THESIS

A BIOCULTURAL EXAMINATION OF TRAUMA FROM THE COLORADO STATE

INSANE ASYLUM SKELETAL COLLECTION, 1879-1899

Submitted by

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ABSTRACT

A BIOCULTURAL EXAMINATION OF TRAUMA FROM THE COLORADO STATE

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This thesis uses a biocultural approach to study skeletal trauma present in the Colorado State Insane Asylum (CSIA) Skeletal Collection from 1879 to 1899. The biocultural approach utilizes both the physical remains and historic documentary material present for this collection to connect the skeletal findings with the cultural environment in which the individuals lived and died. Of the 166 individuals present (both complete and incomplete), 69% in the collection show at least one instance of trauma, while 31% show no evidence of trauma. This trauma rate includes both fractures and dislocations, or acute trauma, in addition to chronic trauma (Schmorl's Nodes). Males have the highest traumatic injury rates, with 40% of the sample having one or more fractures or dislocations. Females show a rate of 29% for acute trauma, while indeterminate sex individuals have a rate of 38%.

The trauma results were then compared with contemporary, mostly Euroamerican, skeletal collections from the Albany Almshouse and the Oneida Asylum in New York to reveal that while all three institutions show similar rates of chronic trauma, the CSIA Collection has much higher rates of acute trauma -- nearly double that of the other populations.

Ultimately, the analysis of trauma as undertaken in this research provides yet another line of evidence to better understand and contextualize the health and health risks of individuals and populations from the nineteenth-century American West, and more specifically, those in institutionalized care during that time.

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Chapter One – Shaping the Question

Human bones tell a story and show that those who have gone before possess a rich history. Their experiences, trials, and culture are embodied in the remnants of their physical forms. For the researcher, human bones can tell about accidents, abuse, disease, nutrition, environment, and cultural aesthetics and preferences.

I first learned about the Colorado State Insane Asylum (CSIA) collection during a seminar course at Colorado State University. In the collection I saw incredible trauma manifested in individuals who went on to live years if not decades after the event. Additionally, I was fascinated by the unique origins of the collection, namely institutionalization. Here were approximately 166 individuals who were primarily of Euroamerican or European descent, living in frontier Colorado, who were judged by society as having a mental illness of some type which eventually resulted in their admittance as patients of the state's first mental asylum. As I continued to compare this collection to other temporally similar Euroamerican groups, it became obvious that the degree of trauma in the CSIA collection exceeded that of any other contemporary civilian cemetery. The only group with a similar rate was found in a collection of skeletons from a Civil War military cemetery, where one would expect to find a high incidence of trauma.

This spurred the big question that would drive my remaining research: Was it mental illness and subsequent institutionalization that caused such high trauma rates? Several hypotheses might explain the phenomenon, including: institutional abuse,

interpersonal violence between patients at the asylum or in the community at large, the occupations of the individuals represented at the asylum, or perhaps just the trials and tribulations of the working class living in the Western frontier.

To examine this question and the resulting hypotheses, the skeletal remains needed to be thoroughly examined and reexamined. Using a biocultural approach that utilized both the physical remains and historic documents, I was able to connect the skeletal findings with the cultural environment in which these individuals lived and died. Additionally, I undertook an exploration of mental illness and the treatment of mental illness in the late nineteenth century in order to understand the physical environment that the individuals had experienced.

Studies of osteology often focus heavily on the physical manifestations of trauma or other medical interests, but with this historic archaeological collection, I hoped by using a biocultural approach to merge both the physical evidence of trauma with a detailed understanding of the contextual cultural and historical environment in which these individuals existed, since I believe that the two are inseparably related. History too often occurs in an academic vacuum, often focused on documentary materials and removed from the physical evidence and remains that could shed light on historical hypotheses about past life. At the same time, professionals in the field of historic archaeology could better utilize historical sources about contemporaneous events. An interdisciplinary mixture of historical methods and questions with biological anthropology and archaeological resources can only further elucidate and incorporate the strengths of each discipline. Fortunately this opportunity is available in the collection of the Colorado State Insane Asylum.

