramintos del claustro se encontraron rastros de madera bajo los individuos, que sugieren que éstos fueron enterrados en ataúdes de madera (Marafa, 1996). Este hecho también se encuentra respaldado por la aparición de varios clavos encontrados en las tumbas (Cunha *et al.*, 1994).

En el análisis de los restos del claustro, realizados por la autora de esta disertación, en las áreas reservadas para el entierro de las monjas, se encontró una gran cantidad de huesos de animales mezclados con restos esqueléticos humanos. Los huesos pertenecían a ovejas/cabras (animales adultos y corderos), cerdo (adulto, hembra), vacas (adultas), e incluso a un carnívoro, probablemente un perro. En algunos de los huesos se veían marcas de corte. En una de las tumbas se encontró un astrágalo de oveja, con la superficie muy pulida, lo que podría sugerir uso frecuente. Teniendo en cuenta que "knucklebones"¹⁹ era un juego muy popular, a menudo representado en el arte, es posible que las monjas también lo jugaran en su tiempo libre. Sin embargo, se requeriría un análisis microscópico adicional para confirmarlo.

1. 4. 2. Fondos históricos y arqueológicos de las poblaciones civiles

¹⁹ Juego de origen antiguo, usualmente jugado con cinco objetos pequeños. Originalmente los "nudillos" eran el astrágalo de una oveja, que se arrojaban y atrapaban en diversas maneras.



La Iglesia de El Salvador en Toledo - POB CIV 1

El Salvador es una iglesia de Toledo, España, que data del 1041, o posiblemente antes. Inicialmente el edificio fue una mezquita y por eso está orientado al sureste, en la dirección de La Meca. Sobrevivió a la conquista de Toledo por los ejércitos cristianos en 1085, para convertirse en una iglesia en 1159 (Aparicio, 1993). Se convirtió en una de las iglesias más ricas de la ciudad "de gente noble, que tiene muchas casas de nobles y oficiales" (Kagan, 1994). Para su construcción fueron reutilizados elementos arquitectónicos de los visigodos fueron reutilizados para su construcción.

Una restauración realizada en 2008 sacó a la luz un cementerio que ocupaba una gran parte del patio exterior y la planta de la iglesia. Los restos de los enterramientos datan de los tiempos medievales y modernos, del siglo XV al XVIII, pero hay que señalar que la mayoría de las tumbas de este sitio son del período entre los siglos XVI y XVIII. Solo cuatro individuos pertenecen al siglo XV, pero no fueron incluidos en este estudio. La excavación fue ordenada por el consorcio de Toledo, dirigida por la empresa ARTEMON y llevada a cabo por el arqueólogo Sánchez García. Los enterramientos fueron en cista, en decúbito supino, algunos en ataúdes y otros simplemente en fosas. La distancia entre las tumbas era de unos 50-60 cm. Los restos óseos del pasillo estaban gravamente dañados por un fuego y a consequencia de la humedad producida por un hueco. Los restos ubicados en el lado oeste de la iglesia también se encontraban mal preservados debido a la humedad, dado que el nivel de la calle era más alto, y había fugas de agua. Los restos mejor conservados son los de la nave central.

En total, se encontraron 79 individuos de ambos sexos. Según los datos históricos disponibles, esta población se ganaba la vida con la agricultura (Lerma-Lluch, 2011). La mayoría de la población eran vasallos, aunque el número de artesanos en Toledo era bastante alto.

La necrópolis civil de Santa Catalina de Siena – POB CIV 2

Los restos humanos se encontraron en el interior de la iglesia, fuera del claustro, en tumbas simples y ataúdes modestos. Éstas serían tumbas de gentes del pueblo, que



pagarían por un entierro en un lugar sagrado. Probablemente todas pertenecen al siglo XIX. Había individuos de ambos sexos, así como niños.

Como en el caso de la población monástica, estos individuos también fueron enterrados en decubito supino, con las manos sobre el pecho. Pocos objetos funerarios se encontraron, entre ellos una mortaja muy lujosa, un par de zapatos, varios alfileres, botones de metal, asas y piezas de madera de un ataúd.

La necrópolis del convento São Francisco - POB CIV 3

El convento de São Francisco fue fundado en 1242, mientras que la necrópolis encontrada dentro del convento data del período entre los siglos XV y XIX. Durante la excavación arqueológica de 1996, se encontraron 93 tumbas con 99 individuos. La mayoría de las tumbas fueron excavadas directamente en la tierra, pero también había tumbas talladas en piedra y otras con ataúdes. La posición en la que estos individuos fueron enterrados era, en la mayoría de casos, supina con las manos en el pecho o en la zona coxal.

No había distinción en cuanto a costumbres funerarias entre diferentes tipos de tumbas. También había varios casos de reutilización de tumbas, así como muchos huesos descontextualizados encontrados en la zona del convento. De los 99 individuos encontrados, 82 eran adultos de ambos sexos y 17 eran niños.

1. 5. Estatus social de las poblaciones en estudio

En el momento en que una chica joven toma los votos de castidad, pobreza y obediencia, se convierte en monja y, por lo tanto, pasa a estar "muerta para el mundo". Permanecería encerrada hasta el final de su vida, sin ningún contacto social, a excepcíon de otras monjas. Pasaría la vida orando, meditando y realizando obras manuales. Considerado como una bendición para aquellos que suspiran por dedicar su vida al servicio de Dios, y sin embargo un castigo tan terrible para quienes no lo buscaban. Los textos históricos están llenos de ambos casos: bellas descripciones que alaban la vida monástica, así como lamentos melancólicos. Sin embargo, está consensuado que dicha forma de vida no era fácil y que la decisión de entrar en un monasterio era casi irreversible.



Durante este período histórico a las mujeres rara vez se les permitía expresar su voluntad. Su futuro era decidido por el padre, hermano u otro relativo masculino. Cuanto más alto era el estatus social, menor era la libertad de decisión de las niñas de la casa. Para las familias ricas, el matrimonio era una forma muy importante de hacer conexiones y alianzas sociales. Dejar a una hija viviendo en un monasterio toda su vida significaba perder una oportunidad para mejorar la posición social de la familia (Ariès & Duby, 1988).

Teniendo en cuenta esto, es muy importante saber cuáles eran las dotes de matrimonio en promedio y compararlas con las dotes dadas a un monasterio. Si dar a una hija a un monasterio era financieramente más provechoso que casarla con alguien, eso podría haber sido una solución para las familias más pobres. Pero si las dotes del monasterio eran más altas que las del matrimonio, entonces podría haberse considerado como un privilegio de las familias más ricas.

1.5.1.España

Dote de matrimonio

Según las fuentes históricas de los siglos XVII y XVIII, la cantá de la dote matrimonial varía mucho, en funcíon del estatus social de la familia, y podía ser pagada en dinero o en ajuar, plata, oro o joyas (Hernández, 1997). La misma fuente menciona varios ejemplos: Don Pedro López de Arrieta se casó con Doña Francisca Cabezón ha recibiendo una casa y un legado por un valor total de 7 000 ducados; Don Juan Antonio de Larrumbe pagó 8 000 ducados por una hija y 11 000 por otra. Algunos padres darían diferentes cantidades de dotes, dependiendo de lo rico que fuese el futuro esposo, como por ejemplo fue el caso del rico comerciante Eugenio de Yepes, que dio 4 000 ducados a una hija, 10 000 a otra, 80 tahúllas a la tercera y 3 000 ducados a la cuarta (Irigoyen & Pérez, 2002).

Hay que tener en cuenta que esos ejemplos pueden considerarse casos extremos de familias muy ricas. Comparando varios casos de 1690-1710 en Murcia, solo 39 de 194 (20%) pagaron más de 1000 reales (91 ducados) (Irigoyen y Pérez, 2002). La cantiá de una dote dependía de varios factores, como el número de hijas, la posición social y la



profesion de los padres. En el siglo XVIII, en Granada, la mayoría de las dotes eran de entre 1000 y 3000 reales (Gómez, 1997), mientras que en Santiago de Compostela las dotes medias para artesanos eran inferiores a 5000 reales (454.54 ducados), y para los comerciantes y los burgueses el promedio era menos de 6000 reales (545.45 ducados) (Burgo, 1984).

Dotes religiosas

Debido a su analogía con la dote que una mujer entrega a su marido cuando se casa, se le dio el nombre de "dote religiosa" a la suma de dinero o de la propiedad que una mujer religiosa o una monja entregaba para mantenerse en el convento.

La cantía de la dote difería de un monasterio a otro, dependiendo del estatus y riqueza de dicho monasterio. Enn los siglos XVI - XVIII, en la mayoría de los casos las dotes no eran inferiores a 600 ducados (Aniz & Callejo de Paz, 1994), pero podían ascender hasta 1200 (Gómez, 2004) e incluso 1500 ducados (Torres, 1991). Parece que las cuantías no cambiaron en el siglo XIX, ya que las fuentes históricas mencionan cantidades de 800 y 872 ducados (Cabañas, López-Yarto & Rincón, 2008).

No se pudo obtener información sobre la dote habitual del convento de Santa Catalina de Siena en Belmonte, pero en el libro monástico se encuentra una nota que menciona a una viuda rica que donó 600 ducados y a cambio pasó sus últimos días en el convento (Caballero & Sánchez, 2013).

Después de analizar los datos históricos, es posible concluir que la dote religiosa en España era mucho más alta de lo que la gente ordinaria podía pagar y, por lo tanto, dar una hija a un monasterio probablemente era un privilegio de los más ricos.

1. 5. 2. Portugal

Dote de matrimonio



En Portugal, la dote matrimonial media en el siglo XVII varió de 800 000 a 300 000 réis (Fialho, 2014), mientras que la mayor cantidad registrada es de 16 000 000 réis (Fialho, 2013).

Dote monástica

En el mismo período (siglo XVII) las dotes monásticas en el municipio de Évora (el municipio al que pertenece el convento de Nossa Senhora de Aracoeli) eran entre 400 000 para San Bento de Cástris, 400 000 - 499 000 para Santa Catarina y 200 000 - 399 000 réis para el convento de Paraíso (Fialho, 2013).

A partir de mediados del siglo XVIII el número de novicios en los monasterios portugueses disminuyó asi, que para sobrevivir, algunos monasterios optaron por aumentar los ingresos (el convento San Bento de Cástris aumentó su dote a 600 000), mientras que otros intentaron exactamente lo contrario: disminuir la dote y aumentar las raciones de alimentos (Fialho, 2013).

Como se puede ver, en Portugal, o al menos en el municipio de Évora, la dote matrimonial no difería mucho de la religiosa. El libro monástico de San Bento de Cástris menciona las profesiones de los padres de los admitidos en el claustro y entre ellos había hijas del alcalde, de un noble de la Casa Real, pero también de un organista e incluso de campesinos (Fialho, 2013).

1. 6. Presencia de niños

Se esperaba presencia de niños en los conventos, ya que muchas fuentes históricas mencionan niños muy pequeños en los conventos. El Concilio de Trento decidió, en el siglo XVI que la edad mínima para entrar en la religión era de 14 años para los niños y de 12 para las niñas (Bamji, 2016). Para éstas, esa edad se consideraba el límite entre la infancia y la edad adulta y desde ese momento se les prohibía pasar tiempo fuera y jugar (Aries & Dubby, 1988). Después de entrar al monasterio, una niña tenía que pasar al menos un año como novicia (Bamji, 2016) antes de tomar sus votos y convertirse en



monja, pero a menudo eso llevaba mucho más tiempo, en algunos casos incluso hasta 7 años (Marín, 2009).

Sin embargo, parece que la regla de la edad mínima era a menudo ignorada en España. El libro monástico (libro de actas) del siglo XVII del monasterio de Santa Ana en Málaga menciona a dos chicas de 7 y 8 años que fueron aceptadas en el monasterio (Marín, 2009). Gerturudis de Santa Ines entró en el monasterio a la edad de 7 años (Barrado, 1995). En el siglo XVII en el monasterio de San Clemente el Real en Toledo Isabel Bazán Manrique entró cuando tenía solo 7 años, mientras que Isabela de Ayala y Manrique entró cuando tenía 4 años (Bravo, López-Yarto & García, 2008). En los protocolos notariales de Córdoba, está escrito que los novicios debían tener 12 años o, si eran de menor edad, necesitarían una dispensación de N. Vicario P. Vicario, "y, si es posible, saber leer y escribir".

Para los monasterios portugueses, los datos recogidos para la zona de Évora muestran que la edad media era de 14,5 años. Para el convento de Salvador alrededor de 19,7 años, en Santa Catarina 16,3 años, en San Bento de Cástris 12,1 años, y en el convento de Paraíso solo había datos de un individuo que citan la edad de 10 años cuando se hizo el contrato de dote.

Más tarde, en el siglo XX, el límite de edad mínima fue cambiado. Según "Normæ", las reglas en uso por la Sagrada Congregación de Obispos y Regulares para la aprobación de los religiosos bajo votos simples, publicada el 28 de junio de 1901, ninguna persona menor de 15 años podría haber sido admitida en una congregación sin un permiso especial de la Santa Sede (De Maeyer, Leplae & Schmiedl, 2004).

1. 7. Reglas monásticas

"Las monjas buscan a Dios observando las normas de la vida puramente contemplativa, manteniendo su retiro del mundo por el recinto y el silencio, trabajando con diligencia, estudiando la verdad con entusiasmo, examinando las Escrituras con corazón ardiente, orando intensamente, practicando voluntariamente la penitencia, persiguiendo la comunión a través de su modo de comportamiento, en la pureza de la conciencia y la



alegría de la concordia fraterna, en la libertad de espíritu." Inocencio IV, 11 de mayo de 1252.

La Constitución de las monjas contiene reglas muy detalladas sobre cada aspecto de la vida en un monasterio. Aquí solo se presentarán algunas de ellas, principalmente aquellas que tuvieron un impacto directo en la salud física de las monjas.

En este sentido uno de los aspectos más importantes de la vida monástica es el ayuno. La segunda regla de la Orden de las Clarisas dedicó un capítulo entero al ayuno y la abstinencia en el que el consumo de carne, huevos y productos lácteos se restringía a circunstancias especiales (Constituiçoens geraes, 1693).

"Ayuno y abstinencia para las hermanas con la excepción de las enfermas y los externos, todas las hermanas deben ayunar desde el Nacimiento de Nuestra Señora (8 de diciembre) hasta Pascua, menos los domingos y el día de Navidad. El resto del año debían ayunar solo los viernes. Además, deben evitar comer carne, excepto en el caso de enfermedad. La abadesa puede dispensar a los más débiles, de acuerdo con sus debilidades. Huevos, queso y productos lácteos pueden ser consumidos excepto de Adviento a Navidad, (...), los viernes y durante el ayuno ordenado por la Santa Iglesia. La abadesa puede dispensar el ayuno a las hermanas más jóvenes, enfermas y ancianas, excepto durante el Adviento y los viernes."

El período de ayuno para la orden dominicana fue aún más largo, desde la Exaltación de la Santa Cruz (14 de septiembre) hasta la Pascua, y el resto del año todos los viernes que no fueran Solemnidades (Hinnebusch, 1975). Los únicos excluidos de la regla eran los enfermos, los niños menores de 14 años y las personas bajo una terapia con sanguijuelas. Incluso para el resto de los días se sugirá consumir los alimentos, especialmente la carne, "con ayuno y abstinencia, hasta que la salud lo permita".

Varios párrafos de la Constitución muestran que las monjas enfermas y débiles tenían un tratamiento especial. En el capítulo uno "Propósito y base de la vida común" se especifica:

"La comida y la ropa serán distribuidas a cada una de ustedes por su superior, no por igual a todos, porque todos no gozan de salud igual, sino más bien de acuerdo a la necesidad de cada uno. Por eso, leemos en los Hechos de los Apóstoles que "tenía todas las cosas



en común y se hacía distribución a cada uno conforme a necesidades de cada persona." (4:32, 35)

El capítulo tres, "Moderación y abnegación":

"Cuando alguien no puede ayunar, no debe tomar ningún alimento fuera de la hora de comida a menos que esté enferma."

La diferencia en el tratamiento del enfermo se puede observar también en otros párrafos: "Si los que se encuentran en una salud más delicada como consecuencia de su antiguo modo de vida son tratados de manera diferente en alimentos, esto no debe ser una fuente de molestia para los demás o parecer injusto a los ojos de aquellos que deben su salud más fuerte a diferentes maneras de vida. Tampoco las hermanas más saludables las consideran más afortunadas por tener alimentos que no tienen, sino que se consideran afortunadas de tener la buena salud que los demás no disfrutan".

"Una vez en buen estado de salud, no deben convertirse en esclavos del disfrute de los alimentos que eran necesario para sostenerlas en su enfermedad. Porque es mejor sufrir un poco que tener demasiado."

En el capítulo cinco "El cuidado de los bienes de la comunidad y el tratamiento de los enfermos" hay un párrafo que se refiere a la higiene corporal, mostrando que bañarse no era muy popular entre las monjas y se realizaba solo por razones médicas:

"En cuanto a la limpieza corporal, una hermana nunca debe negarse a sí misma el uso del baño cuando su salud lo requiere. Pero esto debe hacerse por consejo médico, sin quejarse, por lo que, aunque no esté dispuesta, hará lo que tiene que hacer por su salud cuando el superior lo ordene."

El trabajo parece que era muy importante para las comunidades monásticas, ya que hay un capítulo entero (IV) al respecto y también se menciona el trabajo en el artículo IV, que trata sobre la pobreza:

"Debido a que la pobreza impone a tantas personas la necesidad de trabajar duro para un sustento modesto, las monjas deben dar un testimonio corporativo efectivo al mundo



trabajando diligentemente, viviendo frugalmente y gustosamente compartiendo sus medios modestos con los pobres."

"Es el Señor quien ha dicho al hombre que debe comer su pan en el sudor de su frente (Génesis 3:19); Y el apóstol añade que el que se niega a trabajar no debe comer (2 Tesalonicenses 3:10); Y el profeta delante de él: Comeréis del trabajo de vuestras manos y eso os será bueno "(Salmo 127: 3)."

"Por lo tanto, con la excepción de las horas que las hermanas deben consagrar a la oración, la lectura, a la preparación del Oficio Divino y al canto o el estudio, deben dedicarse a algún trabajo manual, que les da la superiora."

"Debido al esfuerzo que exige, el trabajo es una de las formas más comunes de ascetismo. Además, la perseverancia y la habilidad que requiere y los beneficios que trae fomentan el equilibrio mental, la formación y el desarrollo de personalidad".

Aunque la importancia y la necesidad de trabajar fueron enfatizadas, no se especifica qué tipo de trabajo tenía que ser. Por el contrario, se toma en un sentido muy amplio:

"El término "trabajo" se refiere a cualquier actividad humana, manual o intelectual, en la que participan las monjas".

"De acuerdo con la situación económica de la región, se debe escoger un tipo de trabajo lo más adecuado posible a las necesidades de vida del monasterio".

"Puesto que la ociosidad es el enemigo del alma, la madre y enfermera de todos los vicios, que ninguna hermana en el claustro permanezca ociosa, sino que cada una esté siempre ocupada, en la medida de lo posible, en alguna obra; porque no es fácilmente atrapada por la tentación, la que está empeñada en algún empleo digno".

Parece que era más importante evitar la ociosidad que contribuir económicamente a la comunidad, haciendo lo que se quisiera para mantenerse ocupado, aunque también se apreciaba cualquier ingreso extra.



2. MATERIAL AND METHODS

2. 1. The sample – problems and obstacles

For the purpose of this thesis, skeletal remains of individuals from three monastic populations and three control populations, from the Iberian Peninsula, were used. The condition for the selection of the control populations was to be geographically and chronologically close to the monastic ones.

Other conditions that were applied are that all the individuals selected from both secular and monastic populations were females, over 25 years old and with the Index of Preservation of at least 50%. The reason the age limit was set to 25 years is because by that age growth should have stopped (Kuczmarski et al., 2002; Yai, 1997) (Fig. 10²⁰), the third molar should have fully erupted (Smith, 1991; AlQahtani, 2009; Ubelaker, 1999 and Hillson, 2002) and, for the females, all epiphysis fused (Mays, 2010; Campillo & Subira, 2004) (ANEX I). So only from that age the individual can be considered a fully-grown adult.



Figure 10 - growth charts for girls with presentation of staturefor-age

²⁰ The cahrt retrived from National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000): <u>http://www.cdc.gov/growthcharts</u>



As soon as the search for adequate secular populations started, it turned out that it was not as simple as it had seemed at first. Necropolises from female cloisters are places were during several centuries only, or at least mostly, nuns were buried. For that reason, there is a huge accumulation of skeletal material that belongs to individuals of the female sex. In secular populations number of sub-adults usually make approximately 20-40% of the total number²¹, while the rest of population, should be approximately equally divided between men and women (for more details see the Introduction). This means that even if all individuals would be preserved well enough to determinate their sex (which rarely occurs in historic populations), in normal demographic distribution woman would make only 30-40% of the total number of the deceased. However, that number will be even smaller after applying the criterion of minimum age (≥ 25 years). Maternal mortality in preindustrial societies was high, especially in young girls, and according to the study of WHO²² in Africa and Asia, and Conde-Agudelo, Belizán & Lammers (2005) in Latin America, pregnancy and childbirth is one of a leading cause of death among women from 10-24 years in developing countries. Poor preservation of skeletal remains and reutilisation of tombs can present another problem for determination of the sex and study of individuals.

A good example of all above-mentioned obstacles is necropolis from Prádena del Rincón (Madrid), that has been taken into consideration as one of possible "candidates" for the control population. The reason for it was that this material was already at the Autonomous University of Madrid, so there was no need to require special permission for a study or for transport of the material, and the sample itself was very big. However, it turned out that of 245 individuals 78 were sub-adults (31,8%), at least 49 adult individuals were buried in the ossuary and the remains were all mixed up and very fragmented, so only for 20 individuals it was possible to estimate their sex as female (Muñoz, Herrerín, Cano & Sarkic, in press). Of that number, after applying the criterion of the preservation (IP \geq 50%) and of the age (\geq 25 years), only 4 individuals were suitable for the analysis. Finally, the necropolis of Prádena was discarded due to a very small number of individuals, but it

²¹ Although, due to bone fragility in sub-adults, chances of skeletal preservation is smaller.

²² Retrieved from: <u>http://www.who.int/mediacentre/factsheets/fs334/en/</u>



became clear that it would be hard to find a necropolis with a large sample of female individuals.

Moreover, the second monastic population (POB MON 2) dates from 19th-20th century, and even archaeologists admitted that they doubted whether they should do the excavation of that necropolis at all, and only after "weighed the pros and cons we proceeded to the excavation" (Caballero & Sánchez, 2013, p. 43). Finding secular female population of the same chronology and obtaining a permission to work with it would have been very hard, considering that direct descendants of those individuals could possible still be alive, so it would interfere with many ethical issues. For that reason, the study of the secular population was limited to bone remains found in the church of the same monastery, although the sample was rather small.

Thus, the original idea of comparing the nuns with "ordinary" women encountered obstacles in the form of material preservation, but there were also difficulties in understanding the term "ordinary". In an ideal case, this would be women from nearby villages and towns, from various classes, and therefore of different occupations, health and nutrition status, and living conditions in general, whose diversity would represent a contrast to monastic homogeneity. But as all of the individuals were buried in churches in a very simple way it was not possible to say, relying on burial goods, if there were any important differences in the status between them. Also, as we know that, at least in the case of Santa Catalina, it was obligatory to pay to be buried inside the monastery (Caballero & Sánchez, 2013), probably there were no members of the lowest social class among the buried individuals.

2. 2. First steps in analysis

Osteological material from POB MON 1 and POB CIV 1 was located at the Autonomous University of Madrid. The material was already washed by previous researchers and packed in cardboard boxes, marked by the number of the tomb in which it had been found. The material from POB MON 3 and POB CIV 3 was located at the University of Coimbra and it was already cleaned as well. The remains of POB MON 2 and POB CIV 2 were kept in what once was the convent (today it is a hotel "El Palacio Del Infante Don Juan



Manuel Hotel Spa"). After transporting the remains to the Laboratory for the Physical Anthropology Autonomous University of Madrid they were cleaned and analysed.

2. 2. 1. Cleaning and reconstruction of the material

The osteological material was washed with lukewarm water and a soft brush. After drying the reconstruction of broken fragments was carried out with a transparent, non-aggressive and easily removable glue "Imedio banda azul".

2. 2. 2 Inventory of the material

After cleaning the remains from POB MON 2 and POB CIV 2, an inventory and anthropological sheets for each individual were made.

As already mentioned, POB MON 3 and POB CIV 1 and 3 were previously studied by master and bachelor students from Autonomous University of Madrid and University of Coimbra. In the case of POB CIV 1, only general information regarding age and sex of the total population were available (López, 2011) without having the access to anthropological sheets for each individual made by previous researchers, so it was necessary to re-study the whole population and make the inventory. For the population from Portugal, an inventory and anthropological sheets for each individual were previously made by Cunha and colleagues (1994) and Gama da Silva (1996).

The presence of bone remains of each individual was marked in a sheet (ANNEX II, III and IV) with a schematic representation of human skeleton in anatomical position. In the same sheets, the presence of pathology or taphonomical changes were marked. The presence of teeth was written down in the corresponding form - odontogram, (ANNEX V) in which, apart from the presence or *antemortem* and *postmortem* loss, pathological changes on the teeth and alveoli (caries, abscesses, dental hypoplasia and periodontitis) were marked. The presence of osteoarthrosis was marked in special sheets for each epiphysis of all long bones, vertebras, temporomandibular joint, acetabular, scapula, patella, occipital condyles, wrist and ankle (ANNEX VI). For the entheseal changes "Standardised data collection form for enthesis robusticity and enthesopathies" sheet (Mariotti et al., 2007) was used (ANNEX VII).



2. 2. 3. Calculation of the minimum number of individuals (MNI)

In POB MON 1 many tombs were reutilized several times, and in some cases the skeletal material was impossible to individualize. A method based on counting the presence of the most abundant element was used in order to estimate the number of individuals, giving the minimum number of individuals which must have contributed to an assemblage (Mays, 1998).

2. 2. 4. Preservation Index

The preservation Index (PI) was used for the calculation of the degree of skeletal preservation, proposed by Walker, Johnson and Lambert (1988) and modified by Safont, Alesan and Malgosa (1999). It considers the preservation of different bone-groups (humerus, ulna, radius, femur, tibia, fibula, scapulas, clavicles, pelvis, sacrum, mandible, splanchnocranium and neurocranium) by using the equation PI = bones preserved/bones considered x 100.

2.3 Sex estimation

For the sex estimation the most important morphological characteristics of the coxal and the skull were used.

Females tend to have a wider pubic bone, whereas in males it tends to be narrower - generally less than 90 degrees and more V-shaped (Mays, 1998). Sciatic notch is wider and more U-shaped in females (Heger, 1996). Other characteristics of the female coxal are the presence of the ventral arc, the sub-pubic concavity and the medial border of the inferior pubic ramus, which generally shows a ridge in female individuals, and is blunter in males (Phenice, 1969).

For the estimation of sex based on the subpubic region (including the ventral arc, the subpubic concavity and the ischiopubic ramus ridge) the methods of Phenice (1969) and Buikstra and Meilke (1985) were used. For sex estimation based on the form of the great sciatic notch the methods of Milner (1992), Bruzek (2002) and Walker (2005) were used.



Determination of sex based on parts of the skull follows the observation that males tend to be larger and more robust than females (White, Black & Folkens, 2012). For the estimation based on cranial and mandibular morphology one should be focused on: the nuchal crest, that is either completely absent or hardly notable in females and expressed in males, the form and the size of the mastoid process that are smaller and more round in females and bigger in males, the supraorbital ridges and the glabellar region that are more prominent in men, expression of mental eminence in the mandible which is more expressed in males, and in general male mandibles are characterized by squarer chins, more gonial eversion and more rugose muscle attachments.

The methods of Acsadi and Nemeskeri (1970) and Buikstra and Ubelaker (1994), based on the features of the nuchal crest, the mastoid process, the supraorbital ridges, the glabellar region and the mental eminence in the mandible were used for sex estimation of the skull.

Sexing individuals based on characteristics of the pelvis is very reliable, and most of researchers agree that accuracy is between 95-96% (Mays, 1998; Sutherland & Suchey, 1991; Phenice, 1969). An estimation based on the skull alone is a bit less correct and Mays (1998) reports 92% of accuracy. Combining estimations for the skull and the pelvis gives exactness of 97%, according to Meindl and colleagues (1985).

