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Anthropological evaluation of Old Kingdom human burials from the pyramid field of Abusir

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ABSTRACT

Anthropological research has been going on at the archaeological concession of the Czech Institute of Egyptology in Abusir for nearly 60 years. The first burials dated to the Old Kingdom, more specifically to the Fifth and Sixth Dynasties (2510–2365 BC), were found in 1976. Nevertheless, it has taken almost to the present time to gather more than two hundred skeletons needed to carry out a comprehensive study of the Abusir skeletal sample. This task was preceded by the creation of the *AnuBase*, an extensive and detailed database of anthropological data, and by the acquisition of a suitable depository space where the human skeletal remains are stored.

The present study focuses mainly on the paleodemographic profile of the individuals buried in Abusir cemeteries and the metric analysis of the skeletons dating to the Old Kingdom. The results revealed a lower number of buried females compared to males and very few subadults. Very pronounced sexual dimorphism was noted between the male and female skeletons in both skulls and the infra-cranial skeleton. Male crania are longer but lower than female crania, while females were characterized by higher faces. Although male long bones were longer and more robust than female ones, they do not differ in the proportionality of the upper and lower extremities. High sexual dimorphism in body height is consistent with the presumption of the higher status of individuals buried in Abusir.

The results of both anthropological and paleodemographic analyses show a connection with the social status of the individuals in question. The low number of females buried in the cemeteries of Abusir and the almost missing subadults could indicate specific burial strategies in the area governed by strict rules. Future research should address these issues in detail.

KEYWORDS

Egypt – Abusir – Old Kingdom – anthropology – paleodemographic indicators – osteological measurements – social status – Fifth Dynasty – Sixth Dynasty

تقييم أنثروبولوجى لدفنات بشرية من الدولة القديمة من جبانة أبوصير

بيترا بروكنير هاڤيلكوڤا – ڤيرونيكا دوليكوڤا – شاركا بيدوڤا – بيتر ڤيليمنسكى – ميروسلاڤ بارتا

الملخص

تجرى الأبحاث الأنثروبولوجية بموقع بعثة المعهد التشيكى للآثار المصرية فى أبوصير منذ ما يقرب من 60 عامًا. ومن المعروف أنه تم العثور على أول تلك الدفنات التى تؤرخ بعصر الدولة القديمة، تحديداً إلى الأسرتين الخامسة والسادسة (2510–2365 ق. م)، فى عام 1976. وعلى الرغم من ذلك، فقد استغرق الأمر تقريبًا حتى وقتنا الحاضر لجمع أكثر من مائتى هيكل عظمى، وهو العدد اللازم لاجراء دراسة شاملة من أبوصير. سبق تلك الخطوة إنشاء *AnuBase* ، وهى قاعدة بيانات واسعة ومفصلة للبيانات الأنثروبولوجية من الموقع، وتوفير مساحة مناسبة لتخزين بقايا الهيكل العظمية.

تركز الدراسة الحالية بشكل أساسى على الملامح الديموغرافية القديمة للأفراد المدفونين بجبانة أبوصير والتحليل المترى للهياكل العظمية التى تعود إلى عصر الدولة القديمة. هذا وقد كشفت النتائج عن وجود عدد أقل من دفنات الإناث مقارنة بالذكور وعددًا

قليلًا جدًا من الأشخاص البالغين ، كما لوحظ بشكل ظاهر ازدواج الشكل الجنسى بين الهياكل العظمية للذكور والإناث فى كل من الجماجم وتكونيها العظمى. حيث أتضح أن جماجم الذكور أطول ولكنها أقل من جماجم الإناث، بينما تميزت السيدات بوجوه أعلى. وعلى الرغم من أن عظام الذكور الطويلة كانت أطول وأقوى من عظام الإناث، إلا أنها لا تختلف فى التناسب بين الأطراف العلوية والسفلية. كما يتوافق ارتفاع مثنوية الشكل الجنسى فى طول الجسم مع افتراض المكانة الاجتماعية العليا للأفراد المدفونين فى أبوصير.

تظهر نتائج كل من التحليلات الأنثروبولوجية والديموغرافية القديمة ارتباطًا بالحالة الاجتماعية للأفراد الذين تمت دراستهم. كما يمكن أن يشير العدد المنخفض للإناث المدفونين فى جبانة أبوصير ، وكذلك دفنات الأشخاص البالغين شبه المفقودة تمامًا إلى استراتيجيات دفن محددة فى منطقة تحكمها قواعد صارمة للدفن. حيث يجب أن تتناول الأبحاث المستقبلية هذه القضايا بالتفصيل.

الكلمات الدالة

مصر – أبوصير – الدولة القديمة – الأنثروبولوجيا – المؤشرات الديموغرافية القديمة – القياسات العظمية – الحالة الاجتماعية – الأسرة الخامسة – الأسرة السادسة

The Czech Institute of Egyptology's archaeological concession in Abusir covers an area of approximately 2 km², making it one of the largest foreign concessions in Egypt (Bárta *et al.* 2020). For millennia, the entire area was used at varying intensities primarily as a burial ground for individuals of different social standing (Bárta 2020). From the 1960s, when the exploration of the mastaba of Vizier Ptahshepses (AC 8; Verner 1982; Strouhal – Bareš 1993; Krejčí 2009; Dulíková 2017; Dulíková – Jirásková – Odler 2021) began, anthropological research has been an integral part of research into ancient Egyptian society as reflected through mastabas, tombs and burials in Abusir. Unfortunately, no Old Kingdom burials were initially found during these excavations except for some sparse remains in the burial chamber of Ptahshepses and dozens of intrusive burials in and around the mastaba dating to the Late Period (Strouhal – Bareš 1993). However, later extension of the concession to other areas, first to the shadow of Abusir's southernmost pyramid (1976), then to the area of the non-royal cemetery at Abusir South (1991) and eventually to the Cemetery of Ty (2018), yielded the skeletons from Old Kingdom cemeteries of royal family members and non-royal officials and priests; in the latter case, undisturbed by any larger burial ground from later periods.

Active archaeological and anthropological research is currently underway at three main sites. Two of them, Central and South Abusir, were important burial sites from the Old Kingdom period (*ca.* 2700–2180 BC), more specifically from the Fifth and Sixth Dynasties (2510–2365 BC), although some tombs, such as Hetepi (AS 20), the anonymous mastaba AS 33 (Bárta – Coppens – Vymazalová *et al.* 2010) or Iti (AS 10; Bárta 2001: 1–16), were built as early as the turn of the Third and Fourth Dynasties. Central or royal Abusir, the area comprising tombs in proximity to the pyramids, includes the burials of members of the royal family; 34 tombs dating back to the Third Millennium BC as well as many burials from the First Millennium BC have been uncovered there so far. The second important area within the concession is Abusir South, the area between the pyramids of Abusir and Saqqara. It is a large burial site of officials who often held significant administrative positions. More than a hundred tombs or cult structures have been explored in this part of the concession, and most of the skeletal remains that form the basis of the assemblage under study come from there. The third area represents a group of shaft tombs dated to the Twenty-Sixth and Twenty-Seventh Dynasties.

The construction of shafts more than 20 m deep with a burial chamber at their bottom is typical of this period. One of the most significant discoveries was the finding of the intact burial chamber of the priest Iufaa (AW 2) in a richly decorated limestone sarcophagus (Strouhal – Němečková – Kouba 2003; Strouhal 2004; Bareš – Smoláriková 2008).

ANTHROPOLOGICAL RESEARCH IN ABUSIR

The first objective of this paper is to offer an overview of more than 60 years of anthropological research in Abusir, from the first discoveries of Old Kingdom skeletons to the time of obtaining permanent depository spaces where human skeletal remains can be stored and, finally, the creation of a detailed anthropological database, the *Anup-base*. The second part of the paper is focused on the first results of anthropological analyses based on the data collected in the *AnuBase*, including the sex and age-at-death distribution within the sample and the results of metrical analysis of the skulls and infra-cranial skeletons. Thus, the paper summarizes the long journey from collecting the material and data to the first results.

The first decades of the anthropological research of the Czech Institute of Egyptology at Abusir (and other sites in Egypt) were associated with the name of Eugen Strouhal. Viktor Černý continued his work in the 1990s. In the following years, the anthropological analysis of skeletal remains in Abusir became the domain of women (Martina Kujanová, Pavla Zedníková Malá). The cooperation between the Czech Institute of Egyptology and the Department of Anthropology of the National Museum was established in 2009 when Petra Brukner Havelková became the research coordinator. Since 2012, anthropologists from the National Museum have been providing the complete evaluation of skeletal remains housed in Egypt; this sometimes requires the cooperation of external anthropologists, including especially Šárka Bejdová from the Faculty of Science of Charles University.

The main task of the anthropologists in Abusir is a comprehensive processing of all skeletal remains that have been uncovered, regardless of their dating or the social status of the individual. The research focuses mainly on basic anthropological characteristics, such as age-at-death and sex estimation, metric analysis or description of health status. Although Abusir is perceived primarily as a burial ground of the Old Kingdom elite population, most skeletal remains come from much later periods. The latter burials, often in stratigraphic layers, cover the whole of Central Abusir. They are usually dated to the First Millennium BC (Third Intermediate Period, Late Period, Greco-Roman Period), when the area, especially the close vicinity of the Abusir pyramids and the already partially decayed and silted-up non-royal Old Kingdom tombs, was intensively re-used for burials (for a cluster of such burials around Ptahshepses [AC 8], see Strouhal – Bareš 1993; for a conglomeration around Werkaure [AC 26], see Krejčí – Brukner Havelková *et al.*, *forthcoming*). The reuse of the Old Kingdom pyramid sites for new burials was common in the Memphite necropolis during these later periods (see *e.g.*, Zivie-Coche 1991; Myśliwiec 2008a and 2008b). By contrast, later burials occur sporadically in Abusir South cemetery, which is relatively distant from royal pyramid complexes, both in Central Abusir and in Saqqara. These were simple burials of mummified bodies placed in wooden coffins, wrapped in reed mats or only in linen bandages and buried directly in the sand (Smoláriková – Peterková Hlouchová 2020; Peterková Hlouchová 2017). Due to the simplicity of the latter burials, their precise dating is almost impossible. In our experience, skeletal remains from these burials are usually very well preserved compared to skeletons from Old Kingdom tombs, which are often demineralized and, therefore, considerably decayed and preserved in poor condition. The reason probably lies in the different taphonomic factors. The decomposition of the body and subsequent processes take place differently in an empty space, such as the burial chamber of an Old Kingdom tomb, and in the fill of a grave in the sand (Mant 1987; Prokeš 2007; Duday 2009). A different way of mummification can also play an important role: resin was already widely used in later burials, while most Old Kingdom burials in Abusir were only naturally mummified and wrapped in linen bandages. A significant difference in dating cannot be overlooked, as these funerals are stretched over up to two thousand years. Finally, it is worth mentioning that the discovery of an intact Old Kingdom burial is rare; the skeletal remains of a buried individual are often found robbed and away from the sarcophagus, scattered in the backfill of the shaft (*e.g.* the burial of Kairsu, Bárta – Jirásková *et al.* 2020).

Due to the problematic dating and the lack of further information about individuals buried in later periods, the priority of anthropological and archaeological research in Abusir is focusing on the study of the Old Kingdom tombs and the skeletal remains. The significance of these burials lies, in most cases, in their clear dating based on an assessment of the tomb architecture, written sources, tomb decoration style, burial apartment, burial equipment, ceramics, artefact typologies, *etc*. Unfortunately, obtaining a statistically sufficient number of individuals for a general population study of the Old Kingdom inhabitants was almost impossible until the years 2012 and 2013.

THE HUMAN SKELETAL REMAINS COLLECTION

The first skeletal remains belonging to individuals from the Old Kingdom period in the region of Abusir were found in 1976; they were members of the royal family of King Djedkare, namely Princesses Khekeretnebty and her presumed daughter, Tisethor (AC 15) (Strouhal 1984). In 1987, the skeletons of further three members or close relatives of this royal family were uncovered: Princess Hedjetnebu (AC 19), the skeleton of "Lady L" (AC 20) and the scribe of royal children Faaf Idu (AS 17) (Strouhal 1992; Strouhal – Gaballah 1993; Strouhal *et al.* 2001; Strouhal – Klír – Němečková 2002). Other skeletal remains were discovered in the 1990s, including the hand and a few bones belonging to King Raneferef (AC 3) (Strouhal – Vyhnánek 2000; Strouhal *et al.* 2001; Němečková – Strouhal 2002; Verner *et al.* 2006).

Obtaining skeletal remains for a population study has therefore been a process spanning several decades. It may take an entire excavation season extending over several weeks to properly explore and document the superstructure and substructure of a tomb. The number of shafts within a tomb varies, there may be only one or two, but more often there are more, as these are usually the so-called family tombs. At the bottom of such a shaft is usually the entrance to the burial chamber where the person's burial would be located. Regrettably, most burials were disturbed by thieves already in antiquity, resulting in severe fragmentation or incompleteness of the skeletal remains.

Therefore, the number and preservation of the Old Kingdom burials uncovered during one archaeological season vary considerably each year. Up to ten skeletons are usually added to the assemblage, but no burials at all are discovered or uncovered in some years. The breakthrough came with the unearthing of the burial complex of the high-ranking dignitary Nefer and Princess

Sheretnebty (AS 68) between 2012 and 2014. At that time, 30 Old Kingdom skeletons were uncovered, a number that corresponded to the statistical minimum for various sub-analyses; this is when the idea of studying Old Kingdom individuals from a population perspective was born for the first time (Bárta *et al.* 2014). However, not all skeletons were sufficiently preserved.

In order to increase the number of Old Kingdom skeletons in the sample, the anthropologists who had processed the Abusir material in the past were asked to supply their data. Thanks to that contribution, the data collected from approximately 80 Old Kingdom burials previously uncovered and studied were included in the analysis.

In the case of the oldest findings, however, the results of the partial stages of sex and age-at-death estimation as well as specific analyses, for instance, of non-metric traits or entheseal changes were not part of the previous evaluation of skeletal remains, or their records were not preserved. Although almost every year new skeletal remains become available for the study, the number of individuals still did not match our requirements. We focused our efforts on finding the skeletal remains uncovered in previous archaeological campaigns in order to perform a new and detailed anthropological analysis. Since 2013, all skeletal remains so far uncovered at the site have been stored and examined in a designated place where they can be made available for further studied, if required. At present, almost all skeletal finds are submitted for permanent storage unless otherwise decided, which only happens in cases of insufficient dating. In that case, they are reburied back into the shaft.

