

Article

The Texas State Donated Skeletal Collection at the Forensic Anthropology Center at Texas State

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Abstract: The Forensic Anthropology Center at Texas State (FACTS) began accepting whole-body donations for scientific research and educational purposes under the Texas Anatomical Gift Act in 2008. Research conducted with donated whole bodies involves studies in taphonomy and human decomposition, including reconstructing the postmortem interval. Following decomposition, the skeletal elements of all donors are collected, cleaned, and permanently curated into the Texas State Donated Skeletal Collection (TXSTDSC), which is used for teaching and research by faculty and students at Texas State but is also open to external researchers. To date, FACTS has received 710 donors. Fifty-eight percent of donors are male and 42% are female. Donor ages range from 21 weeks' gestation to 103 years old at the time of death, with a mean of 66 years, and a median of 68 years. Based on self-identified or family-identified ancestry, 90% of donors are White, 4.5% are Hispanic, 3% are Black, less than 2% are of mixed ancestry, and less than 1% are Asian or Native American. Information collected about each donor includes geographic/residential history; occupational history; socioeconomic status; anthropometrics; parity status; alcohol, tobacco, and drug use history; mobility status; an overall health questionnaire; cause and manner of death.

Keywords: body donation; identified skeletal collection; Texas State Donated Skeletal Collection; Forensic Anthropology Center at Texas State; FACTS; TXSTDSC



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1. Introduction

The Forensic Anthropology Center at Texas State (FACTS) is a center within the Department of Anthropology at Texas State University with a mission to advance forensic anthropology and related sciences through world-class education, research, service, and outreach. The center was established in 2006 by the late Dr. Jerry Melbye who served as the Director of FACTS from 2006 to 2008, during which time the FACTS established its Willing Body Donation Program (WBDP) and outdoor human decomposition/taphonomy facility known as the Forensic Anthropology Research Facility (FARF). At 26 fenced acres, the FARF is the largest human decomposition facility in the world and is situated within the larger 3500 acre Freeman Ranch, held in trust, and operated by Texas State University.

After Dr. Melbye's retirement in 2008, Dr. Michelle Hamilton took over as Director of the FACTS, with Dr. M. Kate Spradley serving as Director of the FARF. Drs. Hamilton and Spradley resigned their Director positions in 2010. In 2011, Dr. Daniel Wescott took over the position as Director of the FACTS and Sophia Mavroudas was hired as Coordinator of the FACTS. At this time, the FARF was subsumed under the umbrella of the FACTS. In 2011, the FACTS opened its Osteology Research and Processing Laboratory (ORPL), also located on Freeman Ranch although separate from FARF, for the cleaning and processing of human skeletal remains. In 2017, FACTS moved into the Grady Early Building, which offers a total of 12,000 ft² of classroom, office, and laboratory space including the Grady Early Forensic Anthropology Research Laboratory (GEFARL). The Texas State Donated Skeletal Collection (TXSTDSC), resulting from the WBDP, is housed within GEFARL. With

the addition of the PhD in Applied Anthropology at Texas State in 2018, FACTS expanded to include an Associate Director position, which Dr. Timothy Gocha filled in 2019. The FACTS Director, Associate Director, Coordinator, and all other forensic anthropology faculty (<https://www.txstate.edu/anthropology/facts/aboutus/faculty.html>, accessed 20 December 2021) comprise the FACTS advisory board.

As it stands today, FACTS encompasses three laboratories, the WBDP, and the associated TXSTDSC (see Table 1 for a reference guide to acronyms associated with FACTS operations and facilities). The typical ‘lifecycle’ of a donor to FACTS begins as a donor arrives at ORPL, where an intake process is performed to document the condition of the body and collect anthropometric data as well as samples of blood, hair, and fingernails. The donor is next taken out to FARF and used in decomposition research. Depending on the research project the donor is a part of, they might be buried, placed on the ground surface under a metal cage to prevent scavenging, or on the ground surface without a cage and with a game camera to permit animal scavenging and documentation. The length of time a donor is at FARF varies based on the research protocol but, on average, donors spend approximately 2–3 years at the outdoor facility. Once decomposition is complete or the research is complete, the donor’s skeletal elements are carefully recovered at FARF and taken to ORPL, where they are cleaned of any soft-tissue remnants. Depending on the condition of the remains, cleaning may only involve brushes and water, or they may undergo maceration in a steam-jacketed kettle at 88 °C with an enzyme-active detergent. After being cleaned and inventoried, each skeletal and loose dental element from a donor is labeled with the donor’s unique donation number. Once labeled, the donor is transferred to GEFARL for a final inventory and then curated into the TXSTDSC, where it is available for teaching and research to not only students, staff, and faculty at Texas State University, but also external researchers with approved projects.

Table 1. Definitions and descriptions of acronyms associated with FACTS operations and facilities.

