Chapter 3: Materials and Methods

Castration is a unique and difficult subject to study in humans as the practice generally became unacceptable over the course of the twentieth century. The study of physical remains from castrates who lived in the past cannot be readily undertaken due to a lack of knowledge about where such individuals are interred or, if interment locations are known, inability to disinter remains because of religious, cultural, or other concerns. As there is a minimum of skeletal material, it was necessary to use a number of different materials and methods in the course of this research project to enhance the size of the database to permit statistical analysis.

3.1 Materials

3.1.1 Mummy of Nekht-Ankh, Manchester Museum, Manchester, United Kingdom

In A.D. 1907, Flinders Petrie offered a tomb group containing a pair of mummies and their accoutrements from a 12th Dynasty (1991-1783 B.C., part of the Middle Kingdom (2030-1640 B.C.)) tomb in Rifeh, Egypt, to the Manchester Museum. A manuscript of the scientific study of the tomb group was published in 1910 with a description of the mummies as they appeared following their unwrapping.[136] The physician who oversaw the anatomical investigation of the mummies felt that the skeleton of one of the brothers, Nekht-Ankh, displayed eunuchoid characteristics – slender, delicate bones and faint muscle attachment sites.[137] No subsequent study of the mummies has disputed this claim.[138]

Permission was received to examine the mummy of Nekht-Ankh for signs of castration while the Two Brothers' mummies were removed from display during the reorganisation and creation of the Ancient Worlds galleries at the Manchester Museum in 2011-2012. The mummy is now mostly skeletonized, though some parts of the skeleton (especially the hands and feet) retain flesh. Nekht-Ankh's skeleton has been reassembled in anatomical position for display. The skeleton has been bound to a frame in order to stabilise it, limiting the measurements that could be taken and the ageing and sexing methods that could be employed. Due to the delicate nature of the mummy, it was

[136] (Murray, 1910)
[137] (Cameron, 1910)
[138] (David, 2007, 1979)

not possible to take it to the Manchester University Hospital for a CT scan or radiographs.

3.1.2 Castrate skeleton from University of Lyon Anatomical Museum, Lyon, France

Louis-Charles Émile Lortet, a medical doctor, doyen of the Faculty of Medicine at the University of Lyon, and director of the Natural History Museum in Lyon,[139] was invited to witness the dissection of the corpse of a castrate by Dr. Keatinge, the director of the Cairo School of Medicine in the late 19th century.[140] The individual he examined and whose skeleton he later took to Lyon, France, was a 24-25 year-old castrate who had probably come from the Shillouk people group of what is now Sudan. He had served in a household in Cairo and had died of unknown causes (they were not discussed in Lortet's article). After Dr. Rollet examined the skeleton at the University of Lyon, it was donated to the Anatomical Museum, where it has since remained. The left lower leg of the skeleton, including the tibia, fibula, tarsals, metatarsals, and phalanges was removed by a former curator for study and never returned, though it is thought to remain within the museum's collection. Permission was obtained to examine the skeleton, which examination occurred in April 2010.

3.1.3 Donated skeletons and cadavers in the Medical Studies Training Centre Anatomy Prosection Room, Department of Physiology, Anatomy, and Genetics, University of Oxford, Oxford, United Kingdom

Permission was gained to examine the skeletons and cadavers of donated human remains retained at the Medical Studies Training Centre (MTSC) Prosection Room of the Department of Physiology, Anatomy, and Genetics, University of Oxford. The remains are from bodies donated to science and come from a number of hospitals in Oxfordshire. Therefore, the majority of the remains at the MTSC are from older or ill individuals, which may contribute bias to the data from the sample. The remains are preserved in the morgue at the MTSC and dissected for demonstrations for medical students. Some remains are skeletonized and retained as a skeletal collection for the training centre, including a number of rearticulated skeletons used to demonstrate the correct anatomical positioning of the bones of the body. The skeletal collection was accessed in order to compare aspects of castrate remains to those of normal individuals. The number of

[139] (Gaillard, 1912)
[140] (Lortet, 1896)

skeletal remains used varied by element, ranging from as few as ten to as many as fifty elements. Twelve cadavers were used to assess the viability of transforming anthropometric into osteometric measurements.