ANTHROPOLOGICAL DATABASE *ANUBASE*

With a growing amount of human skeletal remains and data collected, there was a need to input, store and compile the data in the form of a digital database that would allow data processing. However, no suitable kind of database existed.

Since the Czech Institute of Egyptology already had its own archival databases in FileMaker, we decided to follow in its footsteps. Slowly, a database corresponding to the anthropological requirements for the study of ancient Egyptian populations was born. It now contains more than 4,500 database entries.

The database is based on a total of 14 interconnected layouts. The main layout brings together information about the archaeological context, the tomb code, dating, the social status of the individual, estimates of the sex, age-at-death and the living stature, the current storage location of the skeletal remains, a brief description and links to other layouts that show whether partial anthropological analyses could be carried out (fig. 1). Within this main sheet there are also tabs detailing the preservation of the skeleton and the characteristics by which the status of the individual is determined. Additional layouts focus on detailed information on how the sex and age were estimated, the metric analyses including calculations of body indices and height, evaluation of dental health, the description and categorization of pathological conditions, evaluation of cranial non-metric traits, teeth and infra-cranial skeleton, and a more detailed evaluation of manifestations of physical stress on the skeleton. Wherever possible, all sub-stages of the assessment are entered to allow subsequent work with the data (fig. 2).

Currently, the *AnuBase* database contains records of 474 individuals (identified by find/grave numbers) buried at Abusir, 220 of whom are dated to the Old Kingdom. The processing of the skeletal remains of these individuals forms the basis of the results of the present work.

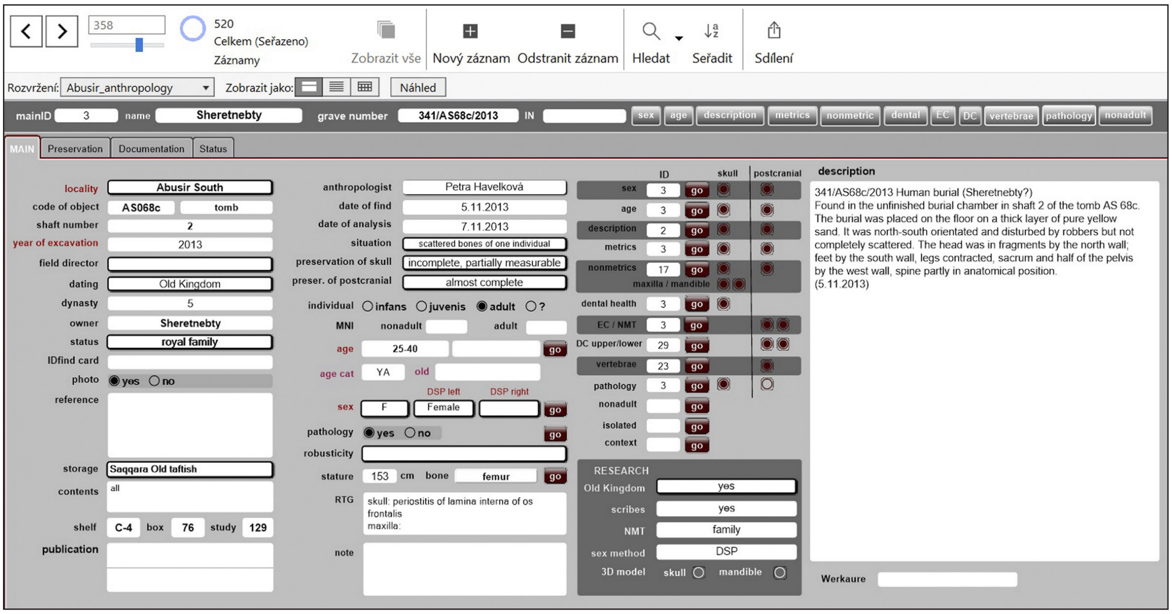


Fig. 1 Example of the main layout from the *AnuBase*

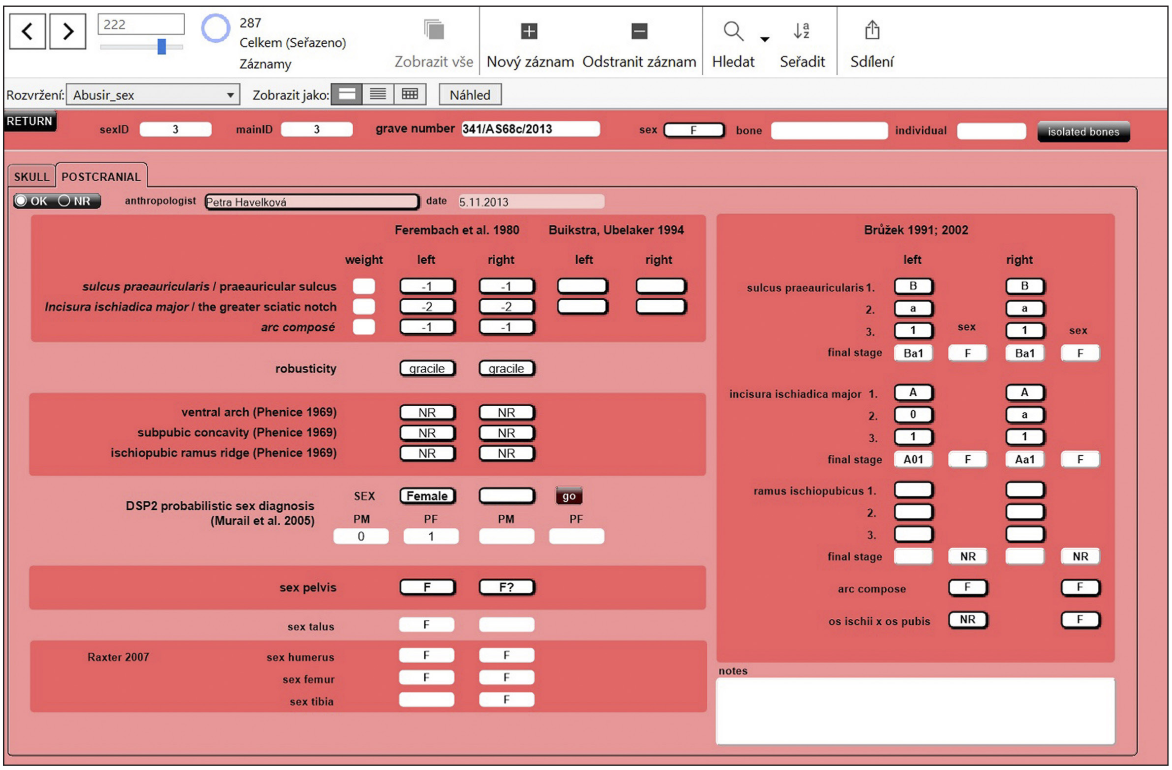


Fig. 2 Example of the sex estimation layout from the *AnuBase* with the sub-stages of the assessment

MATERIAL AND METHODOLOGY OF ANTHROPOLOGICAL RESEARCH

Unambiguous dating was one of the basic criteria for the inclusion of an individual in the assemblage (see above). A total of 220 Old Kingdom individuals were included in the present study; regrettably, the state of preservation of some skeletons did not allow an estimate of either sex or age-at-death. The complete numbers of individuals categorized by sex and age-at-death are summarized in tab. 1.

AGE GROUPS	Males	Females	U	Total
[0–<1]			3	3
[1–4]			3	3
[5–9]			5	5
[10–14]			3	3
[15–19]		2	1	3
Immatures	0	2	15	17
YA	16	17	1	34
MA	53	37	9	99
OA	32	17	2	51
A	1	1	17	19
Adults	102	72	29	203
Total	102	74	44	220

Tab. 1 Summary of the absolute numbers of individuals according to age and sex (F: females; M: males; U: undetermined; YA: young adults; MA: middle adults; OA: old adults)

The human skeletal remains came from altogether 74 tombs that have been unearthed over the past 50 years. The codes of structures (tombs), the owners' names (where known), the number of males, females and subadults in the tomb and a reference to the anthropological publication, if it exists, are given in supplementary tab. S1.

As mentioned above, anthropological research in Abusir began as early as the 1970s. Human skeletal remains, which were continuously uncovered, were processed by various anthropologists using well-established anthropological methods corresponding to the period of research. However, the suitability of the used methods was revised in 2009 when the cooperation between anthropologists from the National Museum and the Czech Institute of Egyptology began. Current anthropological methods became the basis of the evaluation for all subsequently discovered skeletons. Along with the collection of data for the *AnuBase*, revisions of the sex and age-at-death estimates of all preserved skeletons from previous surveys were carried out using the revised methods described below; however, the data from the original evaluation were entered into the *AnuBase* as well. As some of the skeletons from the 1991 and 1993 excavations had been reburied, data based on the original anthropological record cards and published results were included in the *AnuBase*. However, sex and age-at-death estimates for these individuals were already then partly based on methods that are used today (*e.g.*, Ferembach – Schwidetzky – Stloukal 1980; Brůžek – Ferembach 1992). Sex estimation based on metrical analysis of pelvic bones (Murail *et al.* 2005; Brůžek *et al.* 2017) was not part of the methods used then, but as the dimensions needed for the analysis are preserved, the method can be applied also to buried individuals.

The most suitable bone structure reflecting the sexual dimorphism of the skeleton is the pelvic bone, which is closely connected with reproductive function. The metrical approach (Murail *et al.* 2005; Brůžek *et al.* 2017) was used for primary **sex estimation** where possible, together with morphological evaluation of pelvic structures (Ferembach – Schwidetzky – Stloukal 1980; Buikstra – Ubelaker 1994; Brůžek 2002). Where the pelvic bones were missing, the descriptive morphological features of the skull (Ferembach – Schwidetzky – Stloukal 1980; Buikstra – Ubelaker 1994) and discriminant function analysis of visually assessed traits of the skull (Walker 2008) were used. Metric standards for estimating sex using a discriminant function based on selected measurements of long bones (Raxter 2007) were used as auxiliary methods.

Different methods were used to assess the **age-at-death** with respect to the preservation of bony structures. The obliteration of the spheno-occipital synchondrosis in the skull determines adulthood (more than 19 years; Schaefer *et al.* 2009). The mineralization and eruption of the teeth (Ubelaker 1978; Brown 1985), a fusion of epiphyses and apophyses or the length of the long bones diaphysis and other bone measurements (Schaefer *et al.* 2009) were used to determine the age of subadults (immature skeletons). The estimation of age-at-death in adult individuals was based mainly on morphoscopic evaluation of the structures of the pelvic bones: the auricular surface was evaluated according to Lovejoy *et al.* (1985) and Schmitt (2005) and morphological changes of the pubic symphysis according to the Todd (McKern – Stewart 1957) and Suchey-Brooks methods (Brooks – Suchey 1990). The Calce (2012) method of age-at-death estimation in adults using the acetabulum was used as an additional method for the detection of older individuals (Navega *et al.* 2018; Zazvonilová – Velemínský – Brůžek 2020) or where other pelvic bone structures were missing. Several other features reflecting the skeletal age were also taken into account to acquire complex information about the individual's age-at-death. Changes of the sternal end of the clavicle (Szilvássy 1980), degenerative changes of the vertebral column (Stloukal – Vyhnánek 1976) and the inner architecture (the structure of the spongy bone, cavity formation, *etc.*) of the proximal femur and the humerus (Szilvássy – Kritscher 1990) were evaluated where possible. In cases where only the skull or the mandible were present, the degree of dental wear (abrasion, attrition) was the main marker for the age-at-death estimation (Miles 1963; Brothwell 1981; Lovejoy 1985).

Five age groups [0–1 year], [1–4 years], [5–9 years], [10–14 years], [15–19 years] were used to in the case of subadult individuals. Adult individuals were finally divided into three age categories: YA – young adults [20–35 years], MA – middle adults [35–50 years] and OA – old adults [more than 50 years].

A total of 41 **measurements** of the cranium and 74 dimensions of bones of the infra-cranial skeleton (long bones, pelvic bones, scapulae, claviculae, patellae, tali and calcanei) were collected based on the definitions by Martin and Saller (1957) and Knussman (1988). Additional measurements were added from Buikstra and Ubelaker (1994); these measurements are always indicated by a number in parentheses. Measurements of pelvic bones were based on definition in Murail *et al.* (2005). Subsequently, nine cranial and 10 infra-cranial indices were calculated.

The length of the long bones was used for the living stature estimation. Three approaches were used to calculate the individual's living stature. The main method of estimation is based on Raxter *et al.* (2008), a study that was based on the ancient Egyptian population. The Trotter and Gleser (1952, 1958, 1977) formulae for African Americans (which are recommended by Robins (1983) and Robins and Shute (1986) as being more consistent with the skeletons of the ancient Egyptians than those for white Americans) were included to ensure continuity with previous research and for possible comparison. The Sjøvold (1990) method was used where sex was unknown. However, results based on the formulae according to Raxter *et al.* (2008) were primarily used for the purposes of this publication.

SEX AND AGE-AT-DEATH DISTRIBUTION OF OLD KINGDOM SKELETAL SAMPLE FROM ABUSIR

Many bioarchaeological studies dealing with various topics include human skeletal material dated to the Old Kingdom period (*e.g.*, Davide 1972; Masali – Chiarelli 1972; Satinoff 1972; Leek 1980; Kaczmarek 2002; Sarry El-Din – El Banna 2006; Raxter 2011; Zakrzewski 2012; Zaki 2013; Marlow 2014; Habicht *et al.* 2015; Refai 2019). However, most of these studies are based on the evaluation of the human skeletal remains stored in various museum collections originating from archaeological excavations carried out mainly in the first half of the twentieth century. Due to their availability, museum collections are suitable for comparing various anthropological characteristics, but the evaluation of the demographic distribution of the sample can be quite problematic given the frequent selection of skeletons/bones associated with earlier research priorities. Therefore, systematic bioarchaeological studies focused on the complex processing of Old Kingdom cemeteries are rare. As was also the case with the research in Abusir, the findings are usually published gradually by single tombs and summary data about the demographic profile of the cemetery are missing. One of the exceptions is research by the Polish expedition in Saqqara, which has long focused not only on the comprehensive anthropological processing of all human skeletal remains found but also on their summary publication (Kaczmarek 2008; Kaczmarek – Kozieradzka-Ogunmakin 2013). Other Old Kingdom cemeteries where data on overall age-at-death and sex distribution are available include three burial grounds at Giza uncovered by various archaeological expeditions and the cemetery at Mendes in the Nile Delta region. The so-called Minor Cemetery at Giza placed west of the western portion of the royal Khufu cemetery was uncovered in 1915 by Clarence S. Fisher and is assumed to be intended for the tombs of minor court officials (Fisher 1924). Two skeletal assemblages stored in a facility at Giza come from the Western Cemetery at Giza, which is considered the cemetery of high-ranking officials (Hawass 1996): the first was excavated by George Reisner during the Hearst Expedition (1902–1945), the second by the Supreme Council of Antiquities (SCA) under the direction of Zahi Hawass (1989–1992) (Hawass 1996; Hussien *et al.* 2003). The last cemetery in Giza, the South East Cemetery, is also part of the SCA excavations; in contrast to the previous two cemeteries, the workers involved in the construction of the pyramids were probably buried there (Hussien *et al.* 2003). The last comparison sample comes from Mendes, a significant Old Kingdom administrative and cult centrum in the Delta region (Mant 2014). The numbers and frequencies of males, females and subadults buried in the above-mentioned cemeteries, including the ratios of male and female skeletons are summarized in tab. 2.