Acronym	Definition	Description
FACTS	Forensic Anthropology Center at Texas State	Center within the Department of Anthropology at Texas State University
WBDP	Willed Body Donation Program	See text for full description
FARF	Forensic Anthropology Research Facility	26 acre outdoor decomposition facility for taphonomic research
ORPL	Osteology Research and Processing Lab	Laboratory where donor intakes are performed prior to placement and skeletal remains are macerated/cleaned
GEB	Grady Early Building	Location of FACTS offices, classrooms, and the GEFARL
GEFARL	Grady Early Forensic Anthropology Research Lab	Laboratory that houses the Texas State Donated Skeletal Collection, as well as specialized research equipment
TXSTDSC	Texas State Donated Skeletal Collection	Skeletal collection resulting from the Willed Body Donation Program

2. TXSTDSC Description and Legal/Ethical Contextualization

FACTS accepts whole-body donations for scientific research and educational purposes under the legal authority of Texas Health and Safety Code Chapter 692, the Texas Anatomical Gift Act. The Texas Anatomical Gift Act is a state-level version of the federal 2006 Revised Uniform Anatomical Gift Act that provides for uniform laws of anatomical gifts, including organs, tissues, and whole bodies, across the United States and its territories. The Revised Uniform Anatomical Gift Act permits individuals interested in donation to pre-register as donors with approved organizations, and allows individuals, usually family members, to donate a decedent after they have passed away. FACTS accepts donations

under both provisions by allowing individuals to pre-register as ‘Living’ donors and accepting donations from family members deemed ‘Next of Kin’ donations. Although it is legally permissible under the Texas Anatomical Gift Act, FACTS does not accept either unclaimed bodies or Next of Kin donations from family members who are estranged from the decedent. By only accepting pre-registered Living donors and Next of Kin donations where the family was familiar with the decedent’s wishes, FACTS can ensure that the resulting TXSTDSC is only comprised of individuals who wanted their remains used for forensic science teaching and research purposes. The three most common motivations for individuals to donate their remains to FACTS are “an interest in scientific processes, a desire to be helpful, and a desire for an alternative to traditional funeral” [1] (p. 8).

Donation paperwork for both Living and Next of Kin donations consists of a body donation document/release form, as well as a three-page questionnaire. The release form is for the legal transfer of remains to our facility, and the questionnaire is used to both complete death certificates for donors and provide important information for researchers. The most up-to-date donation paperwork can be retrieved from the FACTS website: <https://www.txstate.edu/anthropology/facts/donations/Packets.html> (accessed 1 December 2021). The body donation document/release forms differ for Living donors and Next of Kin donors as dictated by requirements in the Texas Anatomical Gift Act. For individuals pre-registering as Living donors, the release form requires the donor’s signature as well as the signatures of two witnesses, one of whom must not be a family member. For Next of Kin donations, the release form requires only one signature from the next of kin. Both release forms also ask either the living donor or the next of kin to consent to trauma research or other advanced studies (e.g., scavenging). Although explicit consent for advanced research is not required under the Texas Anatomical Gift Act, FACTS includes this in the spirit of informed consent for donations.

The three-page questionnaire requests identical information for both Living and Next of Kin donations. Data collected that permit FACTS to file a death certificate with the State of Texas for donors who passed away in Texas are listed in Table 2. For most donors, FACTS initiates the death certificate in Texas’ online death certificate system, enters required demographic information, and works with the appropriate medicolegal authority (e.g., physician, medical examiner, or Justice of the Peace) who completes the information relating to cause and manner of death. Once the demographic and medical portions of the death certificate are both complete, FACTS submits the death certificate to the State of Texas for filing. Important to note is that categories of ‘Race’ listed on donation paperwork are defined by the Texas Department of Vital Statistics, itself pulling from categories recognized by the United State Census Bureau. Data collected in FACTS paperwork for research purposes are listed in Table 3.

Table 2. Data collected for death certificate purposes.

Full Legal Name	Date of Birth	Social Security Number
Country, City, State of Birth	Biological Sex	Race
Hispanic Origin	Marital Status	Spouse’s Full Legal Name
Mother’s Full Legal Name	Father’s Full Legal Name	Previous Military Service
Previous Police Service in TX	Life-long Occupation	Highest Education Level

