The demographic, socio-economic and temporal contextualization of the Universitat Autònoma de Barcelona Collection of identified human skeletons (UAB Collection)

Running head: UAB collection

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ABSTRACT: Identified human skeletal collections are those in which basic demographic data (sex, age and biological origin) are known and are crucial for developing and testing osteological methodologies. It is important that the identified collection be contextualized, and in this way the collection will be considered a reference collection. To contextualize a collection requires documentation of the basic demographic data of the individuals (sex, age, year of birth, geographical area) as well as information concerning the socio-economic and temporal context in which the individuals lived. The contextualization of a identified collection is very important so the researchers can understand the "point of reference" when applying a method to it or developing a new method. The purpose of this study is to contextualize the identified skeletal collection of the Universitat Autónoma de Barcelona (UAB) which currently contains 35 adult skeletons of both sexes. To carry out the objectives of the present study, the information about the individuals was collected from cemetery registers and compared with the information of the demographic and statistic public institutions of Spain. The results indicate that the UAB collection is formed only by Spanish nationals who mainly lived during the 20th century in Granollers (Barcelona, Spain). Both sexes are equally represented and all of the individual are adults. They reflect the most current adult population structure of Catalonia and be treated as a Catalan reference sample of adults living in the 20th century. This collection offers special opportunities for demographic analysis, including validation studies of skeletal aging and sexing methods that target adult individuals. The collection can also be used in conjunction with other reference samples to investigate secular and populational change in cranial form, sexual dimorphism and stature.

Keywords: Skeletal collections, Osteoarchaeology, Bioanthropology .

Introduction

A documented or identified human skeletal collection is a collection of skeletons in which, basic documentary data are known, such as the sex, age and biological origin of each individual. Identified human skeletal collections are crucial for developing and testing new methodologies and developing error rates that are now required to achieve the standards of rules of evidence in most countries.

Undoubtedly, a collection of identified human skeletons is a valuable reference tool to help increase the accuracy of several fundamental osteological methods. Appropriate reference samples ultimately can lead to better resolution of forensic identifications and opens more windows to our past because newly developed methods enable us to apply better methods to archaeological samples (Cunya and Wasterlain, 2007). In addition, skeletal collections of known age, sex and ancestry are also integral for validation studies, which assess the accuracy and reliability of existing and novel methods for samples of different population affiliation and age structures (Saunders *et al*., 1995 Rissech and Black, 2007; Eliopoulos *et al*., 2007). Likewise, documented collections from different parts of the world allow researchers to compare the expression of sexually dimorphic traits or the manifestation of aging across populations (Eliopoulos *et al*., 2007).

There are three types of identified human skeletal collections: 1) individuals recovered from modern cemeteries, such as Coimbra and Lisbon (Portugal) where identification is reached through obituary records; 2) individuals recovered from more ancient cemeteries, such as Spitalfields and St Bride (London, UK) where identification was accomplished by means of plaque inscriptions on the coffins; and 3) individuals derived from forensic material recovered from autopsies or anatomy courses and is a collection type created mainly by forensic and medical institutions. (Schmitt, 2001).

Each type of reference sample is replete with inherent biases and limitations, including demographic and regional representation (Kromar and Grivas, 2008; Wilson *et al.,* 2006). The Universitat Autònoma de Barcelona Collection of identified human skeletons (UAB Collection) falls in the first category as it comes from Granollers, a modern cemetery in Catalonia (North-East autonomous region of Spain, see Figure 1).

For a documented collection to be useful as a reference collection the individuals need to be contextualized. To contextualize a collection means to investigate the basic documentary data of the individuals (sex, age, year of birth, geographical area) and derive the maximum information possible about the demographic, socio-economic and temporal context in which the individuals lived. The contextualization of a documented collection is very important because the researchers can know the temporal, social and scientific "point of reference". For example it may not be appropriate to apply an method that has been developed on a historic skeletal sample from England to victims of Civil War era mass graves in Spain. Komar and Grivas (2008) hope to abandon the notion of the ''universality'' of osteological methodology and promote standardization of methods. Methodology should not be applied to skeletal material without regard for the secular and regional origin of the reference collection(s) used in the creation of the method.

Therefore, the main objective of this study is to contextualize the UAB collection (to analyze the demography, socio-economic status and time period of the individuals) and discuss whether the collection could reflect the most current adult population structure of Catalonia and be treated as a Catalan reference sample of adults living in the 20th century.