3.1.4 Previously Published Studies on Living and Deceased Human Castrates

As there were limited numbers of skeletal remains available for direct examination, the literature was examined for data that could be used directly or which could be converted into useable data. A number of previously published studies of both living and deceased human castrates and a small number of studies of deceased animal castrates include the raw data from skeletal or anthropometric measurements. These data were used for statistical analysis and to create a baseline of post-castration skeletal development for comparison to the castrates examined during this study.

These previously published works include Tandler and Grosz's report on the examination of the skeleton of a Zanzibarian castrate who died in the Rudolfsspitale in Vienna, Austria;[141] Tandler and Grosz's report about the examination of living Skoptsy in Romania;[142] Koch's report about the examination of living Skoptsy in Bucharest, Romania;[143] Wagenseil's report about the examination of living castrates in Istanbul, Turkey, during the First World War;[144] Wagenseil's report about the examination of living castrates in Beijing, China;[145] and Pittard's report about the examination of living Skoptsy in a small Black Sea village in Romania.[146]

The studies by Pittard, Tandler and Grosz, and Koch of the Skoptsy in Romania contribute to our knowledge of European castrates,[147] while Wagenseil's studies of former servants of the Ottoman and Chinese imperial courts contribute to our knowledge of African and Asian castrates,[148] allowing us to trace potential changes due to ancestry. Pittard's work, despite listing measurements and showing graphical relationships between measurements, does not attribute specific measurements to a particular individual, thus his data are not in a form useful for this investigation. These works provide vital data about castrate measurements, especially proportions and

[141] (Tandler and Grosz, 1909)
[142] (Tandler and Grosz, 1910b)
[143] (Koch, 1921)
[144] (Wagenseil, 1927)
[145] (Wagenseil, 1933a)
[146] (Pittard, 1934)
[147] (Koch, 1921; Pittard, 1934; Tandler and Grosz, 1910b)
[148] (Wagenseil, 1933a, 1927)

disproportions. Combined with modern anthropometric measurements, they allow the most statistically significant changes to the skeleton caused by prepubertal castration and observable in living individuals to be determined. Once these changes have been isolated, the most useful anthropometric measurements can be transformed into osteometric measurements, so that they can be used archaeologically, as most of the human remains recovered archaeologically are skeletons.

Pittard and Wagenseil's measurements were taken at the beginning of the 20th century, when anthropometry was in its infancy and widely accepted standardized measurements had not been created. However, wide-scale, individual measurements of the general population were not undertaken in the early 20th century. Wagenseil took measurements from a mixed sample of the Chinese population, but only published averages.[149] Most castrate populations had died out before modern anthropometric standards were formulated, and those castrate groups that have continued to the modern day (mostly the *hijras* in India[150]) tend not to trust external medical attention, making anthropometric measurements difficult to obtain. Modern standardized anthropometry does not use all of the measurements that Wagenseil or Pittard used, but enough of the measurements have been retained that it is possible to compare modern anthropometric data to the early 20th century data. The majority of these measurements use skeletal landmarks on the living individual, easing the process of translating them into osteological measurements. Pittard did not explicitly state a complete set of measurements for each individual studied, instead grouping his data from smallest to largest for each specific measurement, which means that his castrates cannot be directly compared to other individuals.

In 2003, two adult male skeletons were among 60 burials excavated from an area of the Wutasi cemetery in Beijing, People's Republic of China. This cemetery contained a significant number of eunuch burials from the Ming Dynasty (A.D. 1368-1644).[151] One skeleton had no identifying burial goods associated with it, but the other was identified by his associated grave stele as 'Huang Zhong', a eunuch of the Ming Dynasty. The skeletons were examined and the results from their examination were published by Jacqueline Eng, Quanchao Zhang, and Hong Zhu, and constitute the first examination of castrated human remains by modern osteological techniques. Measurements from the

[149] (1933b)
[150] (Agrawal, 1997; Mukherjee, 1980)
[151] (Eng et al., 2010)

published report were used in the osteological and calibration datasets for statistical analyses.