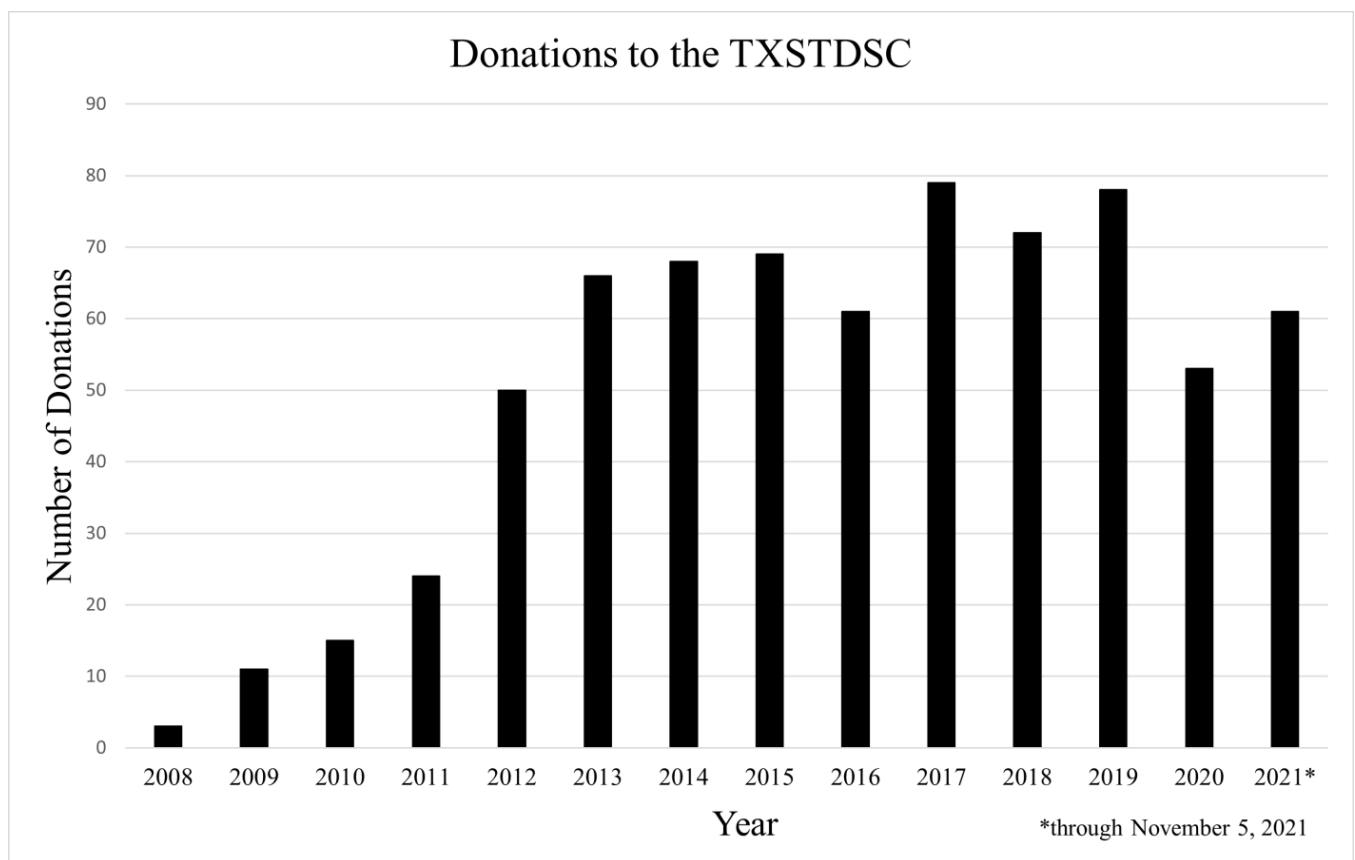
These health questionnaires are screened at the time of submission for potential exclusionary criteria. Aside from unclaimed bodies or estranged Next of Kin donations, the only exclusionary criteria FACTS has for donors are weight and infectious disease status. FACTS does not have a minimum weight for donors but accepts individuals only up to 500 lbs. (226.8 kg). FACTS typically does not accept donors with active infectious diseases that are of concern for transmission to students, faculty, and staff, including HIV/AIDS, hepatitis B and C, tuberculosis, antibiotic-resistant bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA), or prion diseases such as Creutzfeldt–Jakob Disease.

Table 3. Additional data collected for research purposes.

Gender	Parity Status	Number of Pregnancies
Number of Legal Children	Height	Weight
Waist Circumference	Blood Type	Handedness
Tattoo/Piercing Descriptions	Natural Hair Color	Eye Color
Childhood Socioeconomic Status	Alcohol Use	Ancestry
Adult Socioeconomic status	Tobacco Use	Recreational Drug Use
Geographic History (first 15 yrs)	Dietary Habits	Mobility Status
Geographic History (last 20 yrs)	Occupational History	Exercise Habits

Medical history including presence, timing of onset, and treatment of: Alzheimer's disease/dementia, amputation, anemia, antibiotic-resistant infections, arthritis and other joint problems, bone fracture, cancer, cardiovascular disease, chemical/alcohol dependency, COPD/emphysema, diabetes, eating disorders, hepatitis, HIV/AIDS, mental illness, osteopenia/osteoporosis, plastic surgery, seizure disorders, stroke, thyroid disease, and tuberculosis.

FACTS received its first body donation in 2008 and, at the time this article was written (November 2021), has received a total of 710 donations, with more than 1000 individuals pre-registered as Living donors. Figure 1 shows the number of donations received each year. Not surprisingly, the first few years of the program saw few donors but, since 2012, FACTS has averaged 65 donors per year. 2020 saw a significant reduction in the number of donors over previous years due to the COVID-19 pandemic. Although FACTS continued to receive donors throughout 2020, they were limited to Living donors or Next of Kin donors who either added diversity to the TXSTDSC and/or were a good fit for an ongoing research project at that time, although the number of projects were also greatly reduced throughout the year. Of the 710 donors received, 533 were Next of Kin donations, while 177 were Living donors. Below are details of the demographic and metric composition of the donors received by FACTS.

**Figure 1.** Number of donations received each year to the Texas State Donated Skeletal Collection (TXSTDSC).

2.1. Geographic Origin

FACTS has a pick-up radius of 100 miles from our facilities in San Marcos, TX, USA. If a donor passes away within that radius, we can assist with transportation of the donor to FACTS. If a donor is more than 100 miles from San Marcos when they pass, the next of kin must coordinate and cover the cost of transportation of their loved one to FACTS. Not surprisingly, this has resulted in a geographic bias of donors to the program with the vast majority of them having died in Texas, and more specifically the Central Texas area. Eighty-nine percent ($n = 631$) of our donors died in Texas, while the remaining 11% ($n = 79$) died in 22 other states in the U.S. When place of birth is considered, a greater diversity is seen with 43 U.S. states represented and 18 different countries spread between Africa, Asia, Europe, North America, and South America.