The following chapters include a history of the Colorado State Insane Asylum in Pueblo, Colorado, which describes 19th century ideas about mental illnesses and their treatments. Once the historical context has been explored, my thesis will analyze the physical trauma data from the CSIA skeletal collection which represents individuals who were interred between the years 1879-1899. The discussion will examine the trauma findings and place them into their historic environment while comparing them to other populations of both institutionalized and non-institutionalized groups. Also, the thesis will consider occupational hazards and accidents that could explain some of the observed trauma. Ultimately, this research will help elucidate the lives of certain Colorado frontier individuals who were disenfranchised and sometimes forgotten or scorned in their society.

Chapter Two – The Colorado State Insane Asylum Collection

2.1 The Colorado State Insane Asylum 1879-1899

This chapter will focus on the specific conditions at the Colorado State Insane Asylum (CSIA)[1] in Pueblo, Colorado, between 1879 and 1899, the period when the individuals in this study were interred on the asylum grounds. Newspaper accounts of the era demonstrate how public support for the asylum was built, and why that support subsequently declined. It is clear from such historical accounts that the Colorado hospital at first converged with and later diverged from the professed ideals of physicians and other mental health experts of the time. Possible reasons for that philosophical departure will be explored. This section also analyzes the scant information contained in the admission records, and discusses the difficulty of connecting those records with individual skeletal remains.

2.1.1 The Early Years (1879 through 1888)

The initial bill for an asylum was proposed by J. J. Thomas, a member of the Colorado House of Representatives from Pueblo County. He felt that taxes should be utilized to provide for a state inebriate and insane asylum. He suggested that alcoholic beverages be taxed to support the asylum, and that the asylum should be placed in a

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[1] Over time the institution changed its name from the Colorado State Insane Asylum to the Colorado State Hospital in 1917 and to the Colorado Mental Health Institute at Pueblo (CSIAP) in 1991 (Mitchell et al. 2002). In this thesis, the researcher will use the name of the institution at the time of the interment of the collection.

county where no other such facility existed (*Colorado Weekly Chieftain* 1-23-1879). It is interesting to note that the initial focus was on the "inebriate" and the *Colorado Weekly Chieftain* (1-23-1879), a locally published Pueblo newspaper, was quick to point out that the cost of the asylum would call "for no general tax, and imposes no burden upon any class save the drinkers of whiskey, wine, soda water and pop." A week later, the *Chieftain*, published an editorial that demonstrated an increasing concern about alcoholism in Colorado:

> An insane asylum is much needed in our state, and would save many thousands of dollars annually to the people in taking care of our insane. The alarming increase of chronic alcoholism in Colorado calls loudly for an inebriate asylum where the unfortunate victim of dipsomania may receive that peculiar style of treatment necessary for the cure of his terrible disease. Almost every city and town of any size in Colorado has some state institution located in or near it except Pueblo, and it would seem that your city is fairly entitled to this one. The plan proposed to raise revenue for the support of the asylum is by means of the bell punch levying a tax of five mills upon each glass of spirits, wine, beer or soda water sold. By this plan a large revenue can be raised and nobody will feel it (1-30-1879).

For obvious reasons, the local paper favored the Pueblo asylum, but this quote illustrates something else: instead of treating alcoholism as a sin or moral transgression, the journalist or editor was trying to convince readers that those suffering from alcoholism were victims of a disease instead of a social ill. Later articles in the same paper detail additional concerns about the rise of alcoholism in the State and state that the way to solve this problem is through confinement to a state institution where they can "dry out" and return as productive members of society.