In this work, the combination of the coxal and the skull sex estimation was used whenever the preservation allowed for it so as to obtain the highest possible accuracy.

2.4. Age estimation

2. 4. 1. Estimation of age in sub-adults

Methods based on epiphyseal fusion, tooth eruption and bone length were used for the age estimation of sub-adults.

Dental development is less affected by environmental and physiological conditions, such as nutrition and hormone imbalance, because it is under a strict genetic control (Konigsbers & Holman, 1999). It is a common agreement in the scientific community that the estimation of age, based on tooth development, approaches more closely to



chronological age than the estimation based on bone fusion (Garn, Lewis & Polacheck 1959; Lewis & Garn, 1960; Garn, Lewis & Kerewsky, 1965; Cardoso, 2007; White et al., 2012). For aging of sub-adult individuals based on tooth eruption methods of Smith (1991), AlQahtani (2009), Ubelaker (1999) and Hillson (2002) were used.

Each bone in the body has a predictable age range when the fusion of epiphysis occurs. This fact was considered to be of a great importance in forensic and legal studies and for that reason it has been studied by many researchers, like Scheuer and Black (2000), Saunders, DeVito, Herring, Southern and Hoppa (1993), Steele and Bramblett (1988), Bass (1995), to name a few. However, these ages vary by an individual, sex, and population (White et al., 2012). The intensity of epiphyseal activity is greatest between the ages of 15 and 23 (Stevenson, 1924). The beginning of epiphyseal union for several elements overlaps the tooth eruption, making these aging techniques complementary (White et al., 2012). In this study, a compilation of methods for the timing of fusion of the epiphysis, published by Scheuer and Black (2000), was used, and whenever it was possible the estimation obtained based on the fusion of the epiphysis was combined with the estimation based on tooth eruption.

The method of age estimation from long bone length is not considered to be as precise as the previous two (White et al., 2012), but the discrepancy between age estimated according to bone length and age estimation according to tooth eruption can be an indicator of a severe disease and metabolic stress (Demirjian, 1986). The bone length was compared with data compiled by Scheuer and Black (2000).

2. 4. 2. Estimating of age in adults

Over the course of a lifetime, elements of the skeleton undergo various changes. Once when growth is finished, a degenerative process starts. But unlike growing processes, which are determined by hormones and only in rare cases (such as severe malnutrition or diseases) can be stopped or delayed, aging depends on lifestyle, nutrition, social class, genetic predisposition, climate, physical activity, sex, general health of an individual... and it can also differ among populations (Demirjian, 1986; Saunders et al., 1993). All the methods for age estimation, except the fusion of cranial sutures, are the consequence of a



kind of wearing out and remodelling of bone tissue due to mechanical function of the skeleton, and for that reason they are not a consequence of time passing *per se*, but rather of accumulation of behaviour and physiological experiences of that individual (Porčić, 2016, p. 123).

For age estimation of adults, methods based on tooth-wear, changes on the pubic symphyseal surface and the auricular surface of the ilium were used in this study. All the methods were combined, whenever possible, to get the most exact estimation. If teeth and the coxal were not preserved, all epiphysis closed and the third molar fully - erupted, an individual would be assessed as an "adult", without an attempt to estimate the age more precisely. Although there are other methods for age estimation, such as obliteration of cranial sutures, changes on the first and the forth rib ends and ossification of the thyroid, all of them have a sort of disadvantage that will be discussed later in this chapter, which made them unsuitable for application.

The method of age estimation depending on the degree of tooth wear is based on the fact that once when a permanent tooth erupts, it begins to wear, and the older a person is, the more worn out a tooth will be, until the moment when only a root is left or a tooth falls out. However, the patterns of wear are governed by tooth developmental sequences, tooth morphology, tooth size, internal crown structure, tooth angulation, non-dietary tooth use, the biomechanics of chewing, and a diet (McKee & Molnar, 1988; Walker, Dean & Shapiro, 1991). This method should be avoided if both the mandible and the maxilla are not well preserved, because observing only one or a few teeth, without looking at the complete picture, can easily lead to false estimation. In this study the methods of Brothwell (1981) and Lovejoy, Meindl, Mensforth and Barton (1985) were used.

Age estimation based on changes on the pubic symphyseal surface which continue after full adult stature has been achieved and other epiphyses of the limbs fused. In a young adult the horizontal ridges of human pubic symphysis are well-marked and have wavy morphology, but in aged individuals the surface shows depression as rim erodes. For this study, the method of Suchey–Brooks and colleagues (1990) was used.

Estimation based on the auricular surface of the ilium proved to be a reliable indicator of age in older individuals, regardless of sex or ancestry (White et al., 2012). In young



individuals the surface is billowing and with very fine granularity, but it loses relief with age and becomes erosive and porous. For this study Lovejoy, Meindl, Pryzbeck and Mensforth (1985) method was used.

Estimation based on the obliteration of cranial sutures in adult individuals was not taken into consideration due to low accuracy. The method made by Masset (1989) suggests time frame $\pm 14,76$ years in males and $\pm 15,5$ in females. The method of Olivier (1960) is also offering a too broad time frame which we cannot really find helpful for the age estimation²³. There is a similar situation for the method of Mann, Jantz, Bass and Willey (1991), based on the obliteration of palatine sutures, where the author suggests to add the range of error ± 10 years on the time frame that is already very broad²⁴.

Estimating adult age from the rib end can be based on 4th (Işcan, Loth & Wright, 1984) and 1st rib (Kunos, Simpson, Russell & Hershkovitz, 1999). The problem with 4th rib method is that it depends on both the preservation and positive identification of 4th rib, a situation that is difficult and/or uncertain in many archaeological contexts (White et al., 2012). Unless all ribs of an individual are present, or 4th rib was marked on the excavation, it is very hard to distinguish it from other ribs. On the other hand, 1st rib is morphologically very different from the rest of ribs. It is also thicker, and therefore more likely to be preserved. But the evaluation made by DiGangi, Bethard, Kimmerle and Konigsberg, (2009) on a male population of a known age (victims of war in former Yugoslavia), show that accuracy of this method is rather low.

The method based on the ossification of thyroid (Vlcek, 1980) relies on the assumption that complete ossification of thyroid in male individuals means that an individual is over 60 years old. But the problem with the application of this method in an archaeological context is that this mass is very fragile, and thus, rarely preserved. Another problem is that for female individuals the thyroid never ossifies completely (Jurik, 1984). Also, ossification can occur due to metabolic disorders or malignancy (Golghate et al., 2014)

The method for age estimation by tooth cementum annulation is a relatively new, microscopic method for the determination of an individual's age, based on counting the

²³ For example, according to that method coronal suture can be obliterated between 25 and 70 years.

²⁴ Complete obliteration of IN, PM and TP sutures, according to this author, happens between the age of 30 and 50 years.



incremental lines seen in tooth-root cementum. Up to now, it gave very precise results, with an error that did not exceed 2.5 years, according to Wittwer-Backofen, Gampe and Vaupel (2004). Other researchers published less encouraging, but still quite acceptable results, where the mean error was 6.46 years, "and in some cases exceeded 10 years" (Jankauskas, Barakauskas & Bojarun, 2001). What is really good about this method is that it does not depend at all on the reference collection, as it is based directly on the physiology of the formation of dental cement (Porčić, 2016). However, this method has not yet fully taken root as a part of standard practice because the preliminary validation studies were made on the clinical material (Wittwer-Backofen et al., 2004), which means that teeth are not tested on the influence of taphonomic processes. Also, it is still not clear if pathologies can affect the number of these lines (Radović, 2012), because preliminary results indicate that, although the deposition of dental cement is under genetic control, environmental factors can lead to duplication of lines during one year (Wittwer-Backofen & Buba, 2002). Another downside of this methods is that it is still expensive, as its application requires a specifically equipped laboratory and particularly specialized personnel. Besides, it is a destructive method and, thus, not suitable for prehistoric or other extremely valuable skeletal material. The analysis of the material based on cementum annulation was planned for this study, but unfortunately, due to the lack of funding, it was postponed.

In this work, after performing age estimation, the results of analyses for each individual were entered in the computer program Herrerín's Project® designed as a helping tool for physical anthropologists. According to this program age groups were divided into: 0 (*fetus*, neonatal – till 1-year-old), 1 (1-2 years), 2 (2-6 years), 3 (7-13 years), 4 (14-18 years), 5 (19-25 years), 6 (25-39 years, 7 (40-59 years) and 8 (+60 years). The group 9 was reserved for adults, without the possibility for precise age determination.

2.5. Anthropometry

Measurements have been an important part of skeletal biology since the earliest osteological analyses of Blumenbach in 18th century (Buikstra & Ubelaker, 1994). Cranial



and postcranial measurements have typically been used to describe individuals and to compare groups. Population variation in skeletal morphology is the result of genetic and environmental differences among groups. Since heritability studies have demonstrated that genes influence the cranial and dental form and structure (i.e., morphology), it is generally assumed that groups with similar craniofacial morphology are more closely related than groups that display greater differences in cranial form (Pietrusewsky, 2000). Although the skull has been the focus of most quantitative studies, postcranial measurements represent another important source of information. Genes influence postcranial dimensions, as do age, sex, behaviour and nutrition. Dimensions of long bones proved to be useful information in the estimation of stature, age, sex and activity patterns (Buikstra & Ubelaker, 1994).

Although for the purpose of this thesis various cranial and post-cranial measurements were added in the computer program Herrerín's Project®, for calculating cranial capacity, cranial and postcranial indices, stature and robusticity etc. after rethinking it was decided that only measurement for stature should be included. The reason for that decision lies in the fact that a monastic population is not the kind of community based on blood kinship, and thus, their genetic proximity in this case was not considered to be an important factor.

Sex determination based on metric studies of the postcranial skeleton (examination of sexual dimorphism based on the size of different adult elements) was not included in this thesis. Although some authors succeed in achieving remarkable results testing their methods on skeletons of known sex (for example Rios (2005) reports 95,5% accuracy for the diameter of the humeral head; Safont, Malgosa and Subirá (2000) reported 95,3% measuring the minimum radius circumference; Trancho, López-Bueis, Sánchez and Robledo (1996) claimed 99,06% of accuracy for width of femoral distal epiphysis), attempts to repeat testing by other researchers would usually give much lower scores of around 80-90% accuracy (White, 2012).

2.5.1. Stature


The physical growth is considered to be a very sensitive indicator of the quality of the social, economic, and political environment (Fogel, 1986; Komlos, 1994; Schell, 1986; Tanner, 1981). The reason that anthropometry serves as an index of environmental quality is that the development of the human phenotype is highly plastic, and it can respond to changes in the environment, particularly when these are stressful (Bogin & Loucky, 1997). A study performed by Bogin and Loucky (1997) on Maya children, growing up in the United States and in Guatemala, shows that the average height can increase up to 5.5 cm in better life conditions.

There are two basic principles for calculating height from skeletal remains: the mathematical method, that relies on the proportionality between the height and the length of long bones, and the anatomical method, based on measurements of the whole skeleton, with adding of the difference of the soft tissue (Dwight, 1894; Fully & Pineau, 1960; Lundy, 1985). It is clear that the second method is not suitable for archaeological context, where preservation of the entire skeleton, without fractures and fragmentation of bones, is extremely rare. Therefore, only mathematical methods will be described.

The estimation of height in a reliable way is calculated from the measures of long bones by applying a special formula known as 'regression equations' (Brothwell, 1981, p. 100). For the estimation of the stature all the measurements of the long bones were taken in millimetres, with the accuracy of 0.5 mm, except for the measurements taken with the osteometric plate, in which the accuracy was 1 mm. The values were added in the computer program Herrerín's Project® that calculates stature using formulas of Pearson (1899), Olivier, Aaron, Fully and Tissier (1978) and Mendonça (2000) and Trotter and Gleser (1958). The method of Trotter and Gleser (1958) is based on the populations from the north and central America, applying different methods of calculation for different "races". For that reason, although very popular, this method is not very suitable for Spanish and Portuguese populations (Reverte-Coma, 1991; Villanueva-Cañadas & Castilla-Gonzalo, 1991). For the purpose of this thesis, methods of Pearson (1899), Olivier and colleagues (1978) and Mendonça (2000) were used, as they are based on European populations and hence more suitable for the populations in the study (Mendonça, 2000). It is necessary to know the sex of an individual before calculation the



stature, as different kind of formulas are applied to male and female individuals. Formulas applied for calculation of stature are presented in Annex (ANNEX VIII).

The obtained results for stature were divided into height categories proposed by Martin and Saller (1957) (ANNEX VIII).

2. 6. Non-metric skeletal traits

Non-metric, discontinuous, or discrete, traits are minor morphological variants that are often used to determine genetic affiliation between past populations (biodistance). Much of this variations are heavily affected by age, sex, environmental factors (especially habitual physical activities), whereas others have a genetic cause (Veldman, 2013). This kind of traits may indicate a genetic homogeneity of a population, or indicate a migration process and the presence of new members in the community (Hauser & DeStefano, 1989).

In this study, non-metric treats were not analysed, for the same reason as cranial and postcranial measurements, that aimed to establish a genetic distance between the populations, were not included. Monastic population is not the kind of community based on blood kinship, and thus, their genetic proximity was not considered to be an important factor.

2.7. Markers of occupational stress

Research about markers of occupational stress in physical anthropology is an attempt to reconstruct activities, habits, and patterns of work and wear from certain features of the human skeleton (Meyer, Nicklisch, Held, Fritsch, & Alt, 2011). Currently, several different methods have been applied in studies of historic activity patterns, such as analysis of the development of musculoskeletal markers and enthesis, cross-sectional bone geometry, osteometry, patterns of degenerative joint disease and several very diverse phenomena such as stress lesions or various forms of activity-related dental wear (Meyer et al., 2011). The basic premise behind any all of those methods was expressed in Wolff's law, stating that a bone in a healthy person or animal will adapt to the loads under



which it is placed, and if loading on a particular bone increases, the bone will remodel itself over time to become stronger to resist that sort of loading (Ruff, Holt, & Trinkaus, 2006). Applying Wolff's law on skeletal remains of the past populations means that, at least in theory, it is possible to guess a type and intensity of physical activity that an individual performed, relying on changes expressed on muscle insertion on a bone.

2.7.1. Entheseal changes (EC)

In physical anthropology, entheseal changes (formerly also called musculoskeletal stress markers and, in clinical literature, enthesopathies, enthesiopathies, and enthesophytes, Villotte & Knüsel, 2013) are assumed to reflect the activity of the attaching musculature (Dutour, 1992; Hawkey & Merbs, 1995; Robb, 1998). However, the study of EC encounters numerous methodological difficulties (Dutour, 1992). Osseous changes at entheses are influenced by various factors such as age, hormones and body size (Jurmain & Roberts, 2008). Also, one can perform different tasks during lifetime and the skeleton registers activities performed at different periods throughout an individual's lifespan (Robb, 1998). Some authors have also warned against oversimplification of the relationship between osseous changes at entheses and activity (Villotte et al., 2010) which in some cases almost mean using the sign of equality between a certain activity and a certain pronounced muscular marker. As noted by Lane (1887) and Meyer and colleagues (2011), the problem is that many research attempting to assess the problem from the current perspective of industrial, modern society, where most of the heavy labour is performed by machines, forgetting that in the past, heavy physical work represented an inseparable part of daily life. Meyer and colleagues (2011) also warn of the common errors that occur in comparative studies of activities, such as explaining the difference between muscle expression in men and women by sex-specific activities, or comparing populations that are geographically or chronologically very distant.

In this work scoring method by Mariotti and colleagues (2007) was used. Although the author of this thesis is familiar with the Coimbra method, which in the future promises great results, this system is still in the process of changing and improving (Santos, Alves-Cardoso, Assis & Villotte, 2011; Jurmain, Cardoso, Henderson & Villotte, 2012;



Henderson, Mariotti, Pany-Kucera, Villotte & Wilczak, 2015; Villotte, 2016). Therefore, there is still not enough comparative analysis based on this method, and testing still shows a fairly large level of intra-observer and inter-observer error (Parra, 2016).

The Mariotti's system is based on scoring for twenty-three entheses of the postcranial skeleton of upper and lower limbs.

The scoring system by Mariotti et al. (2007) tended to simplify previous systems Robb (1998) by avoiding the use of intermediate scores and reducing the degrees of development of robusticity to three (instead of four) degrees. However, in spite of the said, three subcategories (1a, 1b and 1c) were added for the degree 1, corresponding to the "very slight", "low" and "medium" degrees of development.

For this study the system of Mariott and colleagues (2007) was modified (or rather simplified) and subcategories for the first degree were excluded. The reason is that it is very hard to distinguish them, as the differences are insufficiently noticeable. The second reason is that mixing numerical values with letters is mathematically inconsistent. Therefore, for scoring of the samples system from 0-3 was applied, where "0" represented the bone without any impression, "1" was low-medium entheseal development (Fig, 11), degree "2" corresponded to strong development (Fig. 12), and degree "3" was reserved for very strong development (Fig 13). If a skeletal element is not preserved the field in sheets and in SPSS would have been left empty.





Figure 11 – example of degree "1" low-medium entheseal development



Figure 12 – example of degree "2" strong entheseal development





Figure 13 - example of degree "3" very strong development

As suggested by Mariotti and colleagues (2007), the scores were calculated for each "functional complex", grouped in: shoulder, elbow, forearm, hip, knee and foot (Table 1).

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Enthesis	Functional complex
Costoclavicular lig. (clavicle)	
Conoid lig. (clavicle)	
Trapezoid lig. (clavicle)	
M. pectoralis major (clavicle)	Shoulder
M. deltoideus (clavicle)	
M. pectoralis major (humerus)	
M. lat. dorsii/teres major (humerus)	
M. deltoideus (humerus)	
M. triceps brachii (scapula)	
M. brachioradialis (humerus)	
M. biceps brachii (radius)	Elbow (flexion/extension)
M. triceps brachii (ulna)	
M. brachialis (ulna)	
M. pronator teres (radius)	Forearm (pronation/supination)
Interosseous membrane (radius)	
M. supinator (ulna)	
M. gluteus maximus (femur)	Нір
M. iliopsoas (femur)	
M. vastus medialis (femur)	Knee
Quadriceps tendon (tibia)	
Quadriceps tendon (patella)	
M. soleus (tibia)	
Achilles tendon (calcaneus)	Foot

Table 1 - twenty-three entheses divided in "functional complexes"

The data were analysed using the statistical software program SPSS 20. Comparisons between two groups were carried out using the appropriate rank-order statistics (Mann-Whitney U and Kolmogorov-Smirnov Z), and comparisons among multiple groups were performed using the Kruskal-Wallis H.



The final database to be analysed contained information on 12 "functional complexes" (6 on each side): shoulder, elbow, hand, hip, knee and foot; graded from 0 to 3, in 137 individuals, divided into 6 populations.

2.7.2. Other occupational stress markers

Other markers of occupational stress that were taken into account as indices of workrelated activities are Schmorl's nodes, disc herniation, Charles' facet, squatting facets, jumper knee, *os acromiale* and markers of occupational stress on teeth (Capasso, Kennedy & Wilczack, 1999).

Schmorl's nodes is a herniation of a part of the nucleus pulposus out of the fibrosis wall of the intervertebral disk when the herniation does not cross the annulus fibrous (Miladinović-Radmilović & Vulović, 2013). Most of the cases can be noted on the lumbar vertebras. While some authors interpret this phenomenon as a result of physical effort and carrying heavy loads (Capasso et al., 1999; Lovell, 2008; Waldron, 2009), others think that its etiology may be idiopathic (Roberts & Manchester, 1995), while some are more likely to associate it with diseases such as infections, osteoporosis, degenerative diseases of the lumbar spine and neoplastic diseases (Resnick & Niwayama 1988; Hauger et al. 2001; Williams, Manek, Sambrook, Spector, & Macgregor, 2007). It is noted that this phenomenon is very common in populations that are known from historical sources for performing regularly very exhausting physical jobs (Phillips, 2003; Herrerín, Sarkic & Dinarés, In press). Although it is possible that other factors, including hereditary (Williams et al., 2007), influence the incidence of nodules, it was observed in this paper as one of the indicators of physical activity.

Disc herniation is a more severe form, when parts of the herniated *nucleus pulposus* cross the annulus fibrosis. Clinically the most serious consequences occur when the *nucleus pulposus* slip into the spinal canal, producing pressure from spinal cord or nerve roots, causing severe pain and other nervous disorders (Lovell, 2008; Waldron, 2009). It can be a consequence of aging and general "wear and tear" (Benoist, 2003), but also of the



repetitive mechanism of flexion-extension of the torso and carrying heavy loads (Baxarias & Herrerín, 2008).

Charles' facets are impressions located superior to the articular surface of the medial epicondyle of the femur. The facets occur due to the extension of the articular surface caused by contact with the tibial condyle during hip flexion (Capasso et al., 1999).

Squatting facets are morphological changes in articular surfaces, observed on the anterior surface of the distal tibia and on the neck of the talus, linked to hyperflexion of the joints during a squatting posture (Dlamini & Morris, 2005). In hyperdorsiflexion of the foot, such as in a squat, the anterior aspect of the distal tibia articulates with the superior surface of the talus, more especially the lateral aspect of the neck (Singh, 1959; Warwick & Williams, 1973). Squatting was a common resting position in a population that has no availability of furniture or that for cultural reasons choose this position, but also different household chores, such as cooking or washing laundry, were performed in a squatting position (Dlamini & Morris, 2005; Miladinović-Radmilović & Vulović, 2013).

Jumper knee is a bilateral elongation of the non-articular portion on the inferior pole (nose) of the patella. According to Grelsamer, Proctor and Bazos (1994), the patella can be considered "long-nosed" if the inferior pole is longer than 14 mm. This variation seems to be correlated with patellar tendinosis, typically affecting athletes whose sports involve frequent jumping (Blazina, Kerlan, Jobe, Carter, & Carlson, 1973).

According to some authors, the lack of fusion of the acromial bone - *os acromion*, is a consequence of mechanical stress of the shoulder area in the period of growth, that prevents the bone from fusion (Swain, Wilson & Harsha, 1996). In modern population it is common in professional sportsmen, that train since childhood and often use that part of the body, such as a baseball catcher (Sterling, Meyers, Chesshir & Calvo, 1995).

Non-alimentary use of teeth can leave traces on the surface, usually on the incisive and canines. Both ethnographic and skeletal evidence show that in many cultures teeth were used in manipulation of plant for producing utilitarian items such as fish nets, baskets,



ropes, yarn production etc. (Larsen, 1984; Lukacs & Pastor, 1990; Minozzi, Mnazi, Ricci, di Lernia & Borgognini Tarli, 2003, Erdal, 2008).

For all of the markers of occupational stress only presence ("1") or the absence ("0") were recorded for all the monastic and the secular populations.

2.8. Osteoarthritis

Osteoarthritis, the most common form of arthritis, is characterized by destruction of the articular cartilage in a joint and formation of adjacent bone, in the form of bony lipping and spur formation (osteophytes) around the edges of the joint (White et al., 2012, p. 441). Since the late 60's and early 70's osteoarthrosis began to attract the interest of physical anthropologists as a method for activity reconstruction, and idea that OA "provide important perspective on activity and behaviour" of past populations (Steckel, Larsen, Sciulli & Walker, 2011, p. 31) is still very widespread. However, clinical studies showed that there is no proof to enable the simplistic assumption that OA derives directly from the habitual activity (Weiss & Jurmain, 2007), and that it is more likely a result of combination of various factors that include age, sex, hormones, mechanical stress, and genetic predisposition, but it can also be a consequence of trauma or the invasion of the joint by bacteria (White et al., 2012).

Even if we accept the assumption that OA is not a very trustful marker of activity, this condition deserves attention in itself. Although OA is not considered to be a dangerous illness, it is very frequent and accompanied by various unpleasant symptoms such as stiff joints, swelling, pain that limit the range of motion and can also lead to more serious injuries (Neogi, 2013). Studies of the modern population shown that older adults with hip and knee OA have a higher risk of falling and of bone fracture (Arnold & Faulkner, 2007; Arden et al., 2006).

The physical manifestation of this pathology on skeletal remains is most commonly represented by marginal lipping. In a severe form, the articular surface can be polished (eburnation), which leads to the destruction of the joint surface. In older manuals, such as those of Brothwell (1981), Buikstra and Ubelaker (1994), Waldron (2009), but even



newer ones, such as the one of Steckel and colleagues (2011) and Weiss (2005) surface pitting (also called 'porosity') was considered to be an accurate indicator of osteoarthritis. Nevertheless, the research by Woods (1995) and Rothschild (1997), shows that 'holes' occur independently and in different joint areas from the eburnation. In fact, areas of such porosity appear to be the most common in articular areas that are not in a regular joint contact (Weiss & Jurmain, 2007). Woods (1995) suggested that those changes might reflect some secondary effects due to the vascular invasion to supply undernourished cartilage.

In this study the OA was scored according to Brothwell (1981) and Buikstra and Ubelaker (1994) method: from "0" – absent, to a different degree of severity 1-3 when present. Scoring was carried out for the spine (divided into three anatomical areas: cervical, thoracic and lumbar) and for six joint groups: shoulder, elbow, hip, knee, wrist/hand, and ankle/foot and on the left and right side for each joint group, whenever skeletal preservation allowed it. When the joint was not preserved the field was left empty.

0 = Joint shows no evidence of pathological changes

1 = Slight marginal lipping and slight degenerative or productive changes are present (Fig. 14).

2 = Severe marginal lipping with sharp ridges and severe degenerative or productive changes are present (Fig. 15).

3 = Complete or near complete (more than about 80%) destruction of the articular surface, the presence of eburnation. Joint fusion (synostosis) (Fig. 16).

The examples of different degrees of degenerative changes are presented in figures below.





Figure 14 – the example of degree 1 of OA = slight marginal lipping and slight degenerative or productive changes are present.



Figure 15 – the example of degree 2 = severe marginal lipping with sharp ridges and severe degenerative or productive changes are present.





Figure 16 - the example of degree 3 = complete or near complete (more than about 80%) destruction of the articular surface, the presence of eburnation.

Although in many studies individuals with signs of OA were divided into age categories, in this study this kind of division was avoided, due to small samples size; any kind of further division would make the results less significant.

2.9. Traumas

A trauma may be defined as an injury to living tissue that is caused by a force or a mechanism extrinsic to the body (Lovell, 1997, p. 139). There are various divisions in the classification of traumas: they can be accidental or intentional; *antemortem* or *perimortem*; direct or indirect (stress), fracture (any breaks in the continuity of a bone) or dislocation (the displacement of one or more bones at a joint).

Traumas are a highly revealing indicator of the lifestyle of an individual or a community. They can tell much about tasks that those individuals performed, accidents that might have occurred, interpersonal relations, etc. But even more important - it reveals the



medical knowledge and skills of a certain community. Healing a fracture is a complicated and a long process in which bone must be held in the proper position without moving for a long period of time (Müller, Nazarian, Koch & Schatzker, 2012). For many communities that was a luxury that they could not afford, as they lived exclusively from manual labor. That is why in the past many fractures would end up fused incorrectly, which might have also caused invalidity, an infection and, eventually, death of an individual.

A proper description of an injury is the first step in a trauma analysis, and is the basis for determining the mechanism, or a proximate cause (Ortner & Putschar, 1981; Steinbock, 1976). This includes recording the position along the shaft, the type of fracture, the presence and results of healing. Fractured and unaffected bones from the same individual should be compared (when possible) in order to determine if shortening occurred (Grauer & Roberts, 1996). When analysing a population it is very important to determine fracture frequency rates, most common types and locations in skeletons.

The problems facing determining fracture frequency rates could be poor preservation of material, or distinguishing a *perimortem* fracture from *postmortem* damage (Grauer & Roberts, 1996). Well-remodeled fractures of long bones can pass undetected during macroscopic investigation, or can make the determination of the fracture type difficult.

In this work, the skeletal material was analysed for signs of trauma, using diagnostic paleopathological procedures combining macroscopic observation of each bone (including bilateral verification of bone asymmetry, angular deformities and the presence of callus), detailed written and photographic description, with digital radiography. Radiographs were taken in all cases of possible traumas from Spanish populations (POB MON 1 and 2 and POB CIV 1 and 2) by a radiologist Dr. Dinarès in Unievrsity General Hospital of Catalonia (Barcelona). The frequency of trauma, as well as location in the body was recorded. Special attention was paid to differentiate *antemortem* (injuries which a person survived) from *perimortem* traumas (injuries without signs of healing). For *antemortem* traumas, the process of healing was analysed, whether it passed without complications, or whether the fusion was incorrect and/or followed by infections. Data of this kind are of particular importance because they may point to medical care or lack of



it. The collected data can show not only the incidence of various traumas, but also if they were results of an accident or interpersonal violence.