2.2. Age

Donors received by FACTS range from 21 weeks' gestation to 103 years old at the time of death. Despite this range, the TXSTDSC is biased towards older ages at death. Figure 2 shows the distribution of the number of donors by decade of life. The mean age at death is 66 years, while the median is 68 years. Six donors are fetal, ranging from 21 weeks' gestation up to 38 weeks' gestation. Of the donors who survived after birth, one was two months old at their time of passing, with all others being 16 years or older.

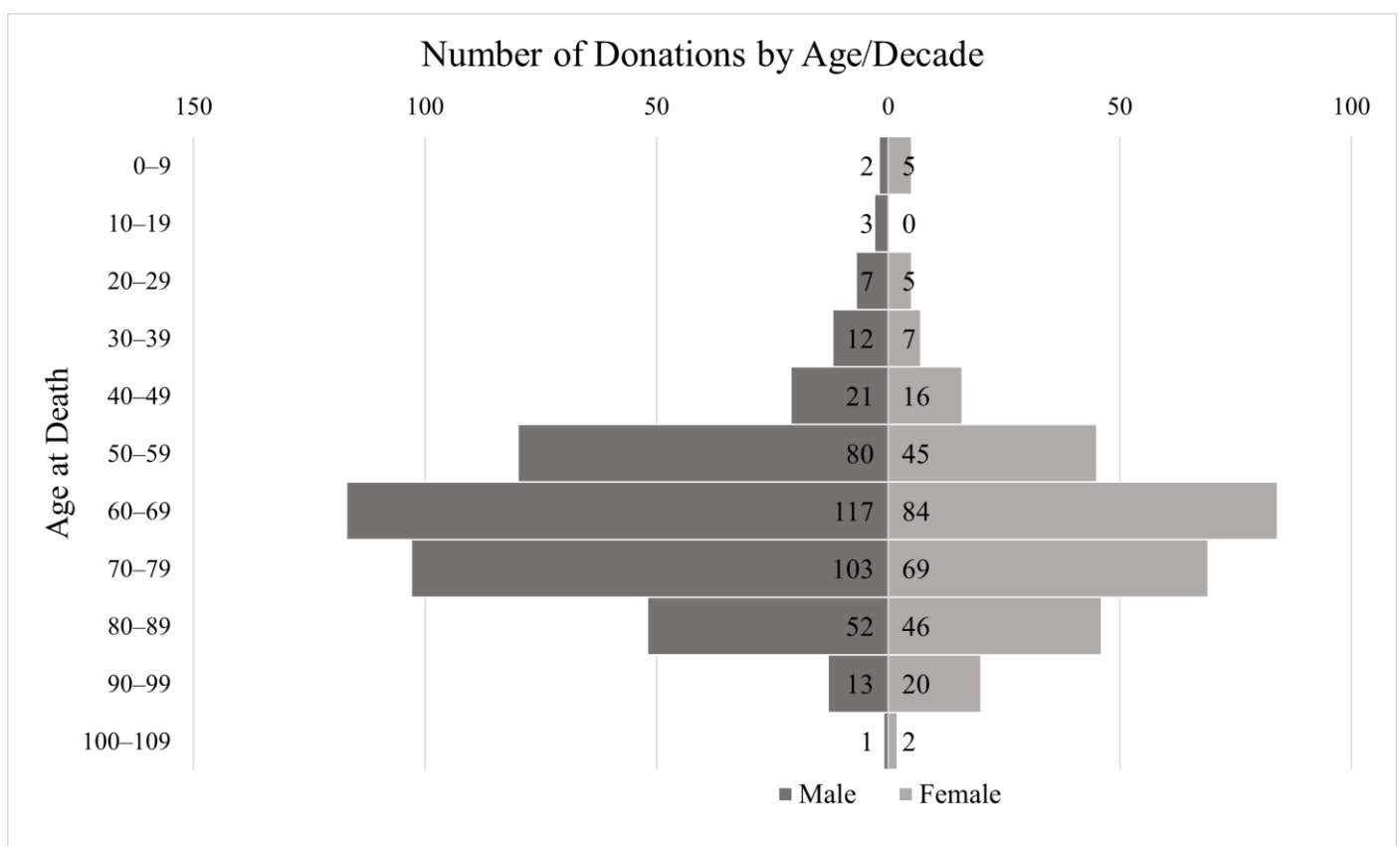


Figure 2. Number of donations per decade of age at death.

2.3. Sex and Gender

The TXSTDSC is also biased in the biological sex of donors, with approximately 58% of donors being male, and the remaining 42% of donors being female. The gender identity of our donors matches their biological sex with the exception of two who identify as transgender. One of these donors was born biologically male but was taking estrogen and transitioning to female at the time of their passing but had not undergone sexual

reassignment/gender confirmation surgery. The other donor was born biologically male but had undergone sexual reassignment surgery to female 17 years prior to their death and had been continually on hormone therapy until their death.