Senators and representatives from Colorado Springs, Trinidad, and Golden also competed for the location of the asylum, but Pueblo finally won with the help of philanthropist, Senator George Chilcott, who donated 40 acres of land. Initially, temporary buildings were planned to hold the patients until more permanent ones could be constructed. Everything seemed to be going well at first, but the issue of funding threatened to halt the entire project. When this occurred, the term "inebriate" was dropped from the name and the funding source for the asylum was no longer based on an alcohol tax, but rather on a property tax and legislative appropriations. Wealthier patients were also required to pay for their own care (*Colorado Weekly Chieftain* 2-20-1879). Funding for eight thousand dollars was appropriated from the state treasury when the second session of the Colorado General Assembly passed the asylum into law on February 8, 1879 (General Assembly of Colorado 1879).

In May 1879, a local physician, Dr. Pembroke R. Thombs, a former Civil War officer, accepted the position of Superintendent of the asylum and the Colorado State Insane Asylum (CSIA) officially opened its doors to patients in October of 1879. The initial buildings were so small that when the asylum opened only about 30 patients could be accommodated (*Colorado Weekly Chieftain* 10-9-1879).

Figure 2.1: The temporary cottage utilized for the first female patients of the CSIA in 1879. (Photo courtesy of the CSIAP Museum).

Initially, the asylum operated like many other mental health institutions at that time. The official national discourse on mental health treatment included the concept of "moral treatment" and incorporated ideas that the environment of the patients must be regimented to encourage reformation and healing. As the patients increased in number, additional buildings were constructed in 1883 and 1888 (Figure 2.2 and Figure 2.3), following the Thomas Kirkbride model, which encouraged large open grounds and cathedral-like buildings (Mitchell et al. 2002, and Colorado State Insane Asylum at Pueblo Museum 2009). Eventually gardens, orchards, and a farm were created to provide patients access to work, exercise, and fresh air.

The press was enthusiastic about the asylum when it opened. The *Colorado Chieftain Weekly* described the institution favorably while also stating the need for even greater facilities:

> Everything in and about the building is arranged in good shape, and in no case has money been needlessly expended. Dr. Thombs, the superintendent, gave his personal supervision to every detail and the institution, though small in capacity, is modeled after some of the best in the eastern states. The attendants seem to understand their duties thoroughly, and the patients are comfortable, clean and contented, as far as persons in their pitiable condition can be. On account of the smallness of the appropriation made by the last legislature, many necessary arrangements have been omitted about the place, but the board of commissioners hope that the next legislature will be more liberal, and that more extended accommodations will be provided for our insane poor (11-6-1879).
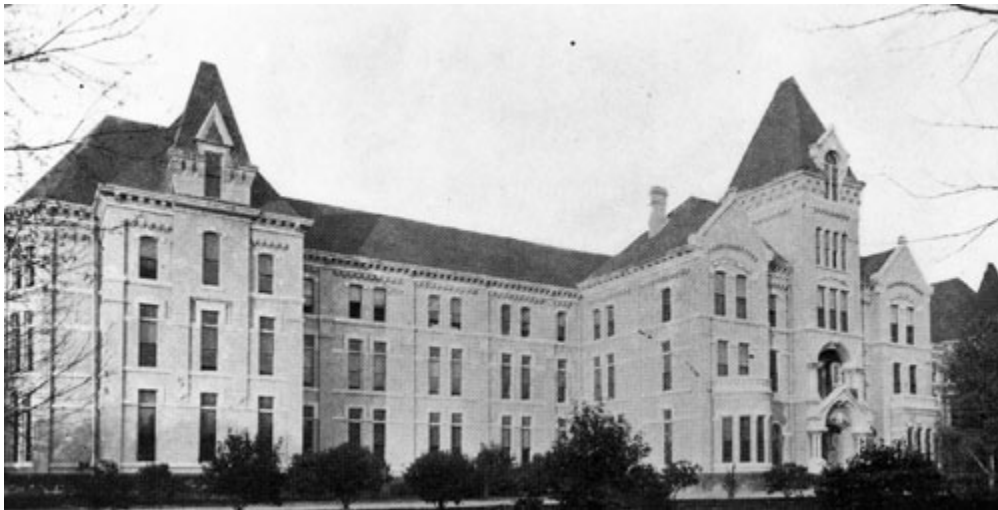
Figure 2.2: The male center built in 1883 in Kirkbridian style. This building was demolished in 1968. (Photo courtesy of CSIAP Museum).