2.10. Stable isotopes

The application of stable isotopes in archaeology started in the mid-1970s with Vogel and Van der Merwe (1977) and until today it has improved a lot in resolution, detection, and overall design of mass spectrometers and became a very important technique in the study of a population of the past (Katzenberg, 2008).

Stable isotope analysis of bone collagen can be used in dietary studies of human populations by analysing the ratios of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) isotopes. Differences in carbon ratio come from consumption of C₃ and C₄ plants. C₃ plants are found in temperate climates, and include domesticated plants such as wheat, barley, rice, legumes, tubers and nuts and have lower carbon stable isotope ratio (-33 to 22‰), while C₄ plants such as corn, millet, sugarcane and sorghum are mostly found in tropical climates and have higher carbon ratio (-16 to -9‰) (Van der Merwe, 1982; DeNiro, 1987). The analysis of stable isotopes of nitrogen indicates whether the diet was more dependent on marine or terrestrial organisms, due to de fact that marine plants have higher nitrogen isotopes ratios than terrestrial plants (Larsen, 2000).

For the purpose of this study samples of 49 individuals from POB MON 1 and 8 individuals from POB MON 2 were analysed at the University of A Coruña by Dr. Grandal Danglade.

The individuals that were selected differed in age, from sub-adults (14-18 years) to old adults (+60 years), in sex (one of the individuals was possibly male, while other were females) and health conditions (some of the individuals showed signs of chronical diseases, while others were considered to be non-pathological). Although the main focus of this thesis is on adult females from monastic population, the analysis of the diet of sub-adults and a possibly male individual would bring important information about life in monasteries and respect of monastic rules. As the rules of the order emphasised that the sick and children under 14 years should be excluded from fasting, it was expected for



their isotopic signal to be different. In the case of the possibly male individual, if the isotopic signal was similar to other nuns, that could mean that he (?) lived with them in the same monastery, while any differences could mean that he (?) did not live, but was only buried there, or that he had a kind of special treatment.

2. 10. 1. Treatment of the samples

Each bone was cleaned by abrasion and sonicated in at least five alternative baths with deionized water and acetone (5 minutes each). Cleaned samples were dried at room temperature for 48 h, then grounded into powder (0.5 mm sieve) with agate mortar and pestle.

Elemental compositions (C, N) of the bone powder were measured, if the sample was available enough, as a previous approximation to the collagen preservation. Although most of the skull fragments yielded very low percent of N, still they were included in the study.

The collagen extraction was carried out according to the procedure described by Longin (1971) and Bocherens and Drucker (2003). 300 mg of bone powder was first demineralized in HCl solution (1M, 20 min, room temperature) and filtered (5 μ m). The residue was soaked in NaOH solution (0.125M, 20h, room temperature) in order to eliminate humic acids, filtered (5 μ m) and solubilized in a weak acid solution (HCl, 0.01M, 17h, 100°C). The dissolved collagen solution was filtered (5 μ m) and freeze-dried for 48 h to be ready for analysis.

Stable isotope ratios (${}^{13}C/{}^{12}C$ and ${}^{15}N/{}^{14}N$) of the extracted collagen were performed using an Elemental Analyser FlashEA 1112 (ThermoFinnigan) connected through a Conflo II (ThermoFinnigan) interface to a Delta plus (ThermoFinnigan) isotopic relationship Mass Spectrometer, in the Instrumental Analysis Techniques Unit (UTIA) of the Research Support Services of the University of A Coruña. Analytical reproducibility is better than 2‰ for both $\delta^{13}C$ and $\delta^{15}N$. All data were averaged from the two replicates.

Stable isotope ratios are expressed with delta notation (δ^{13} C, δ^{15} N) in parts per thousand (‰) relative to international standards, respectively VPDB for C and AIR for N. For the



POB MON 1 collagen preservation was tested according to quality and quantity requirements, which can be summarized as follows: Yield \geq 3,5% (Ambrose, 1990); %C \geq 13% and %N \geq 5% (Ambrose, 1990), C/N ratio within the range of 2.9 to 3.6 (DeNiro, 1985). For the POB MON 2 sample the quality of extracted collagen was even better than in the older samples. All the eight samples have percentages of collagenic C and N above the limits established by Van Klinken (1999), the C/N ratio is within the limit (between 2.9 and 3.6) according to DeNiro (1986) and the yield of the extraction far exceeds the minimum proposed by Ambrose (1990).

2.11. Metabolic diseases

Most of the metabolic diseases have a certain problem in nutrition in common, which may be a result of too much or too little of certain nutrition or problems in the absorption of a nutrient from food. In a paleopathological study investigation of metabolic diseases is limited only to those diseases that can leave traces on bones. The interpretation of the condition from osteological material has various obstacles. One of them is that different diseases can have a similar appearance in bones (Ortner, 2003). Some pathological conditions, such as osteoporosis, may have a dietary component, but are more commonly the result of age-related changes in endocrine function (Ortner, 2003). Other pathological conditions may appear together, making a synergic effect.

Metabolic diseases which leave the traces on bones are osteoporosis, rickets, osteomalacia and scurvy. The porotic hyperostosis and *cribra orbitalia* have been traditionally assigned as indicators of iron deficiency anaemia (El-Najjar, Ryan, Turner, & Lozoff, 1976), but more recent research has put forward alternative causes, including vitamin B12 deficiency or endemic malaria (Brickley, 2000; Wapler, 2004; Walker, Bathurst, Richman, Gjerdrum & Andrushko, 2009).

Enamel hypoplasia was argued to be indicators of nutritional stress, and hence, could indicate the presence of a metabolic disorder (Kelley & Angel, 1987). But nowadays it is a more accepted opinion that enamel hypoplasia does not indicate particular nutritional components that might be missing from a diet, but a general level of metabolic stress (Kozłowski &Witas, 2012), and therefore it will be described in different sub-chapter.



2.11.1. Rickets

Rickets is characterized by disruption of the mineralization process of growing cartilage and bone tissue, often caused by insufficient vitamin D. Our bodies can synthesize vitamin D from ultraviolet light (exposure to sunlight) or from food intake. The reduction of exposure to sunlight due to cultural practices and/or the environment is considered to be the main etiological factor of rickets (Mays, Brickley & Ives, 2006), but geographical latitude, skin pigmentation, and bioavailability of vitamin D in food sources – and cultural factors that determine individual and population risks such as infant and child feeding practices also have influence (Brickley, Moffat & Watamaniuk, 2014).

Reduced mineralization can lead to bowing and deformation of the bones of sub-adults, especially of those which were exposed to some kind of pressure - leg bones and pelvis due to continued bipedal posture, or upper extremity during the period of crawling (Stuart-Macadam, 1989; Ortner & Mays, 1998; Brickley et al. 2005; Brickley & Ives 2008).

In osteological material rickets in children can be recognized by small and circular areas (like pores) in subchondral surfaces of the growth plate (Ortner & Mays 1998) and by bowing of long bones, pelvis and sternum (Brickley & Ives 2008). However, rickets is a systemic disease of early childhood, which has the highest peak of prevalence between 6 months and 2 years (Ortner, 2003). In an adult skeleton, changes such as porosity and roughening of a bone underlying the epiphyseal will be lost, but the bowing deformity of the shaft of long bones in some cases persists (Brickley et al. 2010).

In this study long bone deformities were investigated, focusing on the bowing of the shaft. The recording was undertaken using simple visual analysis accompanied by a detailed description and photographic documentation.

2.11.2. Osteomalacia

Osteomalacia is also caused by a deficiency of the vitamin D, but the difference in manifestation between it and rickets is that in adults the skeleton is no longer growing, and therefore, various changes in the cartilage and bones of the growth plate, which



dominate the picture of rickets, are no longer present (Ortner, 2003). A deficiency of vitamin D leads to reduced levels of calcium and phosphorous in the blood serum, which delays or prevents the mineralisation of newly formed organic bone matrix (Holick, 2002). Small linear fissures or stress fractures (also known as "pseudofractures") can occur at these weakened sites of osteoid accumulation and poorly mineralised bones (Berry et al., 2002). The body will attend to heal the fracture, but due to lack of vitamin D, the forming callus is disorganised (Sevitt, 1981). In severe cases bones may become soft and deformities of ribs and hips are not uncommon (Waldron, 2009). Osteomalacia can also provoke deformities in the spine, flattening of vertebras and angular kyphosis (Ortner, 2003).

For this study careful macroscopic evaluation of all skeletal elements was undertaken following the criterion suggested by Ives and Brickley (2014).

2.11.3. Scurvy

Scurvy is a metabolic disorder caused by the lack of ascorbic acid, vitamin C, in the diet. In the case of humans, some of the non-human primates and guinea pigs, it cannot be produced by the body itself (Maat, 2004). As vitamin C is available in most of fresh fruits and vegetables, its deficiency is usually connected with some kinds of specific life conditions; such as periods of famine, war or a long sea-voyage.

In bone remains changes connected to scurvy can be observed in a form of lesions of abnormal porosity of the cortex, or sometimes, although not consistently, accompanied by new bone formation (Ortner, 2003). According to Ortner, the most characteristic sign of scurvy is the porous lesion of the greater wing of the sphenoid bone (Ortner & Ericksen 1997; Ortner et al. 1999; Ortner et al. 2001). Porotic changes on the skull can also appear on the maxilla, the coronoid process and alveolar of the mandible, on the orbital roof, the hard plate, the parietal and the occipital bone (Ortner & Ericksen1997; Ortner et al. 1999; Ortner et al. 2010). The localization appears to occur at sites where supporting muscles attach. In a postcranial skeleton periosteal new bone reaction and abnormal porosity can be spotted on all long bones, feet and hands in individuals affected by this disease. Some authors also report the presence of ossified haematomas in long bones, especially in the tibia and femur (Van der Merwe et al., 2010; Maat, 2004), but it



seems that those changes are not always accompanying scurvy. In historical and medical records *antemortem* tooth loss, which usually starts with upper incisive, was often associated with scurvy (Fain 2005; Olmedo, Yiannias, Windgassen & Gornet, 2006; Velandia, Centor, McConnell & Shah, 2008).

In this study Ortner and colleagues' (Ortner & Ericksen 1997, Ortner et al. 1999, Ortner et al. 2001) criteria for describing and identification of the lesions were applied. All preserved cranial bones and long bones were examined macroscopically for the presence of abnormal porosity and proliferative bone formation.

2.11.4. Anaemia

Anaemia is defined as a pathological deficiency in either red blood cells or the haemoglobin they contain (Walker et al. 2009). As cells of the body rely upon oxygen "delivered" by RBC, reduction in the number of cells, or compromised ability to bond and carry oxygen, can profoundly affect the body (Kozłowski &Witas, 2012). One of the most important chemical elements in this process is iron, that influences the regulation of oxygen transmission to cells, immunocompetency, neurotransmission, and collagen synthesis (Stuart-Macadam, 1989). Humans acquire iron primarily through food of both animal (red meat, sea food, eggs) and vegetable origin (nuts, beans, whole grains, spinach).

Since 1960's and the first publication of Angel (1966) the porosity of the skull vault (porotic hyperostosis) and orbital roof (*cribra orbitalia*) were connected to iron-deficit anaemia. This opinion was so widespread that over the decades most of analyses of the populations of the past were using this skeletal characteristic as confirmation of the lack of iron in the diet. Later it became a usual interpretation of *cribra orbitalia* as a sign of childhood anaemia (Stuart-Macadam, 1985; Kent, 1986; Walker, 1986, Stuart-Macadam, 1992, etc.), as in most of the cases active porotic lesions were found on skeletons of children and adolescents in archaeological collections, while healed lesions, in contrast, were considered typical for older adults (Stuart-Macadam, 1985; Walker, 1985; Walker, 1985; Walker, 1986).



Recent studies have been more likely to search for a different kind of explanation for those skeletal changes. Djuric and colleagues (2008) believe that porotic lesions in infants found in Stara Torina are not a consequence of malnutrition, but more likely of parasitic infections which led to the development of porotic bone lesions via different mechanisms: parasite-induced blood loss and/or diarrhoea (both iron and magnesium malabsorption); or anaemia as a hepcidin-mediated body-adaptive response to infection. Wapler (2004) states that in the case of what is considered *cribra orbitalia* it often just indicates *postmortem* erosion, while in other cases the presence of *cribra orbitalia* indicates that the individual experienced some kind of chronic health problem, such as vitamin C deficiency. Walker and colleagues (2009), suggest that the main cause of porotic changes is not iron-deficiency anaemia, but rather haemolytic anaemias, such as thalassemia, sickle-cell anaemia and megaloblastic anaemias, whose main cause is Vitamin B₁₂ (cobalamin) and Vitamin B₉ (folic acid) shortage.

In this study, porotic hyperostosis and *cribra orbitalia* were taken into account as signs of general health problems. In the case of *cribra orbitalia* it is more likely that it shows some kind of metabolic stress suffered in childhood, whose traces persist in adult bones.

In skeletal material, porotic hyperostosis can be identified macroscopically as circumscribed areas of pitting and porosity on the external surface of the cranial vault, while *cribra orbitalia*, has a similar appearance and can be spotted in the orbital roofs. The presence of *cribra orbitalia* was estimated at those individuals who had at least one orbit completely preserved. All available skulls were analysed macroscopically, under strong light, to determine the presence or absence of *cribra orbitalia* and porotic hyperostosis, after which cases where lesions occurred *postmortal* were excluded. Since the aim of our study was to investigate the frequency of porotic lesions (no matter the severity), the recording was focused only on the presence ("1") or the absence ("0") of the porotic changes in the orbital roof and cranial vault, and no difference between grades of intensity, nor the size of the surface affected was considered.

2.11.4. Porotic lesions

The cribrous syndrome is a condition defined by Miquel-Feucht and colleagues (1999) and includes femoral and humeral cribra, lesions similar to those that can be spotted in an



orbital roof in *cribra orbitalia*. Its aetiology is still not clear, but experiments on rats suggest that it possibly originates from the lack of magnesium (Miquel-Feucht et al., 1999). The correlation with muscle hyperactivity was also noted (Miquel-Feucht et al., 1999; Polo-Cerdá & Villalaín, 2003). Djurić and colleagues (2009) suggest a possible synergic effect of anaemia and magnesium deficiency, as femoral cribra is often accompanied with cribra orbitalia. It is also noticed by various authors (Polo-Cerda et al., 2000; Djurić et al., 2009; Radi et al., 2013) that the peak of this condition is around the age of 14 and that it reduces after 20 years.

Like in the previous case, only the presence ("1") or the absence ("0") of femoral and humeral cribra were recorded.

2.12. Parietal Thinning

Parietal thinning is defined as external thinning of the parietal bone of the skull (Takata Takao, Yoshida, Hayashi & Yasui, 2008). It is manifested by a partial or complete absence of the diploë of the calvarium at the site and by a corresponding thinness of the skull in the involved portion. It can be unilateral or, more often, bilateral, and its most constant position is just above the temporal ridge and about equidistant from the coronal and lambdoid sutures (Hauser & DeStefano, 1989). The inner table is usually intact.

Parietal thinning is a rare pathology, with prevalence rate estimated at 0.25-0.8% according to Bruyn and Bots (1978) or 0.4-1.3% according to Breitinger (1982). It is more common in women than in men (Lim & Sohn, 2001). Male/female sex ratio is 1:1.9 (Cederlund, Adnren & Olivecrona, 1982), or even 1:2.5 according to some researchers (Bruyn, 1978). It occurs mostly in older people, over 60 years, although there have been some cases of young people, or even children (Humphry, 1874). Even though many authors were suggesting genetic element in the etiology (Sheperd, 1893; Bloch, 1897; Wilson, 1944), this lesion seems to be predominantly sporadic (Bruyn & Bots, 1978). It shows no special association with ancestry or geographical area tendency (Yılmaz, Egemen, Özbakır & Tekiner, 2015).

Although a patient feels no pain in the area, the presence of thinness is thought to facilitate skull trauma with brain injury, and even death following fracture through the thinned



areas (Cederlund et al., 1982; Tsutsumi, Yasumoto & Ito, 2008). Progression of this pathology may result in perforations (Lim & Sohn, 2001). In cases of slowly progressive bony thinning, in actual clinical practice, a cranioplasty may be required to prevent exposure of the brain to atmospheric pressure (Tsutsumi et al., 2008).

Sandifort (1783) is credited with the first detailed description and drawing, while the first radiologic findings were described in 1926 by Greig. Even if this condition has been known for such a long time, there is still no consensus in terms of its etiology. A number of names have been given to this finding. Among these are *"involutions krankheit"* (Virchow, 1854), "senile atrophy" (Humphry, 1874), "symmetrical depressions" (Shepherd, 1893), "symmetrical atrophy" (Hollander, 1901), "symmetrical thinning" (Smith, 1907), "parietal impressions" (Piersol, 1919), and "symmetrical thinness of the parietal bones" (Greig, 1926).

Some authors considered Parietal Thinning an anatomical variant (Pratap, 1969), while others thought it is related to some kind of trauma (Tsutsumi et al., 2008), metastatic tumours or Gorham-Stout disease (Tsutsumi et al., 2008). But follow-up work of Cederlund et al. (1982), which was done for 14 years on x-rays of skulls, showed that slow progress of the disease was noted on 10 of 25 patients, which were proof that it is not congenital, but a progressive anomaly. The same research confirmed that this pathology is often connected to old age, as previously pointed out by Humphry (1874), as the average age for women was 72, and 63 for men.

Histopathological studies have shown a lack of osteoclasts, suggesting that the Parietal Thinning can be related to osteoporosis due to a decrease in bone formation rather than increased bone destruction (Cederlund et al., 1982). In actual clinical practice, hormone treatments that increase bone mineral metabolism in older patients with Parietal Thinning have given a good result (Takata et al., 2008). These results suggest that acceleration of bone resorption is one of the causes of Parietal Thinning in osteoporotic patients.

As the thinning or absence of diploë is a characteristic that distinguishes Parietal Thinning from other pathological conditions that leave depression in the skull (e.g. trauma) or morphological variation, the only certain way to diagnose that condition is to perform



radiological imaging (unless the skull is broken and the thinning/absence of diploë can be observed with a naked eye).

The radilogical analysis of the skulls with possible Parietal Thinning for the Spanish samples was performed by Dr. Rosa Dinarès Solà at the University General Hospital of Catalonia. For the Portuguese samples the radilogical analysis was performed by Dr. Rosa Gaspar at the Hospital of the University of Coimbra.

2. 13. Developmental disorders

The term congenital/development disorder includes various manifestation - from minor developmental disorders that do not affect health, to severe conditions that influence everyday functioning or even life threatening disorders, better known as congenital defects. The non-life-threatening disorders can often be treated as non-metric, epigenetic (also known as "discrete") treats and the frequency of their appearance can be studied in order to examine genetically homogeneity of one population or genetic distance between two populations (Barnes, 2012), as discussed before. For previously explained reasons such a study was not considered interesting for this work, so the focus was on those changes that severely altered normal functioning of an affected individual.

In some cases, it is very hard to distinguish congenital and early childhood deformation. A trauma that occurred in early childhood can be completely fused, and hence invisible even on radiography, but it can affect the size, morphology or the function of the bone.

For the purpose of this work the developmental disorders were analysed and described in details, and documented photographically. The descriptions were compared with cases from modern clinics to get a better picture in which way the pathology affected the life of the individual.

2.14. Infectious diseases

Infection diseases were the most common cause of morbidity and mortality in past human population of the pre-antibiotic era (Djuric et al, 2010). But most of the infections



spreader by faeco-oral route, that must have been common in the past, leaving no stigmata on the skeleton (Waldron, 2009). In fact, the infections that were taking the most of human lives in the past, such as plague, small pox, cholera …were attacking primarily soft tissues and would have lethal outcome very quickly (sometimes in just a few days), before the infection would spread to the bone. For that reason, in osteological studies we are able to see only those kinds of infectious diseases that affected bones as well and that took a long time to destroy the immune system of a host (Ortner, 2003). Paleopathological diagnoses rely on specific patterns, intensity and distribution of bone changes in order to determinate the disease. This task can often be very complicated because the reaction of the bone can vary from one stage to another while suffering from the same disease, the sick person can get better so bones can go through the healing process, and finally one can have several diseases at the same time which can have a synergic effect on their health.

In this work only those infectious diseases that were possibly present in the samples will be described. Those are: venereal syphilis, tuberculosis, osteomyelitis and brucellosis.

2.14.1 Tuberculosis

Tuberculosis (TB) is an infectious disease that affects humans, and is caused by bacteria of the *Mycobacterium* complex, most often *M. tuberculosis* and *M. bovis* (Roberts, 2012). For a long time it was believed that *M. tuberculosis* evolved from *M. bovis* and spreaded between human population, as a result of domestication and coexistence with animals, but analysis of the TB genome shows that it is more likely that this occurred even before the domestication of animals (Brosh et al, 2002). Human-to human transmission usually goes through the respiratory tract, so in 19th century, with industrial revolution and overcrowding of big cities, tuberculosis in Europe reached epidemic proportions (Bates & Stead, 1993).

The study of spreading of tuberculosis in past population faces various obstacles: not all of infected individuals would develop the disease, not all of the sick would develop skeleton lesions, and TB could often be associated with other pathological conditions. Sings of TB in the skeleton can be noted in the spine, especially on the lumbar vertebras,



joints, the hip, the knee, the wrist and the inner surface of the ribs (Waldron, 2009). In letter phases, as the disease progresses, the loss of bone tissues in vertebras bodies could lead to ankyloses and collapse, producing a marked kyphosis of the spine which is known as Pott's disease (Jain, 2002).

2.14.2. Brucellosis

Brucellosis is zoonosis that can be passed to humans through consumption of infected milk and meat. In humans the disease produces a chronic infection of lungs and other organs, characterised by fever (Spink, 1956).

The most common skeletal lesion is in the spine or sacro-iliac joint (Rajapakse, 1995). It consists of a small destructive focus in the superior-anterior margin of the vertebral body, adjacent to the annulus fibrosus (Capasso, 2001; Ortner, 2003). The lesions show a porous osseous structure, due to a granulomatous reaction that has become sclerotic. (Curate, 2006). In later phases the destruction of the vertebral disk and the end place of vertebral bodies can lead to loss of joint space and ankyloses (Ortner, 2003).

2.14. 3. Leprosy

Leperosy, also known as Hansen's disease, is an infection caused by slow-growing bacteria called *Mycobacterium leprae*. It can affect the nerves, skin, eyes, and lining of the nose (nasal mucosa).

In a paleopathological analysis of skeletal remains generic recommendations detailed in standard textbooks (Buikstra & Ubelaker, 1994 and Ortner, 2003) were followed. Special attention is paid to the identification of the specific bone lesions commonly considered relevant for the discussion of a leprosy diagnosis on dry skeletal material such es changes in rhinomaxillary, followed by widening of the nasal aperture and loosing of incisives, bone changes of the hands and feet were researched following and periosteal reactions on long bone (Møller-Christensen; 1961).

2.14.4. Osteomyelitis



Osteomyelitis is a term that can be used for an infection of the bone marrow which results in the inflammatory destruction of bone (Waldron, 2009). The infection may reach the skeleton by several different routes: by direct infection through traumatic wounds, by direct extension from adjacent soft tissue infection or by the hematogenous route from a septic focus (Ortner, 2003). The causative organism in most cases (close to 90% according to Ortner, 2003) is *Staphylococcus aureus*. *S aureus* is a pyogenic organism (pus-producing) that predominantly caused a skin infection that could spread to other organs, including skeleton (Waldron, 2009).

In the skeletal material the best diagnosis evidence for osteomyelitis is drainage canal in a bone (*cloaca*) or sequestration in association with the periosteal bone formation (*involucrum*) (Ortner, 2003). Without these changes it is hard to tell the difference between periostitis and osteomyelitis.

2.14.5. Periostitis

Periostitis has been commonly regarded as an inflammatory response to nonspecific infection or trauma, although clinical literature points to multiple etiologies, including those that are non-infectious, such as nutritional deficiencies, neoplastic, metabolic, congenital, and genetic diseases (Geber & Murphy 2012; Weston 2012). It can affect any bones in the skeleton, but is most often seen in the long bones, particularly the tibiae (Weston, 2012).

Periosteal new bone formation can follow specific infectious diseases such as tuberculosis (Kelly et al. 1994; Roberts & Buikstra, 2003), the treponematoses (Pàlfi, Dutour, Borreani, Brun, & Berato, 1992; Hutchinson, 1993; Lewis 1994; Mansilla & Pijoan, 1995) and leprosy (Lewis, Roberts & Manchester 1995), but in those diseases certain patterns in distribution can be noted, as well as other pathological changes.

Primary periostitis is most cases the result of two pathological conditions: trauma and infection (Ortner, 2003). Trauma should be the first factor eliminated when attempts are made to narrow down the etiological origins of periosteal reactions, as the generally focal, unilateral nature of traumatic periosteal reactions makes them relatively straightforward to identify (Weston, 2012). Whereas the periosteum will always be active in the fracture,



periosteal reactive bone can also be stimulated by an injury that does not produce fracture (Ortner, 2003).

In this study periostitic changes were observed by macroscopic analysis. Pathological changes were documented by descriptions and photographs.

2. 14. 6. Venereal syphilis

Venereal syphilis is a complex systemic illness with protean clinical manifestations caused by the spirochete Treponema pallidum subsp. pallidum (Tramont, 1990). There has been lot of polemics and controversy about its origin, from those who claim that the disease came to Europe from America with Columbus, to those who claim that it came from Africa or that it developed in the same time in the Old and New World (Quétel, 1990; Meyer et al., 2002; Waldron, 2009). Whatever version we choose to believe in, the fact is that the disease from 16th century started rapidly expanding in Europe, soon to alarming proportions.

Characteristic of this disease are symptoms such as Charcot joints, gummas (granulomatous lesions with coagulated necrotic centres) of the skin, the skeletal system, the liver, or the spleen, or lesions in the cardiovascular system (e.g., aortic aneurysm, etc.) or the central nervous system (e.g., dementia, paresis, etc.) (Powell & Cook, 2005).

For detecting syphilis on skeletal remains one should pay attention to porotic lesions in the skull: frontal, parietal and facial parts, which are, in the initial stage, characterized by clustered and confluent pits, becoming in later phases crater-like bone formations called *caries sicca* (Ortner, 2003). In the postcranial skeleton, most commonly affected is the tibia (ten times more often than the rest of long bones, according to Ortner, 2003), typically becoming thicker with gummatous periostitis and a snail-track pattern of lesions.

In the Middle Ages and in the early modern period mercury was used as a cure in cases of individuals suffering from syphilis, a venereal disease and leprosy (Yamada et al.1995, Dracobly, 2004; Rassmusen et al., 2008). In this research, we performed the analysis for detecting mercury accrued in bones of individuals with visible pathological changes that



might correspond to syphilis, in order to detect medical exposure to mercury. The sample was taken from bone marrow of ribs and vertebras, as recommended by Dr Slavko Ćurčić from Institute for the Toxicology and Pharmacology (Belgrade, Serbia) as this part of the bone is less exposed to environmental contamination. Two tasting of the samples were carried out by Dr. Goran Žebić in a laboratory in Belgrade. The method of detection used is cold-vapour atomic absorption spectrometry (CVAAS) with sodium borohydride. The sample was prepared using closed-vessel microwave elevated pressure, during 35-minute program digestion of the sample in the presence of HNO3, HCl, H2O2, HF. The obtained liquid sample had very small residue. The sample was then filtered through a membrane filter and analysed by an atomic absorption spectrophotometer - hydride technique. The hydride technique involves detection of elemental Hg in a mixture of sample, 5M HCl, and 0.3% NaBH4 (sodium borohydride). The chemical analysis was performed on the AAS Agilent Technologies 240FS AA.

2.15. Dental health

Data for the analysis were obtained by macroscopic observation and included information on *antemortem* and *postmortem* tooth loss, the presence of periodontal and dental diseases and developmental anomalies. For each individual separate sheet – odontogram was filled recording the presence of teeth and associated pathologies.