Cemetery	Total	M		F		U		IMM		M : F	reference
	N	N	%	N	%	N	%	N	%		
Abusir	220	102	46.4	72	32.7	29	13.2	17	7.7	1.42 : 1	present study
Saqqara	92	45	48.9	30	32.6	12	13.0	5	5.4	1.5 : 1	Kaczmarek – Kozieradzka-Ogunmakin 2013
Giza Minor Cemetery	125	37	29.6	39	31.2	49	39.2	0	0.0	1 : 1.05	Fisher 1924
Giza Western Cemetery (high-ranking officials)	170	81	47.6	73	42.9	7	4.1	9	5.3	1.11 : 1	Hussien *et al.* 2003
Giza South East Cemetery (workers)	85	29	34.1	29	34.1	7	8.2	20	23.5	1 : 1	Hussien *et al.* 2003
Mendes – Nile Delta	26	10	38.5	8	30.8	3	11.5	5	19.2	1.25 : 1	Mant 2014

Tab. 2 Comparison of male, female and immature skeletons among Old Kingdom cemeteries (IMM: immature skeletons; M: males; F: females; U: unidentified)

The presented sample from Abusir includes 102 males, 72 females and only 17 subadults (tab. 1). Subadult individuals were almost evenly distributed in the age categories – three individuals in each age class except for the age group [5–9 years], which includes five individuals. Two juvenile skeletons [15–19 years] were estimated as female based on metrical analysis of the pelvic bones (Tisethor, the presumed daughter of Princess Khekeretnebty, is one of them). Sex estimation was impossible for 29 adult skeletons due to their poor preservation. The demographic profile of the Old Kingdom Abusir sample exhibits several anomalies. Of the 189 individuals buried in the tombs of Abusir for whom both sex (in adult skeletons) and age-at--death could be estimated, most were males (53.4%). Female burials were less common (37%). The least represented group in the Old Kingdom tombs was subadults, whose skeletons were found only in 17 cases (9.5% if only adult individuals whose age-at-death and sex could be estimated were included; 7.7% when including also adult individuals without an estimated sex and age-at-death). Most subadult individuals died aged up to 15. These 17 subadult individuals include two juvenile females aged [15–19 years]. For further analyses, these two immature skeletons were included among subadults, despite being estimated as female.

The complete demographic profile based on mortality quotients (‰) clearly shows the abnormality of age distribution in the observed population (chart 1). The graphic representation of the mortality quotients and their comparison with the expected theoretical values (Ledermann 1969) reveal that subadult individuals – especially those younger than 15 years – present a quotient largely insufficient compared to that of a pre-industrial population.

The ratio between males and females was therefore 1.4 : 1, which is similar to the results found at the nearby Old Kingdom cemetery at Saqqara from the same period, where the

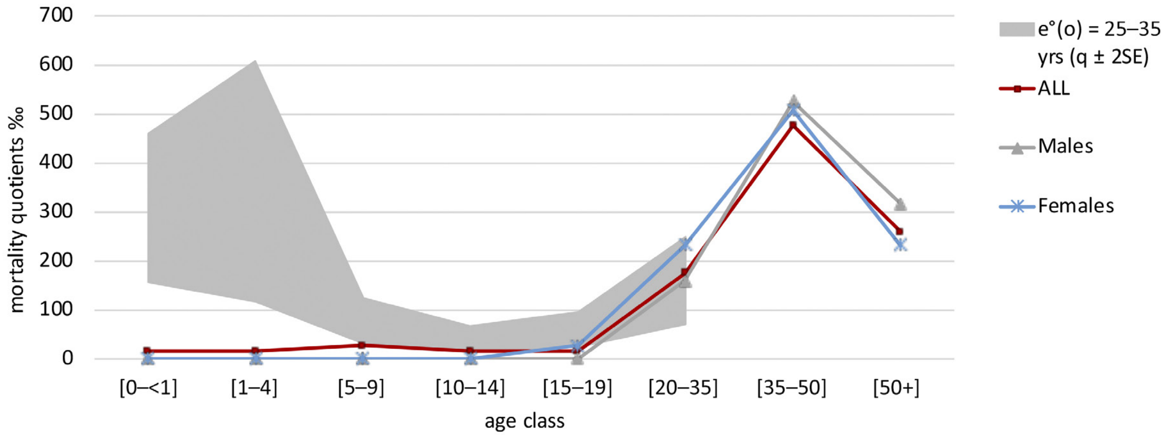
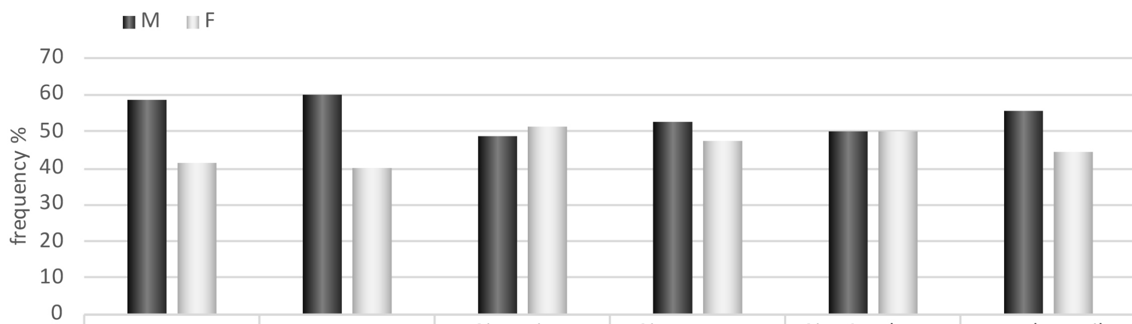


Chart 1 Demographical profile curve of the Abusir sample based on mortality quotients (‰)



	Abusir	Saqqara	Giza Minor Cemetery	Giza Western Cemetery	Giza South East Cemetery	Mendes – Nile Delta
M	58.6	60	48.7	52.6	50	55.6
F	41.4	40	51.3	47.4	50	44.4

Chart 2 Frequencies of male and female burials at different Old Kingdom cemeteries

ratio was 1.5 : 1 (Kaczmarek – Kozieradzka-Ogunmakin 2013): it shows a third more males than females in contrast to the theoretically expected equal sex representation of one male to one female (tab. 2). This theoretical ratio was recorded for males and females buried in the South East Cemetery at Giza, which is defined as the burial ground of workers (Hussien *et al.* 2003). However, the other two burial grounds in Giza also exhibit a M : F ratio very close to 1 : 1 (Fisher 1924; Hussien *et al.* 2003) as visible in tab. 2 and chart 2.

The sex ratio seems to vary depending on the social status of the tomb owner. In previous work, we focused on the comparison of the main (higher status) and subsidiary (lower status) tombs where the characteristics of the main and subsidiary tombs are defined (Havelková – Dulíková 2020). The comparison of selected tombs from the Abusir South cemetery shows that the ratio of females and subadults is higher in subsidiary burials. In the tombs of the high-ranking individuals, males are more frequently represented than females (4 : 1), with no subadult burials documented there at all. Usually, this means that only one female (probably the owner's wife) was buried in multi-shaft tombs; any other burials were exclusively male. The exceptions are, of course, the tombs of the princesses, who had royal status and owned their own tombs. Interestingly, the ratio of buried males and females is almost equal (1.3 : 1) in subsidiary tombs. A similar male to female ratio (1.5 : 1) is mentioned in the tomb cluster around Fetekta's mastaba (AS 5) (Bárta 2002), whose burials are also included in the presented sample; this corresponds to the low social status of Fetekta's cemetery. The overall sex ratio is more similar to that of modest tombs, as these burials predominate in the present sample. These discrepancies provide valuable information about the society of that time and reflect social status in everyday life, or more precisely death. Except for members of the royal family, the number of buried female and subadults seems to decrease with higher social status.

Addressing the issue of missing female burials, according to Kaczmarek and Kozieradzka-Ogunmakin (2013), this cannot rule out a possibility that the number of female burials was lower due to the greater fragility of female skeletons and their subsequent poorer preservation. However, based on our experience in Abusir, the preservation of male and female skeletons within the site is similar. Even immature skeletons, if found, tend to be very well preserved. Vivienne G. Callender (2002) suggests that women who held no function at the royal court may not have had the right to be buried with their husbands. However, the examination of this hypothesis formulated by Callender requires in-depth research of all shafts and cult places within the particular tombs in cemeteries with regard to the social status of relevant tomb owners. Only such a research approach has the potential to answer the question.

In this respect, for example, the presence of the wives' burials within the tombs of their husbands in the late Fifth Dynasty burial complex of the high-ranking dignitary Nefer and Princess Sheretnebty (AS 68) is worth noticing (for the plan of the area, see Bárta 2014: 16, fig. 3). Graves dedicated to females occur in two of four rock-cut tombs:

1. Neferhathor, the spouse of the high-ranking dignitary Nefer, was buried in a finely dressed sarcophagus in Shaft 2 (AS 68d; fig. 3). She held the rank title *iry(t) ḫt nśwt*, property custodian of the king. Nefer's wife was the only woman buried in the tomb (2 males, 1 female, 1 child; Bárta 2014; Bárta *et al.* 2014: 26–30).
2. Princess Sheretnebty (Shaft 2) and probably another woman (Shaft 4) were buried in the rock-cut tomb AS 68c whose anonymous owner was the princess's husband. Six burial shafts were hewn in this tomb (Bárta *et al.* 2014: 25–26).
3. By contrast, female burials are totally absent from the tombs of Shepespuptah Idu (AS 68b; only the tomb owner was interred there; fig. 3) and of Duaptah (AS 68a; 2 male graves; Bárta *et al.* 2014: 22–24).
4. The above-mentioned four rock-cut tombs were used for burying in the middle and late Fifth Dynasty. The stone-built mastaba AS 67 dated to the mid-Fifth Dynasty situated in the close vicinity of the tomb complex AS 68 contains two burial shafts in which the tomb owner and a woman were buried. Her name and titles have not survived. The tomb owner was probably a certain Nefershepes Nefer (Bárta *et al.* 2014: 17–20).

This brief look into the burial arrangements and customs of the Fifth Dynasty elite shows differing burial practices concerning females. With an emphasis on the situation in the particular tombs of different social strata and dating, we would like to scrutinize this topic in future research.

Fig. 3 Female skull of Neferhathor (197/AS68d/2012; upper row) and male skull of Shepespuptah Idu (120c/AS68b/2012; lower row); right, frontal and left view (photos P. Brukner Havelková)

Regarding the age-at-death distribution, most individuals buried at Abusir were middle age (MA; see chart 3). A quarter of the individuals under study lived to more than 50 years. A comparison of males and females revealed that almost 32% of all males died at the age of 50 and over 50, while only 24% of females reached this age (chart 4). Mortality during young adulthood (YA – 20–35 years) is low, only 17.5% of individuals died before the age of 35. As far as sex is concerned, the situation is opposite compared to old individuals: more females (24%) than males (16%) died at a young age. However, the numbers of males and females in all age categories were compared by a $\chi 2$ test and the differences are not statistically significant ($\chi 2$= 2.37; p-value 0.05). The deceased from Abusir seemed to have lived to a relatively high age regardless of sex in comparison to model life expectancy at birth between 25 and 35 years in preindustrial societies (Ledermann 1969). These results are similar to the Old Kingdom cemetery at Saqqara, but the differences are much more obvious at Saqqara. More than half of the females buried at Saqqara died at a young age, whereas most of the male deaths occurred in the middle age, a result similar to the Abusir sample (Kaczmarek – Kozieradzka-Ogunmakin 2013). The frequency of females (28.8%) at Giza's Western cemetery of high-ranking officials, who died at a young age was also higher than that in males (20.8%), and more than half of

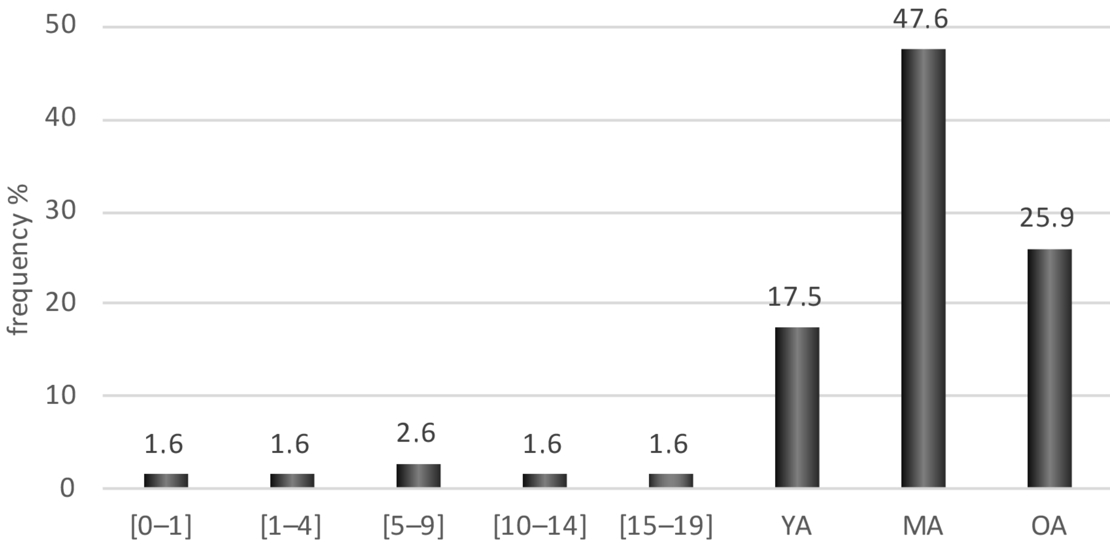


Chart 3 Distribution of all individuals according to age categories (YA: young adults, MA: middle adults, OA: old adults)