Figure 2.2 Female building built in 1888. (Photo courtesy of CSIAP Museum).

2.1.2 Institutional Troubles (1889-1899)

Less than a decade after its auspicious opening, and in spite of subsequent expansion, the asylum became overcrowded, and the tone of the media changed markedly.   In the following account from the *Leadville Daily and Evening Chronicle*, dated December 15, 1888, frustration was expressed because towns throughout Colorado were increasingly being denied a location for their mentally ill citizens and were instead forced to house their insane in local jails:

> Saturday morning Acting Sheriff Loomis received the following letter with regard to Whitney, the man adjudged insane in the county court on Wednesday: "Office of Superintendent Insane Asylum, P. R. Thombs, Supt., Pueblo, Colo., Dec 14, 1888. Sheriff Lamping: Dear Sir-Your favor received. I don't know when I can take the man you have; we are full and running over. There are only five in the Pueblo county jail waiting to get in. Yours Truly, P. R. Thombs." This kind of

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thing is obviously a gross injustice to the unfortunate insane and the next

legislature should make appropriations to provide adequate accommodation for all

insane persons as soon as possible.

This attitude continued for years. In 1891, the *Boulder Daily Camera* noted that local

sheriffs were now having to deal with suicidal patients (8-13-1891).

Changes were also occurring internally at the asylum. By 1888, Thombs

approved the usage of restraints to avoid the destruction of property by violent and

destructive patients. Fifteen straightjackets were produced in the sewing rooms (CSIA

1887-1888). This number increased to 40 straight jackets in 1889 (CSIA 1889-1890), and

a total of 143 would be made for the 20-year period in which the individuals in the

cemetery were interred (Mitchell et al. 2002). This change is notable since the usage of

restraints had been highly discouraged under the "moral treatment" school of thought, a

nineteenth century form of treatment that focused on providing an orderly, and rational

environment to induce healing. Clearly, increased demands were being made on the staff

of the overcrowded, under-staffed asylum.

It is also evident from the CSIA bi-annual reports that the asylum was

experiencing economic hardship, as Dr. Thombs repeatedly requested additional funds

for the asylum but was consistently denied by the legislature. Staff numbers were

reduced, and record-keeping dwindled to almost nothing. This included the burial

records for those individuals interred in the paupers' cemetery on the grounds of the

CSIA. In October of 1898, an inquiry of the asylum was made at the request of Dr.

Thombs. The information about this inquiry mostly comes from *The Pueblo Chieftain*

and *The Denver Republican* newspapers (Mitchell et al. 2002). During the course of the

inquiry, allegations against Dr. Thombs were made, and it was reported by various

employees that few records regarding either finances or patients were being maintained.

Deceased patients were not evaluated by the superintendent, as they should have been,

and employees were filling out the death certificates instead. The allegations also

claimed that Thombs had permitted employees to become negligent in their duties:

patients were dying unattended, and some families were never notified of their loved

one's death (*Colorado Transcript* 2-01-1899). Additionally, at least one patient gave

birth to a child in July 1887. The infant died soon after birth and was secretly buried on

the property (*Aspen Weekly Times* 11-19-1898, Mitchell et al. 2002).

The media latched onto the allegations. Reports of suicides and accidents were

published across the state during the asylum's difficult years. Eventually, Dr. Thombs

was cleared of any wrongdoing, but he was replaced by another superintendent, Dr. A. P.

Busey, on September 1, 1899. The unnamed pauper's cemetery was no longer used after

this appointment (Mitchell et al. 2002:18).

2.2 Asylum Patients

Researchers know little about the people who inhabited the Colorado State Insane

Asylum other than what can be gleaned from historical newspapers and the scant

admission records. Patients came from counties all across the state of Colorado and the

records kept at the asylum during this era included little more than basic demographic

information such as place of birth, age, reason for admittance, occupation, name, cause of

insanity, and sometimes country of origin. A few incidences of accidents or medical

problems are listed on the individual patient records, but only if they occurred at the

institution while under asylum care. Additionally, some of the records indicate when

patients were discharged or died at the asylum, although in the case of death, no one

recorded whether the remains were returned to friends and family to be interred elsewhere, were transferred to a local cemetery in Pueblo, or were interred on the asylum grounds.