In 2006, the remains of Carlo Broschi, known as Farinelli, a famous castrato singer, were exhumed in Bologna, Italy.[152] A team of palaeopathologists examined the remains to assess the biological profile of Farinelli and how his castration affected his voice and therefore his musical career. This was Farinelli's third exhumation, the first taking place after Napoleon's invasion of Italy destroyed the monastery in which he was buried, whereupon his great-niece had his remains moved to the main cemetery of Bologna. The second exhumation ended with the reburial of Farinelli in the future tomb of his great-niece. However, his remains were not reburied within a protective structure, and the tomb in which he was last buried was subject to water penetration. Consequently, his remains were in a very poor, fragmentary condition, limiting the amount of information that could be gained. Little useful long bone data could be obtained, but other morphological changes to the skeleton were used in comparison with the skeletons examined in this study.

The dearth of available skeletal data for castrated individuals made it desirable to combine the much more robust anthropometric dataset with the osteometric dataset. One of the apparent effects of castration that had been noted consistently in the previous literature was the lengthening of the legs, especially in proportion to the torso.[153] As this appeared to be a defining characteristic of castrates, it was deemed an important measurement to establish castrate status. It was therefore necessary to determine the best way of calculating pubic symphysis height from osteological measurements. The anterior, superior edge of the pubic symphysis, used to measure crotch or pubic symphysis height anthropometrically, is approximately in the same position as the head of the femur in a standing individual. If the height of the lower edge of the medial femoral epicondyle from the floor is also measured, both measurements can be combined to gain an approximation of femoral length. Similarly, the height of the upper edge of the medial tibial epicondyle from the floor and the height of the medial malleolus from the floor can be combined to approximate the length of the tibia. However, it is not possible to merely combine osteometric femoral and tibial lengths in order to create a pubic symphysis height.

[152] (Belcastro et al., 2011)
[153] (Lortet, 1896; Pittard, 1934; Tandler and Grosz, 1909; Wagenseil, 1933a, 1927)

There seems to be little consistent study of the effects of castration on the development of male mammals, and what is available tends to be focused on certain animals that are common archaeologically, such as sheep and cattle.[154] As a side-effect of this, and the general assumption that the only reason to castrate an animal is for the improvement of meat or wool or the creation of a draught animal, there seems to be little study in the archaeological community on the effects of castration on non-agricultural domestic animals. Modern agricultural studies seem to be focussed on the creation of the most meat to fat or bone ratio possible, with few studies of the effects of castration on the development of the skeleton.[155] Veterinary clinics can only observe those animals that are brought to them, and veterinary schools seem not to be interested in large-scale investigations into the effects of castration in different animals. The effects of animal castration can vary widely between and within species and breeds of specific animals,[156] but there have been few studies of these differences; those which exist have been mainly archaeologically driven.

3.1.5 "Normal Population" Comparative Data

The "normal population" comparative data used for the statistical analyses were derived from a number of sources, including published skeletal reports, the FORDISC skeletal collection, and the ANSUR anthropometric survey. East African comparative data for the Lyon castrate were derived in part from various published skeletal surveys of Nubian skeletal data from the ancient Egyptian to modern periods.[157] While this material ranges over several millennia, there is a dearth of published or otherwise available modern East African skeletal data. It was decided that the Nubian material was the closest genetic, ethnic, and temporal data available for comparison with the modern East African Lyon skeleton.