2.4. Ancestry

Perhaps the largest source of bias in the TXSTDSC is the ancestral background of donors. Data for this reflect either how the donor self-identified (if they pre-registered as a Living donor) or how they were identified according to their next of kin. Of the 710 donors received, 639 donors (90%) identified as White (non-Hispanic), 32 donors (4.5%) identified as Hispanic, 22 donors (3%) identified as Black or African American, two donors identified as Native American, two donors identified as Asian (one Indian and one Laotian), and one donor identified as Lebanese. The remaining 12 donors identified as multiracial or of mixed ancestry.

2.5. Anthropometrics

At the time a donor is received, FACTS collects standard measurements of cadaver stature and cadaver weight. Of the adult donors in the TXSTDSC, stature ranges from 127 cm (approximately 4'2") to 198 cm (approximately 6'6"), with a mean and median stature of 168 cm (approximately 5'6"). FACTS first acquired a scale for weighing donors in 2015, so cadaver weight is unavailable for donors received between 2008 and 2014, unless weight was received from a hospital or medical examiner's office. For adult donors in the TXSTDSC for whom it was measured, cadaver weight ranges from 26.7 kg (59 lbs.) to 221.8 kg (489 lbs.), with a mean and median weight of 75.7 kg (167 lbs.).

2.6. Cause and Manner of Death

In the early years of the Willed Body Donation Program, FACTS did not have the capability of filing death certificates for donors and relied upon funeral homes who filed the certificate to share that information. As such, cause and manner of death are not known for all donors in the TXSTDSC. However, starting in 2010, FACTS gained access to the State of Texas' online death certificate system and now files the death certificate for most of our donors. Of the 710 donors received, FACTS has documented cause and manner of death for 665 donors. While the causes of death are too varied to enumerate here, manner of death provides a snapshot of the circumstances surrounding a donor's passing. The vast majority of donors died from natural causes ($n = 558$, 84%), followed by accidental deaths and suicides ($n = 46$ for both, 7%). Homicides and undetermined manners of death each account for ~1% of donors ($n = 7$, and $n = 8$, respectively).

3. TXSTDSC Associated Resources

In addition to the self-reported anthropometrics collected via donor paperwork (Table 3), FACTS collects standard measurements of each donor during the intake process after the donor is received. These include cadaver stature, weight, waist circumference, and foot length. FACTS recently acquired an ultrasound machine designed for measuring subcutaneous fat thickness at standardized anatomical locations, which for males includes waist, thigh, and chest, while for females it includes waist, thigh, tricep, and hip. From these measurements, the software associated with the ultrasound then calculates an overall percentage of body fat. This information will be available for donors received in the future. Additionally, during the intake process are hair, nail, and blood samples from the donor for potential future research such as DNA or isotopic analyses.

Standardized photographs are also taken of each donor during the intake process. These include whole-body photographs, as well as detailed photos of the face (both anterior and profile), teeth, torso (anterior and lateral), arms, legs, as well as any scars, tattoos, and injuries. For donors placed on the surface of FARF, standard photographs of the same body regions are taken during the decomposition process, daily for the first 3 weeks, weekly for an additional 1–2 months, and then monthly until decomposition has ceased. Photographs

are again taken at the time the donors' skeletal elements are picked up from FARF and transferred to ORPL for cleaning. At the time of curation into the TXSTDSC standard skeletal and dental inventory photographs are taken of each donor, as well as detailed photographs of any unique trauma or pathology noted. Antemortem photographs of the anterior and profile face have been provided by approximately one-third of donors or their next of kin, allowing those donors to be used in facial reconstruction workshops and research.

In addition to photographs, detailed notes are collected during the decomposition process for each donor on the surface of FARF. Collected data include decomposition scores according to Megyesi et al. [2] permitting the calculation of a total body score, as well as the presence/absence of: insects, marbling, skin slippage, bloat, attachment/detachment of the hair mat, cadaver decomposition island, new vegetation within the cadaver decomposition island, and scavenger activity.

Once a donor has been curated into the TXSTDSC, they undergo further data collection, some of which are standardized for all donors while others are dependent on inclusion in particular research projects. Efforts are ongoing to collect standard postcranial and craniometric data for all non-fetal, non-cremated donors. The data are collected with reference to the Data Collection Procedures for Forensic Skeletal Material 2.0 [3]. Postcranial metrics are collected with GPM calipers or osteometric boards, while craniometrics are collected via a Microscribe 3D digitizer; all metrics are recorded to the nearest 1 mm.

In 2014, the FACTS acquired an X5000 industrial micro-CT system through a National Science Foundation Major Research Instrumentation grant (award number 1338044). The system has the capabilities of advanced 2D X-ray inspection, 2D CT slice reconstruction, CT volume reconstruction for 3D inspection, and 3D internal and external surface scanning with a maximum resolution of ~500 nm. The X5000 has been used in several student, staff, and faculty projects resulting in CT images of various skeletal elements from 190 of the donors in the TXSTDSC. An additional nine donors underwent full body medical CT scans prior to use in decomposition projects.