Material and Methods

The Collection

Formal collection of the UAB assemblage was initiated by the first author in 1996 while conducting her doctoral research at the Biological Anthropology Unit of the Autonomous University of Barcelona. She approached Granollers City Hall (Granollers, Spain, see Fig.1) with the idea of producing a reference skeletal collection in Catalonia to address some of the existing problems in anthropological research. Granollers City Hall granted permission to UAB to collect the remains of individuals that were destined to a communal ossuary in the Granollers municipal cemetery.

In Spanish cemeteries, the dead are usually buried in niches, which are cavities constructed in walls within the cemetery. The practice in Spanish cemeteries allows niches to be acquired as property or to be rented. The possession of a niche lasts for 50 years, or they can be rented for renewable periods of five years. Families are given three months notice before the end of the rental or the property period to claim the remains. Non-payment of rent or property fees results in the loss of rights and the existing remains are exhumed by the City Hall and taken to a common ossuary. The common ossuary is built into the ground or into a double wall in the cemetery where the unclaimed remains are re-deposited. The Biological Anthropology Unit is notified when a niche is opened before the remains are re-deposited in the common ossuary.

As all of the individuals are identified by the gravestones, the niche and number of the cemetery register, it is possible to obtain considerable information for each person. The cemetery registry book contains the niche number, the individual's name, age and place of birth, place of death, death certificate, names of the parents, place of residence and cause of death. With these data, it is possible to access the Civil Register and obtain more information, such as the parents' occupation, inheritances and property.

From the birth certificate it is also possible to find out the address at birth and the names of the grandparents. If, furthermore, individuals have been autopsied and the funeral parlour has the name of the hospital or medical centre of the patient, it is possible to access clinical and medical information from the autopsies. In Spain, there is no form of informed consent for this kind of data collection but every effort is made to protect the identity of the deceased and their families. The data are constructed such that researchers are provided categories of data (e.g. occupation, date of death) without revealing the names of the deceased individuals or their families.

Accession of the skeletal material

The first two individuals were carefully collected by the first author to ensure that all of the bones were recovered. Later, due to working needs of the cemetery, the recovery was carried out by the cemetery personnel who put all of the bony elements of the individual exhumed into a plastic bag. In all cases, the plastic bag containing the skeleton is labelled with the deceased's name, age at death, year of death, niche number and the cemetery register number. In this way, all of the registry information can be recovered. After being transported to the Biological Anthropology Unit, the material is washed with detergent, dried and labelled with its arrival number in the laboratory, which now serves as the identifying number of the skeleton, followed by the letters GR indicating the cemetery of origin, Granollers. The label marking the plastic bag is kept in a file. An additional file is created containing the individual's entire information with the exception of the name. In this file, in addition to the age, sex, year of death, year of birth and the cause of death, there is also an inventory of the skeletal and dental elements and their state of preservation. The documentation of each skeleton can be considered quite precise because it actually comes from the death certificates written by

the doctors; the original death certificate is one of the sources of the death register in Civil Registry Offices. In addition, the information in the birth registries of the Civil Registry Offices provides independent confirmation of the death registry data.

The osteological material of the UAB collection is well preserved and all the skeletons are almost complete. Many of the small bones, such as the phalanges of the feet and hands, are missing due to the fact that the exhumations were carried out mainly by the cemetery workers and were not adequately supervised. Taphonomic factors have also influenced the material depending on where the body was deposited. Those deposited in niches with dry conditions are better preserved than those deposited in damper conditions. In niches where conditions were dry, soft parts have been preserved and in some cases, totally mummified corpses have been found. Dentures, prostheses and personal belongings have also been recovered along with the human remains and are also available for research.

Methods

The demographic profiles, socio-economic and temporal context of the recovered individuals were analyzed. The research was conducted on the cemetery registers to obtain demographic information (age, sex, year of birth, year of death, biological origin) and cause of death. In order to observe the age distribution, the known dates of birth and death of each individual in the collection were categorized into 10 years cohorts. The cause of death is the injury or disease that initiated the fatal event (e.g., gunshot wound, heart disease, or blunt force trauma resulting from a motor vehicle accident). Data describing the demographic, economic and cultural parameters about Catalonia and Spain population from 1900 to today were obtained by the published data of the Center of Demographic Studies of CSIC (El Centro de estudios

demograficos del CSIC), the INE (Instituto Nacional de Estadística), the IEC (Instituto d'estadística de Catalunya) and the Universitary Institute of Public Health of Catalonia (Institut Universitari de Salud Pública de Catalunya). Mortality and birth rates, life expectancy and population structure were extracted from these four institutions.