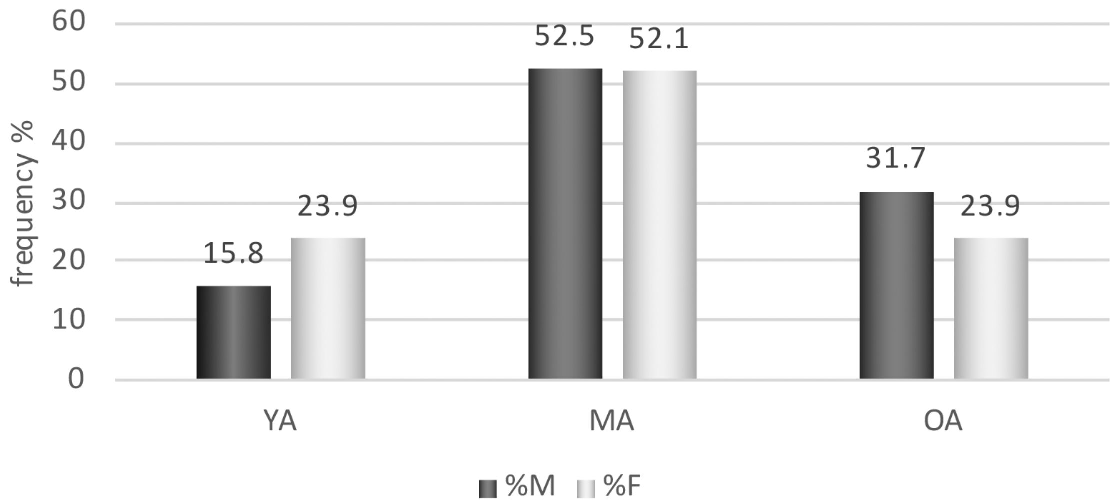


Chart 4 Distribution of adult males and females according to age categories (YA: young adults, MA: middle adults, OA: old adults)

males (53.2%) died in middle age (Hussien *et al.* 2003). Here, the women's risk of death during childbirth may have played an important role.

The burials of subadult individuals at Abusir were documented in various social strata. "Children" from royal family (mastaba of Princess Khekeretnebty, AS 15), high-ranking family (rock-cut tomb of Nefer, the overseer of the royal document scribes and overseer of the two treasuries, AS 68d), middle-ranking families (overseer of the house, Khemetnu, AS 79; elder of the audience hall, Hetepinpu, AS 85) and low-ranking families (phyle member Kaiemtjenenet, AS 38, Vymazalová *et al.* 2011: 30, 34; *ḫntyw-š* official Gegi, AS 7, Bárta 2001: 130–131; anonymous lesser family tombs AS 6, AS 14 and AS 69D; respectively Bárta 2001: 124–126; Vymazalová 2017: 67, 72–73) were buried in their own burial shafts within their family tombs. Moreover, the member of royal family (Tisethor, AC 15; she died at the age 14–18; Verner – Callender 2002: 13–16, 18, 30,114, pl. V) and the member of high-ranking family (the presumed son of Nefer died at the age 10–12; AS 68d Shaft 3) had their own cult places equipped with the false door (the stela of the latter person was stolen in antiquity). In one case, an infant (perinatal) was buried together with his mother (anonymous lesser family tomb AS 6; Bárta 2001: 124–127). Another situation can be observed in the humble mud-brick tomb AS 59, where three children died before the age 5 were buried underneath the floor of the tomb owner's cult place (Vymazalová *et al.* 2011: 41–44).

As previously mentioned, the numbers of immature skeletons are low in the Abusir sample (chart 3). The disproportionately small number of subadult graves also distorts the entire demographic profile of the population sample in question. The proportion of immature versus mature skeletons is 7.7% : 92.3%, significantly lower than might be expected in the stationary population. It is estimated that subadults would have comprised at least one-third of most ancient populations (Lewis 2007: 22). A proportion of subadults between 45% and 64% is theoretically assumed for a life expectancy of 25–35 years at birth (Ledermann 1969) in pre-industrial populations (chart 5), and between 40% and 50% in the case of European prehistoric burial grounds (Neustupný 1983; Stloukal 1989) but these demographic expectations are rarely reflected in the mortuary record. A very similar under-representation of immature skeletons was also observed at the Saqqara cemetery (5.4%; Kaczmarek – Kozieradzka-Ogunmakin 2013), Giza Western cemetery of high officials (5.3%; Hussien *et al.* 2003) and at the Minor Cemetery at Giza, where subadult skeletons were missing altogether (Fisher 1924; tab. 2). A higher

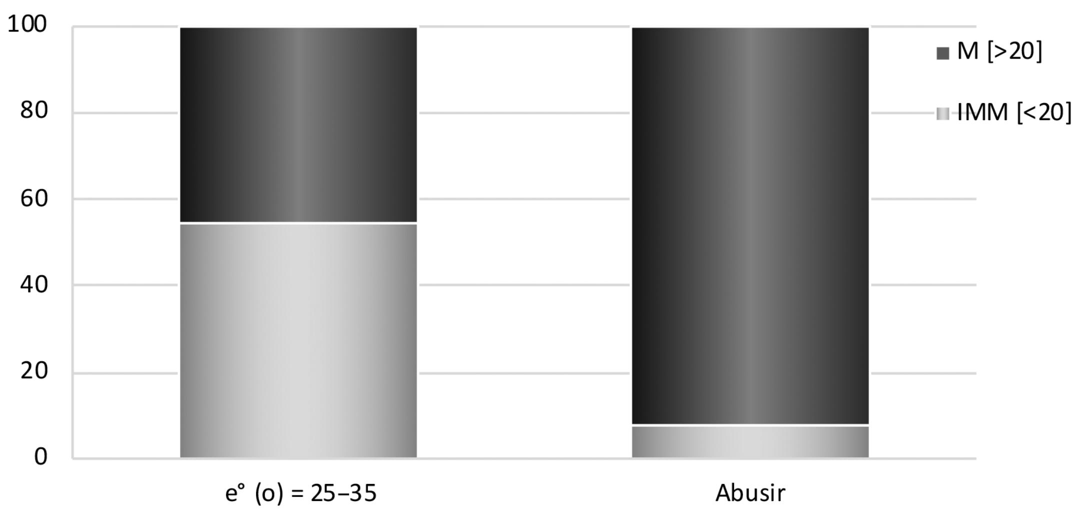


Chart 5 Comparison of the mature-immature ratio between the Abusir sample and the theoretical proportion according to Ledermann (1969) (M: matures, IMM: immatures, e°(o): life expectancy at birth)

frequency of immature skeletons around 20% was recorded at the Giza South East Cemetery of workers (23.5%; Hussien *et al.* 2003) and in Mendes, a provincial centre in the Delta Nile region (19.2%; Mant 2014; tab. 2). Just as a matter of interest, for comparison with an earlier period (*ca.* 3300–3150 BCE), 11% of subadult burials (172 of the total of 1566 graves) were identified in the Naqada III cemetery at Tarkhan (Mawdsley 2000: 171).

The apparent under-representation of subadults in ancient Egyptian cemeteries and the archaeology of childhood and its implications have been recently summarized by Lisa Ann Mawdsley (2000: 169–170, including relevant references). The life expectancy and high infant mortality rates, issues of skeletal preservation, differing cultural practices including burial within settlements and even evidence of possible infanticide and sacrifice have all contributed to the notions of segregation, exclusion and social invisibility (Mawdsley 2000). Under-representation of subadults in mortuary contexts is often attributed to their poor preservation (Lewis 2009); alternatively, the skeletons of young children, and particularly infants, might be absent or poorly represented because they were not buried with everyone else (Milner – Wood – Boldsen 2018). However, Ronika K. Power (2012) identified over 1800 child, infant or foetal burials within a survey of published excavation reports from the Early Dynastic Period to the Middle Kingdom (*ca.* 3300–1650 BC), showing that burials of subadults do exist in significant numbers in many cemeteries. The question therefore remains as to why there are so few recorded subadults in the Abusir cemetery. A comparison of the proportion of subadults in the cemeteries of high-ranking officials and workers at Giza could indicate a link to a different social character of the cemeteries (Hussien *et al.* 2003). As can be seen from the above-mentioned summary of subadults from Abusir cemetery, almost all burials corresponded by their character to other adult individuals buried in the tomb (except for the tomb owner). Thus, they did not differ significantly in character from other adult burials in the given tomb. This is in line with the findings of Lisa Ann Mawdsley, who stated that one key conclusion drawn from her analysis of Naqada III cemetery at Tarkhan is that subadults were afforded similar burials to those of adults (Mawdsley 2000: 201). Put simply, the child's social status reflects the social status of his/her parents; this applies to the quality of the diet, access to medical care but also to the character of his/her burial. According to Sonia R. Zakrzewski (2020), while some ancient Egyptian adults may have been able make some decisions regarding their own burial, it is highly unlikely that ancient Egyptian children were able to make such decisions themselves.

The differences in the demographic profiles of different Old Kingdom cemeteries, especially the numbers of females and subadults, seem to be closely related to the social stratigraphy of the Old Kingdom society with its traditions and especially well-defined funeral customs. It cannot be ruled out that not only the character of the female or subadult burials but also their numbers correspond to the social status of the tomb owner. That means that differences between social groups probably existed also in the hierarchy of family members and the selection of who is buried in the family tomb. Although it may seem that Abusir was a burial ground designated exclusively for members of the elite, there is a clear stratigraphy of tombs by social status, ranging from members of the royal family to lower-ranking individuals, probably household members or priests looking after mortuary cults. Members of the higher elite were buried in stone-built mastabas or rock cut-tombs (*e.g.*, AS 1, AS 16, AS 22, AS 31, AS 67, AS 68 a–d, AS 98), while mud-brick mastabas or single shafts with a simple cult place were built by low-raking individuals around huge stone mastabas (*e.g.*, the courtyard of AS 68, AS 77, AS 78, AS 79, AS 81, AS 84; for references see Bárta *et al.* 2020a and tab. S1).

While the question of social status may be crucial in stratified societies such as that of Old Kingdom Egypt, the issue of the preservation of skeletal remains due to various factors, especially grave robbers, cannot be ignored. The detailed results of archaeological research in the Minor Cemetery at Giza show that only 33% of the excavated shafts contained human skeletal remains (Fisher 1924). No subadult individuals were recorded. It may be due to the accuracy of the anthropological methods and the processing in the early twentieth century (Mawdsley 2000: 173); possibly, the excavators might not even recognize the bones of young children, especially infants, as human (Milner – Wood – Boldsen 2018). It cannot be ruled out, therefore, that some of these "empty" shafts originally contained the burials of females and subadults. A detailed analysis of the shafts without burials, whether false, unfinished, completely empty or robbed, at the Abusir cemetery is under way; we believe that it will bring more information concerning the missing burials in the future.

OSTEOLOGICAL MEASUREMENTS, BODY HEIGHT AND SEXUAL DIMORPHISM OF OLD KINGDOM SKELETONS FROM ABUSIR

The results of basic statistical analyses are summarized in supplementary tab. S2 (cranial measurements) and supplementary tab. S4 (infra-cranial measurements), separately for males and females. Given the significant sexual dimorphism (see below), the average values of the individual dimensions regardless of the sex were not included because they would be misleading.

As was previously mentioned, the differences between males and females were statistically significant for most of the measured dimensions. Thus, the focus was more on dimensions that do not show any sexual dimorphism and reveal the areas that are the same for males and females. Of the total number of 41 cranial measurements (tab. S2), no differences were found in only 13 of them. Except for the basion-bregma height (M17), the transversal (M24) and sagittal (M28) arc and the occipital chord (M31), there are two clearly defined areas in which males and females are similar: the area of the cranial base (both length and breadth of the foramen magnum and the basion-prosthion length)(M40) and the upper facial area (M48) including orbital dimensions (M50–52), the nasal length (M55) and the hard palate dimensions (M60, M62). The similarity of the individual dimensions also corresponds to the calculated indices, for which no statistically significant differences were found in the case of the breadth-height (I3), transversal frontoparietal (I13), orbital (I42), nasal (I48) and mandibular indices (I64). This means that sex does not appear to play a significant role in these cranial areas, whereas in all other dimensions and indices, the sexual differences are statistically significant.

Differences in the shape of the cranium between males and females are best characterized by cranial indices, which define the relationships between individual dimensions (tab. S3). Although, on average, both male and female crania are mainly medium-length (*mesocranial*), identical to crania from Old Kingdom Saqqara (Kaczmarek – Kozieradzka-Ogunmakin 2013), males have a significant shift towards long crania (*dolichocranial*; more than 38%), while shorter crania (*brachycranial*; 24%) were recorded among females. Similar results were recorded regarding the length-height index (*index verticalis*). Both male and female groups featured a medium-high crania (*orthocranial*) on average, but 38.5% of female crania were high (*hypsicranial*) and 25% of male crania were low (*chamaecranial*). Differences in the facial area, characterized by the facial index, were also significant. While the most of female crania showed a high face (70%), more than 60% of the male crania had a low or medium-high face. In general, it is possible to conclude that males from Abusir have longer but lower crania than females, while females are characterized by a higher face.

Sexual dimorphism is, however, much more pronounced regarding the dimensions of the infra-cranial skeleton (tab. S4). There are only three measurements (on both sides) where no significant differences were recorded. Surprisingly, all of them are linked to the pelvic area, where higher sexual dimorphism is to be presumed: the anterior-superior breadth of the sacrum (S5), the spino-auricular length (SA) and the acetabulo-symphyseal pubic length (PUM). The last two dimensions mentioned are among the ten dimensions used in the probabilistic sex diagnosis (Murail *et al.* 2005). This only confirms that no single trait of the human skeleton enables a reliable sex determination (Brůžek – Murail 2006), as some skeletal dimensions are sexually dimorphic with regard to both size and shape (Marlow 2014).