2.15.1. Caries

Caries is progressive, focal demineralization of dental hard tissues by organic acids derived from bacterial fermentation of dietary carbohydrates, especially refined sugars (Lukacs, 2012, p. 560). The appearance of caries can vary from opaque spots on the crown to gaping cavities in the tooth (White et al., 2012).

Caries was identified macroscopically as a necrotic cavity in the tooth crown or root. Every permanent tooth present and visible was assessed. Scoring using a dichotomous



(present/absent) was performed, focusing only on the frequency and without scoring the severity. For each individual, the total number of teeth affected by this pathology was recorded. For the individuals without any tooth preserved, both for *antemortem* tooth loss (AMTL) or *postmortem* tooth loss (PMTL), the field in SPSS program was left empty. The frequency of caries as a simple proportion of the number of affected teeth over the total teeth preserved (including teeth in alveoli and loose teeth).

Although the estimation of the frequency of caries within one population was often performed by simple count of a number of teeth affected that is not the most accurate way to get the precise information of its distribution. If the individual lost many teeth *antemortem*, or if preservation of teeth was poor, the obtained result will not present the real picture. For that reason, in this study the total number of teeth with caries was divided with number of teeth preserved and multiply with hundred, to get the percentage

2.15.2. Calculus

Dental calculus is mineralised bacterial plaque that accumulates on teeth. During lifetime, dental calculus irritates the gingiva, causing gingival inflammation (gingivitis) and later it can lead to the development of periodontal disease. Although mild gingivitis does not cause any changes in the alveolar bone, severe and long lasting gingivitis can lead to periodontal disease and resorption of the alveolar bone (Vodanovic et al., 2012). Levels of calculus and its location are population specific and depend on various factors such as oral hygiene habits, diet, age, ethnic origin, systemic disease and the use of prescription medications (White, 1997).

In this thesis the formation of calculus was scored using dichotomous: teeth with no visible calculus ("0"- absent) and teeth with calculus deposit ("1" – present). Even if calculus was notable only on one tooth it would be marked as "1". Individuals with the maxilla and the mandibular bone which became edentate (due to AMTL or PMTL) were excluded from the analyses of calculus frequency.



2. 15. 3. Periodontal disease (periodontitis)

Periodontal disease is an inflammatory condition that affects any or all portions of the periodontium, which includes the gingivae, periodontal ligament, alveolar bone, and cementum (Lavigne & Molto, 1995). Lesions include destruction of the connective tissue attachment of the tooth and loss of alveolar bone (Soames & Southam, 2005), which will eventually lead to losing of the teeth. Periodontal disease has a multifactorial aetiology, that primarily includes bacterial plaque, but other factors, such as calculus, diet and oral hygiene may influence the nature and progression of periodontal disease (Wasterlain, Cunha & Hillson, 2011).

In this study examination of the presence of periodontal diseases was performed macroscopically. All the individuals were divided into two categories – without manifestation of periodontal disease ("0" - absent) and with periodontal disease ("1" – present). For the estimation of the presence of periodontitis the protocol of Chimenos (1992) was used. According to it, the periodontitis will be recorded as present if the resorption of alveolar bone is greater than 3 mm. Edentates and cases where the estimation of periodontal disease was not possible due to damage of alveolar bone were excluded.

2. 15. 4. Enamel hypoplasia

Dental enamel hypoplasias are deficiencies in enamel thickness resulting from physiological perturbations (stress) during the secretory phase of amelogenesis (Goodman & Rose, 1990, p. 59). Various factors may influence crown development during, including dietary deficiency, childhood fevers, and major infections such as congenital syphilis (Hillson, Grigson, & Bond, 1998; Jacobi, Cook, Corruccini, & Handler, 1992). Due to the inability of enamel to remodel, and the regular and ring-like nature of their development, these defects can provide an indelible, chronological record of stress during tooth crown formation (Goodman & Rose, 1990).

Enamel hypoplasia was observed on incisors, canines and first premolars. The whole sample was divided into two groups: individuals with evidence of at least one-line enamel hypoplasia ("1"- presence) and individuals without signs of hypoplasia ("0" – absence).

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2.15.5. Abscess cavity

Abscess cavity is a consequence of a severe and chronic infection of the dental pulp that may occur as a result of exposure to oral bacteria through caries, attrition or trauma (Dias & Tayles, 1997). Oral abscesses may display a number of forms (Brothwell, 1981). In this work, any kind of abscess cavity was recorded, no matter the shape or size.

2. 15. 6. Antemortem tooth loss

Loss of teeth during life may be the result of periodontal disease, penetrating caries, severe occlusal wear or trauma (Lukacs, 2012). The difference between AMTL and PMTL is presented in progressive tooth reabsorption.

2. 15. 7. Postmortem tooth loss

PMTL can be a consequence of the taphonomic process, careless excavation and/or treatment in a laboratory.

Although many authors suggest scoring of caries based on the severity and dividing into different groups depending on the position in teeth (Brothwell, 1981; Metress & Convay, 1975; Hillson et al.,1998), scoring of the severity of hypoplasia (Schultz et al., 1988; Brothwell, 1981), calculus (Brothwell, 1981) and alveolar bone resorption (Brothwell, 1981; Ogden, 2008), this study is focused only on the presence and frequency of those conditions. The reasons for that are: 1. some of the samples of populations, especially civil ones, are already very small (due to the reasons that were explained in the introduction) 2. in many cases the preservation of the tooth and alveoli is poor or incomplete 3. a lot of the individuals are elders, so they lost teeth *antemortem*. Any further division would make the samples even smaller, and therefore less reliable for the comparison.

Statistical analyses were performed in computer program SPSS 20, using Chi-square tests.

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3. RESULTS

3.1. Demography

3. 1. 1. The total number of individuals and sex distribution

In POB MON 1, from the convent Santa Catalina de Siena in Belmonte, dating from 16th - 18th century, 85 individuals in 25 tombs were found. Of that number, 76 individuals were females, 1 individual was possibly a male, 8 indeterminate and 1 sub-adult whose sex was impossible to determine (Chart 1).



Chart 1- The total number of individuals and sex distribution in POB MON1

The secular population POB CIV 1, which was used for comparison with POB MON 1, was excavated in the church of El Salvador in Toledo. The chronology of this necropolis was similar, 16th - 18th century and the distance from Belmonte is 150 km. Both towns share similar geographic charateristics: they are located in central Spain, far away from the coastline, on hilly terrain.



In total 79 individuals were found there, of that number 13 were males, 23 females and 43 indeterminate (Chart 2).



Chart 2- The total number of individuals and sex distribution in POB CIV 1

The second monastic population in this study - POB MON 2, was also from the convent Santa Catalina de Siena in Belmonte, but its chronology is 19th - 20th century (1850 to 1921). In total 31 individuals were found: 26 females and 5 indeterminate (Chart 3).





Chart 3 - The total number of individuals and sex distribution POB MON 2

For the comparison with the monastic population POB MON 2, the civil population from Belmonte was chosen, that was buried in the floor of the church of monastery Santa Catalina de Siena, dating from 19th century. This population consisted of 26 individuals – 24 adults and 2 sub-adults. The adults comprised 14 females, 8 males and 2 were indeterminate (Chart 4).



Chart 4 - The total number of individuals and sex distribution in POB CIV 2



The third monastic population that was included in this study, POB MON 3, was found in the convent Nossa Senhora de Aracoeli in Alcaser do Sal, with the chronology 16th -19th century. Although more than 200 individuals were found in total in the convent (Curate, 2006), not all of them were nuns. For the purpose of this study 132 individuals from the convent were analysed, of which 104 were females and 28 were indeterminate (Chart 5).



Chart 5 - The total number of individuals and sex distribution in POB MON 3

The third secular population, POB CIV 3, comes from the convent São Francisco in Santarem. The chronology of this population is $15^{\text{th}}-19^{\text{th}}$ and the distance from Alcácer do Sal is 120 km. This population consisted of 99 individuals – 82 adults and 17 sub-adults. The adults comprised 30 males, 35 females and 17 indeterminate (Chart 6).


Chart 6 - The total number of individuals and sex distribution in POB CIV 3

Taking a look at the charts above it can be noted that sex ratio in secular populations shows unequal distribution (especially in POB CIV 1 and 2), and that in all three populations the number of female individuals was much higher than that of males.



In monastic populations, there were individuals whose sex was impossible to determine. However, only in the case of one individual, 411 from POB MON 1, the sex was estimated as "possibly male". According to archaeological data, the way this individual was buried did not differ from the rest of the necropolis. The individual was found in anatomical position, about 50% of skeleton was preserved. The tomb was previously occupied by an individual numbered by archaeologists as 412, whose bones were piled in a corner of the tomb to make a room for the individual 411. The object associated with this individual



Figure 17 - individual 411, assigned as "possibly male", in situ

were bucket made of iron, found in the abdominal area, and pin made of coper, found just above the head, that left a green stain of oxidation on left clavicle (Fig. 17).

The sex of this individual was determined based on morphological characteristics of the skull, as the coxal was not preserved. The stature of this individual was estimated to be 168,92 cm based on methods of Olivier and colleagues' (1978), as insuficient preservation of remains did not allow application of other methods.

The lack of sub-adult in POB CIV 1 is surprising, while in POB CIV 2 only 2 individuals (7.6%) were estimated as sub-adults. Only POB CIV 3, with 17 sub-adult individuals (17.17%), had the distribution of sub-adults close to expected for historic populations.



The remains of sub-adults were noted just in one monastic population, POB MON 1, where two sub-adults were buried in an area reserved for nuns. Their age was determined by methods based on epiphysis fusion and tooth eruption. According to those analyses, the individual 812 aged between 10 and 12 (Fig. 18) and the individual 922 between 14 and 18 years (Fig. 19) at the times of their deaths. For the individual 922, the sex was determined as female.



Figure 18 - Indivdiaul 812, POB MON 1. Age estimated 10-12 years based on epiphysis fusion and tooth eruption



Figure 19 - individual 922, POB MON 1, subadult, 14- 18 y. o., female



3. 1. 2. Preservation Index

Preservation Index (PI) deferred a lot from one population to another, being much higher in more recent populations (from 19th and 20th century), which is the result that was expected. Also, the shorter one necropolis was in use, the less possibility for disturbance and reutilisation of the graves would be.

IP for POB MON 1 is 39.38%

IP for POM MON 2 is 62%

IP for POB MON 3 is 32%

IP for POB CIV 1 – data not available

IP for POB CIV 2 is 71.88%

IP for POB CIV 3 – data not available

3. 1. 3. Number of individuals and age distribution of individuals suitable for the analysis

After applying the criterions of:

- 1. sex (only individuals that can be estimated as females)
- 2. age (only individuals \geq 25 years)
- 3. preservation (only individuals with IP \geq 50%)

on all 6 populations, the number of individuals was reduced significantly. Individuals whose sex and was not possible to determine were not included.

The total number of individuals suitable for the analysis:

In POB MON 1 the sample for analysis contained 35 female individuals divided into three age groups (Chart 7). IP preservation was 70.25%





Chart 7 - POB MON 1 age groups for individuals suitable for the analysis

According to obtained results most of the individuals died before 40 years of age, but a number of older individuals is also relatively high. Expressed in percentiles 45.7% of the sample died between 25 and 39 years, 28.5% died between 40 and 59 and 25.7% of the sample were over 60 at the time of death (Chart 8).



Chart 8 - POB MON 1 representation of the age groups in percentiles

In POB CIV 1 only 12 individuals were suitable for the analysis. IP for the sample was 66.8% (Chart 9).





Chart 9 - POB CIV 1 age groups for individuals suitable for the analysis

The number of people determined to be between 25-39 and 40-59 years was equal. In percents, the first and the second group made 41.66% of the total sample, while 16.66% were older than 60 years (Chart 10).



Chart 10 – POB CIV 1 representation of the age groups in percentiles

The sample of POB MON 2 contained 20 individuals, divided into three age groups. IP is 81.5% (Chart 11).





Chart 11 - POB MON 2 age groups for individuals suitable for the analysis

Most of the indvduals from the sample died between 40-59 years. Expressed in percentiles 60% of the population were between 40 and 59 years at the age of death, 30% were 25-39 years old, while 10% were older than 60 years (Chart 12).



Chart 12 - POB MON 2 representation of the age groups in percentiles

The sample from POB CIV 2 contained 12 individuals (Chart 13). IP was 80.75%.



6



Chart 13 - POB CIV 2 age groups for individuals suitable for the analysis

Most of the individuals died between 40 and 59 years of age. In percentiles 41.66% of sample died between 40 and 59 years, 33.33% died between 25 and 39 years, while 25% of individuals from this sample were older than 60 years (Chart 14).



Chart 14 - POB CIV 2 representation of the age groups in percentiles



In POB MON 3 the total number of sample was 35 individuals, with IP 62.2% (Chart 15).



Chart 15 - POB MON 3 age groups for individuals suitable for the analysis

Most of the individuals died between 40 and 59 years, but the number of individuals who were over 60 was also high. In percentiles 45.71% of individuals from the sample were 40-59 years old at the time of death, 34.28% were over 60 years old, while only 20% were between 25-39 years old (Chart 16).



Chart 16 - POB MON 3 representation of the age groups in percentiles





The sample from POB CIV 3 contained 23 individuals, with IP 69.6% (Chart 17).

Chart 17 - POB CIV 3 - age groups for individuals suitable for the analysis

Most of the individuals died between 25 and 39 years of age. Expressed in percentiles 43.47% died before the age of 40 years, 39.13% individuals died between 40 and 59 years and 17.39% were over 60 years old (Chart 18).



Chart 18 - POB CIV 3 representation of the age groups in percentiles



After applying the criterion of age, sex and preservation, the age distribution changed in some of the populations. The most numerous age group in POB MON 1 was 25-39 years old, in POB CIV 1 the age distribution in two groups -25-39 and 40-59 years was equal, while in POB CIV 3 most of the individuals died between 25 and 39 years.

POPULATIONS	Ν	%
POB MON 1	35	25.5
POB MON 2	20	14.6
POB MON 3	35	25.5
POB CIV 1	12	8.8
POB CIV 2	12	8.8
POB CIV 3	23	16.8
Total	137	100

Distribution of individuals in each population is presented in the table below:

Table 2 - distribution of individuals in each population

3.1.4. Age groups

In order to determinate if differences in life expectancy between monastic and secular populations were statistically important analytics software that provides statistical analysis, SPSS 20.0, was used. The first step was to estimate if the distribution was normal.

In bigger samples (greater than 30) the sampling distribution tends to have a normal distribution with a mean equal to the population mean (Field, 2009). In the smaller samples, like the ones used in this study, the distribution of the sample tends to be is significantly different from a normal distribution. The Kolmogorov–Smirnov test and Shapiro–Wilk test compare the scores in the sample to a normally distributed set of scores with the same mean and standard deviation (Field, 2009). If the test is non-significant (p > .05) it tells us that the distribution of the sample is not significantly different from a normal distribution (i.e. it is probably normal), but if the test is significant (p < .05) then



the distribution in question is significantly different from a normal distribution (i.e. it is non-normal).

	Kolmogorov-Smirnov			Shapiro-Wilk		
POPULATIONS	Statisti	df	Sig.	Statistic	df	Sig.
	c					
POB MON 1	.289	35	.000	.768	35	.000
POB MON 2	.327	20	.000	.771	20	.000
POB MON 3	.234	35	.000	.804	35	.000
POB CIV 1	.257	12	.028	.807	12	.011
POB CIV 2	.209	12	.153	.824	12	.018
POB CIV 3	.272	23	.000	.788	23	.000

Table 3 - the results of normality test

The results of Chi-square tests for each pair of monastic and non-monastic (secular) groups that were compared is presented by two tables. The first one is Crosstabulation table that contains the number of cases that fall into each combination of categories. The second table presents the results of the actual test. Pearson's chi-square test examines whether there is an association between two categorical variables, which are in this case age groups in the monastic and corresponding control population. The significance value in each test was more than .05, which means that there is no important difference in life expectancy between those groups. The *Likelihood Ratio* corrects the main chi-square result for the smaller samples (Field, 2009). But similarly, those tests showed no significant difference between the groups.

	POB MON 1	POB CIV 1	POB MON 2	POB CIV 2	POB MON 3	POB CIV 3
25-39 у. о.	16	5	6	4	7	10
40-59 y. o.	10	5	12	5	16	9
+ 60 y. o.	9	2	2	3	12	4
Total	35	12	20	12	35	23

Table 4 - Crosstabulation table containing the number of cases that fall into each combination of categories

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Chi-square test	POB MON 1/ POB CIV 1	POB MON 2/ POB CIV 2	POB MON 3/ POB CIV3	POB MON1/ POB MON2
Pearson Chi-Square	0.662	0.454	0.123	0.064
Likelihood Ratio	0.663	0.460	0.122	0.062

Table 5 - results of Pearson Chi-square and Likelihood ratio tests

Chi-square test was also performed for POB MON 1 and 2, which belonged to the same convent, but there was an important chronological difference between them. The idea was to find out if modernization brought any differences in the duration of the average lifetime. Like in previous cases, the comparison between POB MON 1 and 2 also showed that there was no significant difference in life expectancy.

3. 2. Stature

The stature was calculated according to three methods: 1. Pearson (1899), 2. Olivier and colleagues (1978) and 3. Mendonça (2000)

3. 2. 1. Pearson's method

Person's method for calculation of the stature was possible to apply to most of the individuals in two monastic and all three secular groups, with the exception of POB MON 3 where poor preservation and fragmentation of bones left less than 50% of individual available for analysis. The number of individuals that were taken into the analysis is presented in the chart below.





Chart 19 - number of individuals in each population analysed by Pearson's method

STATURE PEARSON METHOD								
	POB MON 1	POB CIV 1	POB MON 2	POB CIV 2	POB MON 3	POB CIV 3		
N Valid	32	10	18	7	17	20		
N Missing	3	2	2	5	18	3		
Mean	153.66	150.80	151.56	155.29	152.82	152.75		
Median	154.50	151.50	151.00	154.00	152.00	153.00		
Skewness	216	.009	.444	.458	.593	.077		
Std. Error of Skewness	.414	.687	.536	.794	.550	.512		
Kurtosis	084	-1.670	.262	749	416	581		
Std. Error of Kurtosis	.809	1.334	1.038	1.587	1.063	.992		
Minimum	146	142	145	149	147	146		
Maximum	163	159	161	162	160	161		

Table 6 - values obtained for all 6 populations using Pearson's method for calculation of the stature

The results obtained using Pearson's method show the highest mean for the POB CIV 2 and the lowest for POB CIV 1 (Table 6). According to the classification of Martin and Saller (1957) POB CIV 1, POB MON 2, POB MON 3 and POB CIV 3 belong "below



medium height" height class, while POB MON 1 and POB CIV 2 belong to "medium height" class for women.

Kolmogorov-Smirnov and Shapiro-Wilk normality tests were performed in order to determinate normality of the distribution. As normality tests showed normal distribution for all of the populations it was possible to perform parametric tests in order to estimate if the differences in the stature between populations were statistically significant. For this purpose, independent-samples *t*-test was used.

t-test for equality of means	POB MON 1/ POB CIV 1	POB MON 2/ POB CIV 2	POB MON 3/ POB CIV3	POB MON1/ POB MON2
Sig.	0.101	0.06	0.954	0.088
Mean Difference	2.856	-3.730	0.074	2.101
Standard Error Differences	1.702	1.890	1.279	1.206

Table 7 - results obtained using t-test for Pearson's method

Using t-test for independent sample, comparison of the stature estimated by Pearson's method, between all three monastic populations and the corresponding control samples, as well as the comparison between POB MON 1 and 2, did not show any significant difference between populations.

3. 2. 2. Olivier's method

The number of individuals that were preserved well enough to be estimated by Olivier's method for calculation of the stature was very close to the number of individuals estimated by Pearson's method, although the obtained results in some cases were



drastically different. The number of analysed individuals is presented in the chart below:



Chart 20 - number of individuals in each population analysed by Olivier's method

STATURE OLIVIER'S METHOD								
	POB MON 1	POB CIV 1	POB MON 2	POB CIV 2	POB MON 3	POB CIV 3		
N Valid	33	10	18	7	19	20		
N Missing	2	2	2	5	16	3		
Mean	158.48	155.60	155.17	159.43	157.79	157.10		
Median	159.00	156.00	155.50	158.00	156.00	156.50		
Skewness	190	422	.554	.563	.690	.129		
Std. Error of Skewness	.409	.687	.536	.794	.524	.512		
Kurtosis	134	642	.262	014	702	479		
Std. Error of Kurtosis	.798	1.334	1.038	1,587	1,014	.992		
Minimum	150	145	145	152	151	149		
Maximum	168	164	161	168	166	165		

Table 8 - values obtained for all 6 populations using Oliviers's method for calculation of the stature

The results obtained using Oliviers's method show also the highest mean for the POB CIV 2 and the lowest for POB CIV 1 (Table 8), but according to this method POB CIV 1 and POB MON 2 belong to category "medium height" (classification of Martin and Saller



(1957), while POB MON 1, POB MON 3 and POB CIV 3 belong to "above medium", and POB CIV 2 belongs to "tall height" category.

As Kolmogorov-Smirnov and Shapiro-Wilkall tests showed normal distribution for all of the populations, it was possible to perform parametric tests in order to estimate if the differences in stature between populations were statistically significant. For this purpose, independent-samples *t*-test was used.

t-test for equality of means	POB MON 1/ POB CIV 1	POB MON 2/ POB CIV 2	POB MON 3/ POB CIV3	POB MON1/ POB MON2
Sig.	0.101	0.47	0.37	0.011
Mean Difference	2.856	-4.262	6.89	3.318
Standard Error Differences	1.702	-2.035	1.451	1.258

Table 9 - results obtained using t-test for Olivier's method

Using t-test for an independent sample, a comparison of the stature estimated by Olivier's method did not show a significant difference for any of compared pairs.

3. 2. 3. Mendonça's method

Mendonça's method for calculation of the stature was used to compare the stature of monastic and secular groups. The number of individuals that were preserved well enough to be taken into account was smaller than in the previous two analyses.





Chart 21 - the number of individuals in each population analysed by Mendonça's method

STATURE MENDOÇA'S METHOD								
	POB MON 1	POB CIV 1	POB MON 2	POB CIV 2	POB MON 3	POB CIV 3		
N Valid	24	7	16	6	11	14		
N Missing	9	5	4	6	24	9		
Mean	154.92	152.14	152.06	153.83	154.55	154.36		
Median	155.00	153.00	152.50	153.00	152.00	154.00		
Skewness	.494	422	.361	.916	1.542	.838		
Std. Error of Skewness	.456	.687	.564	.845	.661	.597		
Kurtosis	.463	642	.590	.710	1.321	.737		
Std. Error of Kurtosis	.887	1.334	1.091	1,741	1,279	1.154		
Minimum	148	145	144	149	151	147		
Maximum	166	164	164	161	165	169		

Table 10 - values obtained for all 6 populations using Mendonça's method for calculation of the stature

Unlike two previous methods, the results obtained using Mendonça's method show the highest mean for the POB MON 1 and the lowest for POB MON 2 (Table 10). POB CIV 1 and POB MON 2 belong to "below medium" category, while the other populations are of "medium height" class (classification of Martin and Saller,1957).



As all of the populations, except POB MON 3, showed normal distribution it was possible to perform parametric tests in order to estimate if the differences in stature between monastic and secular populations were statistically significant. For this purpose, independent-samples t-test was used. For the comparison between POB MON 3 and corresponding secular population POB CIV 3 non-parametric alternative to the t-test, Mann Whitney U test, was used. A comparison of the stature estimated by Mendonça's method did not show a significant difference for any of compared pairs (Table 11).

	POB MON 1/ POB CIV 1	POB MON 2/ POB CIV 2	POB MON 3/ POB CIV3	POB MON1/ POB MON2
Sig.	0.847	0.184	0.609	0.438
Mean Difference	3.318	2,780	-1,771	0.188
Standard Error Differences	1.258	2,186	2,393	2,282

Table 11 - results obtained using Mann Whitney U test for Mendonça's method

In summary, the comparison of the stature between all three monastic and corresponding secular populations, as well as for the two monastic populations from the same monastery, using three different methods, did not give any statistically significant differences.

The results obtained by using different methods show a huge discrepancy and are not even comparable since there is no consistent ratio that would allow equalizing those methods of calculation by subtracting or adding of a certain percentile. In general, Pearson's method shows lower values than the other two, but the difference between the obtained valued can vary from a very small difference of 1 or 2 centimetres, to differences that go up to 10 cm. This points to the need for unification of the methodology and adjusting to a population under investigation.

3. 3. Markers of ocuparional stress

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3. 3. 1. Entheseal changes

The results obtained present the mean degree of development calculated for each "functional complex" - shoulder, elbow (flexion/extension), forearm (pronation/supination), hip, knee and foot, for all the populations. For each functional complex mean score (MEAN), standard deviation (SD) and variation (V) were calculated.

Entheseal changes – POB MON 1 and POB CIV 1									
		POB MON 1			POB CIV 1				
	Ν	MEAN	SD	V	Ν	MEAN	SD	V	
L. shoulder	10	1.21	0.472	0.222	2	1.50	0.354	0.125	
L. elbow	10	1.16	0.624	0.389	4	1.15	0.342	0.117	
L. forearm	17	1.27	0.543	0.295	4	1.08	0.419	0.176	
L. hip	23	1.61	0.811	0.658	4	1.38	0.629	0.396	
L. knee	13	1.03	0.630	0.397	5	1.47	0.506	0.256	
L. foot	12	1.50	0.826	0.682	6	1.50	0.707	0.500	
R. shoulder	9	1.36	.601	.361	1	1.50			
R. elbow	12	1.23	0.474	0.224	4	1.35	0.443	0.197	
R. forearm	17	1.24	0.643	0.413	5	1.20	0.901	0.811	
R. hip	23	1.74	0.810	0.656	5	1.50	0.612	0.375	
R. knee	16	1.08	0.803	0.644	5	0.93	0.641	0.411	
R. foot	12	1.50	0.826	0.682	6	1.50	0.707	0.500	

Table 12 - Mean score (MEAN), standard deviation (SD) and variation (V) for each functional complex, upper and lower limbs, left and right sides for POB MON 1 and POB CIV 1

Entheseal changes – POB MON 2 and POB CIV 2								
POB MON 2				POB CIV 2				
	Ν	MEAN	SD	V	Ν	MEAN	SD	V
L. shoulder	13	1.33	0.512	0.262	6	1.21	0.458	0.235
L. elbow	7	1.20	0.589	0.347	4	1.45	0.412	0.170
L. forearm	14	1.29	0.583	0.339	9	1.00	0.33	0.111
L. hip	14	1.21	0.699	0.489	8	1.50	0.598	0.357
L. knee	9	1.00	0.324	0.105	5	1.13	0.558	0.311
L. foot	8	1.00	0.756	0.571	7	1.50	1.041	1.083
R. shoulder	9	1.40	0.394	0.155	2	1.94	0.88	0.008
R. elbow	10	1.32	0.434	0.188	3	1.07	0.416	0.173
R. forearm	14	1.40	0.587	0.345	6	1.17	0.459	0.211
R. hip	11	1.32	0.603	0.364	7	1.21	0.636	0.405
R. knee	8	1.75	0.427	0.183	7	1.14	0.634	0.402
R. foot	8	1.00	0.756	0.571	7	1.50	1.041	1.083



Table 13 - Mean score (MEAN), standard deviation (SD) and variation (V) for each functional complex, upper and lower limbs, left and right sides for POB MON 2 and POB CIV 2

Entheseal changes – POB MON 3 and POB CIV 3								
POB MON 3					POB CIV 3			
	Ν	MEAN	SD	CV	Ν	MEAN	SD	CV
L. shoulder	5	1.45	0.288	0.083	9	1.39	0.532	0.283
L. elbow	4	1.15	0.342	0.117	10	1.12	0.567	0.322
L. forearm	6	1.22	0.172	0.30	11	1.97	0.526	0.277
L. hip	19	1.84	0.554	0.766	12	1.63	0.801	0.642
L. knee	10	1.20	0.804	0.647	12	1.97	0.643	0.413
L. foot	11	1.00	0.500	0.250	9	1.17	0.866	0.750
R. shoulder	2	1.56	0.088	0.008	7	1.18	0.322	0.103
R. elbow	4	1.35	0.443	0.197	8	1.25	0.602	0.363
R. forearm	6	1.89	0.404	0.163	13	1.13	0.442	0.195
R. hip	20	1.93	0.766	0.586	16	1.47	0.670	0.449
R. knee	8	1.00	0.471	0.222	8	1.88	0.689	0.474
R. foot	11	1.15	0.500	0.250	9	1.17	0.866	0.750

Table 14 - Mean score (MEAN), standard deviation (SD) and variation (V) for each functional complex, upper and lower limbs, left and right sides for POB MON 3 and POB CIV 3

The test of normality did not show normal distribution. For that reason, a non-parametric test was used to estimate if there was a statistically significant difference between monastics and corresponding secular populations.