The descriptions we have of the patients at the asylum come mostly from the local newspapers. These were filled with stereotypes and offensive language, which reflected contemporary views of insanity, race, and class. Early newspaper articles revealed unflattering opinions toward various groups such as females, Germans, the Irish, African Americans, thieves and overweight individuals, as well as an insensitive understanding of treatment for the mentally ill.

Articles from this period provide valuable insight into the asylum and its patients not only because they reveal negative attitudes towards the patients and mentally ill individuals in general, but also because they express contemporary attitudes toward immigrants and individuals of different ethnic origin. The newspaper accounts also offer hints regarding the diseases in question.

2.3 The Colorado State Insane Asylum Skeletal Collection

The remains of approximately 166 individuals were recovered during the 1992 and 2000 excavations of the Colorado State Insane Asylum at Pueblo (previously Colorado State Insane Asylum) in an unmarked cemetery in Pueblo, Colorado. These remains are currently housed at Colorado State University. The remains are assumed to date from approximately 1879 to 1899 and represent the early years of operation until the departure of the first superintendent, Dr. Thombs. The ages of the individuals in the collection range from about seven years old to well over 80.

It is interesting to note that some of the individuals came from secondary burial pits, i.e., they had been previously unearthed and then collectively reburied. Further complicating the picture is the fact that the remains were often fragmentary, and individual skeletons were intermixed as a result of construction events over time. However, the preservation of the individual elements is excellent even though the excavation methods (partially accomplished via industrial bulldozer and unskilled staff) sometimes resulted in breakage or complete destruction of various skeletal elements.

The cemetery was discovered by accident during the expansion of facilities at the current Colorado State Insane Asylum in Pueblo, Colorado in 1992, and the site was assigned Smithsonian numbers 5PE527 – 5PE527.6. The site's eligibility status for the National Register of Historic Places is currently determined as "needs data."

As mentioned, death records on the individuals buried at this site are either scant or non-existent. The cemetery was apparently not advertised, and any markers or memorials that were supposed to represent the location of burials were either of an ephemeral material, such as wood, or entirely absent. The individuals from the collection likely represented individuals of low economic status such as the laboring classes, since those with family who could afford it (and were notified) would have been buried in other cemeteries. Additionally, if an individual's kin could not be located, and the patient's funeral costs were not sponsored by either the military or a previous employer, he or she might have been buried on the grounds to save costs, no matter their social status.

The medical and admission records from the asylum provide some of the only primary evidence available to researchers of this collection, but they are superficial and

typically mention the same data one would expect to find on a census from the era. These details include information such as admittance date, age, sex, ethnicity or background, and discharge dates or death dates. Those records that describe the death of an individual under state care do not discuss the final burial place of the individual. It is not possible at this time to match individuals buried in the unmarked cemetery with the medical and admission records.

Chapter 3 – Trauma, Methods, and Definitions

The current analysis of the Colorado State Insane Asylum (CSIA) collection

occurred between the Spring of 2006 and the Spring of 2008 and consisted of hundreds of

laboratory hours. The following chapter details the methods utilized to catalog,

inventory, investigate, and analyze the skeletal assemblage. Included are brief

background discussions of the roles and functions of the skeleton in the human body, as

well as discussions of the kinds of trauma that can be seen on skeletal remains.

Admission records from the CSIA are examined to determine the occupations and

backgrounds of patients from the inception of the CSIA in 1879 to the end of Dr.

Thombs' term in 1899.