As in the case of cranial indices, infra-cranial indices also better reveal the differences in overall proportionality. Significant differences in single dimensions tell us that male bones are longer and more robust. This is in concordance with both humeral and femoral robusticity indices, where significant differences were also recorded. However, all other indices, which primarily concern the proportions between/among long bones, reveal that males and females from Abusir had a similar ratio between their upper and lower extremities. These results are similar to the conclusions of Sonia R. Zakrzewski (2003), who traced changes in stature and the pattern of body proportions among the ancient Egyptians from the Pre-Dynastic Period to the Middle Kingdom to assess differences between the sexes and among various periods. While all long bone lengths exhibit significant sexual dimorphism as far as long bone ratios and indices are concerned, this only applies to the intermembral index, which may result from different body plans (proportions of upper and lower limbs) in males and females (Zakrzewski 2003). However, the results include individuals from all periods studied, with only 25 of the 150 falling into the Old Kingdom period.

The estimated body height is also an important factor in reconstructing health conditions, serving as an indicator of socioeconomic status (Habicht *et al.* 2015). Heritability values for stature are ~0.8–0.9, *i.e.* up to 80%–90% of its variance can be explained by genetics (Ellison 2001). Environmental factors that can affect human growth include climate, nutrition, disease and socioeconomic factors (Mielke – Konigsberg – Relethford 2010). Stature and body size, and the sexual dimorphism expressed within them, are important as not only are they effects of childhood health, but they are also linked to aspects of gender relations and interactions with social hierarchy and social ranking (Zakrzewski 2015).

Male estimated stature in Abusir sample ranged from approximately 152 cm to 184 cm with a mean of 167.7 cm, while females reached a height between *ca.* 146 cm and 170 cm with a mean of 153.4 cm (tab. S4; last row). Moreover, in this case, the differences between the sexes were statistically significant. Very similar values were estimated in males (168.3 cm) and females (155.4 cm) in the Old Kingdom population group from Saqqara (Kaczmarek – Kozieradzka-Ogunmakin 2013). The comparison of the body height of individuals buried at Abusir with the skeletal samples from Giza and Meidum, where the estimated statures were 168.8 cm in males / 159.6 cm in females (Zakrzewski 2003) and 166.9 cm in males / 154.6 cm in females (Raxter 2011), respectively, shows slight differences especially in the case of females.

The stature coefficient of variation (CV) was 3.2 in males and 2.6 in females from Abusir, which is similar to the stature variation in an Old Kingdom sample studied by Raxter (2011) for both males (3.3) and females (3.0). In comparison to other periods (from Pre-Dynastic to Roman-Byzantine), the Old Kingdom males exhibit the highest stature variation while the females the second lowest (Raxter 2011), along with the highest mean stature difference between the sexes (approximately 12 cm). The mean stature difference between males and females is even higher (approximately 14 cm) in the Abusir sample.

As mentioned above, growth is highly sensitive to environmental factors such as social, nutritional, economic and health conditions, which may lead to sexual dimorphism if males and females are differentially affected (Steckel 2009; Zakrzewski 2015). Populations under environmental stress may exhibit lower sexual dimorphism while less stressed populations produce taller adults and exhibit greater stature sexual dimorphism. The taller individuals and higher stature sexual dimorphism for Old Kingdom Egyptians are expected as these groups are composed of higher strata individuals from more socially stratified periods with lower environmental stress (Raxter 2011). The results of our study exhibit high sexual dimorphism in body height, which is consistent with the presumption of higher status of the individuals buried in Abusir.

Although the individuals buried in Abusir may be seemingly perceived as a homogeneous group of higher-ranking individuals, there are still significant differences in their social status characterized by the type and decoration of the tomb, titles, burial equipment, *etc*. As mentioned above, in a previous work (Havelková – Dulíková 2020), we focused on the comparison of the main (higher status) and subsidiary tombs (lower status). One of the observed features was also the body height of the individuals buried in the Abusir cemetery. Statistically significant differences between individuals from the main and subsidiary tombs were recorded, especially among the males. On average, the males buried in the main tombs, where higher social status of the owners is presumed, were more than 170 cm tall, while their low-ranking contemporaries averaged only 165 cm. The trend is exactly opposite in females, although the differences are not statistically significant. The females in the main tombs were smaller (154 cm on average) than those in the subsidiary tombs (157 cm).

An author team led by Michael E. Habicht compared body height estimates of the general population with the mummies of the members of royal families from all periods of ancient Egyptian history (Habicht *et al.* 2015). Their results correspond to our findings. The kings were generally taller than their contemporary subjects, while the queens were shorter than the average females across all studied periods (Habicht *et al.* 2015). Michelle H. Raxter (2011) reveals no significant mean stature differences between Old Kingdom elites and non-elites for both sexes. However, the elites of both sexes were taller than their non-elite counterparts. The differences between the skeletons of workers and high-ranking officials from cemeteries at Giza were examined by the team of Zahi Hawass (Hussien *et al.* 2003; Hussien *et al.* 2006). They also revealed significant differences in the body height: the mean stature of high-ranking officials exceeded that of workers.

Social status is therefore strongly connected with the final body height in adulthood. Several theories are considered, most of them reflecting environmental factors, such as nutrition or disease, and socioeconomic factors. One of them presumes that male growth is more sensitive to environmental stressors compared to females, mainly during the prenatal period (for references, see Stinson 1985; Raxter 2011). From an evolutionary perspective, it would be advantageous for females to be better buffered against environmental stress due to their greater investment in reproduction; however, the exact mechanisms that lead to females being less sensitive to the environment are not yet fully understood (Stinson 1985). Sexual dimorphism thus generally decreases in periods of crises or external stress, as the males do not reach their full growth potential, while the females are less affected (Robins – Shute 1983). In addition, male children in some societies are favoured and receive better nutritional and medical resources, resulting in a differentiation between the sexes (Stinson 2000).

This theory could explain not only the differences in body height between males and females but also the differences observed in stature variation, which is higher in males and lower in females, in different social groups. The lower status of individuals buried in Abusir may be associated with a different kind of nutrition or medical treatment compared to higher social classes. When comparing workers and high-ranking officials from cemeteries at Giza, Fawzia Helmy Hussien and her colleagues (Hussein *et al*. 2003) presumed physical stress, especially during puberty when the long bones are very sensitive to environmental adverse effects, along with different nutrition and health of the workers to be the main factors explaining the differences in the estimated stature. As for the Abusir sample, such significant differences in the degree of physical activity between the individuals buried in the main and subsidiary tombs are unlikely, as all of them belonged to elite individuals to some extent.

Another factor worth mentioning is the lower body height of higher-ranking females, as exhibited in our study (Havelková – Dulíková 2020); and when comparing the general population with female mummies from royal families (Habicht *et al.* 2015). The shorter stature of the royal wives may be explained by sexual selection: short women are considered more attractive by males, as has been proved in contemporary Western and African societies (for detailed refferences see Habicht *et al.* 2015). Moreover, it has been observed that in some traditional populations, shorter women are more reproductively successful (Kirchengast 2000).

The importance of the heritability of body height must not be overlooked. Most of the tombs in Abusir are family tombs. The results mentioned above may also indicate how important a role family ties played in determining the social status of an individual (Havelková – Dulíková 2020). However, if we considered the social status as one of the important factors influencing final body height, it is important to realize that we are talking about the social status of the parents, rather than the studied individual, as the body height in adulthood is mainly determined in the prenatal and childhood periods. Last but not least, the increase in sexual dimorphism of the long bone lengths and the body height during the Old Kingdom is related to the character of a society transitioning from egalitarianism to a situation characterized by a hierarchy, inequality and unequal access to resources (Zakrzewski 2003; Marlow 2014).

CONCLUSION

It has taken several decades of archaeological research and the work of many anthropologists to obtain sufficient anthropological material for a comprehensive study of the Old Kingdom individuals buried at Abusir.

The anthropological analysis of the skeletal remains of more than 200 individuals buried in Abusir yielded several interesting findings. The sex and age-at-death distribution of the Abusir sample exhibits fewer females compared to males and, above all, a very low number of subadult burials. A very pronounced sexual dimorphism was noted between the male and female skeletons in both skulls and the infra-cranial skeleton. The male skulls are longer but lower than the female skulls, while females were characterized by higher faces. Although the male long limb bones were longer and more robust than those of female both sexes do not differ in the proportionality between the upper and lower extremities. The results of our study exhibit high sexual dimorphism in body height, which is consistent with the presumption of the higher status of individuals buried in Abusir.

However, the most important knowledge gained from this extensive research does not lie in the anthropological figures themselves but in relation to historical and archaeological findings, which are crucial for the interpretation of the obtained results. The findings based on the evaluation of the Abusir sample and comparisons with other Old Kingdom cemeteries reflect the significant influence of social status and related customs within the Old Kingdom society. The low number of females buried in Abusir and the almost missing subadults could indicate selective burying in an area governed by special rules, which seem to reflect the social status of the tomb owner or the character of the whole cemetery (the frequency of female and subadult burials is higher in tombs/cemeteries characterized by lower status). However, it cannot be ruled out that the missing females and especially subadults were originally buried in the shafts that were robbed in antiquity, which is why no bones were discovered during the excavation. Leaving aside the tomb owners and their wives, it should also be emphasized that the documented female and subadult burials do not differ in their character from male burials from the same tomb (in terms of the design). Thus, their social status was probably perceived similarly to that of the males buried in the same tomb, except for the owner.

Since more questions than answers have arisen during the presented research, we would like to focus on testing several hypotheses in detail on the complete set of individuals buried in Abusir in the future.

As part of this follow-up research, the following major scientific issues should be addressed:

1. Evaluation of paleopathological changes which may indicate different lifestyles and availability of medical care with special regard to a detailed evaluation of trauma patterns, which best indicate certain risk behaviours without being influenced by internal factors such as heredity.

2. Reconstruction of specific physical activity of high-ranking officials in the Old Kingdom. This includes an evaluation of skeletal markers connected with physical stress and habitual activity, especially of entheseal changes or infra-cranial morphological features as

accessory facets, fossae, imprints, crests, or tubercles, which reflect repetitive or excessive physical stress, and degenerative changes of the vertebral column and appendicular skeleton.

3. Tracing possible biological affinities by an evaluation of selected non-metric (epigenetic) traits, such as dental morphology.

4. Creation of a database of 3D models of Old Kingdom skulls and mandibles which can later be used for further shape and size analyses using the methods of geometric morphometry and their differences between individuals from different social groups.

5. Detailed analysis of the shafts without remnants of a burial with an emphasis put especially on the differentiation between robbed, unfinished, dummy and completely empty shafts where possible. Such an analysis should shed more light on the issue of the missing female and subadult burials within the individual tombs and within the cemeteries on a global scale.

Some of these sub-tasks are in a certain stage of processing already.

Anthropological research of a complex society such as Old Kingdom Egypt was closely related to the customs, social stratification and burial rules. Social status not only affected an individual's life and the way he or she was buried; it also affects our perception of what we discover in the sand today. Recent research by our team members has proved that a new and complex approach to a detailed study of ancient Egyptian human skeletal remains may lead to interesting results while showing direction for further research that is necessary to address the issues that have arisen.

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Tomb	old code of object	year	owner	identified names
AC003	I	1997	Raneferef	Raneferef
AC015	B	1976	Khekeretnebty	Khekeretnebty, Tisethor
AC017	D	1987	Faaf (good name Idu) and Khenit	Faaf Idu
AC019	K	1987	Hedjetnebu	Hedjetnebu
AC020	L	1987	Anonymous	"Lady L"
AC022	J	1994	Pyramid complex Lepsius no. 24	Reputnub ?
AC023	M	1987	Nebtyemneferes	Nebtyemneferes
AC030		2014	Khentaus III	Khentkaus III
AC031		2016	anonymous	
AC033		2018	Kairsu	Kairsu
AS001	AA	1991	Kaaper	Kaaper
AS002	AA (Tomb 2)	1991	anonymous	
AS003	CC	1991	Hetepi	Hetepi
AS004	DD	1991	Rahotep and Isesiseneb	Rahotep, Isesiseneb
AS005	BB	1991	Fetekty and Mety	Fetekty, Mety
AS006	Tomb I	1993	anonymous	
AS007	FF	1993	Gegi	
AS008	Tomb III	1993	anonymous	
AS009	Tomb IV	1993	anonymous	
AS010	EE	1993	Iti	Iti
AS012	Lake of Abusir 5, Tomb 2	1993	Shedu	Shedu
AS014	Lake of Abusir 6, Tomb 4	1993	anonymous	
AS015	Lake of Abusir 6, Tomb 1, 6	1993	anonymous	
AS016	GG	1995	Qar (vizier)	Qar
AS017	HH, shaft 2, B	2000	Qar Junior	Qar Junior

Tab. S1 Summary of uncovered tombs containing anthropological material including the names of the owners, the identified names within the tomb and the numbers of individuals (IMM: immatures skeletons; M: males; F: females; U: unidentified)

IMM	M	F	U	Total	anthropological reference
	1			1	Němečková – Strouhal 2002; Strouhal – Vyhnánek 2000; Strouhal *et al.* 2001
		2		2	Strouhal 1984, 1992; Strouhal – Gaballah 1993; Strouhal *et al.* 2002
	1			1	Strouhal *et al.* 2002
		1		1	Strouhal 1992; Strouhal – Gaballah 1993; Strouhal *et al.* 2002
		1		1	Strouhal 1992; Strouhal – Gaballah 1993; Strouhal *et al.* 2002
		1		1	Černý *et al.* 2008; Strouhal *et al.* 2000
		1		1	Černý *et al.* 2008
		1		1	unpublished
		2		2	unpublished
	1		1	2	Bárta *et al.* 2020
	1			1	Černý – Strouhal 1995, 2001
	1	4		5	Černý – Strouhal 1995, 2001
	1	1		2	Černý – Strouhal 1995, 2001
	1	1		2	Černý – Strouhal 1995, 2001
	2			2	Černý – Strouhal 1995, 2001
2	1	2	1	6	Černý – Strouhal 1995, 2001
1	3			4	Černý – Strouhal 1995, 2001
	2			2	Černý – Strouhal 1995, 2001
	1	1		2	Černý – Strouhal 1995, 2001
	1			1	Černý – Strouhal 1995, 2001
	5	4		9	Černý – Strouhal 1995, 2001
1	1			2	Černý – Strouhal 1995, 2001
	4	1		5	Černý – Strouhal 1995, 2001
	2	2		4	Černý 2009
			2	2	Černý 2009