A collection of skeletal measurements taken from radiographed mummies from the National Museum of Antiquities, Leiden, the Netherlands, was used to compare to the skeleton of Nekht-Ankh.[158] The mummies mostly dated from the Late to Roman periods and are therefore several centuries younger than Nekht-Ankh. Statistical analysis

[154] (Davis, 2008, 2000; Noddle, 1974)
[155] (Andersen and Ingvartsen, 1984; Prescott and Lamming, 1964; Robertson et al., 1970; Shahin et al., 1992)
[156] (Davis, 2000; Moran and O'Connor, 1994; Noddle, 1974)
[157] (Mukherjee, 1955; Salvatori et al., 2008; Strouhal, 1984; Welsby, 2001)
[158] (Raven and Taconis, 2005)

of shape change in Egyptian skulls has found that skull measurements have remained relatively stable over the millennia.[159] Although not without some reservations, this lack of change makes it reasonable to use the mummies for comparative purposes.

It was impossible to obtain skeletal measurements from Shillouk or other East African individuals, thus the Lyon castrate has been compared to the FORDISC forensic database population and material examined by Margaret Judd from the Kerma population.[160] FORDISC, the forensic discriminant functions program created by Stephen Ousely and Richard Jantz, uses a large database of forensic and institutional skeletal studies to assess the ancestry of unknown individuals. The database is comprised of mainly North American individuals, including skeletons from the Terry and Haman-Todd Collections. Around four hundred individuals in the database derive from skeletons examined by J. Lawrence Angel, while the rest derive from forensic cases and measurements taken from contemporary skeletal collections housed around the United States.[161] The long bone data for approximately seven hundred individuals came from the FORDISC database. This database contained information for American individuals in a wide range of ages, including infants, children, adolescents, and adults from the twenties to the low hundreds. The infants and children (numbering less than ten individuals) were excluded, but those individuals fifteen or older were retained for comparison to the skeletal remains and for inclusion in the calibration dataset. While this data is not as precise as that from specifically East African individuals would be, it does not unduly distort the significance of the results and will suffice until data that is closer to the Lyon castrate both geographically and temporally can be obtained.

Anthropometric data specific to East Asians and East Africans is difficult to obtain, hence Tandler and Grosz, Koch, and Wagenseil's data have been compared to the U.S. Army 1988 anthropometric survey (ANSUR) and various anthropometric surveys undertaken in the last 30 years.[162] The ANSUR data reflect the ethnic make-up of the U.S. Army in 1988, and therefore contain more African-American data than Asian-American, but enough of both are available from the ANSUR and other surveys that comparisons to the Wagenseil Chinese castrates can be made. There are methodological issues in using the ANSUR data, as most African-Americans are of West African origin,

[159] (Timm, 2002)
[160] (Ousley and Jantz, 2005; Welsby, 2001)
[161] (Ousley and Jantz, 2005)
[162] (Gordon et al., 1989; Hiernaux and Hartono, 1980; Hu et al., 2007; Lin et al., 2004; Wang et al., 2002)

Asian-Americans are not exclusively from China, and admixture between African-Americans, Asian-Americans, and European-Americans in the U.S. may have changed the proportions and values of those individuals measured in the ANSUR survey. Despite these deficiencies, it was determined that a close enough relationship could be demonstrated that the data was used.

3.2 Methods

3.2.1 Literature Review

As seen in Chapter Two, there is a large body of literature relating to the history and study of castration in both humans and animals. In addition, work in endocrinology, palaeopathology, medicine, zooarchaeology, and veterinary studies can contribute greatly to theories about and understanding of castration and its physical manifestations in the male mammalian body. The literature review of the history of castration and its study undertaken in Chapter Two is complemented in Chapter Five by a review of the known facts about the effects of castration on the development of the male mammalian skeleton, which was undertaken in order to attain a firm understanding of what could be expected in castrate skeletons before beginning the examination of available castrate skeletons.