In 2019, FACTS acquired a Leica DM6M microscope along with a Leica M205C Stereoscope and Leica Aperio CS2 Scanner through a National Science Foundation Major Research Instrumentation grant (award number 1920218). Since this acquisition, FACTS is fully equipped with histology and microscopy equipment to investigate mineralized tissue microstructure. Using this equipment, the Texas State Comparative Histology Collection was initiated in 2019 to create a database of undecalcified bone slides associated with the TXSTDSC. To date, 235 individuals from the TXSTDSC have histological slides of a mid-thoracic rib, and six individuals have slides of a femoral midshaft and midshaft of a metatarsal. All slide images are scaled and available in both bright-field and polarized light. Basic histomorphological and histomorphometric data are available including cortical area, relative cortical area, osteon area and circularity, Haversian canal area and circularity, and counts of osteon types following Crowder et al. [4] including intact, fragmentary, drifting, double zonal, and type II osteons. Slides are also available from transverse cross-sections through dental roots allowing examination of dental cementum and dentin for 30 donors.

Several isotopic studies have also utilized the TXSTDSC over the years, resulting in 63 donors having isotopic data available for research use. The exact elements sampled and isotopic profiles developed varies for each donor based on the research protocol of the specific isotopic study, but may include bone apatite, bone collagen, enamel, and/or hair samples to produce profiles of Carbon, Oxygen, Nitrogen, Strontium, and Hydrogen isotopes, as well as trace elements including Lead.

In 2020, FACTS acquired an Einscan Pro 2X handheld 3D scanner that can be used to quickly scan whole skeletal elements for generating three-dimensional models with an accuracy of 0.04 mm. To date, the Einscan has been used to scan whole os coxae of 90 donors in the TXSTDSC.

The use of digital images (CT, histological, photography, etc.) of the TXSTDSC previously collected by FACTS personnel can be requested for research purposes. FACTS has

copyright ownership of all digital images produced using FACTS personnel. The digital data are securely encrypted, stored, and archived on the Texas State University server and can be transferred via secure file transfer protocol to qualified researchers.

4. TXSTDSC Scientific Contributions

Documented and ethically sourced skeletal collections are preferred for the development and testing of scientific methods/techniques for estimating biological characteristics such as age at death, sex, and ancestry. The diversity of the collection is important for the application of forensic anthropological methods since the identification of unknown decedents from marginalized groups is complicated by the application of methods developed on historic collections or collections that do not represent the forensic population being targeted. However, no skeletal collection directly reflects the local living population [5], and especially not the forensic population (i.e., homicide victims). As a result, most contemporary donated skeletal collections are skewed, especially regarding age and ancestry, making them less than ideal for developing and validating methods. Unfortunately, this skewness is related to the nature of who donates their bodies for scientific research in many countries. In the United States, for example, we are fortunate enough that the mortality rate among children is low, and even when deaths occur the family is unlikely to donate children for scientific research. As a result, the TXSTDSC contains almost no children or adolescents. Likewise, young adults compose a very small portion of the population because deaths among young adults are low and typically individuals in this age range do not consider the need to preplan for donation. Therefore, most donors are older adults. Most donors in the TXSTDSC also self-classify themselves as White. While generational, cultural, and religious beliefs about what should happen to bodies after death are likely to play a role in who donates their remains [6,7], the dearth of knowledge about the value of donated skeletal collection and the lack of outreach specifically targeting communities of color may play a significant role [5]. This may explain why the TXSTDSC is composed of only 4.5% of Hispanics despite FACTS being in Central Texas with a large Hispanic population (43.1%). However, although minority groups are underrepresented in the TXSTDSC, variation in population affinity is increasing within the collection through time. The relatively high population diversity of the TXSTDSC when compared to other contemporary documented collections at taphonomic facilities [8,9] is likely related to both the geographic location of FACTS in Central Texas (i.e., 52 miles north of San Antonio, a city of 1.5 million, 64.2% of which is Hispanic, and 168 miles from Houston, city of 2.3 million people comprised of 45% Hispanic and 22.6% Black or African American based on 2019 US Census estimations), and the reputation of FACTS is bolstered through strong community education programs and partnerships with local jurisdictions. As underrepresented groups become aware of our willed body donation program as a viable and trusted option for body donation, the overall numbers of non-White donors have been increasing.

4.1. Contributions to Biological Profile Methods

Despite some of the biases, the TXSTDSC is a valuable resource for scientists interested in contemporary human skeletal variation. To date, several methods related to the biological profile have been developed or tested using the TXSTDSC. Age estimation methods ranging from the use of gross morphological indicators of age with the application of Sugeno fuzzy integrals [10,11] to DNA methylation [12] and proteomic changes [13] have been studied using the TXSTDSC. The collection is ideal for studies focused on a geriatric population and the development of methods for extending age-at-death estimation beyond 50 plus years. The collection was also used in the development of MorphoPASSE [14,15] focusing on morphoscopic traits of the pelvis and skull as well as sex methods using phalanges [16], greater sciatic notch morphology [17], the femur and acetabulum [18], and other bones [19]. The collection has also contributed to the macromorphoscopic ancestry estimation program MaMD [20] and metric ancestry estimation in FORDISC [21].

While age and ancestry biases exist, other characteristics like the prevalence of obesity in the TXSTDSC closely mirror that of the local living populations. As a result, the TXSTDSC is an ideal collection for examining how obesity might affect characteristics used for estimating age, sex, and other biological parameters. In addition, the TXSTDSC is a great collection for studying novel and accurate methods for estimating body mass, a characteristic that is normally ignored in the development of the biological profile but has significant implications for the estimation of other characteristics [22,23]. Currently, FACTS and Johns Hopkins University researchers are examining shape and density models to estimate body mass index in unidentified human skeletal remains using the TXSTDSC. The TXSTDSC has also been used to develop regression models for estimating body mass based on the talus and distal humerus for application to paleoanthropology [24,25].