3.1 The Human Skeleton

The skeleton performs many vital roles in the human body, functioning as a

support scaffold, a protector of soft tissues such as the brain and the most vital organs of

the torso (heart and lungs), a reservoir for calcium and potassium mineral storage, and as

leverage for muscles to permit motion. Internally, the marrow within bones supplies the

body with erythrocytes or red blood cells and other components of the blood. To the

trained osteologist or biological anthropologist, the skeleton is a permanent record of

certain diseases such as syphilis, rickets, and anemia; it also provides clues regarding past

diets, population health, genetics, and trauma and hardships experienced by individuals.

Additionally, a trained researcher can use the skeleton to determine the approximate age

at death, as well as sex, ethnic background, and stature (White 2000:2).

3.1.1 Microstructure of Bone

At the molecular level, the human skeleton is primarily composed of two

materials: hydroxyapatite, a dense inorganic material composed of calcium phosphate;

and collagen, a flexible protein. Collagen comprises about 90% of the bone's organic

content (White 2000:25) and is the most common protein in the body. The combination

of hydroxyapatite and collagen allows bones to provide both rigid support and flexibility

when forces or stressors are exerted upon them.

Cellularly, skeletal material is formed and maintained by three different types of

cells: osteoblasts, osteoclasts, and osteocytes. Osteoblasts are the bone-forming cells that

create and deposit bone material, while the osteoclasts remove and reabsorb portions of

bone. Osteocytes are the stable cells that reside in a portion of bone tissue called lacunae

and are responsible for maintaining bone tissue (White 2000:27). The human body is

very efficient; its bones remodel throughout the life of the organism, constantly adapting

in response to particular stressors.

Bone responds to continual stressors by changing form and adjusting so that more

bone is added by osteoblast cells where needed and removed where not needed. This

growth is termed appositional or periosteal growth because the outer portions of the bone

are responding to minor stresses by adding more bone to these portions (Ortner and

Turner-Walker 2003:21). Intense physical labor that increases muscle mass—for

example, blacksmithing or working with heavy tools for extended periods of time—

causes bone to reinforce itself at muscle attachments. This process can result in an enlargement of the arm bones of a dominant hand, allowing researchers, in some cases, to determine handedness for an individual.

Conversely, if an individual suffers a stroke so that various muscles no longer work, the osteoclast cells will remove bone mass, causing the limbs to become more fragile and atrophied. Persistent disease and trauma can also leave marks on the skeleton if the bones are allowed to heal and remodel. Over time, smaller breaks can almost disappear as bones continue to remodel, rendering fractures visible only in radiographs.

Bone remodeling can be amazingly distinct. For example, forensic anthropologists have been able to determine that an individual played a wind musical instrument simply by examining the muscular attachments on a specimen's mandible (Byers 2002:346). Remodeling also occurs as the body tries to compensate for additional support, as in the case of torn muscles that work to reattach themselves, or in osteophytic or boney growths around bones that are often suggestive of arthritis.

The living body responds to physical insults in a multitude of ways. Torn connective tissues heal. Skin forms scars. Human bone, one of the more durable materials of the human body, responds to stressors in one of two ways: by either remodeling or rebuilding bone that is damaged, or by removing bone. Human bone is constantly remodeling itself even after an individual has stopped growing (Ortner and Turner-Walker 2003:30).

3.2 Methods

The entire CSIA collection of approximately 166 skeletons was inventoried and analyzed for trauma during this project. The analysis was based on the methods

described in *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). This work establishes a basis for comparative analysis across skeletal collections. First, some basic measurements were collected to provide an initial inventory. This process entailed determining the completeness of both skeletons and individual elements. Each element that could be identified was measured for completeness and analyzed for signs of infectious disease and trauma, as well as ante-, peri-, and post-mortem damage. All bones were inventoried to control for missing or incomplete skeletal elements. Discrete individuals were analyzed *in toto* to determine, when possible, their sex, approximate age, ethnicity and other identifying information. The size of the skeletal sample also permitted seriation (a relative dating technique in which items from a collection can be placed in order by chronological age) of individuals to better understand the gradation of morphological features present in the population, which resulted in a more accurate determination of age. The frequency of traumatic injury was calculated based on the number of observable elements.