3.2.2 Social Theory Analysis

Within the contemporary historical, anthropological, and medical study of castration, there has been a great deal of work undertaken on the gender and sex of castrates and how they have been perceived in different societies throughout time.[163] This has, in fact, formed the bulk of contemporary historical investigations of castration that are not related to the musical ability or professional capacity of the castrati. Castrates readily inform the investigation of sex and gender in the past as they are a man-made intersex category, and therefore a society's reaction to castrates allows a glimpse into their overall sex and gender schemas. However, sex and gender are not the only areas of social theory in past societies into which castration provides access. Attitudes to castrates and their consensual and non-consensual sexual use in the past are now being used to investigate social perceptions of sexuality.[164] In their theory of imperial

[163] (André, 2006; Aucoin and Wassersug, 2006; Brett et al., 2007; Finucci, 2003; Furth, 1988; Nanda, 1999; Ringrose, 2003; Tougher, 1999)
[164] (Tougher, 2013)

eunuchism, Patterson and Hopkins put forth a schema of imperial authority, power, and semi-divinity as demonstrated through the use of castrates as imperial guards and body servants.[165]

However, certain aspects of social theory such as group identity and self-categorization have been largely ignored in favour of viewing castrates as a cohesive whole. While this eases the study of castrates as a group, it does not address the total reality of castrates' experiences, something that must be taken into account for the archaeological study of castration. A systematic review of the social theory relevant to castration, its usefulness to archaeology, and the significance of particular aspects of social theory to the skeletal study of castration is undertaken in Chapter Four.

3.2.3 Osteological Analysis

The macroscopic analysis of human remains has a long-standing tradition. It is the best, fastest, easiest, and cheapest way to obtain the maximum amount of information about a human skeleton with minimal invasion. Analysis can be performed with a minimum of tools (spreading and sliding callipers, osteometric board, and soft measuring tape), and therefore can take place in a multitude of locations and under a variety of conditions. Macroscopic examination is non-damaging, and measurements can be repeated multiple times. Standards for the osteological investigation of human remains were compiled as early as the mid-19th century, making it possible to reuse older skeletal reports if the standard used for that report is given and available.[166] Two sets of standards have been produced within the last twenty years, detailing the methods that are widely accepted and used for the contemporary recording and analysis of skeletonized human remains.[167]

The analyses of the skeletonized human remains examined in this study were recorded following both the Buikstra and Ubelaker and Brickley and McKinley sets of standards.[168] Additional measurements, such as some long bone shaft diameters and diaphyseal breadths were taken in order to make human and animal skeletons as directly comparable as possible. Zooarchaeological standards require more long bone diaphyseal breadths and shaft diameters than human osteological standards do, which provides more

[165] (Hopkins, 1978; Patterson, 1982)
[166] (Humphry, 1858; Martin, 1928, 1914; Parsons, 1905; Quain and Godlee, 1894)
[167] (Brickley and McKinley, 2004; Buikstra and Ubelaker, 1994)
[168] (Brickley and McKinley, 2004; Buikstra and Ubelaker, 1994)

information relevant to detecting castrates.[169] As the human skeletons examined were rearticulated in anatomical position and, in one case, mounted to a frame in a semi-reclining position, it was not possible to use an osteometric board to measure the individuals. Instead, a soft measuring tape secured to the table on which the skeletons were examined and two upright end pieces were used to take long bone measurements. Smaller measurements such as long bone breadths and skull measurements, where possible, were taken using a Wiha dialMax sliding calliper and an iGaging DigiCal Outside Diameter digital spreading calliper. The articulated nature of the skeletons prevented many of the standard ageing and sexing methods usually employed in osteology, restricting age assessment to the visible epiphyses, teeth, and skull sutures, and sex assessment to the visible morphological features of the skull and pelvis. As only two skeletons could be personally examined, it was not possible to assess stunting, gracility, degree of sexual dimorphism, or non-metric traits as factors affecting skeletal development in concert with castration.