4.2. Other Scientific Contributions

While the TXSTDSC has been used for research on traditional identification questions, one clear advantage of the skeletal collection is the possibility to conduct research on important questions beyond those associated with identification. In fact, the homogeneity (i.e., lots of older White individuals) of the collection and the way it is developed are potentially its strength. The homogeneity of the collection and detailed health and lifestyle information allow for research focused on inter- and intra-skeletal variation in histomorphometry, bone mineral density, stable isotopes, proteomics, and other variables while controlling for demographic, socioeconomic, and health characteristics. Furthermore, with 632 individuals currently in the collection between the ages of 50 years and 103 years, the TXSTDSC is ideal for examining variability related to skeletal senescence and associated pathological changes including arthritis, diffuse idiopathic skeletal hyperostosis (DISH), diabetes, mobility restrictions, and other disorders.

Figure 3 shows an example of how demographic homogeneity can lend itself to important studies of inter-individual variation in skeletal health, morphology, etc. Both donors pictured are 68-year-old White individuals who were born, raised, and lived most of their adult lives in southeast Texas. Both donors passed away within days of each other in late 2019, and therefore lived contemporaneously. The donor on the left side of the image was a female with a lifelong disability and was wheelchair bound from the age of 12 on, and who reached an adult stature of only 4'2". The donor on the right side of the image is a male whose stature was measured at 6'6" and performed physically demanding manual labor in Texas oilfields and offshore drilling. As evident in Figure 3, the remains of these two donors convey very different lived experiences which can be scientifically examined in myriad ways.

An additional important contribution for forensic anthropological research is the accompanying taphonomic data for most of the skeletal remains in the TXSTDSC. This allows researchers to examine the taphonomic influence on morphoscopic and chemical indicators used to develop the biological profile and postmortem interval [13,26–29] as well as to distinguish postmortem damage from perimortem trauma. Since some donors provide consent for advanced research, novel and ground-breaking approved studies focused on thermal, ballistic, sharp, and blunt force trauma are possible [30,31]. In fact, the TXSTDSC contains numerous skeletons with thermal trauma accompanied with temperature data from burning experiments conducted at the FARE. In addition, since it is a growing collection, specific research questions can influence the taphonomic process the remains undergo prior to skeletonization, which allows for specialized research into the taphonomic effects on skeletal morphology. The availability of advanced imaging equipment housed with the skeletal collection, including microcomputed tomography and microscopy, opens unique avenues of research with which to study these skeletons.