	POB MON 1 /	POB MON 2 /	POB MON 3/	POB MON 1 /
EC	POB CIV 1	POB CIV 2	POB CIV 3	POB MON 2
L. shoulder	0.324	0.567	0.500	0.418
L. elbow	0.633	0.444	0.831	0.806
L. forearm	0.487	0.285	0.136	0.968
L. hip	0.627	0.207	0.532	0.142
L. knee	0.159	0.628	0.545	1.00
L. foot	0.886	0.308	0.723	0.177
R. shoulder	0.861	0.093	0.178	0.688
R. elbow	0.378	0.549	0.864	0.503
R. forearm	0.968	0.373	0.299	0.384



R. hip	0.667	0.639	0.110	0.187
R. knee	0.835	0.206	0.591	0.472
R. foot	0.886	0.308	0.723	0.177

Table 15 - the p values of Mann–Whitney U test between compared pairs of populations

The results for entheseal changes show that there were no statistically important differences between monastic and their control populations, nor between POB MON 1 and 2, in any of "functional complexes" which were analysed.

3. 3. 2. Other Markers of Occupational Stress

The activity of populations was estimated by the degree of expression of entheseal changes, but also by markers of occupational stress, such as Schmorl's nodes, disc herniation, Charles' facet, squatting facets, jumper knee, *os acromiale* and markers of occupational stress on teeth. The results are presented in the table below (Table 16).

Markers of Occupational Stress								
	POB MON 1	POB CIV 1	POB MON 2	POB CIV 2	POB MON 3	POB CIV 3		
Charles' facet	28%	8.3%	20%	41.6%	31.42%	30.45%		
Squatting facets	45.71%	25%	45%	41.6%	37.14%	34.72%		
Jumper knee	8.5%	-	-	8.3%	-	-		
Os acromiale	2%	-	-	8.3%	5.7%	4.3%		
Schmorl's nodes	31.4%	8.3%	40%	33.3%	5%	4.3%		
Disc herniation	2.8%	16.66%	15%	16.66%	5.71%	4.3%		

Table 16 - frequency of markers of occupational stress expressed in percentiles

Markers of occupational stress on teeth was noted only in the case of one individual from POB MON 3.

3. 4. Osteoarthrosis



Osteoarthrosis was very frequently presented in all populations and in both upper and lower limbs. In order to clearly illustrate the frequency of osteoarthrosis of 12 "functional complexes" – shoulder, elbow, hand, hip, knee and foot (for both sides of the body) is presented on figures above. The yellow arrows show the frequency of OA presented in marked zones, expressed in percentiles (Fig. 20 - 22).



Figure 20 - frequency of OA in POB MON 1 and POB CIV 1

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Figure 21 - frequency of OA in POB MON 2 and POB CIV 2





Figure 22 - frequency of OA in POB MON 3 and POB CIV 3

The statistical comparison performed in SPSS 20.0, of monastic and corresponding secular populations, as well as for POB MON 1 and 2, did not show any statistically important difference, except in frequency of OA in the right hip between POB MON 3 and POB CIV 3 (Table 17).

	POB MON 1/	POB MON 2 /	POB MON 3/	POB MON 1 /
OA	POB CIV 1	POB CIV 2	POB CIV 3	POB MON 2
L. shoulder	0.947	0.714	0.698	0.871
L. elbow	0.406	0.701	0.558	0.091
L. hand	0.425	0.308	0.191	0.841
L. hip	0.343	0.688	0.354	0.877
L. knee	0.565	0.688	0.553	0.254
L. foot	0.652	0.192	0.289	0.937
R. shoulder	0.048	0.345	0.507	0.258
R. elbow	0.921	0.758	0.073	0.786

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R. hand	0.741	0.547	0.033	0.524			
R. hip	0.061	0.519	0.004	0.117			
R. knee	0.768	0.693	0.476	0.790			
R. foot	0.601	0.280	0.518	0.737			
Cervical	0.971	0.348	0.805	0.326			
Thoracic	0.922	0.200	0.855	0.253			
Lumbar	0.973	0.975	0.985	0.984			

Table 17 - the p values of Mann–Whitney U test between compared pairs of populations

The frequency of the most severe expression of OA, degree "3", was analysed separately for three functional complexes that were assumed to be the most affected by the religious practice of nuns: hands, knees, and feet. The red arrows in figures below show the frequency of OA presented in marked zone, expressed in percentiles (Fig. 23-25)



Figure 23 - frequency of degree "3" in POB MON 1 and POB CIV 1





Figure 24 - frequency of degree "3" in POB MON 2 and POB CIV 2



Figure 25 - frequency of degree "3" in POB MON 3 and POB CIV 3



The only area in which the frequency was notably higher in all three monastic populations was the knee.

A similar comparison was performed for the three zones of the spine: cervical, thoracic and lumbar, presenting the frequency of the most expressed form, degree "3", with red arrows, and the frequency of OA in general with the blue arrows (Fig. 26-28). All values are expressed in percentiles.



Figure 26 - frequency of OA (blue arrows) and OA degree "3" (red arrows) in POB MON 1 and POB CIV 1



Figure 27 - frequency of OA (blue arrows) and OA degree "3" (red arrows) in POB MON 2 and POB CIV 2



Figure 28 - frequency of OA (blue arrows) and OA degree "3" (red arrows) in POB MON 3 and POB CIV 3



3.5.Traumas

In POB MON 1, except traumas found on the male individual, there were only five individuals with traumas spotted in this sample (5.8%):

- 1. a fracture of the sternum
- 2. a fracture of the humerus
- 3. a fracture of the femur
- 4. a fracture of the sacrum
- 5. a fracture of the left scapula and the left ulna

All of them, except the fracture of the sacrum, showed signs of healing, while the sacrum fracture had a fatal outcome. The sacrum presents a transverse fracture, which caused a more pronounced angulation in the normal curvature of the bone (Fig. 29). The bone was without the presence of healing, suggesting that it has occurred *perimortem*.



Figure 29 - transverse perimortem fracture of sacrum

The same individual that presented perimortem fracture of sternum also had a very curved shaft of the femur, suggesting a possible relation between those two conditions.



In POB MON 2, there were more individuals with signs of traumas (in relation to the size of population -22.5%), mostly on legs and ribs. Unlike POB MON 1, in this population many of the traumas resulted in an infection, but also attempts of medical treatment was noted.

1. a fracture of the wrist (healed)

2. a trauma of both femurs and right ribs (not healed) with the woven bone formation surrounding the fractures. Only one of the ribs presented callus, while other did not show signs of healing.

- 3. a fracture of the first rib (healed)
- 4. a complete fusion of the calculus and the talus (as a consequence of trauma)
- 5. an injury of the tibia (infection)
- 6. an injury of the femur (infection)
- 7. a fracture of the fibula (an attempt of treatment, Fig. 34)

In POB MON 3 the number of traumas was very high (31.42%) and in most of the cases included fractures of various bones. All the fractures were *antemortem* and the healing process was completed at the time of death.

- 1. a fracture of the tibia
- 2. a fracture of the right femur and the left acetabular
- 3. a fracture of the rib
- 4. a fracture of tibia and the astragal
- 5. a fracture of the axis
- 6. a healed trauma on the frontal bone and a possible injury on tibia
- 7. a fracture of the right tibia

8. a blunt force trauma on frontal bone, a fracture of the sternum and a fracture of an incisive (22) (Fig. 30)

9. a fracture on the vertebras -C7, T1 and T2. Apart from that, this individual has various other pathologies, such as: lack of fusion of *os acromion*, scoliosis, asymmetry of the radius and bowing of the proximal part of the left tibia, which could be explained as a consequence of repetitive traumas and overload in childhood.

10. a fracture of the fibula



11. a fracture of the tibia and the fibula



Figure 30 - individual from POB MON 3 with various traumas: blunt force trauma to frontal bone, an antemortem fracture of the sternum and a fracture of an incisive

In POB CIV 1, two individuals (16.6%) had signs of injuries. All injuries were *antemortem*.

1. a fracture of the right humerus and a rib

2. fractures of all long bones in the right arm (humerus, ulna and radius) and of the first metacarpal.

In POB CIV 2, two individuals (16.6%) had certain signs of trauma on various parts of the body:

1. a fracture of the tibia, discus hernia and a compression fracture of vertebras.

2. an *antemortem* trauma in the frontal bone, a fracture of the left ulna and a fracture of the right tibia and the fibula.

On the individual 18, the head of the left femur had some irregularties that could be connected with Legg-Calvé-Pertes disease, or slipped capital femoral epiphysis. Unfortunately, the head of that femur is severely damaged taphonomically (by roots of plants) so it was impossible to make a certain diagnosis.





Figure 31 – taphonomically damaged femur with possible antemortem trauma

In POB CIV 3, only two individuals had signs of injuries (8.6%). In both cases the injuries were healed before the death of the individuals.

- 1. a fracture of styloid process of the left ulna
- 2. a fracture of the right foot

Most of the fractures found in both the monastic and the secular population can be attributed to accidental traumas. Surprisingly, the injury on the scapula of individual 2413, from POB MON 1, is in such a position and of such appearance, that suggests that it could be a consequence of interpersonal violence. The injury was located in the central area of the body of the left scapula (Fig. 32). A linear cut-mark is perpendicular to the bone surface, that affects both sides of the scapula – due to the thinness of the bone at this area – but that logically was made in the posterior or the dorsal surface. The small cutmark could be produced by a sharp object such as a knife or an arrow. Signs of healing were also notable, but the person died before the wound healed completely. The morphology of these signs points to be in a stage of formation of primary bone callus (Ortner, 2003), the process that usually begins about two or three months after trauma



(Etxeberría, 2003), but that depends on different factors. In this case, the callus was not completely formed, so the death of the individual seems to have occurred some months after the trauma happened. Intentional violence would be something quite unexpected in a female convent, but the location and the morphology of the injury leaves little possibility that this could be an accident. Another possible diagnosis is pseudo-fracture, as a consequence of osteomalacia. This will be discussed in Metabolic diseases sub-chapter.



Figure 32 - Injury of scapula, presented from anterior and posterior perspective

The same individual had the fracture of the distal ulna. Like in the case of the scapula, the new bone formation is notable, suggesting that process of healing was ongoing in the moment when the death of the individual occurred (Fig. 33). This location in ulna is also frequently affected in the cases of osteomalacia.





Figure 33 - fracture of the left distal ulna presenting signs of healing

Osteomalacia could also be a possible explanation for the changes in individual 23, from POB MON 2, that present (pseudo)fractures on both femurs and right ribs (Fig. 41).

In POB MON 2, a fracture of the left fibula was observed, showing signs of an infection in the process of healing. On the lateral side of the fibula, a green strain, the result of oxidation of copper-containing metal object was discovered, precisely on that bone part where the fracture was present. The photos from the excavation and other archaeological documentation confirmed the presence of a metal plaque discovered *in situ*, in close contact with the bone (Fig. 34). The second metal plate was discovered a few centimetres away, closer to the right knee, but this may be the result of displacement due to taphonomic processes or during the excavation, since the traces of oxidation on the medial side of the tibia, at the same height as the fibula, were noted, indicate that the two metal object was placed in parallel. This was probably an attempt at fixing the bone after trauma, as a part of medical treatment. The assumption can be supported by a similar finding of remedial medical treatment with copper-alloy plates, published in the paleopathological literature, which confirms that such a practices existed in monastic orders (Knüsel, Kemp & Budd, 1995).





Figure 34 - fracture of the left fibula with the metal plaque discovered in situ (possible remedial medical treatment)



Periostitis may be caused by non-specific bacterial infections or traumas. Infectious diseases that spread through the hematogenic route expand on the bone (Ortner, 2003). Infection or trauma stimulate the osteoblastic cells that are found in the inner layer of the periosteum, which causes a new, poorly organized bone that covers the original cortical bone.

In the POB MON 2 several individuals presented perisostitic post-traumal infection (Fig. 35).

Figure 35 - post-traumatic tibial infection

Individual 3 from POB MON 3, a woman aged 40-59 years, had an *antemortem* fracture of the right femur and dislocation left acetabular. This condition was very severe, leaving the individual with the right femur notably shorter (Fig. 36).




Figure 36 - left and right femur from individual 3, POB MON 3, notably different in size

The right, pathological femur, is much smaller and more robust than the left one, which can be considered normal. The neck of the femur is also shorter, more robust and with a greater angle than normal. The morphology of distal epiphysis of the right femur was very alterated by posttraumatic arthritis. The traumatic injuries changed the mechanics of the joint, making it wear out more quickly.

The short size of femur leads to the conclusion that traumatic occasion happened in the childhood, so that femur did not reach its full size, even though epiphysis has fused.

On the left acetabular a line of healed fracture can be noted. The morphology of the socket was altered, probably due to dislocation of the femur. The head and the neck of the left femur were not preserved, but it is expected that this pathological condition had its reflection on this area as well. Only righ patella was preserved with very pronounced enthesophytes (16 mm). Lower legs and foot were not preserved.

This traumatic event (or events) probably altered importantly the life of the individual, affecting her health, motoric and physical appearance.

The individual assigned as a "possible male", from POB MON 1, also had traumas in both tibias and in the sternum. Tibias had the sign of periostic reaction secondary to trauma. The thickness of the midshaft and hematoma can be noted, but there is no sign of active reaction (Figure 37). Sternum has irregular form and sign of a healed, but malaligned, fracture. It is possible that injuries of tibias and of sternum present the part of the same traumatic event.





Figure 37 - peristic reaction and hematoma on "posible male" individual

3.7. Stable isotopes

Collagen quality

17 of 66 human samples yielded collagen poorly preserved: 3 of them because of too low yield (under 3.5%) and 14 because of bad quality (low percent of C or N, C/N out of the accepted range). The remaining 49 samples showed C/N into the accepted range, C and N percents over 13% and 5% respectively (Ambrose, 1990), and 42 of them met a more restrictive requirement, with C > 30% and N >11% (Van Klinken, 1999).

As for the animal samples, all but one sample (a fish vertebra with C/N =3.8) yielded good quality collagen.

Isotopic analyses compare 48 individuals from 16th and 17th centuries (POB MON 1), 8 individuals from the 19th-20th century (POB MON 2) and 13 faunal specimens including sheep, *Gallus*, pigs and marine fish.

The sample from POB MON 1 presented similar values for most of the individuals except for one "outlier" whose diet was based more on meat (higher values of δ 15N) (Fig. 38).

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Figure 38 – results of stable isotopes analysis for POB MON 1

Humans	5"N	5 ¹³ C	
mean all (n=49)	11.4% ± 0.790 (9.7 to 13.9%)	-18.0% ± 0.369 (-16.2 to -18.6%)	
With no outlier (n=48)	11.4% ± 0.711 (9.7 to 12.7%)	-18.1% ± 0.259 (-17.5 to -18.6%)	
Outler	13,9%	-16,2%	
Fauna			
Sheep mean (n=7)	8.2% ±1.101 (6.6 to 9.6%)	-20.1% ± 0.560 (-19.4 to -21.0%)	
Hen mean (n=3)	8.6% ±0.825 (7.8 to 9.4%)	-19.6 %+ 0.275 (-19.3 to -19.9%)	
Catfish	11.3%	-12,2%	
Sus scrofa	9.0%	-18,7%	
Sus domesticus	9.9%e	-19.3%	

Table 18 - results of stable isotopes analysis for POB MON 1 in numeric values

In order to compare possible differences within the population, individuals were divided into groups according to age (from sub-adult to +60), sex, health condition (individuals with signs of chronical diseases and those without), and stratigraphy (earlier and later burials). Except for the "outlier" other individuals in POB MON 1 did not present any statistically significant differences (Table 19).



equal median/mean probability	number of cases	8 ¹³ C	8 ¹⁵ N	test
Sex	males: 1 females: 45 allophys: 2 unknown: 1	0.8754	0.4404	Kruskal-Wallis
Age	13 to 19: 1 20 to 39: 13 40 to 59: 21 260: 11 unknown: 2	0.8882	0.2002	Kruskal-Wallis
Health condition	healthy: 42 pathologic: 6	0.0668*	0.8545	Mann-Whitney
Stratigraphy	early: 32 late: 16	0.1552	0.8579	Nest

Table 19 - the results of statistical comparison between different groups within POB MON 1

The results obtained for the POB MON 2 present very similar values, except for the 3 individuals, whose diet was more relied on C4 plants (Table 20).

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Tumba	Especie	Rend %	% C col	% N col	at C/N	δ ¹³ C VPDV (‰)	δ ¹⁵ N AIR (‰)
T-21	Homo sapiens	20.0	40.73	14.67	3.2	-15.7	11.1
T-23	Homo sapiens	26.5	41.76	15.03	3.2	-18.6	12.3
T-24	Homo sapiens	24.7	37.75	13.75	3.2	-15.7	11.4
T-28A	Homo sapiens	27.2	40.83	14.74	3.2	-15.8	11.7
T-28B	Homo sapiens	24.2	40.81	14.84	3.2	-18.3	10.4
T-30	Homo sapiens	23.1	36.45	13.19	3.2	-17.9	12.6
T-36	Homo sapiens	19.0	41.18	14.72	3.3	-17.8	13.0
T-44	Homo sapiens	23.9	37.58	13.64	3.2	-18.6	12.0

Table 20 - the results of Isotopic analysis for POB MON 2

Two of three individuals from POB MON 2, with the different isotopic signal, had signs of the chronical pathological condition, while the third one did not express any pathological changes (Fig. 39).



Figure 39 - Results for POB MON 1 and 2 presented together.



3.8. Metabolic diseases

3. 8. 1. Rickets residual in adult

Bowing deformity in adults, especially on the shaft of long bones, can be attributed to residual rickets (Fig. 40). It has been noted in both monastic and secular populations in approximately similar frequency (Table 21).

In POB MON 1 it was noted on 4 individuals (11.4%), both in upper and lower extremities, as well as in sternum.

In POB MON 2, 4 individuals (12.9%) had bowing deformities, but only in the sternum and upper extremities.

In POB MON 3, 6 individuals (17.1%) had bowing deformities, mostly in lower limbs.

In POB CIV 1, 2 individuals (16.6%) had bowing deformities.

In POB CIV 2, 2 individuals (16.6%) had bowing deformities.

In POB CIV 3, 4 individuals (17.9%) had bowing deformities, mostly in lower limbs.



Figure 40 - variouse examples of ricket residual from monastic populations

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	POB MON1	POB MON2	POB MON3	POB CIV1	POB CIV2	POB CIV3
STERNUM	3	2	-	-	-	-
LEFT	-	-	-	-	-	1
HUMERUS						
RIGHT	-	2	1	-	-	1
HUMERUS						
LEFT RADIUS	-	1	-	1	-	-
RIGHT	-	1	-	-	1	-
RADIUS						
LEFT ULNA	-	-	-	1	-	-
RIGHT ULNA	1	1	1	-	1	1
LEFT FEMUR	1	-	2	1	-	2
RIGHT FEMUR	2	-	2	1	-	2
LEFT TIBIA	1	-	2	1	1	1
RIGHT TIBIA	2	-	2	1	-	1
LEFT FIBULA	-	-	-	-	-	1
RIGHT FIBULA	-	-	1	-	-	1
SCOLIOSIS	1	-	-	-	-	-

Table 21 - Bowing deformity in adults in monastic and secular populations

3.8.2. Osteomalacia

As discussed previously, two individuals from monastic populations had fractures that could possibly be related to osteomalacia instead of a trauma. Since microscopic analyses were not performed, the assumption was based on the macroscopic examination of bones and similarly to the previously described paleopathological cases (Ives & Brickle, 2014), both in terms of the location in the body as in apearance of the fracture and callus.

The fractures were described in the Trauma subchapter.

In the case of the individual 23, aged 40-59 years, from POB MON 2, the locations of fractures – ribs and femurs, are typical for osteomalacia. Organisation of callus, notable on only one rib, also resemble this condition (Fig. 41). In the case of femurs, the (pseudo)fracture was surrounded by a porous woven bone, but there were no signs of healing.





Figure 41 - fracture of rib, individual from POB MON 2

The individual 2413, aged over 60, from POB MON 1 (previously described in Truma sub-chapter), had a fracture on the body of the left scapula, surrounded by a porous woven bone fracture callus, and on the distal ulna of the same side, the process of healing was also not finished. Locations of fractures are common for osteomalacia (Ives & Brickle, 2014).

In both cases the injuries were still in healing process, and obviously individuals died before this process ended. Both individuals were older, with very porous bones and a lot of osteoarthrosis in knees (which produced eburnation) and in the spine (which produced fusion of various vertebras).



3. 10. Scurvy

One of the individuals from the secular population, POB CIV 2, presents possible signs of scurvy. It is a young female individual, estimated to belog to the age group 25-39 years old, but more likely to be at the beginning of that group, as a line of epiphysis fusion can still be noted on clavicle and sacrum.

Porotic lesions were noted in various parts of the skull. Ectocranial porosity spotted on the parietal bones can be characterised by an 'orange peel'-like porosity (Fig. 42, left). A small fragment of sphenoid bone was preserved with notable porosity (Fig. 42, right). Abnormal porosity is also visible on the occipital bone fragment and on temporal bones too. The changes noticed on hard plate displays a mixture of micro and macro porosity (Fig 43, right). On the maxilla and mandible abnormal porosity is noticeable in the alveolar bone (Fig 43, left).



Figure 42 - Ectocranial porosity on the parietal (left). A small fragment of sphenoid bone was preserved with notable porosity (right)





Figure 43 - four lines of enamel hypoplasia notable on 34 (left). Abnormal porosity on hard plate (right)

On postcranial skeleton, abnormal porosity was noticeable on all preserved long bones and on coxal.

A part from possible signs of scurvy this individual also had four lines of enamel hypoplasia - suggesting that she suffered at least four different episodes of physiological stress before reaching the age of 7 (Fig. 43, left, red arrow), and *cribra femoris* on both femurs (Fig. 44, left).

Schmorl's nodes were notable on several thoracic and lumbar vertebras (Fig. 44, right).



Figure 44 - Cribra femoris (left) and Schmorl's nodes (right)



3. 11. Frequency of porotic lesions

Four different types of porotic lesions were recorded in this study: *cribra orbitalia*, *cribra femoral* and *humeral cribra* and porotic hyperostosis in skulls. The frequencies were presented in the following table (Table 22).

Frequency of porotic lesions								
POPULATION	cribra o	rbitalia	cribra fe	moral	humera	ıl cribra	p. hype	rostosis
	N	%	N	%	N	%	N	%
1 POB MON 1	1	7.7	9	32.1	2	6.1	0	/
2 POB MON 2	0	/	4	22	0	/	1	6.3
3 POB MON 3	0	/	6	17.1	0	/	1	6.7
4 POB CIV 1	1	14.3	0	/	0	/	0	/
5 POB CIV 2	1	12.5	2	22	0	/	6	54.5
6 POB CIV 3	0	/	4	17.4	0	/	0	/

Table 22 – the frequency of porotic lesions in monastic and secular populations. N – number of cases, % - values expressed in percentiles

Porotic changes were unequally distributed between the population. *Cribra femoral* was the most present lesion, notable in all but one population, with the frequency between 17.1 - 32.1%. Other lesions were less notable, with an exception of porotic hyperostosis in POB CIV 2, that was present in 54.5% of population.

In the case of cribrotic syndrome, especially for *cribra orbitalia* and *cribra femoris*, it was very important to know the age of individuals, as those are changes typically more frequent in young individuals. For that reason, the occurrence of this condition, divided in the age groups, was represented in the table below (Table 23).

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POPULATIONS		cribra orbitalia	cribra femoris	humeral cribra	p. hyperostosis
	Ν	1	9	2	0
	25 – 39 y. o.	1	5	1	/
POB MON 1	40 – 59 y. o.	/	3	1	/
	+ 60 y. o.	/	1	/	/
	N	0	4	0	1
	25 – 39 y. o.	/	1	/	/
POB MON 2	40 – 59 y. o.	/	2	/	1
	+ 60 y. o.	/	1	/	/
	Ν	1	6	/	1
	25 – 39 y. o.	1	2	/	0
POB MON 3	40 – 59 y. o.	/	4	/	0
	+ 60 y. o.	/	/	/	1
	N	1	0	0	0
	25 – 39 y. o.	1	/	/	/
POB CIV 1	40 – 59 y. o.	/	/	/	/
	+ 60 y. o.	/	/	/	/
	Ν	1	2	0	6
	25 – 39 y. o.	1	1	/	4
POB CIV 2	40 – 59 y. o.	/	1	/	2
	+ 60 y. o.	/	/	/	/
POB CIV 3	N	0	4	0	0
	25 – 39 y. o.	/	1	/	/
	40 – 59 y. o.	/	3	/	/
	+ 60 y. o.	/	/	/	/

Table 23 - the frequency of porotic lesions in monastic and secular population, divided in the age groups



3. 12. Parietal Thinning

Using macroscopic examination and radiological imaging it was possible to determinate the presence of Parietal Thinning in 5 skulls from POB MON 1. In this necropolis, of 85 individuals found there, only 53 skulls were preserved well enough for examination, which means that the frequency of individuals with Parietal Thinning was 9.43% of the total number.

Partial Thinning was suspected in 6 skulls from POB MON 3. In two cases skulls were broken, so thinning of diploë was obvious, while 4 other cases were sent for radiological imaging, but it did not show presence of the pathology. In this collection, from 132 exanimated individuals only 66 had skulls that were preserved well enough for examination, so the frequency of Parietal Thinning is 3,03%.

POB MON 1

The skull 925 is very incomplete, only part of the neurocranium was recovered. It was impossible to determine the precise age, while sex estimation was based on postcranial bones, which showed characteristics of a female individual. In the right parietal bone thinning and big depression was observed. We do not know if it was bilateral, because the left parietal area was not recovered. In the affected area it can be noted that the diploë has disappeared. While the inner table remains intact, the outer table also disappeared.

The skull 2504 corresponded to a woman over 60 years old. The most of the splanchnocranium is missing. A very marked depression is present on left parietal. In this case, it is unilateral. In the area of parietal depression, diploë is very thin, it almost disappeared.

The skull of the individual 1712 was poorly preserved; only fragments of the skull with 2 incomplete parietals were present. The sex and age were determinate based on postcranial skeleton, showing that this individual was a woman aged between 40 and 59 years. A significant depression in the two parietal is present, in the area between the sagittal suture and the parietal prominence. The rest of the skeleton was strongly affected with osteoarthritis and osteoporosis.

The skull of the individual 2312 is incomplete, the splanchnocranium is missing, but both parietal were preserved, as well as occipital and temporal bones. The sex and age were



determined based on postcranial skeleton, which belonged to a woman, over 60 years old. Significant depression in both parietal can be noted, as well as in area of sagittal and lambdoid sutures. In sagittal suture very important depression and thinning is noticeable, particularly in the area close to lambda. The CT image shows very narrow parietal, with loss of almost all the diploë, though in one of the parietal two tables were preserved (Fig. 45). The rest of the postcranial skeleton was strongly affected with osteoarthrosis and osteoporosis.



Figure 45 – Noticable depression in both parietal. The CT image shows very narrow parietal, with loss of almost all the diploë.

The skull 1305 was incomplete, only a part of the neurocranium was recovered. The individual was a woman over 60 years old. On both sides of parietal bones, the depression



can be noted. *Postmortem* fracture on the left side of skull allows us to see that the diploë disappeared, while the inner table remains intact. On this individual strong signs of osteoarthritis can be noticed on occipital condyles. The rest of postcranial skeleton was not preserved.

POB MON 3

The skull 51 was incomplete, only neurocranium was recovered. The sex and age were impossible to determine, although complete obliteration of the sutures suggest that the person was older. The bilateral thinning affected importantly the morphology of skull, leaving a very prominent depression. The right side of the skull was partly broken in the affected area of parietal bone, exposing the thinning that was so emphasized that diploë disappeared completely while the skull was as thick as an egg-shell (Fig. 46).