Tomb	old code of object	year	owner	identified names
AS018	HH, shaft 1, A	2004	Senedjemib	Senedjemib
AS019	HH, shaft C	2002	Ikay ?	Ikay ?
AS020	II	1999	Hetepi	Hetepi
AS022	JJ	2000	Inti	Ankhemtjenenet, Inti, Inti Pepyanch
AS023	Lake of Abusir 2002, Tomb 1	2002	anonymous	
AS025	Lake of Abusir 2002, Tomb 3	2002	anonymous	
AS035	MM EAST II	2007	anonymous	
AS036	NN 2004	2012	Ptahotep	Ptahhotep
AS037	OO 2006	2007	Neferinpu	Neferinpu
AS038	OOsub	2010	Kaiemtjenenet	Kaiemtjenenet
AS039		2013	Shepseskafankh	Shepseskafankh
AS041	KK IV	2007, 2016	anonymous	
AS042	KK III	2007	anonymous	
AS047	ASW 1	2007	anonymous	
AS051	MM east IV	2009	anonymous	
AS052	MM East V	2009	anonymous	
AS053	MM-EII west wall	2009	anonymous	
AS054		2010	anonymous	
AS057		2010	anonymous	
AS059		2010	anonymous	
AS060		2010	anonymous	
AS061		2016	Kaaper Junior	Kaaper Junior
AS062		2016	anonymous	
AS065		2010	Neferherptah	Neferherptah
AS067		2012	Nefershepes Nefer?	Nefershepes Nefer, Weser, Memy
AS068		2012, 2013	Sheretnebt	Sheretnebty , Sefekhu, Khai, Hetepuni

Tab. S1 Summary of uncovered tombs (continuation)

	IMM	M	F	U	Total	anthropological reference
		1			1	Černý 2009
		1			1	Černý 2009
		1			1	unpublished
		4			4	Černý 2009
	1	1	6	4	12	Černý 2009
		1			1	Černý 2009
		1			1	Malá 2010
		1		1	2	unpublished
		3	2	1	6	Havelková 2014
	1	5	2	1	9	Zedníková Malá 2011
		1	5	1	7	unpublished
			2		2	unpublished
			1		1	unpublished
			1		1	unpublished
		1	1	1	3	Malá 2010
		4	1		5	Malá 2010
		1	1	1	3	Malá 2010
		1	1		2	unpublished
		2	2		4	Zedníková Malá 2011
	3	2	1		6	Zedníková Malá 2011
			1		1	Zedníková Malá 2011
		4	2		6	unpublished
		1			1	unpublished
		1		1	2	Dulíková *et al.* 2015; Dulíková *et al.* 2011
		2	1	1	4	Arias Kytnarová *et al.* 2013
		6	1	2	9	Havelková 2013

Tomb	old code of object	year	owner	identified names
AS068a		2012, 2013	Duaptah	Duaptah, Nefermin
AS068b		2012	Shepespuptah	Shepespuptah
AS068c		2012, 2013	Sheretnebty	Sheretnebty, Ankhiemaptah, Iti
AS068d		2012, 2014	Nefer	Nefer, Neferhathor
AS069D		2016	anonymous	
AS076		2015	Kaisebi	Kaisebi
AS076b		2015	Ptahwer	Ptahwer
AS077		2015	anonymous	
AS078		2015	anonymous	
AS078b		2015	anonymous	
AS079		2015	Khemetnu ?	Khemetnu, Setib
AS081		2015	anonymous	
AS083		2015	anonymous	
AS084		2015	anonymous	
AS084b		2015	anonymous	
AS085		2015	Inpuhetep	
AS088		2016	anonymous	
AS091		2016	anonymous	
AS092		2016	anonymous	
AS095		2016	anonymous	
AS103		2017	anonymous	Nefertius
AS104		2018	Nyankhseshat	Nyankhseshat, Sekhemka
AS108		2018	anonymous	
Total				

Tab. S1 Summary of uncovered tombs (end of table)

IMM	M	F	U	Total	anthropological reference
	2	1		3	Havelková 2013; Vymazalová – Havelková 2019
	1			1	Havelková 2013; Vymazalová – Havelková 2016
	5	2	3	10	Havelková 2013
1	2	1		4	Havelková 2013; Havelková *et al.* 2014
1				1	unpublished
			1	1	Dulíková *et al.* 2017
	1			1	Dulíková *et al.* 2017
			1	1	unpublished
	4	1		5	unpublished
	1			1	unpublished
2	3	2	1	8	unpublished
	1	2	1	4	unpublished
	1			1	unpublished
	1	1		2	unpublished
		2		2	unpublished
1	1	2		4	unpublished
1	1	1		3	Odler *et al.* 2021
			1	1	Peterková Hlouchová *et al.* 2017
		1	1	2	unpublished
	1			1	unpublished
	1			1	Odler *et al.* 2018a, 2018b
	1	1	1	3	Odler – Peterková Hlouchová *et al.* 2019a, 2019b
	1	1	1	3	unpublished
15	**102**	**74**	**29**	**220**	

Cranium and mandible			Males					Females					t-test		
No.	Measurement/ Index	t	N	Mean	Min	Max	Std. Dev.	N	Mean	Min	Max	Std. Dev.	t-value	df	p
M1	Maximum cranial length	**	52	185.8	161.0	199.0	6.9	35	177.0	162.0	188.0	6.5	5.98	85	0.000
M5	Cranial base length	**	28	102.7	95.0	110.0	4.0	23	97.1	90.0	110.0	4.5	4.76	49	0.000
M8	Maximum cranial breadth	**	48	141.5	132.0	153.0	5.3	35	138.5	130.0	149.0	4.9	2.65	81	0.010
M9	Minimum frontal breadth	**	52	95.0	86.0	111.0	4.9	33	91.4	86.0	101.0	3.3	3.69	83	0.000
M10	Maximum frontal breadth	**	49	117.4	98.0	133.0	7.0	33	111.9	93.0	121.0	7.4	3.39	80	0.001
M11	Biauricular breadth	**	35	111.0	98.0	125.0	7.5	25	103.9	96.0	116.0	5.0	4.14	58	0.000
M12	Biasterionic breadth	**	31	116.5	102.0	133.0	7.3	26	110.9	100.0	121.0	4.7	3.39	55	0.001
M17	Height of the skull (basion-bregma)		33	134.3	99.0	140.0	7.1	26	132.3	118.0	142.0	5.5	1.15	57	0.256
M23	Horizontal circumference	**	33	528.5	498.0	562.0	17.3	22	507.4	480.0	533.0	13.2	4.87	53	0.000
M24	Transversal arc		23	317.9	298.0	333.0	9.3	17	313.8	292.0	340.0	14.7	1.09	38	0.282
M25	Medio-sagittal arc	*	19	376.5	357.0	427.0	15.4	17	366.2	344.0	391.0	11.3	2.28	34	0.029
M26	Frontal sagittal arc	*	37	128.5	111.0	144.0	7.5	21	124.3	113.0	135.0	6.0	2.18	56	0.033
M27	Parietal sagittal arc	*	38	129.8	114.0	148.0	7.8	20	125.1	110.0	140.0	7.5	2.23	56	0.030
M28	Occipital sagittal arc		25	117.6	100.0	150.0	9.9	17	114.1	102.0	131.0	6.7	1.30	40	0.203
M29	Frontal chord	**	48	114.4	101.0	127.0	6.3	32	109.6	96.0	118.0	4.8	3.68	78	0.000
M30	Parietal chord	**	48	117.3	107.0	131.0	5.0	33	111.9	99.0	125.0	6.0	4.40	79	0.000
M31	Occipital chord		31	101.3	88.0	135.0	7.8	29	98.8	91.0	111.0	4.9	1.46	58	0.150
M7	Foramen magnum length		16	35.3	31.0	39.0	2.5	16	33.9	29.0	39.0	2.7	1.52	30	0.139
(23)	Foramen magnum breadth		14	29.5	26.0	34.0	2.3	16	27.6	23.0	33.0	2.8	1.99	28	0.056
(24)	Mastoid length		7	36.1	25.0	48.0	8.6	6	32.0	20.0	45.0	9.5	0.81	11	0.432

Tab. S2 Comparison of cranial measurements and indices between males and females (No.: measurement number; N: valid number of cases; Min: minimal value; Max: maximal value; Std. Dev.: standard deviation; t: t-test; df: degrees of freedom; p: p-value; * statistically significant value at the p-level of 0.05; ** statistically significant value at the p-level of 0.01)

Cranium and mandible			Males					Females					t-test		
No.	Measurement/ Index	t	N	Mean	Min	Max	Std. Dev.	N	Mean	Min	Max	Std. Dev.	t-value	df	p
M40	Facial length (basion-prostion)		22	95.5	87.5	103.0	3.9	21	93.4	86.0	100.0	3.9	1.72	41	0.093
M43	Upper facial breadth	**	36	104.2	97.0	114.0	4.2	25	99.7	92.5	108.0	3.7	4.28	59	0.000
M44	Biorbital breadth	*	20	97.2	89.0	118.0	6.5	18	92.4	85.0	101.0	4.3	2.66	36	0.011
M45	Bizygomatic breadth	**	14	129.9	119.0	142.0	5.6	14	118.9	111.0	128.0	4.6	5.71	26	0.000
M46	Mid-facial (bimaxillary) breadth	*	24	96.7	85.0	133.0	9.1	19	90.7	84.0	99.0	4.3	2.64	41	0.012
M47	Facial height	*	22	116.3	104.0	132.0	7.0	16	111.5	101.0	129.0	6.6	2.13	36	0.040
M48	Upper facial height		27	69.9	59.5	82.0	4.3	20	68.3	64.0	78.0	3.4	1.37	45	0.178
M50	Inter-orbital breadth		15	23.9	19.0	29.0	3.2	10	22.2	17.0	26.0	2.7	1.40	23	0.174
M51L	Left orbital breadth		25	39.5	35.0	44.0	2.7	21	38.8	33.0	43.0	2.4	0.90	44	0.371
M51R	Right orbital breadth		21	39.7	35.0	45.0	2.7	17	39.1	36.0	44.0	2.3	0.62	36	0.537
M52L	Left orbital height		28	33.6	29.0	42.0	2.7	21	34.0	29.0	40.0	2.7	-0.47	47	0.642
M52R	Right orbital height		24	33.0	30.0	38.0	2.1	17	34.0	29.0	38.0	2.5	-1.38	39	0.177
M54	Nasal breadth	**	29	26.1	23.0	29.0	1.8	22	24.7	22.0	28.0	1.8	2.87	49	0.006
M55	Nasal height		27	50.9	33.0	58.0	4.8	18	47.9	25.0	57.0	8.0	1.59	43	0.119
M60	Maxilloalveolar length		23	54.0	46.0	63.0	4.4	17	53.3	49.0	58.0	2.6	0.59	38	0.557
M61	Maxilloalveolar breadth	**	27	62.5	41.0	70.0	5.6	20	57.2	46.0	64.0	3.5	3.68	45	0.001
M62	Internal palatal length		13	45.7	37.0	56.0	5.5	9	43.3	30.0	49.0	6.6	0.91	20	0.372
M63	Internal palatal breadth	**	18	39.5	33.0	46.0	3.6	12	33.5	29.0	40.0	3.1	4.66	28	0.000
M65	Bicondylar breadth	**	28	119.8	103.0	138.0	7.0	24	110.3	96.0	127.0	6.3	5.13	50	0.000
M66	Bigonial breadth	**	37	95.1	80.0	107.0	5.8	27	87.2	74.0	98.0	6.5	5.12	62	0.000
M69	Chin height	**	44	32.1	26.0	39.0	3.0	30	29.6	19.0	40.0	4.0	3.14	72	0.002

Tab. S2 Comparison of cranial measurements and indices between males and females (continuation)

Cranium and mandible			Males					Females					t-test		
No.	Measurement/ Index	t	N	Mean	Min	Max	Std. Dev.	N	Mean	Min	Max	Std. Dev.	t-value	df	p
M70L	Left maximum ramus height	**	29	66.4	54.0	74.0	5.0	27	58.7	48.0	71.0	5.9	5.31	54	0.000
M70R	Right maximum ramus height	**	33	64.8	42.0	73.0	6.3	22	58.3	48.0	72.0	6.5	3.70	53	0.001
M71L	Left minimum ramus breadth	**	34	33.8	27.0	41.0	3.0	29	30.9	25.0	35.5	2.4	4.15	61	0.000
M71R	Right minimum ramus breadth	*	38	33.1	21.0	40.0	3.6	25	31.0	25.0	34.5	2.6	2.52	61	0.014
I1 (8:1)	Cranial index	**	47	76.0	70.5	82.6	3.1	33	78.3	74.1	90.1	3.2	-3.24	78	0.002
I2 (17:1)	Length-height index	**	32	72.0	66.0	77.3	2.6	26	74.6	69.4	80.4	2.8	-3.67	56	0.001
I3 (17:8)	Breadth-height index		32	94.6	67.8	105.3	6.4	25	95.1	80.8	104.5	5.2	-0.32	55	0.749
I13 (9:8)	Transversal frontoparietal index		42	67.0	59.2	77.5	3.6	29	65.6	59.1	72.7	3.1	1.69	69	0.096
I38 (47:45)	Facial index (by Kollmann)	*	13	89.2	80.6	100.0	5.7	10	94.7	86.9	102.4	5.2	-2.40	21	0.026
I39 (48:45)	Upper facial index (by Kollmann)	**	11	53.0	49.3	57.8	3.0	13	57.6	52.5	62.3	2.9	-3.82	22	0.001
I42L (52:51)	Left orbital index		25	85.0	70.5	120.0	8.7	21	87.7	76.3	105.4	7.0	-1.15	44	0.257
I42R (52:51)	Right orbital index	*	21	82.9	75.0	90.0	4.2	17	87.0	76.3	100.0	7.1	-2.20	36	0.034
I48 (54:55)	Nasal index		24	51.5	42.9	87.9	8.6	17	54.6	43.6	104.0	14.8	-0.87	39	0.391
I64 (66:65)	Index mandibularis		28	79.9	71.4	95.1	5.2	24	78.4	70.8	85.2	4.0	1.12	50	0.268