Results

The UAB collection currently consists of 35 identified skeletons - 19 men and 16 women. All the individuals are of Spanish origin, born between 1892 and 1959 (Fig. 2) and they died between 1977 and 1991 (Fig. 3), and therefore lived in the 20th century. Thus, the UAB collection is not a historical, but a recent collection.

The age range of the UAB collection is from 31 to 97 years old and both sexes are equally represented, although there are slightly more men than women (Fig. 4). The average age for males is 62.68 years old and 79.86 years old for females. All of the individuals have documented available data (age, sex, year of death, year of birth) with the exception of one, whose information is currently being compiled. Information on the cause of death is also available for many skeletons. Causes of death observed in the collection, following the World Health Organization's classification of the major disease groups (WHO, 1992) are: 1) related to problems of the circulatory system; 2) a case of carcinoma and 3) two cases of traumatic death - one gunshot fatality and one car accident.

At present, the professional occupations of the individuals in the UAB collection are not known. These data will have to be completed using the Civil Register. However, the fact that their remains were exhumed for non-payment and abandoned by their families suggests the individuals came from a middle to low social-economic class. Long-term care of the dead is privileged and niches are kept in families for generations.

Individuals are only deposited in the common ossuary when a deceased individual is not claimed or the family does not have money to maintain the niche. This is analogous to bodies of known identity but unclaimed in anatomy room samples, such as the Hamann-Todd and Terry collections. Wilson et al. (2007) show that individuals who donate their bodies before death generally have a higher education level and come from a higher socioeconomic background than individuals who are donated by family members or the medicolegal authority after their death.

Granollers is the capital and most densely populated city of the area of Vallès Oriental a population of 100,000. It is an industrial, commercial and trade city, situated 25 km North-east of Barcelona (Figure 1). The importance of Granollers as a centre for commerce grew in the Middle Ages, and the importance of its market is mentioned in chronicles dated in 1040 A.C (Garriga-Andreu, 1997). In the second half of the 19th century, farming was replaced by industrial and commercial activities. Since the 1960s, industrial, commercial and trade (retailer) diversity is one of the outstanding features of Granollers' economy (Panareda-Clopés et al., 1989). Figures 5 and 6 show the populational structure of Catalonia in 1900 and 1950. Figure 7 and Table 1 show the behaviour of mortality and birth rates, and life expectancy for men and women during the 20th century in Spain.

Discussion

The need for a modern human skeletal collections has been documented by many authors (Tobias, 1991; Miller-Shaivitz, 1996; Schutkowski, 2001; Hunt and Albanese, 2005; Rissech, 2008) and it is demonstrated by the recent creation of several collections as the Athens Collection in the Department of Animal and Human Physiology at the University of Athens (Eliopoulos et al., 2007), the Lisbon Collection

in the Department of Zoology and Anthropology in the University of Lisbon (Cardoso, 2006) and Pretoria Collection in the Department of Anatomy in the University of Pretoria (L'Abbé *et al*., 2004). Such collections have many benefits in both teaching and research. The UAB collection has the potential of becoming a great instrument of osteological research in Catalonia and also in Spain and Southeastern Europe in general, in part this is because it is the only existing Catalan collection and in part for its potentital for future growth. A collection like this offers the most direct evidence of the biological profile of Catalan population in the twentieth century and links it to recent historical records.

As shown in Figure 4, all of the individuals in the collection are adult and most are elderly. It is important to mention that the processes for collecting the skeletal material are not selective. In fact, the UAB collection represents a sample of a modern Catalan cemetery population, which is comprised mainly of adult individuals. Since the beginning of the 18th century children have been buried with their relatives (Ariès, 1983). Only the non-baptized infants were buried in a special area of the cemetery grounds. However infants were baptized as soon as possible, usually in the first three days after birth (Séguy and Signoli, 2008). In urgent cases, when the life of newborns was in danger, "rapid baptism" was applied. It could be administered immediately after birth, *in utero*, or in recently deceased children in order to save the childs' soul (Séguy and Signoli, 2008). That means in most cases children were buried with their relatives (Séguy and Signoli, 2008). We believe that the most probable explanation for the age distribution of the UAB collection could be due to both the improving conditions of the population in the 19th and 20th centuries, which increased life expectancies, and the greater probability of selecting an adult in a population where adults are the most abundant, taking into account that the individuals selected are few.