POB MON 3 - 51 Figure 46 - very emphasize bilateral thinning of parietal and complete disappearance of diploë

The skull 1789 is very fragmented, only parietal bones and fragment of frontal bone were preserved. The thinning was notable on both parietal bones. Due to bad preservation the sex and age were not possible to determinate. Coronal, sagittal and small part of occipital suture were partly obliterated, but still visible. The thinning of diploë was very prominent and it could be observed even without radiography, due to a *postmortem* fracture of the skull in the affected area.



3. 13. Developmental disorder

Various development disorders were detected in both monastic and secular populations. As explained previously, in this work we focused only on those that could affect health, appearance and mobility.

3. 13. 1. Coxa valga

Coxa valga, a deformity in which the neck-shaft angle of the femur is greater than 140 degrees, results in bowlegged appearance (Staheli, Duncan & Schaefer, 1968). Due to bow legs, a person's posture places abnormal pressure on the knee and ankle joints, which later causes joint inflammation, pain and swelling on the knee, and may cause problems with normal daily activities and reduce the range of motion or mobility. Coxa valga can be congenital, a consequence of trauma or it can develop in childhood (Spencer, Shadle, Watkins & Wiener, 1978).

Coxa valga on one or both femurs were noted in all 3 monastic populations and in 2 secular populations. Only cases without accompanying signs of a trauma or without other pathological condition (e. g. bowing of the shaft) were taken into account. In POB MON 1 there were 7.14% of the population with that deformity, in necropolis POB MON 2 he frequency was 5%, while in POB MON 3 - 8%. In secular female populations the frequency of coxa valga was 8.3% in POB CIV 1 and 13.06% in POB CIV 3, while in POB CIV 2 this pathology was not recorded.

3. 13. 2. Small lateral femoral condyle

The individual 213 from POB MON 1 was a woman over 60 years old with a pathological condition on both legs expressed by a small lateral femoral condyle. While the medial condyle appears to be of normal size and shape, the lateral condyle is much smaller (Fig. 47). The condition is bilateral, although more expressed on the left femur, which eliminates the possibility of its traumatic condition. The neck-shaft angle of both femurs is greater than normal (coxa valga). Medial and lateral condylar articulation, in both femurs, indicates osteoarthrosis ridges.



The alteration can be spotted also on the level of articulation with the tibial plate. One can observe a very significant asymmetry between the two facets of joints. The medial tibial plate is of normal size and form (consistent with the observed in the normal medial condyle of the femur) while the lateral tibial plate is much smaller and has a more oval shape, consistent with the medial femoral condyle's altered morphology. Furthermore, visible osteoarthritic ridges are present around the articular area. Strong osteoarthrosis, with eburnation and porosity, can be noted on knees too. The pathology did not influence the length of the femurs or tibia.



Figure 47 - small lateral femoral condyle notable on both legs. The alteration can be spotted also on the level of articulation with the tibial plate and on both patellae.

3. 13. 3. Klippel-Feil syndrome

The individual 8 from the necropolis in Alcácer do sal was an older woman (over 60 y. o.) with signs of Klippel-Feil syndrome.

Klippel-Feil syndrome is an uncommon disorder, that occurs in approximately 1: 40,000–42,000 births (Thomsen, Schneider, Weber, Johannisson & Niethard, 1997) and it is characterized by the fusion of two or more cervical vertebrae. Individuals with this pathology have the predisposition to serious neurologic pathology after a relatively minor



trauma as well as occurring spontaneously (Smith & Griffin, 1992). Physical appearance of those individuals is characterized by a short neck, limited neck motion, and a low posterior hairline (Fig. 48). A number of anomalies are associated with Klippel-Feil syndrome, including urologic anomalies (35% to 64%), deafness (36%), congenital heart disease (14%), Sprengel's deformity of the scapula (30%), scoliosis (60%) and congenital neural abnormalities such as mirror movements (18% to 20%) (Toker et al., 2009). The main consequence is the loss of motion in the involved area.



Figure 48 - clinical case of individual with Klippel-Feil ²⁵

In the case of individual 8, a fusion of the atlas with the occipital bone and of C2 and C3 can be noted. Apart from that, she also had very strong scoliosis and osteoarthrosis in every vertebra (Fig. 49).

In spite of the condition and possible complications that went along, she had various occupation markers like squatting facets and *os acromiale*. As already mentioned, the

²⁵ Retrived from <u>http://adc.bmj.com/content/79/4/352</u>



lack of fusion of the *os acromiale* according to some authors can be also attributed to significant physical efforts in the period prior to bone fusion.



Figure 49 - pathological condition Klippel-Feil in which 2 or more vertebras are fused

3. 13. 4. Possible facial paralysis

The individual 44 from POB MON 2 was a woman aged 40-59 years with enormous deposits of calculus, that on some teeth were covering the whole surface (Fig. 50). On the last molar on the right side of the maxilla (18), and on the first and second molars on the right side of the mandible (46 and 47; 48 was lost *antemortem*) green algae-like formation can be noted (Fig. 51). Green colour can often be found on the bones, due to taphonomic staining (contact with oxidised coper objects). However, in that case a green stain would have probably be noted on the mandibular and maxillary bone or on teeth, and the object would have probably be preserved, due to its recent chronology. But even if the green colour can be explained by some taphonomic processes, the algae-like morphology of the deposit and its firmness, as well as reduction of alveoli that follows the line of the deposits, suggests that this formation was created during the life of the individual. Nevertheless, some additional microscopic analyses are required.





Figure 50 – blocks of calculus



Figure 51 – green, algae-like formation on the last molars



Blocks of calculus that are covering the whole surface of the tooth could hardly be possible to form, if the person was able to chew. If algae-like formation were formed during the life, it is hard to imagine that a person under normal circumstances would allow such a lack of hygiene, or at least not be disturbed by, it and try to remove it with a tongue. Total absence of tooth wear, except slight attrition on the upper and lower incisive (11, 21, 31 and 41), is not in accordance with her age (40-59 years) (Fig. 52). Taking into account all these facts it is possible that she suffered from some kind of facial paralysis and that she was fed with a straw (which could explain the attrition of the incisive).

Muscle skeletal markers in upper and lower extremities, presence of osteoarthritis in all preserved vertebrae, wrist, metacarpals, epiphysis distal of the right femur and in right knee, and presence of discus hernia in T7 and T9, are signs of physical activities that shows that she was able to move the rest of her body.



Figure 52 - tooth wear can be noted only on the upper and lower incisive, suggests the use of straw as a way of eating

3.13.4. Plagiocephaly

Congenital deformities were also noted in one of the civil populations. The female individual 113, aged 25-39 years, from POB CIV 3 had signs of plagiocephaly, also known as flat head syndrome (Kabbani, & Raghuveer, 2004) (Fig. 53). This condition is characterized by an asymmetrical distortion (flattening of one side) of the skull. It is characterized by a flat spot on the back or one side of the head. Plagiocephaly is the word that is used to describe a diagonal asymmetry across the head shape. This word



particularly describes a flattening which is to one side at the back of the head and there is often some facial asymmetry. Plagiocephaly is divided into two group:

- 1. Synostotic plagiocephaly with one or more cranial sutures is fused.
- 2. Nonsynostotic (deformational) plagiocephaly

Nonsyntotic (deformational) plagiocephaly develops when an infant's rapidly growing head attempts to expand, and meets some type of resistance - either prenatally in the mother's womb, or after a delivery because a baby's head is pressed against a bed or other flat resting surface. Many babies develop deformational plagiocephaly by sleeping regularly in one position, or by spending extensive time sitting in the same position. On the other hand, synostotic plagiocephaly involves much more serious malformations of the skull bones. While positional head deformity nowadays can be treated with physical therapy or a head orthosis ("helmet"), synostotic plagiocephaly requires an operation, restructuring the posterior fossa to provide adequate space for normal brain development as well as restoring normal symmetry.

Synostotic plagiocephaly occurs in approximately one of every 100,000 infants (Lowe & Woolridge, 2007; Goodrich & Argamaso, 1996), while positional head deformity is not

as rare, and the incidence nowadays is one in every 300 healthy infants (Pospíšilová & Procházková, 2006). The positional head deformity is caused by external pressures on the rapidly prolonged developing skull from exposure to one position and produces more facial asymmetry than synostotic plagiocephaly, because of the forehead protruding on the side of the flattening. The skull of the individual 113 is very asymmetric and all sutures were close, which can lead to a conclusion that she suffered from synostotic plagiocephaly.



Figure 53 – skull wih plagiocephaly from POB CIV 3



3.14. Dental health

Various parameters of dental hygiene were tested for all populations.

3. 14. 1. Caries

Although the estimation of the frequency of caries within one population was often performed by simple count of a number of teeth affected that is not the most accurate way to get the precise information of its distribution. If the individual lost many teeth *antemortem*, or if preservation of teeth was poor, the obtained result will not present the real picture. For that reason, in this study, the total number of teeth with caries was divided with a number of teeth preserved and multiply by hundred, to get the percentage. The results are presented in the table below (Table 24).

CARIES							
POPULACION	N	% Mean	Std. Deviation				
POB MON 1	28	18.92	21.11				
POB MON 2	17	25.92	20.38				
POB MON 3	24	43.55	25.65				
POB CIV 1	9	38.11	14.11				
POB CIV 2	11	27.35	29.86				
POB CIV 3	14	33.03	31.88				

Table 24 - frequency of caries. N - the number of analysed individuals. % Mean. Std Deviation – standard devoation.

3. 14. 2. Calculus

Calculation of the frequency of calculus was estimated only by presence/absence of the deposit, regardless of the size. The obtained results are presented in the table below (Table 25).

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CALCULUS							
POPULACION	N	n	%				
POB MON 1	28	25	89.3				
POB MON 2	16	12	75				
POB MON 3	24	20	83.3				
POB CIV 1	9	7	77.8				
POB CIV 2	11	6	54.5				
POB CIV 3	14	12	85.7				

Table 25 - frequency of calculus. N - number of analysed individuals, n – number of individuals with calculus, % - the percentage of individuals with calculus in relation to the total number

3. 14. 3. Antemortem tooth loss

The total number of teeth lost *antemortem* is calculated for all populations. The difference between AMTL and PMTL is manifested in the presence of absorption and bone reaction. The results are presented in the table below (Table 26).

AMTL					
POPULACION	N	Mean	Std. Deviation		
POB MON 1	33	6.00	8.250		
POB MON 2	18	7.22	6.865		
POB MON 3	20	8.9	8.996		
POB CIV 1	11	8.27	6.798		
POB CIV 2	12	11.08	8.979		
POB CIV 3	19	8.26	6.244		

Table 26 – frequency of AMTL: N – number of individuals, Mean – average number of tooth lost, Std. Deviation – standard devoation

3. 14. 4. Enamel hipoplasia



Presence of hypoplasia was analysed in all individuals that had preserved incisors and canines, as those teeth are most likely to have lines of hypoplasia. The results are presented in the table below (Table 27).

	Distribution of hypoplasia			
POPULACION	Ν	n	%	
POB MON 1	35	21	60	
POB MON 2	20	17	85	
POB MON 3	35	20	57.14	
POB CIV 1	12	11	91.66	
POB CIV 2	12	7	58.33	
POB CIV 3	23	15	65.21	

Table 27 - frequency of hypoplasia: N - number of analysed individuals, n - number of individuals with hypoplasia, % - the percentage of individuals with hypoplasia in relation to the total number

3. 14. 5. Periodontal diseases

The presence of periodontal diseases was analysed for all the maxillar and mandibular bones that still have teeth preserved. Edentate maxillar and mandibular bones were excluded from the analysis. The results are presented in the table below (Table 28).

Periodontal disease						
POPULACION	n	N	%			
POB MON 1	23	27	85.2			
POB MON 2	15	16	93.8			
POB MON 3	16	17	94.1			
POB CIV 1	9	9	100			
POB CIV 2	10	11	90.9			
POB CIV 3	11	13	84.6			



Table 28 - frequency of periodontal disease: N - number of analysed individuals, n – number of individuals with signs of periodontal disease, % - the percentage of individuals with periodontal disease in relation to the total number

The comparision between monastic and corresponding secular populations, performed in SPSS using Chi-square test, for all the dental diseases, shows that the only statisticaly significant difference exists between the frequency of caries between POB MON 1 and 2, being much more frequent in the last (Table 29).

Chi-square test	POB MON 1 /	POB MON 2 /	POB MON 3/	POB MON 1 /
	POB CIV 1	POB CIV 2	POB CIV 3	POB MON 2
Hypoplasia	0.027	0.095	0.537	0.045
AMTL	0.200	0.233	0.832	0.162
Caries	0.006	0.133	0.022	0.003
Calculus	0.402	0.270	0.854	0.221
Perio. disease	0.116	0.784	0.391	0.377

Table 29 - comparision between monastic and corresponding secular populations



3.15. Infectious diseases

3. 15. 1. Syphilis

The individual SS 110, from POB CIV 1, had pathological changes on the skeleton that most likely could be connected to syphilis. *Caries sicca* was noted on the frontal, parietal and occipital bone (Fig. 54). Various changes were noted on long bones, from plaque-like layers, thickness, periostitis and gummatous, but in some cases it was hard to distinguish from posttraumatic changes, a consequence of a very complicated and not successfully healed fracture of the arm. However, *cares sicca* in the skull and "melted-wax" changes on tibia are pathological changes typical for syphilis that differs from periostitis, osteomyelitis and other pathological signs connected with trauma.

The same individual had variouse other pathologies such as coxa valga, bowing of long bones in lower extremities (suggesting rickets residual) and *antemortem* fracture of the left arm and sternum with irregular alignment (the left bone was shorter and curved, Fig. 55). A complicated condition of this individual requires a more detailed analysis which will be provided in the Discussion.

The analysis of mercury levels in bone remains of this individual confirmed the presence of mercury in concentration 2.24 mgHg/kg.

The presence of mercury in the bones does not necessary mean that the individual was exposed to some kind of syphilis treatment with mercury, as bones could be contaminated by mercury in soil. According to the study performed by Walser, Jakob & Kristjánsdóttir (2017, April) in Iceland, the levels of contamination of the soil with mercury were between 0.002 to 1.35 mg/kg, with the median of 0.022. They compared those results with the results obtained from the bones of individuals from 16th century that had pathological changes connected to syphilis. The level of mercury in the bones of those individuals expressed values from 0.93 - 3.42 mg/kg. Similarly, the study performed in Poland ($16^{th} - 17^{th}$ century) compared values of mercury in bones of individuals that had no pathological changes with those that had signs of syphilis (Kępa et al., 2012). The



mean for the non-pathologic group was 0.80 mg/kg, with the highest values 1 mg/kg, while two individuals with pathological changes had statistically significantly higher quantity, namely 2.1 and 2.6 mg/kg, which suggested possible mercury treatment (Kępa et al., 2012).

The values obtained in those two studies, for individuals with syphilitic changes, were similar to the one from the Spanish sample, which could suggest the possibility of a mercury treatment.



Figure 54 – skull with caries sicca lesions, typical for the advanced stage of syphilis.





Figure 55- antemortem fracture with irregular alignment of left humerus and sternum and bowing deformity of tibia

3. 15. 2. Leprosy

One of the individuals from the monastic population POB MON 2, aged 40-59 years, had pathological changes that could be attributed to leprosy. This infectious disease in a living individual affects the skin, the mucous membrane, soft tissues and nerves (Ortner, 2003). On the skeleton, it can be recognized by destruction of nasal bones (disappearance of the anterior the nasal spine, the rounding and widening of the nasal aperture, pitting and new bone formation in both the nasal floor and the palate), reabsorption of premaxilla alveolar process, loss of upper incisors, atrophy and erosive changes in hands and feet (Job et al., 1966; Ortner, 2003; Antunes-Ferreira, Matos & Santos, 2013). Neurotrophic changes of the hand and feet are also present on this individual, leading to the destruction of the sensory nerves and circular alteration (Cooney & Crosby, 1944), eventually leading to the loss of sensation in hands and incapacity of using them.

The individual has the pathological changes on the metacarpals and the metatarsal, AMTL in both the maxilla and the mandible, as well as the widening of the nasal aperture (Fig. 55).





Figure 55 - pathological changes related with leprosy

3.15.3. Brucellosis

In POB MON 1, there was one individual with typical signs of brucellosis on lumbar vertebrae, exhibited by lytic lesions in the anterosuperior portion of the body (Fig. 56), and another individual with less clear signs (maybe beginning of the disease). In POB MON 2, the individual who had signs corresponding to brucellosis was in an advance stage of this condition. Both individuals with signs that are likely to be connected with brucellosis had also banding of lower and upper limbs, suggesting surviving of rickets in childhood.





Figure 56 - lytic lesions on lumbar vertebra, typical for brucellosis



Figure 57 – pathological changes in the hip area, a possible sign of brucellosis

One of the individuals from the secular population (POB CIV 2) presented pathological changes on the hip, that according to Ortner (2003) can also be an area affected with brucellosis, although in this case the diagnosis is less certain (Fig. 57).



3. 16. Metastatic bone tumour

One of the individuals from POB MON 2, aged 40-59 years, expresses the signs of severe pathology spread over the entire thorax, the skull and the coxal area and the proximal femur, while the rest of lower limbs stayed intact. The lesions are lytic, with undercut edges, without any signs of healing or remodelling, most likely corresponding to a tumour (Fig. 58). Metastatic tumours are much more common than primary tumours and they can spread to bones through the vascular system, by direct spread from a tumour adjacent to a bone, through the lymphatic system or through the cerebrospinal fluid in those with tumours in the brain (Waldron, 2009). In this case, the area that was affected, as well as the morphology of lytic is correspond to the breast cancer. This type of cancer is the most frequent malignant tumour that leaves traces in bones in females (Resnick & Niwayama, 1988). In most cases, it is present at the age between 50 and 65 (Waldron, 2009), which corresponds to the actual age of the individual in the study.



Figure 58 – lytic lesions corresponding to a tumour

This individual also presented a bowing deformity of right forearm (without signs of healed trauma, Fig. 59) and various lines of hypoplasia, suggesting that she suffered several episodes of physiological stress in her childhood.





Figure 59 – bowing deformity of right forearm, without signs of healed trauma, possibly rickets residual

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4. DISCUSSION

Demography

The demographic picture presented in Results shows characteristics of both monastic and control populations in terms of life expectancy, sex distribution and sub-adult mortality.

Sex distribution

Unequal sex ratio noted in secular populations could partly be explained by bad preservation of bones, as there was a high number of indeterminate individuals, which leaves the possibility that the sex ratio here presented is not realistic. Yet, male bones tend to be thicker and more robust, and therefore less affected by taphonomic processes, so maybe this explanation is not the most accurate.

In the monastic population the presence of a possible male individual in the burial area reserved only for nuns is not easy to explain. According to Cunha and colleagues (2000) the burial of a male individual in an area reserved for nuns' burials was forbidden, but despite the prohibition the presence of a young male sub-adult, aged around 11 years, was confirmed using DNA analysis in monastery Santa Clara-a-Velha (Coimbra). The only men allowed to enter in a convent was a bishop, so our presumption went in that direction. However, this individual had very pronounced muscle skeletal markers and healed injuries in tibias and sternum, which is hard to relate to someone who spent his life in meditation and prayers. But at the same time, the isotopic signal did not differ from the rest of nuns, so it is very likely that this individual lived with the nuns. Of course, the possibility that sex estimation based on the skull was not correct, despite very pronounced male characteristic, general robusticity and stature much higher than average, cannot be ruled out.



Mortality of sub-adults

The number of subadults in secular populations was much smaller than expected. In POB CIV 1 there were no sub-adults at all, in POB CIV 2 only 2 individuals (7.6%) were subadults, and in POB CIV 3 17 individuals (17.17%) were in this category. Only POB CIV 3 had the distribution of sub-adults close to usual for historic populations (see Introduction). In other two cases the lack of sub-adult remains could be explained by bad preservation (bones of children are smaller, more fragile and more subjected to taphonomic destruction) or some kind of cultural practice, weather children were buried in a separate necropolis or this presented necropolis of distinguished persons.

In the monastic population, POB MON 1, the remains of 2 sub-adults, aged 10-12 and 14-18 were found. As previously explained in Introduction, before 20th century the minimum age for entering a monastery was 12 years for girls, although historical sources mention even younger children. The individual 812, aged 10-12 years, did not have any pathologies, but this can also be due to bad preservation. The individual 922, aged 14-18, had caries on 3 teeth (in one case affecting almost the entire root) and deposit of calculus. The lines of enamel hypoplasia can be noted on upper canine (13), suggesting physiological stress during growth (Goodman & Rose, 1990).

In POB MON 2 and 3, there were no remains of sub-adult found, but that does not necessarily mean that there were no children accepted in the monastery – that only means they did not die before becoming adults. The possibility that the rule set in 1901, that no person may be admitted into a congregation under the age of 15 without a special permission of the Holy See, could influence child mortality in the case of POB MON 2, does not seems to be likely. Knowing that the last burial in monastery Santa Catalina occurred in 1921, and that there were no individuals younger than 19-25 years in the population, it is logical to assume that most of the nuns (if not all) entered the monastery before 1901, so that this rule was not applicable to them.

Life expectancy

Relying on previously mentioned demographic and osteological studies, regarding life expectancy for females, it was expected that nuns who were supposed to practice celibate



and have no children, would live longer than secular women (see Introduction). Although the number of elderly individuals was high in the monastic population (especially POB MON 3) Chi-Square test shows that there is no statistically significant difference in the life expectancy between monastic and secular groups, so the suggested hypothesis that avoiding pregnancy would result in longer life on average can be rejected, at least for the tested samples. However, POB CIV 1 and 2 present very unusual demographic characteristics: in both populations sub-adult individuals are not sufficiently (or at all) presented, and the number of female individuals is noticeably higher than males. This irregular distribution suggests that not all individuals from the secular population were buried in those necropolises and that individuals found there are in the same way selected. This, together with the small size of the sample, can possible be the explanation for the absence of significant differences between two secular and the monastic population in the term of life expectancy. One of the suppositions could be that some of the individuals buried in the civil cemetery of Santa Catalina in Belmonte were actually lay sisters. Unlike nuns, lay sisters would enter the convents without paying dowry, nor make solemn vows, and they were allowed to leave a monastery, mainly to get supplies or whatever was necessary, but they spent most of the time in a similar way as nuns - within monastery walls, praying and working. Probably they were not permitted to be buried in the same area with choir nuns and abbesses, but the civil cemetery was just one floor above, within the same monastery complex. The possibility that some of the females buried in the civil area (POB CIV 2) could belong to the monastery is supported by the observation that some of them had very pronounced OA on the first metacarpals (maybe due to frequent use of rosary), while one was buried in identical rubber shoes as choir nuns (of course, this in itself may not be sufficient proof, as in a small town such as Belmonte perhaps greater choice of shoes did not exist). If this assumption about the presence of lay sisters would prove to be true, that would explain the prevalence of female skeletons and a small number of children in the secular population, but also very small differences in many segments of life between monastic and secular populations. Unfortunately, in the absence of funeral goods or historical evidence this will remain only a speculation.


The comparison between monastic population from Belmonte, POB MON 1 and 2, did not show statistically important differences either, so the assumption that modernization and industrialization would bring longer life in average did not prove to be true, but it seems that it brought different mortality patterns. Namely, the highest peak of mortality in POB MON 1 was between 25 and 39 years (45,71%), but the number of individuals that were over 60 years old was very high (25,71%). On the other hand, the highest peak of mortality for POB MON 2 was between 40 and 59 years (60%), but the number of individuals over 60 years old was smaller (10%).

Stature

In summary, the comparison of the stature between all three monastic and corresponding secular populations, as well as for two monastic populations from the same monastery, using three different methods, did not give any statistically significant differences. The supposition that the stature of the monastic population could differ from secular or due to the assumed high class origin or due to possible metabolic stress that entering the monastery could provoke, was not confirmed.

The values obtained for both monastic and secular populations are also similar to other historic populations from the Iberian Peninsula from the medieval period (9th -13th century), that presents average values from 154.29-158.9 cm according to Olivier's method, and 154.14-158.48 using Mendonça's method (Maroto, 2004), and early modern time (15th century) that presents average stature of 155.29 cm according to Pearson and 159.27 cm according to Olivier's method.

The results for stature, obtained by using different methods, show a huge discrepancy. The systems are also incommensurable, since there is no consistent ratio that would allow to equalize them by subtracting or adding a certain percentile. In general, Pearson's method tends to show lower values than other two, but the difference between the obtained valued can vary from the very small difference of 1 or 2 centimetres, to differences that goes up to 10 cm. This points out to the need for unification of the methodology and of adjusting it to a population under investigation.



Osteoarthritis

The estimation of the frequency of OA, presented in the Results, shows that it was very widespread, affecting over 50% in all populations. Areas that were particularly affected were hands/wrists and knees. The comparison between monastic and secular populations did not show any statistically significant difference.

Recent research is trying to comprehend OA as a result of a variety of external influences, but also genetic predispositions, where age and sex play an important role. As in this study there were no male individuals included, and no individuals younger than 25 years, results obtained are perhaps more accurate than the usual comparison between populations, where similar results are often repeated (women having more OA in knees than men, for e.g.) and interpreted as sexual division of tasks, while those differences actually originate from genetic factors.

According to clinical studies, only severe expressions of OA, such as eburnation, can be interpreted as an indicator of extreme repetitive mechanical loading (Manek et al.,2003; Thelin et al.,2004; Weiss & Jurmain, 2007). Bearing this in mind, if instead of recording the presence of any expression of OA, attention is turned only to extreme manifestations of this pathology, a very different picture would be obtained. The degree "3", described as "complete or near complete (more than about 80%) destruction of articular surface, the presence of eburnation or joint fusion (synostosis)" turned out to be a lot more frequent in monastic populations than in secular ones in areas of knees. This can be attributed to the religious practice of kneeling several times a day during the prayers.

The frequency of porotic lesion

Analysing the frequency of porotic lesions – *femoral cribra, humeral cribra, cribra orbitalia* and porotic hyperostosis, some unusual patterns were noted. *Cribra femoris,* presented in all populations, except in POB CIV 1, with the frequency of 21.1 - 32.1 %, is a characteristic that should have had its highest peak around the age of 14, and the prevalence should have decreased after 20 years of age (Polo-Cerda et al., 2000; Djurić et al., 2009; Radi et al., 2013). In samples that are objects of this study *cribra femoris* was presented in all age groups, even with individuals over 60 years old. According to some



authors, the correlation between *cribra orbitalia* and *femoral cribra* exists: Miquel-Feucht and colleagues (1999) reported that in their sample all individuals who had *cribra orbitalia* also had *cribra femoris* (100 %), while in the study of Djurić and colleagues (2009) those characteristics were associated with 33.33% of cases. In the samples presented here *cribra orbitalia* was very rare, while *femoral cribra* was quite frequent, but only one individual presented both of those characteristics. *Humeral cribra* was noted only in POB MON 1, while *porotic hyperostosis* was not frequent or not present at all in most of the populations, except POB CIV 2 where its frequency was surprisingly high – 54.5%. Also, many authors stated that *cribra orbitalia* and *porotic hyperostosis* are associated in the sense that *cribra orbitalia* is the initial manifestation of the lesion which later affects the other bones of the cranial vault (El-Najjar et al., 1976; Lallo et al., 1977; Walker, 1986; Stuart-Macadam, 1989; Wapler et al., 2004), but in this study, the relationship between those two was not noted, since only one individual had signs of these two conditions.

Metabolic diseases

Bowing deformity - possible residual rickets in adults

As explained previously, rickets is a consequence of a metabolic disorder caused by the lack of sunlight or the lack of vitamin D in the diet. A number of individuals with bowing deformities of long bones and sternum – characteristic for individuals who suffered from rickets in childhood, was surprisingly high in most of the monastic and secular populations (from 4.7 to 17.9%). According to Hess (1930) only 10–25% of cases of rickets that resulted in visible bending of the leg bones would have retained visible deformity in adults, which means that number of individuals affected by rickets in childhood was much higher. Brickley, Mays and Ives (2010) report similar percentage (14,81%) of adults with bended long bones, which they attribute to rickets residual, found in the cemetery of St Martin's in England. But unlike England, which is famous for rainy and foggy weather and lack of sunlight, Spain is one of the sunniest countries in Europe.