Tab. S2 Comparison of cranial measurements and indices between males and females (end of table)

Index	definition	F	%	M	%	Total	%
Cranial index	dolichocranic	3	9.1	18	38.3	21	26.3
	mesocranic	22	66.7	25	53.2	47	58.8
	brachycranic	7	21.2	4	8.5	11	13.8
	ultrabrachycranic	1	3.0	0	0.0	1	1.3
	total	33	100.0	47	100.0	80	100.0
Length-height index	chamaecranic	1	3.8	8	25.0	9	15.5
	orthocranic	15	57.7	21	65.6	36	62.1
	hypsicranic	10	38.5	3	9.4	13	22.4
	total	26	100.0	32	100.0	58	100.0
Breadth-height index	tapeinocranic	6	24.0	9	28.1	15	26.3
	metriocranic	13	52.0	14	43.8	27	47.4
	akrocranic	6	24.0	9	28.1	15	26.3
	total	25	100.0	32	100.0	57	100.0
Transversal frontoparietal index	stenometopic	17	58.6	15	35.7	32	45.1
	metriometopic	8	27.6	14	33.3	22	31.0
	eurymetopic	4	13.8	13	31.0	17	23.9
	total	29	100.0	42	100.0	71	100.0
Facial index	low	0	0.0	2	15.4	2	8.7
	middle	3	30.0	6	46.2	9	39.1
	high	7	70.0	5	38.5	12	52.2
	total	10	100.0	13	100.0	23	100.0
Upper facial index	low	0	0.0	1	9.1	1	4.2
	middle	2	15.4	8	72.7	10	41.7
	high	11	84.6	2	18.2	13	54.2
	total	13	100.0	11	100.0	24	100.0
Nasal index	mesorhin	4	23.5	7	29.2	11	26.8
	chamaerhin	6	35.3	10	41.7	16	39.0
	hyperchamaerhin	2	11.8	1	4.2	3	7.3
	total	17	100.0	24	100.0	41	100.0

Tab. S3 Distribution of the number of individuals according to cranial index categories (M: males; F: females)

Infracranial			t	Males					
Bone	No.	Measurement/Index		N	Mean	Min	Max	Std.Dev.	
Scapula	Sc1 L	Morphologic height	**	5	156.0	142.0	164.0	9.3	
	Sc1 R			6	153.2	141.0	166.0	11.4	
	Sc2 L	Morphologic length	**	9	108.8	100.0	120.0	5.7	
	Sc2 R		*	15	107.4	95.0	124.0	8.7	
	Sc12 L	Glenoid maximum height	**	40	37.1	32.0	41.0	2.1	
	Sc12 R		**	42	37.5	32.0	42.0	2.2	
	Sc13 L	Glenoid maximum breadth	**	44	27.9	23.0	32.0	2.3	
	Sc13 R		**	41	28.4	24.0	33.0	2.4	
Clavicle	Cl1 L	Maximum length	**	28	153.9	129.0	172.0	11.2	
	Cl1 R		**	26	154.3	136.0	176.0	10.6	
	Cl4 L	Supero-inferior midshaft diameter	**	51	11.3	9.0	16.0	1.5	
	Cl4 R		**	47	11.2	9.0	14.0	1.2	
	Cl5 L	Dorso-ventral midshaft diameter	**	51	11.7	9.0	17.0	1.7	
	Cl5 R		**	46	12.1	9.0	17.0	1.8	
Humerus	H1 L	Maximum length	**	45	317.3	261.0	358.0	16.4	
	H1 R		**	43	324.1	292.0	376.0	19.3	
	H2 L	Total length	**	28	313.0	259.0	355.0	17.5	
	H2 L		**	30	321.9	289.0	373.0	19.4	
	H3 L	Proximal epiphysis breadth	**	44	47.8	42.0	56.0	2.8	
	H3 R		**	43	49.1	44.0	59.0	2.8	
	H4 L	Epicondylar breadth	**	60	61.1	53.6	70.0	3.1	
	H4 R		**	62	62.1	51.0	70.0	3.5	
	H5 L	Maximum midshaft diameter	**	71	21.0	14.5	26.5	2.0	
	H5 R		**	73	21.7	14.0	25.0	1.9	
	H6 L	Minimum midshaft diameter	**	71	16.8	13.4	22.0	1.7	
	H6 R		**	73	17.2	13.0	22.0	1.7	
	H7 L	Minimum shaft circumference	**	48	59.4	52.0	69.0	4.3	
	H7 R		**	47	61.0	52.0	69.0	4.4	
	H8 L	Head circumference	**	22	137.0	125.0	159.0	7.7	
	H8 R		**	26	139.7	127.0	160.0	7.8	
	H9 L	Transversal head diameter	**	49	42.3	37.6	54.0	3.1	
	H9 R		**	44	42.9	37.0	53.0	3.4	
	H10 L	Vertical head diameter	**	48	44.1	35.3	52.0	3.2	
	H10 R		**	53	44.8	36.0	52.0	3.3	

Tab. S4 Comparison of infra-cranial measurements and indices between males and females (No.: measurement number; N: valid number of cases; Min: minimal value; Max: maximal value; Std. Dev.: standard deviation; t: t-test; df: degrees of freedom; p: p-value; * statistically significant value at the p-level of 0.05; ** statistically significant value at the p-level of 0.01)

Females					t-test		
N	Mean	Min	Max	Std.Dev.	t-value	df	p
5	129.6	118.0	147.0	11.1	4.08	8	0.004
4	139.8	133.0	149.0	6.7	2.10	8	0.069
7	97.4	92.0	107.0	5.5	4.00	14	0.001
6	98.0	85.0	105.0	7.2	2.35	19	0.030
26	32.2	23.5	39.0	3.3	7.28	64	0.000
23	32.0	23.0	38.0	2.9	8.59	63	0.000
25	23.6	19.0	34.0	3.0	6.62	67	0.000
23	24.3	21.0	33.0	2.7	6.37	62	0.000
20	136.7	126.0	160.0	8.1	5.85	46	0.000
23	136.0	122.5	159.0	9.3	6.39	47	0.000
35	9.3	7.0	13.0	1.3	6.38	84	0.000
32	9.1	7.0	12.0	1.2	8.05	77	0.000
35	10.0	8.0	14.0	1.3	4.97	84	0.000
32	9.6	7.0	14.0	1.3	6.80	76	0.000
28	289.6	260.0	312.0	13.1	7.54	71	0.000
28	291.2	270.0	330.0	14.6	7.72	69	0.000
16	286.6	270.0	309.0	10.6	5.47	42	0.000
20	290.9	270.0	328.0	14.9	6.07	48	0.000
28	42.9	40.0	51.0	2.5	7.52	70	0.000
26	43.7	40.0	48.0	2.2	8.35	67	0.000
34	53.1	46.0	61.0	2.8	12.25	92	0.000
43	54.5	50.0	64.0	3.5	10.97	103	0.000
48	18.4	12.0	22.4	1.9	6.94	117	0.000
49	19.2	16.0	22.6	1.4	7.62	120	0.000
47	14.2	11.0	19.0	1.5	8.40	116	0.000
49	14.0	12.0	17.0	1.2	11.49	120	0.000
28	50.6	38.0	65.0	5.3	7.86	74	0.000
32	51.4	43.0	59.0	3.9	9.92	77	0.000
12	122.4	106.0	134.0	8.7	5.05	32	0.000
15	121.2	105.0	137.0	9.0	6.92	39	0.000
34	37.0	33.0	42.6	2.4	8.32	81	0.000
32	36.7	30.0	44.6	2.8	8.34	74	0.000
33	38.7	35.0	46.0	2.8	7.82	79	0.000
33	38.4	31.0	45.0	2.9	9.26	84	0.000

Infracranial			t	Males					
Bone	No.	Measurement/Index		N	Mean	Min	Max	Std.Dev.	
Radius	R1 L	Maximum length	**	41	253.0	226.0	286.0	12.3	
	R1 R		**	34	254.4	232.0	287.0	12.1	
	R1b L	Parallel length	**	25	239.2	216.0	271.0	13.7	
	R1b R		**	24	243.0	222.0	271.0	13.8	
	R4 L	Maximum shaft diameter	**	53	15.3	10.0	18.0	1.4	
	R4 R		**	58	15.6	11.0	20.0	1.7	
	(47) L	Transverse diameter at midshaft	**	47	14.7	12.0	17.0	1.2	
	(47) R		**	48	15.0	11.0	18.5	1.4	
	R5 L	Antero-posterior shaft diameter	**	53	11.8	10.0	16.0	1.0	
	R5 R		**	58	12.1	9.0	16.0	1.1	
	(46) L	Sagittal diameter at midshaft	**	47	11.9	9.4	14.0	1.0	
	(46) R		**	49	11.8	9.0	14.0	1.0	
	R5_6 L	Distal epiphysis breadth	**	48	33.1	29.1	38.0	2.3	
	R5_6 R		**	40	33.7	29.1	37.0	2.1	
Ulna	U1 L	Maximum length	**	30	275.8	244.0	311.0	13.7	
	U1 R		**	36	274.2	246.0	311.0	16.4	
	U11 L	Antero-posterior shaft diameter	**	59	13.4	11.0	20.7	1.9	
	U11 R		**	59	13.6	11.0	19.0	1.6	
	U12 L	Transverse shaft diameter	**	58	16.3	10.0	21.1	2.3	
	U12 R		**	59	16.2	10.5	21.2	2.0	
Pelvis	DCOX L	Maximum pelvic height	**	31	208.0	187.0	235.0	10.9	
	DCOX R		**	30	209.6	194.0	235.0	11.8	
	SCOX L	Iliac breadth	*	25	157.0	138.0	182.0	10.4	
	SCOX R		**	32	155.4	140.0	175.0	9.4	
	SA L	Spino-auricular length		41	78.2	68.0	91.0	5.2	
	SA R			42	78.7	68.0	90.0	5.0	
	SS L	Spino-sciatic length	**	42	73.3	64.0	84.0	5.0	
	SS R		**	43	73.0	63.4	81.0	4.2	
	IIMT L	Depth of the great sciatic notch	**	34	35.8	27.0	46.0	5.1	
	IIMT R		**	42	38.0	26.0	56.0	5.4	
	VEAC L	Vertical acetabular diameter	**	44	54.2	49.0	61.0	2.9	
	VEAC R		**	46	54.6	49.0	65.0	3.2	
	SPU L	Cotylo-pubic breadth	**	34	29.6	23.4	35.0	2.8	

Tab. S4 Comparison of infra-cranial measurements and indices between males and females (continuation)

Females					t-test		
N	Mean	Min	Max	Std.Dev.	t-value	df	p
21	221.3	194.0	250.0	14.6	9.01	60	0.000
29	225.8	199.0	265.0	12.9	9.03	61	0.000
11	212.1	191.0	227.0	10.8	5.82	34	0.000
15	219.2	202.0	254.0	11.9	5.51	37	0.000
35	13.0	11.0	17.0	1.3	7.76	86	0.000
34	13.4	10.0	17.0	1.5	6.44	90	0.000
27	12.4	10.0	17.0	1.4	7.17	72	0.000
32	13.0	10.0	16.0	1.4	6.04	78	0.000
36	9.7	8.0	13.8	1.1	9.33	87	0.000
35	10.1	8.0	14.0	1.1	8.65	91	0.000
26	9.6	8.0	13.0	1.0	9.32	71	0.000
31	9.8	8.0	11.3	0.9	8.92	78	0.000
23	28.3	24.0	30.5	1.4	9.35	69	0.000
34	29.1	23.0	37.0	2.6	8.51	72	0.000
23	241.7	213.0	263.0	13.4	9.03	51	0.000
26	243.0	218.0	265.0	13.7	7.89	60	0.000
39	11.3	9.0	15.5	1.5	5.75	96	0.000
37	11.6	9.0	15.2	1.7	5.76	94	0.000
40	13.9	10.0	18.2	1.8	5.57	96	0.000
39	14.0	10.0	18.2	1.9	5.25	96	0.000
18	189.6	172.0	206.0	10.4	5.78	47	0.000
20	190.4	170.0	222.0	13.6	5.31	48	0.000
24	149.6	137.0	177.0	9.3	2.63	47	0.011
22	147.5	134.0	162.0	7.9	3.25	52	0.002
28	79.0	69.5	88.0	5.1	-0.65	67	0.519
32	76.8	65.2	89.0	5.7	1.46	72	0.148
27	65.3	53.0	78.0	4.9	6.54	67	0.000
32	65.2	56.0	77.0	4.7	7.54	73	0.000
30	47.5	33.0	59.0	5.6	-8.80	62	0.000
27	49.1	39.0	63.0	5.2	-8.44	67	0.000
26	46.8	43.0	52.0	2.3	11.11	68	0.000
26	47.7	43.0	54.0	2.5	9.38	70	0.000
24	23.7	18.5	37.0	3.7	6.91	56	0.000

Infracranial			t	Males					
Bone	No.	Measurement/Index		N	Mean	Min	Max	Std.Dev.	
Pelvis (cont.)	SPU R		**	39	29.3	23.0	38.0	3.0	
	SIS L	Cotylo-sciatic breadth	**	45	37.9	32.0	45.0	3.0	
	SIS R		**	46	38.1	30.0	44.0	3.1	
	PUM L	Acetabulo-symphyseal pubic length		18	68.4	61.0	78.0	4.3	
	PUM R			30	67.0	59.0	81.0	5.5	
	ISMM L	Post-acetabular ischium length	**	38	107.7	98.0	117.0	5.2	
	ISMM R		**	39	107.5	97.0	116.0	5.2	
Femur	F1 L	Maximum length	**	42	462.1	418.0	536.0	25.7	
	F1 R		**	41	460.0	423.0	542.0	28.3	
	F2 L	Bicondylar length	**	37	459.0	416.0	535.0	27.0	
	F2 R		**	39	455.6	420.0	542.0	28.7	
	F6a L	Antero-posterior midshaft diameter	**	75	29.7	23.0	37.0	2.6	
	F6a R		**	72	29.9	23.8	37.0	2.7	
	F7a L	Transverse midshaft diameter	**	75	26.6	21.2	31.0	2.1	
	F7a R		**	71	26.2	20.8	32.0	2.1	
	F7b L	Upper transverse shaft diameter	**	52	30.2	25.0	36.0	2.5	
	F7b R		**	51	29.7	24.0	35.0	2.2	
	F7c L	Upper antero-posterior shaft diameter	**	52	26.3	22.0	34.0	2.4	
	F7c R		**	51	26.8	21.0	34.0	2.5	
	F7d L	Lower transverse shaft diameter	**	40	35.4	25.0	45.0	4.6	
	F7d R		**	40	34.5	22.0	45.0	4.5	
	F7e L	Lower antero-posterior shaft diameter	**	39	29.6	22.0	35.0	2.4	
	F7e R		**	38	29.8	25.0	34.0	2.2	
	F8 L	Midshaft circumference	**	52	87.4	75.0	107.0	6.7	
	F8 R		**	44	87.4	74.0	108.0	7.0	
	F9 L	Transverse subtrochanteric diameter	**	74	33.4	25.8	44.0	3.2	
	F9 R		**	69	32.8	26.0	42.0	3.1	
	F10 L	Antero-posterior substrochanteric diameter	**	74	25.7	21.0	34.0	2.5	
	F10 R		**	68	25.6	21.0	33.0	2.3	
	F13 L	Proximal epiphysis length	**	50	96.5	83.9	117.0	6.2	