In the second half of the 19th century living conditions greatly improved in Spain, and specifically Catalonia, resulting in increased life expectancy and sharp decreases in infant mortality rates (Cabré *et al*., 2002). Both of these demographic characteristics, together with a reduction of the birth rate, transformed the composition of the Spanish and Catalan populations toward a more elderly population typical of a developed country (Cabré *et al*., 2002). The life expectancy (Table 1) doubled from 33.8 years for men and 35.1 years for woman in 1900 to 66.95 years for men and 71.82 for women in 1960. The mortality rate (Figure 7) was halved during this period, changing from 24‰ to 12 ‰ between 1900 and 1950 (Cabré *et al*., 2002). This change in population structure started in Catalonia in 1900 (Figures 5 and 6), a little earlier than Spain in general. Thus, the adult composition of the UAB collection closely reflects the most recent population structure of Catalonia.

Spanish collections

Only two documented collections existed in Spain before 1985: (i) the Collection of Pathological Cases housed in the Anthropological Laboratory of Granada University (Granada, Spain) and (ii) the Olóriz (Olóriz collection) Skull Collection stored in the Anatomical Museum of the Department of Anatomy and Human Embryology I of the Complutense University of Madrid (Madrid, Spain). Both collections were initiated in 1885. The Collection of Pathological Cases was started by Dr. Duarte, Professor of Surgery in the Hospital Clínico of the Granada University (Olague de Ros, 2001) and the Olóriz collection was started by Dr. Olóriz, Professor of Anatomy in the Complutense University of Madrid (Olóriz, 1899; Guirao Gea, 1956). Both collections are comprised of isolated skeletal elements rather than complete skeletons, but the biological and social information available for each individual is

considerable. For this reason they are considered to be of great referential value. All of the individuals were born in the 19th century and the collection period ended in the early 20th century upon the deaths of Oloriz and Duarte. Thus, both collections can be considered historical rather than modern collections.

The osteological material of the collection of Pathological Cases originates from patients that were treated in the Hospital Clínico of Granada University, and data available for each specimen include age, sex, city of origin, cause of death, the pathological diagnosis, and a wax or plaster bust to demonstrate the appearance of the pathology in life. When the Anthropological Laboratory of Granada University was founded in 1972 the collection was moved to this laboratory (Guirao Pérez, 1979).

The osteological material of the Olóriz Collection comes from individuals originating from the different regions of Spain and originally consisted of 2250 skulls. At the beginning of the 20th century, this collection was considered one of the most important in the world due as much to the number of skulls as to the tremendous amount of information obtained for each individual (e.g. age, sex, place of birth, ancestry, and a host of soft tissue and osteological observations and measurements) (Gómez Ocaña, 1913). When the Complutense University of Madrid was moved from the center of the city to the *Zona Universitaria* (a new university area outside of the city), the collection was divided among three different departments of the Complutense University of Madrid: Legal Medicine, Anatomy I and Anatomy II. The largest part of the collection (1000 skulls) was destined to the Department of Anatomy I headed by Dr. Olóriz (now the Department of Anatomy and Human Embryology I), and corresponds to the current Olóriz collection.

It wasn't until the end of the 20th century when reference skeletal collections comprising complete individuals was deemed necessary that an initiative arose in

several Spanish Universities to create documented skeletal collections of this kind. The first started in the Department of Anatomy of Valladolid University in 1985, undertaken by Dr. Francisco Pastor (Pastor *et al*., 1995), and other collections were later created in the 1990s, such as those at the Complutense University of Madrid (Dr. José Sánchez), Granada University (Dr. Miguel Botella and Dr. Inma Alemán), and the Autonomous University of Barcelona (Drs. Rissech and Malgosa). All of these collections are derived from modern cemetery samples. These collections are important because they are complete skeletons from different geographical areas of Spain: the centre, Madrid; the south, Granada; the north-centre, Valladolid and the north-east, Barcelona.

A recent trend in osteological studies is for a researcher to test a newly developed method, controlling for the same variable(s) as the original study but using a different documented sample. Typically, such studies have resulted in lower accuracy rates than the original investigation. Population variability is the most common explanation for this lack of agreement (e.g., Wiredu et al., 1999; Asala, 2001; Alunni-Perret et al., 2003; Burrows et al., 2003; Rıos, 2003; Kemkes and Göbel, 2006) and there is a claim of several authors from different parts of the World (e.g. Wu, 1989; Trancho et al., 1997; King et al., 1998; Mall et al., 2000; Barrio et al., 2006; Rissech et al., 2007) have called for the development of region-specific standards. These Spanish osteological collections are important in this regard.