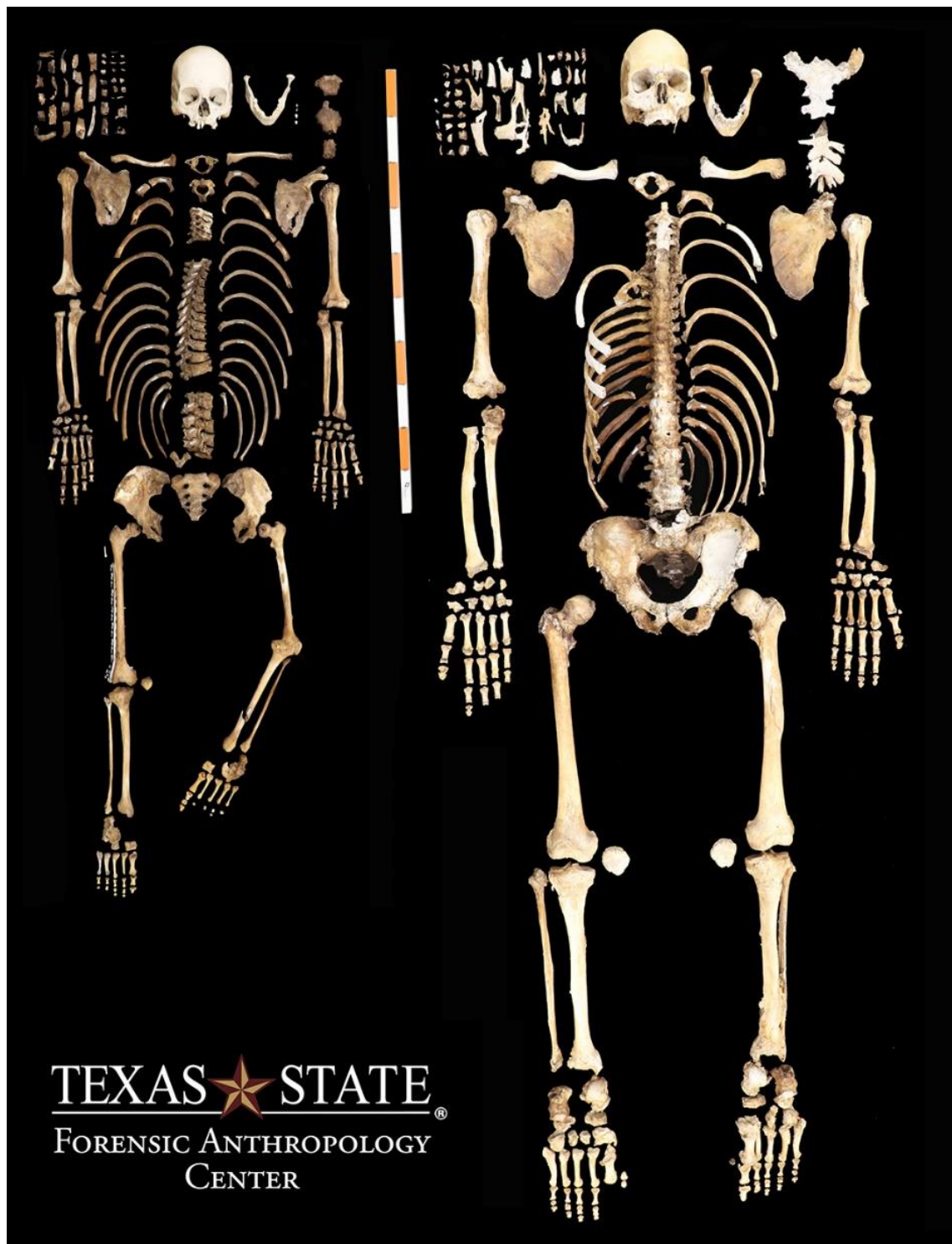


Figure 3. Example of human variation within the TXSTDSC. Scale bar is in decimeters.

Due to the detailed information such as residential locations, socioeconomic status, health records, occupation, and habitual activities, the TXSTDSC has significant potential for research examining the relationship between bone morphology and demographic and lifestyle characteristics. For example, an important but understudied area of research in which the TXSTDSC can be used for is how bone responds to mobility impairment [32]. Within the collection there are 21 individuals with at least one lower-limb amputation and numerous others with other forms of mobility impairment. Likewise, since the collection

contains information on body mass at death studies can use obesity as a natural experiment to examine bone functional adaptation. Another unique feature of the TXSTDSC is that most of the donors provide photographs at various stages of life. These photographs are ideal for research related to facial approximation and the relationship between hard- and soft-tissue features. While few studies have used the TXSTDSC to examine the relationship between genetic markers and skeletal features, most donors have accompanying blood cards. The geographical residential information also makes the TXSTDSC an excellent collection for validating isoscape maps.

4.3. Protocol for Research Requests

The Texas State University Donated Skeletal Collection is available for study by qualified individuals conducting research with a solid scientific foundation. Researchers interested in utilizing the collection must complete a research request form (<https://www.txstate.edu/anthropology/facts/Forms.html>, accessed 1 December 2021), and are encouraged to attach additional supportive materials such as research grant proposals, IRB/ethical approval, equipment training documents, and any other relevant documents. Student researchers must also submit a signed letter from their advisor/supervisor with the research request form. The letter should objectively discuss the scientific merit of the research, the role of FACTS in the research, the student's level of proficiency in utilizing the necessary equipment, and the student's previous experience in collecting the specific data. Standard, non-destructive research may be approved at the sole discretion of the FACTS Director. In some instances, the proposed research may be approved by the Director with consultation of the FACTS advisory board (e.g., if the proposed research duplicates any current FACTS efforts or requires off-site analysis). Research proposals that involve sampling and destructive analysis of skeletal remains must be approved by the entire FACTS advisory board.

Researchers can also request services such as high-resolution computed tomography imaging, 3D external surface scanning, and 3D digitizing. Requests for bone sampling are occasionally granted. Research requests for non-destructive analyses should be submitted at least 1 month prior to the anticipated arrival date, especially if using FACTS equipment. Student researchers are required to submit a signed letter from an advisor or supervisor. Once received the request is reviewed and if approved the Director will provide the researcher with information regarding fees or other costs that must be paid to FACTS for use of the collection and/or services. Fees are associated with use of FACTS' specialized equipment (e.g., microCT scanner, histology preparation and imaging, and 3D scanner), as well as any approved destructive analyses. Fees are not typically assessed for standard, non-destructive analyses. However, if the research is considered non-standard and requires extensive involvement from FACTS faculty, staff, and/or students then bench fees may be assessed on a case-by-case basis (e.g., commingling research). Researchers may document their research using digital radiography and photography, but researchers are required to provide FACTS with copies of all data and images and acknowledge the role of FACTS in publications and presentations using the TXSTDSC.

5. Conclusions

The Texas State University Donated Skeletal Collection is a unique, ethically sourced, and effectually documented skeletal collection that is available for study by qualified researchers. FACTS began accepting whole-body donations in 2008 and has received 710 donors as of November 2021. The collection grows at an annual rate of 60 to 70 skeletons and contains individuals with known medical histories, disease processes and treatment, and several types of traumas. The demographic makeup of the collection makes it ideal for studies focused on skeletal changes associated with senescence, body size, and taphonomic influences on biological profile indicators.

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Informed Consent Statement: All donors in the TXSTDSC either pre-registered as donors to the Forensic Anthropology Center at Texas State or were donated by a legal next of kin. Donation paperwork for each donor, including consent to advanced/traumatic research, is considered evidence of informed consent for forensic science education and research.

Data Availability Statement: Data reported on the TXSTDSC reside in a local database at the Forensic Anthropology Center at Texas State. Qualified researchers are welcome to request raw data from the TXSTDSC by filling out a research request form as outlined in Section 4.3 above.

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