And this is even more accurate if we take into account that Belmonte and Toledo are located in central Spain, that is famous for the dry climate and a lot of sunny days. According to Holick (2004), the exposure time required for sufficient doses of vitamin D is only 5–10 min, two to three times per week with limited skin exposure. As Portugal is also located in the south of Europe, it has a lot of sunshine hours too, but in winter rainy periods can be very long. Alternatively, vitamin D may be ingested through dietary sources. Oily fish, such as codfish and sardines, that is very frequently used in Portuguese cuisine, are the richest nutrient with vitamin D^{26} . Consequently, rickets should not be very common in selected populations.

Bowing caused by rickets usually occurred in periods of fastest growth: usually in earliest childhood, but it can also happen during puberty (Oppenheimer & Snodgrass, 1980; Elder & Bishop, 2014). The highest peak of growth for girls in puberty is between 11 and 15 years (Yai, 1997; Proos, Hofvander & Tuvemo, 1991), which corresponds to the average time of becoming novices. Maybe entering cloister – enclosure behind high walls, thick clothes that were covering whole bodies, hard physical work and reduced alimentation and fasting, could produce a sort of metabolic shock, especially knowing the fact that most of the girls came from a high class of society.

But even if this explanation could be valid for monastic populations it is hard to explain the equally frequent occurrence of bowing deformity in secular populations. Bowing deformity in children can be caused by various factors, other than rickets, but physiological bowing should normally be corrected during the growth and it is rarely persisting into adulthood (Bleck, 1982), while traumatic bowing deformities, such as acute plastic bowing deformities is considered to be very rare (Stuart-Macadam et al., 1998)

Osteomalacia

Two individuals from Belmonte, POB MON 1 and 2, had fractures that perhaps could be ascribed to osteomalacia, although the possibility of an intentional or accidental trauma

²⁶USDA, 2013. U.S. Department of Agriculture, Agricultural Research Service. USDA. National Nutrient Database for Standard Reference, Release 26. Nutrient Data Laboratory Home Page. Retrieved from http://www.ars.usda.gov/nutrientdata



cannot be rejected. In the case of the individual 23, from POB MON 2, changes noted on the ribs and the femurs present typical locations of pseudo-fractures caused by vitamin D deficiency. Also, the appearance of callus in one of the ribs is very similar to callus produced in cases of osteomalacia.

In the case of the individual 2413, from POB MON 1, fractures in the scapula and the distal ulna are not considered as strongly indicative for osteomalacia, if not followed by a rib fracture (ribs were not preserved), and it is suggested that a possibility of an accidental trauma should be considered (Ives & Brickle, 2014). However, the appearance of an injury on the scapula does not resemble fractures caused by an accident, as there are no fracture lines radiating from the main injury. It is also noteworthy that fractures of the scapula are rather rare (Lovell, 1997; Baxarias & Herrerín, 2008). From the characteristic of this trauma, and its location, it could be attributed either to an intentional injury involving a sharp object or to osteomalacia. Although it is hard to be sure without microscopic examination, it seems easier to assume that a nun a who spent all her life in the enclosure would suffer from the lack of vitamin D, than to imagine nuns who stubbed each other with knives. It is also important to take into account that both individuals were older (the individual 2413 had over 60 years old), which is another argument toward ostomalacia. A range of clinical work examining the capability of the skin and organs to synthesise vitamin D demonstrated that older adults are likely to be at an increased risk of osteomalacia (Chapuy et al., 1997; Halloran & Portale, 1997; Holick 1998; Mosekilde, 2005).

The possible explanation for the presence of osteomalacia in POB MON 1 and 2 and not in POB MON 3, although supposedly all of them lived under prohibition of leaving the monastery, is that the first two populations originated from Belmonte, which is located in the continental part of Spain, while Alcácer do Sal is located on the coastline of Atlantic Ocean. The frequency of sea fish in the diet could have provided sufficient amounts of vitamin D and that could substitute for the sun exposure.

In any case, it is necessary to carry out more detailed analyses in the future, involving a microscopic examination, that would provide more data for studying manifestations of osteomalacia and confirm or reject those assumptions.



Scurvy

A young individual, aged approximately 25-30 years, from POB CIV 1, had several signs of malnutrition among which there was scurvy. Scurvy is a metabolic disorder caused by the lack of ascorbic acid, vitamin C, in the diet. In the case of humans, some of the non-human primates and guinea pigs, it cannot be produced by the body itself (Maat, 2004). Clinical consequences of scurvy include bleeding gums, tooth loss, pain in the extremities, vertigo, faintness, excessive sweating, hemorrhagic spots in the eyes, xerosis, hyperkeratosis, bent and coiled body hairs, and impaired wound healing (Hodges et al. 1969, Hirschmann & Raugi 1999).

The porotic changes were noted in various parts of the skull and the post cranium skeleton, and on the preserved fragment of the sphenoid bone, which is, according to Ortner (Ortner & Ericksen, 1997; Ortner et al., 1999; Ortner et al. 2001), the most characteristic sign of scurvy. Porosity caused by scurvy is a vascular response to chronic bleeding at the site, and it can sometimes be accompanied by new bone formation, which presents a more severe expression of this condition (Ortner, 2001). In the case of this young woman new bone formation was not noted, suggesting that she did not suffer from scurvy during a long period of time. Vitamin C is available in most of the fresh fruits and vegetables, so the appearance of scurvy is usually connected with natural or social disasters, such as long-term droughts or besieged places, and specific life conditions, like life of sailors on transoceanic sailing ships (Miladinović-Radmilović & Vulović, 2015). However, there are in fact various factors or lifestyle issues that might increase the risk of scurvy, such as food allergy diets, eating disorders (anorexia nervosa or bulimia) or other conditions that provoke a chronic loss of nutrients (diarrhoea, for example).

In this individual several lines of enamel hypoplasia (up to four on some teeth) and *cribra femoris* on both femurs were noted, suggesting that she survived several periods of physiological stress and malnutrition since early childhood. Porotic hyperostosis noted on cranial vault could be caused by the lack of vitamin C, but it could also be caused by the shortage of other nutritive components such as vitamin B12, vitamin B9 (folic acid) or parasite-induced blood loss and/or diarrhoea (both iron and magnesium malabsorption). The lack of iron and magnesium is considered to be the cause of *cribra femoris* as well (Miquel-Feucht et al., 1999). But, as it was noted by Stuart-Macadam



(1989), scurvy often occurs with anaemia. In fact, experiments performed on guinea pigs showed that progressive anaemia is one of the symptoms of dietary deficiency in vitamin C (Mettier & Chew, 1932). Therefore, a possibility of co-morbidity should not be ruled out.

Schmorl's node on several thoracic and lumbar vertebras suggest that she also performed hard physical labor.

Summarizing the information about the diet and metabolism, collected from the bones of both monastic and secular populations, it is notable that all the populations suffered from the lack of vitamin D and possible lacks of iron and/or magnesium during the period of growth. Some of the individuals from the populations from the monastery in Belmonte suffered from the lack of vitamin D even in the adult age, probably due to the enclosure (hence the lack of sunlight) and lack of diet rich in this vitamin. In the monastic population from Alcácer do Sal the presence of osteomalacia was not noted, but the high frequency of healed fractures in this population could be explained by the lack of vitamin D that makes bones more prone to fractures. Although nuns had religious restriction concerning meat and animal products during approximately half of a year this did not leave traces on their bodies. Isotopic signal, together with the analysis of skeletal remains, showed that nuns had a uniform but sufficient diet, and that example of harsh malnutrition were not noted. In contrast, the secular population from 19th century (POB CIV 2) expressed very frequent presence of porotic hyperostosis and even one case of chronic malnutrition, manifested by signs of scurvy, cribra femoris and up to four lines of hypoplasia. On the other hand, here studied monastic populations did not express signs of overconsuming of meat (DISH), very typical for male monastic communities (Bruntjes, 1987; Waldron, 1985; Waldron, 2009), which could mean that they obeyed the rules more strictly.

Isotopes

Isotopic analyses of 49 individuals from the POB MON 1 and 8 individuals from POB MON 2, together with 13 faunal specimens, shed that female monastic population of



Santa Catalina de Siena in the majority had a very uniform diet that did not change over the time. Most of the individuals present $\delta 13C$ values which are within a limited range, from -17.6% to -18.6%, while δ 15N shows a shift between 9.7 and 12.7%. There was only one outlier in POB MON 1: an individual marked as 1224, a female, 25 to 39 years old, presenting $\delta 15N$ values much higher than the rest of the populations, which indicates a diet relying more on animal proteins. According to monastic rules, the sick had the right to avoid fasting and eat meat during the period of illness, but in recovery they had to go back to habitual restrictions. A person whose diet significantly differed in terms of consumption of food of animal origin had no visible pathological changes, except slight osteoarthrosis. One of the possible explanations is that this woman did not enter the convent in her adolescence, like most of the nuns, but later (maybe as a widow), after spending most of her life in a noble family. We know about one case from this convent from 19th century, where money for the reparation of the oven in kitchen was obtained by dowry of 600 ducats "which gave a lady of the court who had been retirement in the convent" (Caballero & García, 2013), which means that such a practice existed. On the other hand, individuals from POB MON 1 with pathological changes in the skeleton, corresponding chronic diseases, such as tuberculosis or brucellosis, did not show any signs of a different diet. One of the sub-adult individuals, aged 14-18 years, had one of the highest values of $\delta 15N$, if the "outlier" was not taken into account, suggesting that her diet changed relatively recently. This could mean or that either she joined the congregation not so long ago, or that she was excluded from fasting, which is in accordance with the rules of order (see Introduction). The diet of a possible male individual presented values that completely corresponded to average values of the monastic community ($\delta 15N = 11,6\%$, $\delta 13C = -18,3\%$), suggesting that he (?) probably spent many years living (and eating) with the nuns. The results also showed that the individuals of old age did not have a special diet.

In POB MON 2, three individuals had a diet that contained more C4 plants, probably corn (and sugar). Two of three individuals, whose diets were based more on C4 plants were chronically sick, having brucellosis and (possibly) breast cancer, but the third individual didn't have any pathological changes on her skeleton. The use of corn in traditional medicine is well known, but it is not clear if that was the reason for its higher consumption. Although corn was known since Colombo's voyage and "discovery" of



America, there was no sign of its usage in POB MON 1, neither in archaeological excavation, nor in the isotopic signal. Historical sources explain that occurrence, saying that until 18th century corn was food for the poor and animals only, but after periods of famine in 18th century it became used by all social classes (Azcoytia, 2009).

Markers of occupational stress

Entheseal changes

The results for entheseal changes show that there were no statistically important differences between monastic and their control populations, nor between POB MON 1 and 2, in any of "functional complexes" which were analysed. Although recently there has been a lot of criticism of entheseal changes as a method for comparison between populations or groups inside of one population (Santos, 2011; Villotte, 2016; Henderson, Mariotti, Pany-Kucera, Villotte & Wilczak, 2013; Meyer et al. 2012) in this study many of the habitual errors were avoided. Analyses and scoring on all 6 populations were recorded by the author of this thesis, which meant avoiding inter-observer errors and misunderstanding of terminology. Furthermore, all the criterions suggested by Meyer and colleagues (2012) were fulfilled: the compared pairs were from the same chronology, the cemeteries were not in use over too long period, so all of the individuals originated from time-framed context and of known historical background. In addition, all individuals were females which meant avoiding sex-related comparison, that can easily lead to wrong interpretations (Mays, 1999; Weiss and Jurmain, 2007; Meyer et al, 2012).

But the main problem with the presented results is the lack of division in age groups, as most of the authors agree that entheseal changes present age-related phenomenon (Robb, 1998; Mariotti, 2007), and that severity of its expression with increase with age, but as explained before small sample of populations would not allow it. However, as in those populations there were no sub-adults, or very young adults (less than 25), and the statistical test did not show significant differences in life expectancy, it can be assumed that age did not affect the obtained results importantly.



Those results show that the expression of entheseal changes did not differ between secular and monastic populations which means that nuns performed similar amount of manual labour as women from the secular population.

Other osseous changes, connected with occupational stress, such as Schmorl's nodes, Charles' facet, squatting facets, disc herniation, jumper knee, *os acromiale* and markers of occupational stress on teeth show similar results – that nuns worked as much, or even more, than females from secular populations. The most frequent changes are those on tibia – squatting facets, that can maybe be explained by position during religious service, but Schmorl's nodes and disc herniation implicate mechanical overload of the spine (Williams et al., 2007). The lack of fusion of acromial bone *- os acromion*, could be a consequence of mechanical stress in the period of growth, which would mean that even very young individuals were performing hard physical tasks. In the case of one of the individual from POB MON 3, the clearly defined groove can be noted on the first upper incisive (11). Smooth edges indicate that this was not a consequence of any kind of accidental trauma, but rather a repetitive task that included the use of teeth, as a "third hand".

Congenital deformations and early childhood pathologies

The study of congenital deformation and early childhood pathologies, that could affect health, physical appearance or mobility, was considered to be of high importance for the female monastic populations of the past. The fact that there were no hospitals, nor mental institutions, impose the question what happened to the women who were in some way unfit to perform their biological functions.

Monastic books from England were mentioning various cases of "idiots", "deaf and dumb" or completely insane: "all the nuns appeared separately before the Bishop, with the exception of Alicia Benyntone, who is out of her mind and confined in chains" (Power, 1988, p. 32). "... the practice, which certainly existed, of placing in nunneries girls in some way deformed, or suffering from incurable defect" (Power, 1988, p. 28). In the detailed study of archives from English monasteries and historical sourcies, Power (1988) also mentioned popular medieval songs, that sugest that going to monastery was the only option for woman rejected by the society: "*Now earth to earth in convent walls,*



to earth in churchyard sod. I was not good enough for man, and so am given to God".

In the belief that same thing was happening in Iberian Peninsula congenital deformations and childhood deformities within three populations from nunneries in Spain and Portugal were examined.

Various pathologies were detected among monastic populations, that ranged from less severe pathologies that would cause walking abnormalities or pain during long standing, to serious conditions. But in spite of the deformities, all of the women were performing every day's tasks and had an average length of life, or even longer than average, which probably wouldn't be possible without proper care of the community.

Dental diseases

As presented in the Results, the comparison between monastic and secular populations did not show any statistically significant differences in terms of dental diseases. In fact, the only significant difference was between two monastic populations from the monastery Santa Catalina in Belmonte, where the population from $19^{th} - 20^{th}$ century had a much higher frequency of caries than the one from 16th - 17th century. The results also showed the higher frequency of AMTL in POB MON 2, although those values were not statistically significant. Those results are corresponded to the change of the isotopic signal in the more modern population, suggesting a higher use of C4 plants. But on the contrary, calculus, that is usually connected with the lack of dental hygiene, just like caries and AMTL, was less frequent in POB MON 2. Of the monastic population the highest frequency of caries was noted in POB MON 3. Perhaps this could be explained by the fact that this monastery belonged to the order of "Clarisas" which is famous for their pastry (Braga, 2015), but yet the frequency of caries in POB MON 3 (43.55%) was way lower than what Cunha and Cardoso (1997) reported for the monastery Santa Clara-a-Velha (85.7%) that belonged to the same order, located in Coimbra. The frequency of enamel hypoplasia, which is considered to be a highly sensitive indicator of physiological and metabolic changes in childhood (Goodman & Rose, 1990), was over 50% in all



populations, with the highest frequency for the secular populations - 91.66% (POB CIV 1), and 85% for the monastic populations (POB MON 2).

Infectious diseases

Leprosy

Although leprosy was more common in the middle ages, it appeared occasionally in Western Europe until 1940 (Ortner, 2003). This disease, probably more than any other in human history, was always followed by stigmatisation and segregation, even up to the 20th century (Lynnerup & Boldsen, 2012). In some cases, the individuals with leprosy were sent into designated isolated geographic areas, while in others they were forced to wear a bell to warn other citizens when they were passing (Cule, 2002).

In the case of the individual from POB MON 2, this did not seem to be a case. Atrophy of hands (and maybe feet) meant that she must have had problems with mobility and that she was incapable of taking care of herself, but the advanced phase in which the disease was suggests that she lived a long time with that condition. This, again, points to the fact that the community took a good care of the weak and sick members, no matter what was their condition was. She was buried in the area of the chorus, like other nuns, with the year of death engraved in the gravestone -1911. Preserved pieces of monastic clothes such as robe, shoes and buttons, show that she died as a full member of her congregation, not isolated or stigmatized.

Brucellosis

Brucellosis was discovered in both populations from Belmonte, while in the case of Nossa Senhora from Alcácer do Sal two cases were previously described by Curate (2006). Brucellosis is a typical zoonotic infection caused by gram-negative bacteria of the genus Brucella. Brucellosis found in all three monastic populations can be a consequence of close contact with animals (mostly goat) or consumption of non-pasteurised milk and dairy products. Archaeological sources confirmed the presence of



stables in both monasteries, while archeozoological analysis verified the presence of sheep/goat bones in Santa Catalina and in Nossa Senhora.

Tuberculosis

Possible cases of tuberculosis were discovered in all three monastic populations. However, tuberculosis in its less severe forms (before reaching collapse of spine known as Pott's disease) is manifest by lytic lesions on vertebras body, cortical destruction in hips, knees and wrists, in some cases new bone formation on the ribs and changes on skull and sternum (Waldron, 2009), which are pathological signs shared by many diseases and for that reason diagnosis can be difficult.

According to historical data in 18th and 19th century tuberculosis reached epidemic proportion, and therefore the high prevalence of this disease in POB MON 2 and POB CIV 2 was expected. However, in many cases patients affected with TB would die quickly, and the proportion of those who developed skeletal lesions was probably no more than 2% (Pertuiset et al., 1999).

Syphilis

Possible signs of venereal syphilis were noted in one individual from the secular population, 16th - 18th century, aged 40-59 years. The periostic reaction in the postcranial skeleton was noted on the tibia, which is, according to Ortner (2003) the most common area and the clavicles, while lesions called *caries sicca*, typical for advanced stages of the disease, were noted on the skull. The same individual had various lines of enamel hypoplasia, *coxa valga*, bowing of long bones in lower extremities (suggesting rickets residual) and severe fractures of the left arm and the sternum with irregular alignment (the arm was shorter and curved). While *coxa valga* could be a congenital deformity, bowing of long bones and enamel hypoplasia suggested physiological stress in childhood. It is not very clear at which moment of her life the fracture of arm occurred but is obvious



that she lived a long time with this condition as it alterated the complete morphology of the arm and created important amount of secondary (posttraumatic) osteoarthrosis.

The analysis of the presence of mercury in bones was performed in order to discover if she was exposed to mercury treatment, which was considered to be a cure for syphilis. The analysis confirmed the high concentration of mercury, suggesting that there was an attempt of curing, although it is hard to say if this had any effects, or (knowing that mercury is a very poisoning element) even a contra-effect.

Parietal Thinning

As we said before, Parietal Thinning is a rare pathology, whose prevalence is considered to be between 0.25-0.8% according to some research, or 0.4-1.3 % according to other. In the necropolis at Belmonte, of 84 individuals found there, only 53 skulls were preserved well enough for examination and of that number the presence of Parietal Thinning was found in 5 individuals, which makes 9.43% of the total number, which is the highest recorded prevalence up to now. Closer prevalence to this one is the one reported by Smith (1908) from one necropolis in Giza (4.9% prevalence), but as the radiography of these cases does not exist, nor photography, we cannot be sure if his observations were reliable and if changes on skulls noted by Smith can be attributed to Parietal Thinning.

Partial Thinning was also confirmed in tow cases from POB MON 3. Taking into account the number of skulls that were well enough preserved the frequency of this condition was 3.03%. One of the broken skulls from this population had such a prominent thinning that in the broken part the bone was as thick as an egg shell. Even a minor trauma in that area could have had a lethal outcome.

Such a high prevalence of this pathology at the necropolis at Belmonte is not easy to explain, even if we know that this anomaly affects mostly elderly women, which is the most presented group in this necropolis (54.28 % of them over 40 years old), still knowing that almost 10% of preserved skulls were affected by Parietal Thinning probably means that some specific life conditions were influences this population. Maybe long periods of fasting could increase the deficit of calcium in the bones? Or was it a cultural component



that aggravated the disease? The iconographic representation of nuns in the 16th and 17th century is often with heavy headdresses. This kind of headdresses could affect a blood supply and increase the severity of the disease. Strong osteoarthritis of the occipital condyles of the individual 1305 could suggest that this individual was carrying weight loads on the head (Baxarias & Herrerín, 2008). This kind of physical work may also deteriorate the condition, especially knowing that this skeleton was already affected by osteoporosis.

Metastatic bone tumour

One of the individuals from POB MON 2 had the severe stage of a metastatic tumour, that is most likely to be related to breast cancer. The stage of cancer was very advanced, which means that this individual lived many years with it, and probably in the last stage of the disease, she was not able to take care of herself. This presents another example of generous concern of this community for sick members.



5. CONCLUSION

The here presented study of skeletal remains from female monastic communities (16th-20th century) from the Iberian Peninsula is the first of its kind in the territory of Spain, but it also represents a logical continuation of preceding studies from Portugal. Our previous knowledge of the life in the monastery was based mostly on historical sources, monastic rules and books of expenses. But information about daily life, nutrition, diseases, and possible violations of the rules, is difficult to obtain only on the basis of those sources. In addition, these remains offer a unique opportunity to study the effect of the transition to industrialisation on the population which almost entirely preserved its way of life over the centuries. Using the multidisciplinary approach by combining archaeological data, bioarchaeology, radiology, stable isotopes analysis and paleopathology, important information was obtained.

The main idea of this study is to find out how monastic communities differed from secular women. The hypothesis was that the specific conditions in which they lived - in isolation, under food restrictions and vows of chastity and poverty - left traces on their bones. The methodological approach relies on a statistic comparison of various anthropometric and quantifiable pathological changes between three monastic and three control (secular) populations by using a computer program SPSS Statistics 20.0. All the individuals selected from both secular and monastic populations were adult females (over 25 years old) and with the Index of Preservation of at least 50%.

It was also very important to know which social class they originated from, and whether there was any precondition, biological or cultural, that would predetermine them for going to the monastery.

The first step in this study was analysing historical data in order to discover what the average marriage dowry was and compare it to the dowries given to a monastery (religious dowries). Turns out that the monastic dowry in Spain was very high, and it is



very likely that the place in a monastery was reserved only for the daughters of wealthy citizens. In Portugal the amount paid for a religious dowry was similar to average marriage dowries, which made it available to all social classes, as confirmed by the monastery book from Evora where a listing of parental occupations of novices shows peasants, craftsmen as well as noblemen.

Paleodemographic analyses have shown the presence of two subadults (10-12 and 14-18 years) in one of the monasteries, which did not appear to be a big surprise since it was known from historical sources that the minimum age for entering religion was 12 years for girls, but it occurred that even younger children were accepted (in spite of the rule). The lack of children in two out of three secular populations presented a bigger surprise, along with the unequal distribution of the sexes in the same populations (many more females than males). This does not present the normal demographic picture of one population and it could indicate that people that were buried here were somehow segregated. One of the assumptions is that some of the individuals buried in one of the secular cemeteries were lay sisters who could not be buried with choir nuns and abbesses, but who lived most of their lives in the monastery in a way very similar to nuns. This would explain the prevalence of female skeletons and the lack of children in what was considered to be a secular population, but it would also explain very small differences in many segments of life between monastic and secular populations.

Comparison of life expectancy between secular and monastic populations did not show any important differences and the assumption that avoiding pregnancy will result in a longer life on average did not prove to be true. Comparison between two monastic populations POB MON 1 ($16^{th} - 17^{th}$ century) and POB MON 2 ($19^{th} - 20^{th}$ century) has shown that the mortality pattern has changed with industrialisation.

Statistical analysis of the stature, as an important indicator of physiological stress, did not show any significant differences between populations, presenting values typical for populations from Iberian Peninsula.

The frequency of osteoarthritis did not differ significantly among the populations. However, when the severity of this condition was considered as a criterion, it was noted that the number of individuals with eburnation in the area of knees was much higher in



the monastic than in the secular population. Although new research in physical anthropology tends to perceive osteoarthritis in a broader context, not as a direct consequence of physical activity but rather as a combination of various factors such as genetics, body mass, sex, age ... and activity, severe expression of this condition, such as eburnation, could be the indicator of repetitive mechanical loading. With this in mind, the presence of the severe degeneration in monastic populations can be attributed to the religious practice and the custom of kneeling several times a day, during long religious services.

Skeletal markers of activity and repetitive traumas, such as entheseal changes, Schmorl's nodes, Charles' facet, squatting facets, discal hernias, jumper knee, *os acromiale* and markers of occupational stress on teeth were equally presented in monastic and secular populations (in some cases even more presented in the monastic populations), which can lead to the conclusion that nuns did perform physical labour, probably even from subadult period. The claim that nuns avoided physical labour and that a great amount of work was done by the lay sisters and by the servants, based on monastic expenses, as well as high social status of nuns (Rey, 2009), must be rejected, at least when these monastic populations are concerned.

High frequency of accidental traumas in all three monastic populations (especially in the Portuguese one) suggests a similar conclusion of hard and frequent work. In the most recent monastic population many of the traumas resulted in infection, which could be a consequence of medical treatment – an attempt of fixing the bone with metal plates, noted in one of the individuals. Nevertheless, some of the traumas could also be a consequence of the lack of vitamin D (osteomalacia) which makes bones more prone to fracture. Life in enclosure, surrounded by high walls and layers of thick clothes that are covering the whole body could produce the lack of exposure to sunlight even in sunny, Mediterranean countries, such as Spain and Portugal.

Of the porotic lesions in monastic populations only *femoral cribra* was relatively frequent, while the others (*humeral cribra, cribra orbitalia* and porotic hyperostosis) were not that common. *Femoral cribra* is usually interpreted as lack of iron and magnesium, due to low intake, but even more likely due to metabolic disturbance and frequent diarrhoea, during the period of growth.



The presence of rickets residual is very frequent in all populations, which can be considered very unusual given the latitude and the number of sunny days (especially in the case of Spain), as well as the nutrient rich sea fish (especially in the case of Portugal). Even if rickets in the monastic populations could be explained by the same factors as in osteomalacia – enclosure, thick clothes, hard physical work and reduced alimentation and fasting (but in this case during the period of growth) – it is hard to explain the presence of rickets in secular populations that did not live in such extreme life conditions.

Isotopic analyses that were performed only on two monastic populations from Santa Catalina de Siena, show a very uniform diet, which did not change over the centuries, except for one individual in POB MON 1, who had a diet relying more on animal proteins, and three individuals from POB MON 2, whose diets contained more C4 plants, probably corn and/or sugar. According to monastic rules, the sick had a right to avoid fasting and eat meat during the period of illness, but in recovery they had to go back to habitual restrictions. A person whose diet significantly differed in terms of consumption of foods of animal origin had no visible pathological changes, except some osteoarthritis. A possible explanation could be that this individual was a rich widow who withdrew into the monastery after the death of her husband. The book of the monastery Santa Catalina mentions a donation of 600 ducats from a widow who spent her last days in the monastery, which means that such practice existed. On the other hand, other individuals with chronic diseases from POB MON 1 did not show any signs of a different diet. In the case of POB MON 2, two out of three individuals, whose diets were based more on C4 plants, were chronically sick. The corn has various uses in traditional medicine, but it is not clear if this could be the reason for its higher consumption of those three individuals.

It seems that religious restriction concerning meat and animal products during approximately half of a year did not leave traces on the bones of nuns, as no example of harsh malnutrition was noted. In contrast, more than half of the secular population from the 19th century (POB CIV 2) had signs of porotic hyperostosis and even one case of chronic malnutrition, manifested by signs of scurvy, *cribra femoris* and up to four lines of hypoplasia. On the other hand, here studied female monastic populations did not



express signs of overconsuming of meat either, that was often noted in male monastic communities, which could mean that they followed the rules more strictly.

Infectious diseases such as tuberculosis, brucellosis and leprosy were noted in the monastic populations, while in the secular populations one case of probable venereal syphilis was observed.

Brucellosis can be a consequence of close contact with animals or consumption of nonpasteurised milk and dairy products. The archaeological sources confirmed the presence of stables in the monastery Santa Catalina in Belmonte, while archeozoological analysis confirmed the presence of sheep/goat bones in Nossa Senhora from Alcácer do Sal.

The presence of this tuberculosis in the monastery was expected, as the living conditions there presented a perfect environment for developing and spreading the disease: cold thick walls, lack of sunlight, a lot of individuals locked in the same place, constantly in close contact with each other and eating all together.