Importance of the UAB collection

The UAB collection is not noted for its size, but this does not impair its value in the different areas of research, including anthropology, archaeology, medicine, anatomy and forensic sciences. The contribution of the UAB collection to the field of osteoarchaeology is evident, as it can form part of the basis for the development and

improvement of methodologies that allow us to obtain demographic information for the purposes of identification and to reconstruct the lifestyle of a population (bioarchaeology). It can help to answer the question of whether there is population variation in the expression of sexually dimorphic traits and to evaluate the variability in the skeletal manifestations of aging across populations. Given its age structure and its modern composition, the collection will be especially useful to validate different methodologies of adult age estimation that seek accuracy and reliability within older adult age intervals, which are very important in forensic cases (Komar and Grivas, 2008; Ousley *et al.,* 2009).

The scientific contribution of UAB collection can be even more extensive. The Catalan geographic region is underrepresented in existing skeletal collections and can add to our understandings of the range of variation observed among living Spanish groups. For instance, craniometric differences among regional Spanish groups and across the Iberian Peninsula and clines of robusticity have been observed by anthropologists (Olóriz, 1894; Turbón, 1981; López-Martínez, 2000; López-Costas, 2007). Catalan data, in association with other Mediterranean collections (archaeological and non archaeological) can help to understand the migrations in the Mediterranean sea. Portuguese and multiregional Spanish data, can help decipher how multiple waves of immigration and conquest in Spanish history (e.g. Muslims, Greek, Romans) have impacted modern population structure of Spain and Spanish regions.

Such population variation data are particularly important to ongoing human rights investigations of mass graves from the Spanish Civil War era. Since 2000 archaeologists have worked to recover historic memory of the Spanish Civil War by exhuming the remains of victims of extrajudicial executions (c.f. Rios et al., 2008; Gassiot et al., 2007; Gassiot and Steadman, 2008). Physical anthropologists develop a

biological profile of the victims for identification purposes but most of the skeletal aging and stature standards available were developed on U.S. reference samples. The magnitude of error involved in applying these methods to Spanish individuals who were likely born around the beginning of the 20th century is unknown. For example, the method for the calculating stature based on U.S. reference samples fails in the estimation of living height in Catalonia. In Catalonia, to use the formulae proposed by Pearson (1899) at the end of 19th century based on a French sample performs better, because of the biological proximity between French and Catalan populations (Safont, 2003). Powanda (2008) and Corcione (2008) conducted validation studies using classical methods of adult age estimation and each showed significant error. The accuracy obtained by Powanda was only of 50% and 76% when she preformed Lovejoy and Suchey-Brooks methods respectively; for Corcione was 37% and 66.7%. The temporal context of the UAB and other Spanish collections are important because they are temporal and geographic cohorts with those who were killed during the war.

UAB collection has been used as part of osteological studies such as: 1) developing new methodologies for sex determination (Safont *et al*., 2000); 2) development of new methodologies for adult age estimation (Rougé-Maillart *et al*., 2004; Rissech *et al*., 2006, 2007); 3) biomechanics (Galtés *et al*., 2008); 4) reliability and precision in classic adult age estimation methodology (Corcione, 2008; Powanda, 2008) and 5) skeletal development (Rissech, 2001, 2008; Rissech and Malgosa, 2005, 2007; Rissech *et al*., 2001, 2002, 2003, 2008). Therefore, the UAB Collection can be the basis of a great many forensic and bioarchaeological osteological studies.

Conclusion

In the face of growing concern for methodological standardization and presentation of error rates and appropriate geographic representation of reference samples in in forensic anthropology and bioarchaeology, the need for a greater number of well-documented and contextualized, complete skeletons of known age and sex is clear. The individuals of the UAB collection lived during the 20th century and died in Catalonia.. It is constituted by 35 adults who likely come from middle to low social-economic class from the industrial and commercial city of Granollers with equal representation of both sexes.

The UAB collection is currently rather small yet, as a comparative sample, it can address vital osteological questions, particularly pertaining to the development and validation of aging methods on older individuals. Further, as a representation of the Catalan geographic area, the sample will prove quite important for populational comparisons and especially for intra- and international comparations with victims from Catalonia, the rest of Spain and foreigners exhumed from Civil War era mass graves. As the collection grows, its utility in anthropological research will continue to increase.

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