3.2.4 Anthropometric Analysis

Anthropometric analysis has been used to study the growth and proportions of living individuals for at least a century, with widely available sets of standards published by the early 20th century.[170] Lower body anthropometric measurements based on Martin's measurements (used by Wagenseil)[171] were assessed on twelve cadavers, eleven soft-preserved and one hard-preserved, at the Medical Studies Training Centre, University of Oxford, in order to assess the viability of combining anthropometric measurements and osteometric measurements. The study was performed using a standard metal tape measure and pens to mark landmark locations. As a necessity, the cadavers were measured while reclining, and the feet had to be held upright as though the individuals were standing, necessitating two individuals to take a measurement and one to record it. In addition, in order to assess whether tissue depth of the calcaneus would affect measurements such as pubic symphysis height, pins were pushed into the centre, anterior, posterior, medial, and lateral edges of the flesh pad caudal to the calcaneus of the cadavers in order to measure tissue depth.

[169] (Brickley and McKinley, 2004; Buikstra and Ubelaker, 1994; Davis, 2000; von den Driesch, 1976)
[170] (Dupertuis and Tanner, 1950; Frisancho, 1990; Hrdlička, 1918; Kron, 2005; Martin, 1928, 1914)
[171] (Martin, 1928, 1914; Wagenseil, 1933a, 1927)

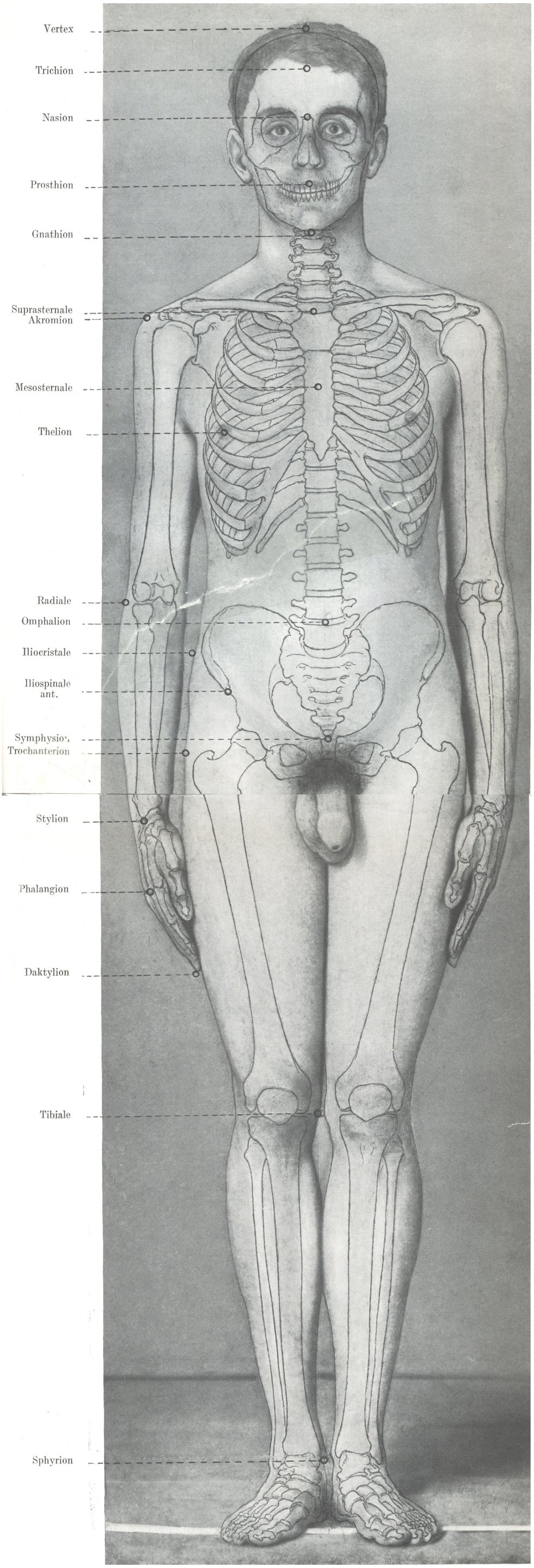


Figure 3.1: Anterior view of anthropometric measurement landmarks from Martin 1928, 1914.