Tab. S4 Comparison of infra-cranial measurements and indices between males and females (continuation)

Females					t-test		
N	Mean	Min	Max	Std.Dev.	t-value	df	p
26	23.2	20.0	27.0	1.9	9.12	63	0.000
29	33.1	28.0	41.0	3.6	6.21	72	0.000
32	33.4	27.0	43.0	3.5	6.40	76	0.000
16	66.6	48.0	78.0	6.9	0.92	32	0.367
18	68.9	61.0	79.0	5.0	-1.20	46	0.236
23	95.5	88.0	109.0	5.5	8.66	59	0.000
25	96.0	85.0	109.0	6.8	7.53	62	0.000
22	419.3	379.0	487.0	22.3	6.62	62	0.000
28	418.8	377.0	485.0	21.8	6.49	67	0.000
23	411.4	376.0	486.0	23.5	6.96	58	0.000
29	411.5	373.0	485.0	22.5	6.86	66	0.000
51	25.1	21.0	33.0	2.3	10.20	124	0.000
45	25.1	21.0	34.0	2.5	9.60	115	0.000
51	23.2	20.0	29.0	2.0	9.06	124	0.000
44	22.6	19.0	29.0	1.9	9.16	113	0.000
31	26.1	21.0	35.0	3.0	6.64	81	0.000
33	25.6	21.0	35.0	3.3	6.90	82	0.000
31	23.1	17.0	33.0	2.8	5.57	81	0.000
33	23.3	17.5	33.0	2.8	5.98	82	0.000
21	30.8	21.0	38.5	4.5	3.76	59	0.000
23	30.7	22.0	38.5	4.5	3.22	61	0.002
21	25.8	22.0	32.0	2.6	5.69	58	0.000
23	25.3	22.0	33.0	2.6	7.40	59	0.000
31	75.5	64.0	100.0	6.5	7.88	81	0.000
27	76.1	67.0	102.0	7.0	6.62	69	0.000
42	28.5	24.0	34.0	2.2	8.73	114	0.000
43	28.4	23.0	34.0	2.3	7.96	110	0.000
42	22.2	19.2	30.0	2.3	7.47	114	0.000
43	22.6	18.9	30.0	2.4	6.50	109	0.000
33	82.6	72.8	96.0	5.7	10.17	81	0.000

Infracranial			t	Males				
Bone	No.	Measurement/Index		N	Mean	Min	Max	Std.Dev.
Femur (cont.)	F13 R		**	50	95.9	84.0	116.0	7.0
	F21 L	Epicondylar breadth	**	33	79.5	73.0	87.0	3.6
	F21 R		**	23	78.5	73.0	87.0	3.1
	F18 L	Vertical head diameter	**	58	45.6	40.0	51.0	2.3
	F18 R		**	60	45.6	40.7	52.0	2.3
	F19 L	Transversal head diameter	**	47	45.3	40.6	49.0	2.0
	F19 R		**	48	45.1	40.0	50.0	2.1
Tibia	T1 L	Maximum length	**	35	383.5	350.0	454.0	21.5
	T1 R		**	36	384.9	346.0	452.0	20.8
	T1b L	Medial total length	**	33	377.0	350.0	444.0	22.0
	T1b R		**	34	377.4	350.0	441.0	21.4
	T3 L	Maximum proximal epiphyseal breadth	**	34	74.6	67.0	85.0	3.8
	T3 R		**	34	74.8	69.0	87.0	3.8
	T6 L	Maximum distal epiphyseal breadth	**	37	48.0	42.0	55.0	3.4
	T6 R		**	30	47.4	41.6	54.0	3.1
	T8 L	Maximum midshaft diameter	**	63	30.8	26.0	39.0	2.4
	T8 R		**	64	31.0	26.0	37.0	2.4
	T8a L	Maximum diameter at nutrient foramen	**	63	35.1	25.2	42.0	3.2
	T8aR		**	65	35.4	28.7	41.0	2.6
	T9 L	Minimum midshaft diameter	**	63	20.5	17.0	24.0	1.8
	T9 R		**	64	21.0	16.0	26.0	2.1
	T9a L	Minimum diameter at nutrient foramen	**	64	23.2	18.4	28.0	2.3
	T9a R		**	65	23.5	18.9	29.0	2.2
	(74) L	Circumference at nutrient foramen	**	41	93.8	71.0	107.0	8.0
	(74) R		**	45	94.6	82.0	110.0	7.0
Fibula	Fi1 L	Maximum length	**	17	366.9	338.0	434.0	22.1
	Fi1 R		**	16	368.7	341.0	428.0	20.9
	(76) L	Maximum diameter at midshaft	**	35	16.0	11.0	21.0	2.2
	(76) R		**	33	16.2	12.0	21.0	2.0

Tab. S4 Comparison of infra-cranial measurements and indices between males and females (continuation)

Females					t-test		
N	Mean	Min	Max	Std.Dev.	t-value	df	p
31	83.2	74.0	94.0	4.4	9.08	79	0.000
18	69.4	65.0	76.0	3.1	10.05	49	0.000
19	68.9	63.0	73.0	3.0	10.13	40	0.000
33	39.5	35.0	44.0	2.0	12.96	89	0.000
35	39.7	35.0	45.0	2.3	11.94	93	0.000
30	38.7	34.8	43.0	1.9	14.78	75	0.000
35	39.3	35.0	45.0	2.2	12.09	81	0.000
24	341.9	310.0	410.0	22.0	7.25	57	0.000
22	343.2	313.0	415.0	20.5	7.45	56	0.000
17	336.6	302.0	398.0	24.6	5.90	48	0.000
19	336.1	303.0	401.0	21.1	6.78	51	0.000
21	65.6	59.0	74.0	3.3	8.99	53	0.000
23	66.3	61.0	74.0	3.6	8.61	55	0.000
25	41.5	36.0	48.0	2.7	7.88	60	0.000
21	42.5	37.1	48.0	3.1	5.63	49	0.000
40	25.5	23.0	30.0	1.5	12.52	101	0.000
43	25.7	22.5	32.0	1.7	12.73	105	0.000
40	28.9	25.0	40.0	2.6	10.31	101	0.000
41	29.4	24.0	40.0	3.0	10.96	104	0.000
40	17.3	14.0	20.0	1.5	9.25	101	0.000
42	17.4	14.0	20.0	1.5	9.56	104	0.000
40	19.8	16.0	25.0	2.1	7.60	102	0.000
41	20.0	17.0	25.0	2.1	8.15	104	0.000
23	79.1	65.0	90.0	6.0	7.66	62	0.000
26	80.2	68.0	97.0	6.6	8.54	69	0.000
14	337.8	307.0	367.0	17.4	4.00	29	0.000
14	333.4	309.0	357.0	13.6	5.39	28	0.000
21	13.1	10.0	16.0	1.8	4.95	54	0.000
22	13.3	11.0	17.0	1.5	5.84	53	0.000

Infracranial			t	Males					
Bone	No.	Measurement/Index		N	Mean	Min	Max	Std.Dev.	
Patella	Pt1 L	Maximum height	**	39	41.9	34.0	49.0	3.1	
	Pt1 R		**	33	42.4	37.0	59.0	4.1	
	Pt2 L	Maximum breadth	**	35	44.6	40.0	52.0	2.7	
	Pt2 R		**	31	45.1	39.0	51.0	2.7	
	Pt3 L	Maximum thickness	**	41	21.9	18.0	29.0	1.9	
	Pt3 R		**	37	22.1	18.0	27.0	1.8	
Talus	Ta1 L	Physiological length	**	56	52.6	43.7	60.0	3.4	
	Ta1 R		**	49	52.6	48.0	59.0	2.8	
	Ta1a L	Maximum length	**	41	57.2	53.0	64.0	2.7	
	Ta1a R		**	36	57.1	52.0	65.0	3.1	
	Ta2 L	Maximum breadth	**	47	40.4	27.3	46.0	4.5	
	Ta2 R		**	40	40.5	28.3	47.0	4.5	
	Ta3a L	Maximum height	**	49	30.7	18.5	37.0	3.5	
	Ta3a R		**	46	30.8	19.4	36.0	3.6	
Calcaneus	Ca1a L	Maximum length	**	48	78.0	65.9	93.0	5.5	
	Ca1a R		**	52	77.9	63.0	91.0	6.0	
	Ca2 L	Middle breadth	**	33	43.0	39.0	50.0	2.6	
	Ca2 R		**	36	42.9	38.0	48.0	2.4	
Sacrum	S2	Anterior length	**	26	115.9	91.0	134.0	10.9	
	S5	Anterior-superior breadth		21	107.1	91.0	120.0	7.9	
Indices	L	Robusticity index (Hu)	**	30	18.8	16.9	21.2	1.3	
	R		**	32	19.2	16.8	22.0	1.4	
	L	Robusticity index (Fe)	**	36	35.6	28.6	42.8	2.9	
	R		**	38	35.7	29.4	43.0	2.7	
	L	Index platymericus (Fe)		74	77.4	56.8	100.0	7.8	
	R			68	78.3	57.1	96.7	7.7	
	L	Index cnemicus (Ti)		63	66.5	52.6	89.5	7.4	

Tab. S4 Comparison of infra-cranial measurements and indices between males and females (continuation)

Females					t-test		
N	Mean	Min	Max	Std.Dev.	t-value	df	p
14	36.4	32.0	43.0	3.0	5.76	51	0.000
12	36.6	34.0	43.0	2.4	4.62	43	0.000
14	39.2	33.0	44.0	3.4	5.88	47	0.000
13	39.9	33.0	45.0	3.7	5.21	42	0.000
17	19.2	17.0	22.0	1.4	5.30	56	0.000
15	18.9	17.0	22.0	1.6	6.05	50	0.000
30	45.6	42.0	57.4	3.1	9.45	84	0.000
34	46.8	42.0	55.9	2.8	9.10	81	0.000
19	49.3	46.0	54.0	2.2	11.20	58	0.000
22	49.7	44.0	53.0	2.3	9.68	56	0.000
29	33.4	23.6	40.0	5.2	6.19	74	0.000
28	35.3	25.2	40.0	3.9	4.94	66	0.000
26	25.5	17.1	30.0	3.7	6.11	73	0.000
30	26.2	17.9	31.0	3.4	5.53	74	0.000
29	66.7	60.1	80.0	4.8	9.19	75	0.000
27	67.5	59.0	79.0	4.3	8.03	77	0.000
19	36.7	23.0	43.0	4.2	6.62	50	0.000
16	37.4	33.0	44.0	3.0	7.20	50	0.000
13	100.8	84.0	113.0	8.5	4.37	37	0.000
17	104.4	88.0	120.0	7.5	1.05	36	0.299
15	17.5	15.1	20.4	1.2	3.01	43	0.004
20	17.6	15.2	19.2	1.0	4.65	50	0.000
23	30.6	26.9	39.0	2.9	6.43	57	0.000
28	30.6	26.7	40.0	2.9	7.33	64	0.000
42	78.2	66.4	96.8	7.3	-0.50	114	0.618
43	79.8	63.2	100.0	9.4	-0.93	109	0.355
40	68.5	55.0	86.2	6.3	-1.48	101	0.143

Infracranial			t	Males					
Bone	No.	Measurement/Index		N	Mean	Min	Max	Std.Dev.	
Indices (cont.)	R			65	66.5	54.3	83.3	6.1	
	L	Intermembral index (Hu, Ra, Fe, Ti)		15	67.2	62.6	69.7	1.8	
	R			18	68.3	66.1	70.9	1.4	
	L	Humero-femoral index		31	69.5	61.4	75.2	2.5	
	R			31	70.5	66.8	76.5	2.1	
	L	Tibio-radial index		22	65.2	63.0	67.6	1.5	
	R			23	65.8	61.9	68.2	1.7	
	L	Brachial (humero-radial) index		32	78.7	73.8	84.6	2.4	
	R		*	25	78.4	75.3	81.7	2.1	
	L	Femoro-tibial index		25	82.7	76.9	87.2	2.4	
	R		**	28	83.0	77.8	87.9	2.3	
	L	Crural index		13	103.8	101.9	105.3	1.0	
	R			13	104.1	102.0	107.1	1.6	
Stature			**	70	167.7	151.6	183.6	5.4	

Tab. S4 Comparison of infra-cranial measurements and indices between males and females (end of table)

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Females					t-test		
N	Mean	Min	Max	Std.Dev.	t-value	df	p
41	68.1	53.1	82.1	6.0	-1.31	104	0.192
8	67.4	64.0	70.5	1.9	-0.28	21	0.784
12	68.1	65.1	71.6	2.0	0.36	28	0.719
15	69.6	65.5	72.0	1.9	-0.05	44	0.957
20	70.3	66.4	73.1	1.8	0.40	49	0.692
14	64.1	56.2	69.5	3.2	1.44	34	0.158
15	65.2	57.7	70.3	3.0	0.77	36	0.446
12	77.1	72.1	80.8	2.5	2.00	42	0.052
18	77.1	73.4	80.3	2.1	2.08	41	0.043
15	81.2	77.5	86.6	2.2	1.89	38	0.067
16	81.3	78.9	83.6	1.2	2.73	42	0.009
11	103.0	99.7	105.4	1.9	1.34	22	0.195
10	103.8	101.4	105.9	1.6	0.47	21	0.643
53	153.4	146.0	169.5	4.0	16.20	121	0.000

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