Leprosy has its highest peak in the middle ages, but it was still present in Europe until 1940. Historical sources are mentioning the spreading of this disease in the 19th century. Leprosy was always followed by stigmatisms and segregation, even up to the 20th century, and the affected individuals were sent into isolated geographic areas or quarantines. But in the case of an individual from POB MON 2 this did not seem to be the case. The advanced phase in which the disease was suggests that she lived a long time with that condition and that the community took a good care of her. She was buried in the area of the chorus, like other nuns, and preserved pieces of monastic clothes indicate that she died as a full member of her congregation, not isolated or stigmatized whatsoever.

Venereal syphilis was noted in one individual from the secular population from 16th - 18th century, presented by the lesions *caries sicca*, typical for advanced stages of the disease. The same individual presented various lines of enamel hypoplasia, coxa valga, bowing of long bones in lower extremities (suggesting rickets residual) and a severe fracture of the sternum and left arm with irregular alignment (the left arm was shorter and curved),



indicating the long history of illness and suffering. The analysis of mercury levels in the bone remains of this individual confirmed the presence of mercury in high concentration, suggesting that she was exposed to medical treatment for syphilis in accordance with medical knowledge of the epoch.

Various developmental disorders and early childhood pathologies that affect health, appearance and mobility were detected among monastic populations. These changes ranged from less severe pathologies that would cause walking abnormalities or pain during long standing, to serious conditions such as Klippel-Feil. The hypothesis that those pathologies influenced the possibility to get married and/or have children, and hence were the reason for sending girls to the monastery, cannot be confirmed with certainty, due to relatively small size of these samples (in order to obtain the full accuracy of this claim the research should be carried out on a much larger sample and various monasteries), but examples mentioned in the monastic books from medieval England, popular songs and examples from literature, are suggesting that nunneries were places for women that were in some way rejected from society. However, in spite of the deformities, all of the women had various markers of activities, which could suggest that they performed everyday tasks and were well integrated into the congregation. They also had an average length of life, or even longer than average, which in case of severe conditions would not be possible without proper care of the community.

The presence of Parietal Thinning, a condition of unknown aetiology, was noted in all three monastic samples. Although this condition is considered to be very slow developing and relatively benign, in case of one individual from a Portuguese monastic sample the thinning of the skull was so prominent that it could have easily provoked the death of that person. Although it is known that this disease is more common in women than in men, and in older than in younger people, in which way the populations from nunneries are the most vulnerable group, the frequency observed in these monastic populations has never been recorded in the history of this pathology. There is no one simple explanation for this phenomenon. It is more likely that it is caused by several factors, such as deficit of calcium due to food restriction, lack of vitamin D due to sun exposure and affected blood supply due to heavy headdresses that could increase the severity of the disease.



Although the dental health of the monastic populations did not differ a lot from secular ones, it can be considered as bad. This may be a reflection of the lack of awareness for hygiene, but also of the intentional neglect of the body, as advised by St. Jerome, in order to prevent the awakening of lust and temptations that follow. It seems that dental health got even worse over time as the analyses showed a statistically important increase of caries in the 19th-20th century, which can probably be explained by the use of corn and/or sugar, confirmed by the isotopic analysis. Other dental diseases such as calculus, periodontal disease, dental enamel hypoplasia, abscess cavity and *antemortem* tooth loss did not present significant differences in frequency of occurrence.

One of the individuals from the 19th and the 20th century presented pathological signs that can probably be associated with quite advanced metastatic carcinomas that spread all over the thorax area and on the skull. Reaching such an advanced stage of this condition in the historical period that she lived in probably meant that she had good medical care. This individual also presented a much banded forearm (without signs of healed trauma) and various lines of hypoplasia, suggesting that she suffered several episodes of physiological stress in her childhood.

It is obvious that the care of the sick, whether with chronic diseases or congenital deformities, as well as the integration of persons with disabilities, was much emphasized in the monasteries. Although in some cases medical treatments were not very effective, or were even more harmful than beneficial, they were consistent with the medical knowledge and beliefs of the time they lived in.

Even if the habits of the nuns had not changed over time – which was confirmed by the similar patterns of activities and signs of osteoarthrosis – changes that occurred in the world during the transition to industrialization would have left traces even in that hidden part of the world. New aliments, like corn and sugar, were easily available sources of carbohydrates, but they led to a drastic decrease of dental health. Even if life expectancy was a bit higher on average the infective diseases were more frequent.

The synergistic effect observed in many examples presented in this study (rickets and syphilis, vitamin D and fractures, rickets and osteomalacia, scurvy and anaemia, tuberculosis and vitamin D...) is of great importance for further paleopathological



research. Nutrition deficiency does not usually relate to one particular ingredient, because if a person starved he or she would be missing a whole host of essential nutrients in the diet. An illness that attacks the organism will make the immunity defence weaker and hence more susceptible to other diseases. Even illnesses survived in the childhood will leave a trace on adult health by making it more sensitive to impacts. It seems that the popular saying "what doesn't kill you makes you stronger" should be changed to "what doesn't kill you makes you vulnerable", at least when it comes to human physiology. Although this explanation may sound logical even to a layman, in paleopathology we often tend to focus only on a particular representation of the disease without considering the broader picture, due to the fact that we don't have a living patient in front of us, but a skeleton.

Although this study has succeeded in answering some of the research questions related to the life of women in the monastery, it has also launched a whole series of new ones, clearly pointing out the need for further research. While it cannot be said that we comprehend the whole picture, we managed to peek through the monastery walls behind which those women hid in their quest for God.



5. CONCLUSIONES 🖾

El estudio aquí expuesto sobre los restos esqueléticos de las comunidades monásticas femeninas (siglos XVI-XX) de la Península Ibérica, es el primer estudio de este tipo en España, pero también representa una lógica continuación de los estudios precedentes de Portugal. Nuestro conocimiento previo sobre la vida en el monasterio fue resultado de varias investigaciones basadas, sobre todo, en fuentes históricas, en el estudio de reglas monásticas y en los libros de gastos. Pero el acceso a la información sobre la vida diaria, la nutrición, las enfermedades, el incumplimiento de las normas y las reglas monásticas, es complejo usando solo las fuentes indicadas con anterioridad.

Además, estos restos nos ofrecen la oportunidad de llevar a cabo un estudio sobre los efectos resultantes del proceso de transición a la industrialización sobre una población que preservó casi completamente su modo de vida a lo largo de los siglos. A través de una aproximación multidisciplinar, combinando datos arqueológicos, bioarqueológicos, técnicas radiológicas, análisis de isótpos estables y estudios paleopatológicos, se obtuvo información de gran importancia.

El objetivo principal de este estudio es descubrir cuáles eran las principales diferencias entre las comunidades monásticas y las mujeres seculares. La hipótesis de partida era que las condiciones específicas en las que vivían – el aislamiento, las restricciones alimenticias y los votos de castidad y pobreza – dejaron huella en sus restos óseos. La aproximación metodológica se basa en la comparación estadística de varios cambios patológicos antropométricos y cuantificables, entre tres poblaciones monásticas y tres poblaciones seculares, usando el programa estadístico informático SPSS Statistics 20.0. La muestra seleccionada, tanto de las poblaciones seculares como de las monásticas, corresponde con mujeres adultas de más de 25 años de edad, con un Índice de Preservación del 50% como mínimo. También se consideró importante conocer la clase social de procedencia y si existía alguna predisposición biológica o cultural que les predeterminara a su ingreso en el monasterio.



La primera fase de este estudio se inició con el análisis de los datos históricos, con el fin de conocer cuál era la dote matrimonial media de la época, y compararla con las dotes dadas a los monasterios (dotes religiosas). El resultado de este análisis reveló que la dote necesaria para ingresar en la vida monástica en España era muy alta, por lo que es posible deducir que el ingreso a los monasterios estuviera reservado solamente a las hijas de los ciudadanos con mayores recursos económicos. En Portugal, la cantidad necesaria para la dote religiosa era similar a las dotes matrimoniales medias, lo que suponía la posibilidad de acceso a la vida monástica para un procentaje de población más alto, abarcando más capas sociales, como lo confirma el libro del monasterio de Évora, en el que se recoge una lista de ocupaciones paternales de las novicias, en la que aparecen campesinos y artesanos, además de nobles.

Los análisis paleodemográficos de la muestra revelan la presencia de dos subadultos (de 10-12 años y 14-18 años) en uno de los monasterios, lo que no pareció ser un dato sorprendente puesto que se conocía, gracias a las fuentes históricas, que la edad mínima para la entrada en la vida religiosa era de 12 años para las niñas, aunque habiendo casos de niñas de edad incluso más temprana (a pesar de las normas). Por el contrario, la ausencia de niños en dos de las tres poblaciones seculares estudiadas fue más sorprendente, junto con la distribución por sexo desigual de las mismas poblaciones, habiendo un mayor número de mujeres que de hombres. Estos datos no corresponden a un cuadro demográfico esperable de una población normal, lo cual podría indicar que los individuos enterrados en estos lugares se encontraban de alguna manera segregados. Una de las hipótesis podría ser que parte de los individuos de la muestra, enterrados en un cementerio secular, fueran mujeres laicas que habrían formado parte de la comunidad religiosa, de alguna manera, compartiendo sus cotidianidades y estilo de vida, pero sin ser miembros con voto como las monjas del coro y las abadesas. Estó explicaría la prevalencia de esqueletos femeninos y la ausencia de subadultos en lo que se consideraba una población secular y, además, explicaría las pequeñas diferencias que se observan en muchos de segmentos de la vida entre las poblaciones monásticas y las seculares.

La comparación de las expectativas de vida entre las poblaciones seculares y las monásticas no mostró ninguna diferencia relevante. La suposición de que la ausencia de embarazos, y de los riesgos que ellos conllevan, diera como consecuencia un posible



aumento de la esperanza de vida, no resultó cierta. La comparación entre dos poblaciones monásticas, la POB MON 1 (siglos XVI-XVII) y la POB MON 2 (siglos XIX-XX) ha demostrado que el patrón de mortalidad cambió con la industrialización.

El análisis estadístico de la estatura, como un importante indicador del estrés fisiológico, no demostró ninguna diferencia significante entre las poblaciones, presentando valores típicos para todas las poblaciones de la Península Ibérica.

La frecuencia de la artrosis no difirió considerablemente entre las poblaciones. Sin embargo, cuando se considera la severidad de esta condición como un criterio, se aprecia que el número de individuos con eburnación en el área de las rodillas era mucho más alto en las poblaciones monásticas que en las seculares. No obstante, las nuevas investigaciones en antropología física suelen percibir la artrosis en un contexto más amplio, no como consecuencia directa de la actividad física, sino como una combinación de diversos factores como la genética, la masa corporal, el sexo, la edad... y la actividad. Una expresión severa de esta condición, tal como la eburnación, podría ser el indicador de una carga mecánica repetitiva. Con esto en mente, la presencia de una grave degeneración ósea en las poblaciones monásticas puede atribuirse a las prácticas religiosas, concretamente a la costumbre de arrodillarse varias veces al día durante largos oficios religiosos.

Los marcadores esqueléticos de actividad y los traumas repetitivos, tal es como los cambios en las entesis, los nódulos de Schmorl, las facetas de Charles, las facetas de acuclillamiento, las hernias discales, "jumper knee", *os acromiale* y los marcadores del estrés ocupacional en las piezas dentales, se encontraban igualmente presentes en las poblaciones monásticas y las seculares (en algunos casos incluso con mayor presencia en las monásticas), por lo que se podría concluir que las monjas llevaban a cabo labores físicas considerables, probablemente incluso desde el período subadulto. Por lo tanto, se rechaza la afirmación de Rey (2009) de que las monjas evitaban el trabajo físico y que una gran cantidad de dichas labores eran realizadas por las hermanas laicas y los sirvientes, afirmación basade en los gastos monásticos y en el alto estatus social de las monjas, por lo menos con respecto a estas poblaciones monásticas.



La alta frecuencia de traumas accidentales en las tres poblaciones monásticas (especialmente en la portuguesa) sugiere una conclusión parecida de realización de trabajos físicos severos y habituales. En las poblaciones monásticas más recientes, muchos de los procesos traumáticos presentaban lesiones infecciosas, lo cual podría ser consecuencia de tratamientos médicos, como el uso de placas metálicas con intención de reparar los traumas observado en uno de los individuos. Aún así, algunos traumas también podrían ser consecuencia de la falta de vitamina D (osteomalacia), que volvería a los huesos más propensos a fracturarse. Esta carencia de vitamina D se vería relacionada con la vida en los recintos eclesiásticos, los cuales se veían rodeados por paredes altas y donde los atuendos constaban de capas gruesas de ropa que cubrían los cuerpos enteros, hechos que podrían haber llevado a una falta a la exposición solar incluso en los países mediterráneos de climas más soleados, tales como España y Portugal.

En cuanto a las lesiones poróticas, en las poblaciones monásticas, la cribra femoral era la única relativamente habitual, mientras que las otras (cribra humeral, cribra orbitalia y hiperostosis porótica) no eran tan usuales. La cribra femoral normalmente se interpreta como falta de hierro y magnesio, consequencia de un consumo deficiente de éstos, pero se relaciona, aún más, con trastornos metabólicos y procesos diarreicos frecuentes durante el período de crecimiento.

La presencia de raquitismo es muy común en todas las poblaciones estudiadas, lo que se puede considerar muy inusual dada la latitud y el número de días soleados (especialmente en el caso de España), además del consumo de pescado marino (especialmente en el caso de Portugal). Aunque el raquitismo en las poblaciones monásticas del presente estudio se podría explicar a través de los mismos factores analizados en el caso de la osteomalacia – recintos cerrados, ropas gruesas, trabajo físico severo, además de una alimentación reducida y ayunos (en este caso, durante los períodos de crecimiento), es difícil de explicar la presencia de raquitismo en las poblaciones seculares, que no vivían en condiciones de vida tan extremas.

Los análisis isotópicos que se hicieron en las dos poblaciones monásticas de Santa Catalina de Siena, muestran una dieta muy uniforme, que no se vio modificada a lo largo de los siglos, a excepción de un individuo perteneciente a la POB MON 1, que presentaba una dieta que dependía más de las proteínas animales, y tres individuos de la POB MON



2 cuyas dietas contenían más plantas C4, probablemente maíz y/o azúcar. De acuerdo con las reglas monásticas, los enfermos tenían el derecho de evitar el ayuno y comer carne después de el período de padecimiento, pero tenían que volver a las restricciones habituales después de recuperación. La única persona cuya dieta se diferenciaba considerablemente en cuanto al consumo de comida de origen animal no presentaba aspectos patológicos visibles, excepto algo de artrosis. Una explicación probable para uno de los casos puede ser que este individuo fuese una viuda, de nivel económico alto, que se retirara al monasterio tras la muerte de su esposo. El libro del monasterio de Santa Catalina menciona una donación de 600 ducados de parte de una viuda, que pasó sus últimos días en el monasterio, lo que significa que dicha práctica existía. Por otro lado, otros individuos con enfermedades crónicas de la POB MON 1 no mostraron ningún indicio de una dieta diferente. En el caso de la POB MON 2, dos de los tres individuos cuyas dietas se basaban más en plantas C4, presentaban enfermedades crónicas. El maíz tiene varios usos en la medicina tradicional, pero no está claro si ésto podría ser la razón por la cual estos tres individuos presentaban un consumo mayor.

Parece que la restricción religiosa en relación con la carne y los productos de origen animal durante aproximadamente la mitad del año no dejó huellas en los huesos de las monjas, ya que no se ha observando ningún ejemplo de malnutrición severa. En contraste, más de la mitad de la población secular del siglo XIX (POB CIV 2) tenía signos de hiperostosis porótica, e incluso hay un caso de desnutrición crónica, manifestada por signos de escorbuto, cribra femoral y hasta cuatro líneas de hipoplasia. Por otro lado, las poblaciones monásticas femeninas, aquí estudiadas, no expresaron signos de consumo excesivo de carne, que sí se han observado a menudo en comunidades monásticas masculinas, lo que podría significar que siguieron las reglas más estrictamente.

Enfermedades infecciosas tal es como la tuberculosis, la brucelosis y la lepra se encontraban presentes en las poblaciones monásticas, mientras que en las poblaciones seculares se observó un caso de probable sífilis venérea.

La brucelosis encontrada en las 3 poblaciones monásticas puede ser consecuencia de un contacto frecuente con animales o de consumo del leche y productos lácteos no pasteurizados. Las fuentes arqueológicas confirmaron la presencia de establos en el



monasterio de Santa Catalina en Belmonte, mientras que el análisis zooarquelógico confirmó la presencia de huesos de ovejas/cabras en Nossa Senhora de Alcácer do Sal.

La presencia de tuberculosis se preveía desde un inicio dado que las condiciones de vida en los monasterios suponían un entorno perfecto para el desarrollo y la propagación de esta enfermedad: paredes frías y gruesas, falta de sol, muchos individuos encerrados en un mismo lugar, continuamente en contacto unos con otros y alimentándose juntos.

Aunque la lepra fue más típica de la Edad Media, estuvo presente en Europa hasta 1940. Las fuentes históricas mencionan la difusión de esta enfermedad en el siglo XIX. La lepra fue siempre seguida de estigmas y segregación, incluso hasta el siglo XX, y los individuos afectados eran enviados a áreas geográficas aisladas o en cuarentenas. Pero en el caso de un individuo de POB MON 2 esto no parecía ser así. La fase avanzada en la que se encontraba la enfermedad sugiere que vivió mucho tiempo con esa condición y que la comunidad le cuidó bien. Fue enterrada en el área del coro, como otras monjas, y las piezas de ropa monástica preservadas indican que murió como miembro de pleno derecho de su congregación, no siendo aislada o estigmatizada de ningún modo.

El caso de sífilis venérea se observó en un individuo de la población secular de los siglos XVI-XVIII, reflejada a través de lesiones *caries sicca*, típicas en etapas avanzadas de la enfermedad. El mismo individuo presentó varias líneas de hipoplasia del esmalte, coxa valga, huesos arqueados en las extremidades posteriores (sugiriendo que sufrió raquitismo) y una fractura severa localizada en esternón y en brazo izquierdo y otra en el esternón de alineamiento irregular (hueso izquierdo más corto y curvado), indicando una larga historia de enfermedad y padecimiento. El análisis de los niveles de mercurio en los restos óseos de este individuo confirmó la presencia del mismo en alta concentración, sugiriendo que se vio expuesto a tratamientos médicos para el tratamiento de la sífilis, de acuerdo con el conocimiento médico de la época.

En las poblaciones monásticas se detectaron varios trastornos del desarrollo y patologías de la primera infancia, que afectan a salud, apariencia y movilidad. Estos cambios iban desde patologías menos graves que causaban anomalías en el caminar o dolor de pie, hasta problemas más graves tales como Klippel-Feil. La hipótesis es que, esas patologías influirían en la posibilidad de casarse y/o tener hijos, y, por lo tanto, pudieron ser el



motivo de el ingreso de las niñas en los monasterios, no se pueda confirmar con certeza, por no contar con una muestra mayor y que abarque un contexto geográfico y temporal más amplio. Sin embargo, ejemplos mencionados en libros monásticos de la Inglaterra medieval, canciones populares y ejemplos procedentes de la literatura sugieren que los conventos eran sitios para mujeres de alguna manera rechazadas por la sociedad. Por otro lado, a pesar de las deformidades, todas las mujeres tenían varios marcadores de actividad, que podrían sugerir que hacían tareas diarias y que estuvieron bien integradas en la congregación. También presentan una duración de vida dentro de la media, e incluso en algunos casos por encima de ésta, lo que indicaría que existía un cuidado apropiado por parte de la comunidad a los casos miembros que presentaban enfermedades graves.

La presencia de adelgazamiento parietal, una condición de etiología desconocida, se observa en dos de las tres muestras monásticas. Aunque esta condición se considera relativamente lenta en su desarrollo y relativamente benigna, en el caso de un individuo de la muestra monástica portuguesa, el adelgazamiento del cráneo era tan elevado que habría podido causar la muerte de éste fácilmente. Aunque se sabe que esta enfermedad es más frecuente en mujeres que en hombres, y en personas mayores que en jóvenes, que hace de las poblaciones monásticas el grupo más vulnerable, la frecuencia observada en las poblaciones monásticas aquí estudiadas nunca ha sido documentada en la historia de esta patología. No existe una explicación simple de este fenómeno. Es más probable que esté causado por varios factores, tales como el déficit de calcio causado por las restricciones alimenticias, la falta de vitamina D como consequencia de la poca exposición solar, o a un riego sanguíneo afectado por unos pesados tocados que podrían aumentar la severidad de la enfermedad.

Aunque la salud dental de las poblaciones monásticas no difirió mucho de las seculares, puede ser considerada como mala. Ésto puede ser un reflejo de la falta de higiene bucodental, pero también de la negligencia intencional del cuerpo, según lo aconsejado por San Jerónimo, con el fin de impedir el despertar de la lujuria y las tentaciones que siguen. Parece que la salud dental empeoró con el paso del tiempo, existiendo análisis que demuestran un aumento estadísticamente importante en los siglos XIX y XX, lo que probablemente se pueda explicar por el uso del maíz y/o azúcar, confirmado por el análisis isotópico. Otras enfermedades dentales como el sarro, la enfermedad periodontal, la



hipoplasia del esmalte dental, la abcesos y la pérdida de dientes *antemortem* no presentaron diferencias considerables en frecuencia de ocurrencia.

Uno de los individuos de los siglos XIX y XX presentó señales patológicas que probablemente se pueden asociar con carcinomas metastásicos muy avanzados, que se extendieron por todo el tórax y por el cráneo, donde lo avanzado de la patología para, en este período histórico, demuestra la existencia de una buena atención médica. Este individuo también presentó un antebrazo muy curvado, sin señales de trauma fusionado (probablemente consequencia de raquitismo) y varias líneas de hipoplasia, lo que sugiere que sufrió varios episodios de estrés fisiológico durante la formación del esmalte, lo que aporta una cronología para estos episodios en el período de infancia.

Es obvio que el cuidado de los enfermos, ya fueran crónicos o con deformidades congénitas, así como la integración de las personas con discapacidades, fue una práctica llevada a cabo en los monasterios. Aunque en algunos casos los tratamientos médicos no eran muy eficaces, o incluso eran aún más perjudiciales que beneficiosos, eran consistentes con el conocimiento médico y las creencias del tiempo en que vivían. Aunque las costumbres y los hábitos de las monjas no presentan modificaciones con el paso del tiempo, lo que ha sido confirmado por la presencia de patrones similares de actividad y signos de artrosis, los cambios ocurridos durante la transición a la industrialización habrían dejado huellas incluso en esa parte oculta del mundo. Hay cambios visibles a través de los nuevos alimentos, como el maíz y el azúcar, los cuales suponían fuentes de carbohidratos fácilmente disponibles, que llevaron a una drástica disminución de la salud dental. Incluso si la expectativa de la vida era un poco más alta en promedio, las enfermedades infecciosas eran más frecuentes.

El efecto sinérgico observado en muchos de los ejemplos presentados en este estudio (el raquitismo y la sífilis, la vitamina D y las fracturas, el raquitismo y la osteomalacia, el escorbuto y la anemia, la tuberculosis y el déficit de vitamina D...) tiene una gran importancia para las próximas investigaciones paleopatológicas. Las deficiencias nutricionales generalmente no se relacionan con un ingrediente concreto, pues si un individuo es susceptible de haber padecido hambre, se asume que a ese individuo le



faltaría toda una multitud de nutrientes esenciales de la dieta, sin especificar. Una enfermedad que ataca a un organismo debilita las defensas inmunitarias y, por lo tanto, le vuelve más susceptible a otras enfermedades. Incluso aquellas enfermedades sobrevividas en la niñez dejan un rastro en la salud de los individuos adultos, volviéndolos más vulnerables. Parece que el dicho popular "lo que no te mata, te hace más fuerte" se debería modificar por "lo que no te mata, te hace más vulnerable", al menos cuando se trata de fisiología humana. Aunque esta afirmación puede parecer lógica, incluso para un laico, en paleopatología se tiende a centrar la atención en una representación particular de la enfermedad, sin considerar una visión más en conjunto, debido, posiblemente, a que no tenemos ante nosotros un paciente vivo, si no su esqueleto.

Aunque este estudio ha logrado contestar algunas preguntas sobre la vida de la mujer en el ámbito monástico, también ha lanzado toda una serie de nuevas cuestiones que evidencian la necesidad de ahondar en esta temática de investigación. A pesar de no lograr obtener un conocimiento general de la vida de estas mujeres, sí se ha conseguido mirar a través de los muros de los monasterios, tras los cuales estas mujeres se escondían en su búsqueda de Dios.



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ANEX

ANEX I – a schematic representation of epiphyseal fusion after Mays, 2003.

ANEX II – an example of schematic representation of human skeleton in anatomical position (ADULT) used in this study

ANEX III - an example of schematic representation of human skeleton in anatomical position (SUBADULT) used in this study

ANEX IV - an example of schematic representation of human skeleton in anatomical position (PERINATAL) used in this study

ANEX V – an example of odontogram used in this study

ANEX VI – an example of sheets used to mark the presence of osteoarthrosis

ANEX VII – a standardised data collection form for enthesis robusticity and enthesopathies after Mariotti et al. (2007)

ANEX VIII - Pearson's (1899) formula for estimation of stature, Olivier and colleagues' (1960) formula for estimation of stature, Mendonça's (2000) formula for estimation of stature, nine height classes defined by Martin and Saller (1957) for H. sapiens



Schematic representation of epiphyseal fusion after Mays, 2003











ODONTOGRAMA DENTADURA ADULTO



ODONTOGRAMA DENTADURA DECIDUA

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85 84 83 82 81	71 72 73 74 75

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Metacarpals			
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Metatarsals			
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UNIVERSIDAD AUTONOMA
DE MADRID

	SUPERFICIE DISCAL	OSTEOFITOS	SINDESMOFITIS	CARETES ARTICULAR	NODULOS DE SCHMORL
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APPENDIX 2 STANDARDISED DATA COLLECTION FORM FOR ENTHESIS ROBUSTICITY AND ENTHESOPATHIES

Specimen																		
	M / F / NI		YA/MA/OA/NI		M / F / NI		YA/MA/OA/NI			M / F / NI			YA/MA/OA/NI					
Sex / age	Left			Right		Left		Right		Left			Right					
	Rob	EF	OL	Rob	EF	OL	Rob	EF	OL	Rob	EF	OL	Rob	EF	OL	Rob	EF	OL
SCAPULA																		
M. triceps brachii																		
CLAVICLE																		
Costoclavicular lig.																		
Conoid lig.																		
Trapezoid lig.																		
M. pectoralis major																		
M. deltoideus																		
HUMERUS																		
M. pectoralis major																		
M. lat.dorsii/teres major																		
M. deltoideus																		
M. brachioradialis																		
RADIUS																		
M. biceps brachii																		
M. pronator teres																		
Interosseous membrane																		
ULNA																		
M. triceps brachii																		
M. brachialis																		
M. supinator																		
FEMUR																		
M. gluteus maximus																		
M. iliopsoas																		
M. vastus medialis																		
PATELLA																		
Qudriceps tendon																		
TIBIA																		
Qudriceps tendon																		
M. soleus																		
CALCANEUS																		
Achilles tendon		1											1					



ANEX VIII

n	c 1. c	
Pearson's	from dried long	bones
	Male	Female
Stature	81.306 + 1.880 F	72.884 + 1.945 F
"	70.641 + 2.894 H	71.475 + 2.754 H
"	78.664 + 2.376 T	74.774 + 2.353 T
**	89.925 + 3.271 R	81.224 + 3.343 R

Olivier and colleagues' (1960) formula for estimation of stature:
2,991 x length of humerus + 67 \pm k 3,55 cm
4,000 x length of radius $+73 \pm k$ 3,4 cm
$3,964 \text{ x length of ulna} + 65 \pm \text{k} 3,4 \text{ cm}$
1,758 x length of femur + $84 \pm k$ 3,5 cm
2,239 x length of tibia + $83 \pm k$ 3,7 cm
1,820 x (humerus + radius) +63 \pm k 3,2 cm
$1,821 \text{ x} (\text{humerus} + \text{ulna}) + 60 \pm \text{k} 3,2 \text{ cm}$
$1,329 \text{ x} (\text{humerus} + \text{femur}) + 68 \pm \text{k} 3,2 \text{ cm}$
$1,460 \text{ x} \text{ (humerus + tibia)} + 64 \pm \text{k} 3,2 \text{ cm}$