The CSIA collection consisted mostly of individuals of European ancestry. This allowed for increased precision in the determination of population and individual characteristics, since many of the methods used to determine attributes like age and sex were established from European and American skeletal series. The collection contains many single burials, but some remains were commingled as a result of having been disturbed during construction work some time prior to excavation of the cemetery in 1992 and 2000. In cases of comingled remains, attempts were made to try to separate the individuals as much as possible and to establish a minimum number of individuals (MNI) for each comingled group.

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3.2.1. Sex Determination

To determine sex, the researchers examined the individual's overall size and paid particular attention to the morphology of the pelvis and cranium when available. In general, females are usually smaller and less robust than males in human populations, but additional information must be considered, as there is some overlap in size ranges between men and women. Robustness and size are assessed when examining the cranium, paying particular attention to five different sites: the nuchal crest, the mastoid process, supra-orbital margins, supra-orbital ridge/glabella and the mental eminence. For the inventory, a scoring system of 1 to 5 (1 being female, 3 being ambiguous, and 5 being male) was utilized, as outlined in Buikstra and Ubelaker (1994:19-20). The cranial information was then analyzed in conjunction with any available postcranial information.

In postcranial remains, the most indicative element used to determine the sex of an adult individual is the pelvis. Pelvic morphology can be utilized along with cranial observations for increased accuracy in determining sex. Many of the techniques utilized during analysis were adopted from Buikstra and Ubelaker (1994) who used Phenice's technique to determine sex from the pelvis (Buikstra and Ubelaker 1994; Phenice 1969). Five specific elements of the pelvis, including the ventral arc, subpubic concavity, ischiopubic ramus ridge, preauricular sulcus, and greater sciatic notch, were scored. The resulting score for the pelvis was compared with that from the cranium. Both cranial and postcranial lines of evidence were used where possible and sex was determined from these scores. Some remains were too incomplete and fragmented and in these cases, the individuals were scored as an individual of indeterminate sex. If an individual fell within

the range of having both male and female characteristics and a definite sex could not be determined these individuals were scored as ambiguous.

3.2.2 Age Determination

Age is perhaps one of the most difficult metrics to determine. Remains often need to be seriated to compare and contrast between individuals within a given population for more accurate results. Multiple lines of evidence were compared in this sample to determine the age ranges of individuals. The Suchey-Brooks Pubic Symphysis Scoring system (Brooks and Suchey 1990 and Buikstra and Ubelaker 1994) was used to assign age ranges via seriation. These results were then compared with an examination of the auricular surface using a method described by Lovejoy et al. (1985) and Meindl and Lovejoy (1989).

In cases of discrepancies, other lines of evidence were used, including an examination of the fourth rib (Iscan and Loth 1986 and White 2000), and cranial suture closure. However, cranial suture closure is generally an unreliable method as there can be considerable variation among individuals, and some medical conditions can change the rates when closure occurs. Data were not collected on individuals regarding tooth wear, since much of the methodology on dental wear was collected from Native American populations (White 2000:346), who lacked refined foods and sugar in their diet. The coarseness of the Native American diet resulted in increased tooth wear that is not present in this population. Still, the CSIA collection shows generally poor dental health (though some individuals have gold dental work that might have occurred pre-institutionalization) which is likely the result of diet combined with less than ideal oral health.

Ultimately, multiple lines of evidence were used when appropriate with the available skeletal elements, and the resulting age ranges were based on the methods described above. Whenever possible, age ranges were assigned to each individual. The ages within the asylum ranged from seven years old to individuals older than 80, as reflected in the medical record.

3.3 Trauma Determination

Osteological observation of trauma is relatively simple to detect by the trained eye, and the easiest way to develop this skill is via experience with comparative studies of normative individuals as well as individuals exposed to various forms of trauma. To develop this skill, the author attended osteology classes and participated in the initial inventory of this collection in the Spring of 2006. To reduce intra-observer error, or personal error, the trauma found on each of the skeletons in the collection was initially recorded in the spring of 2006. Then the collection was re-examined more thoroughly from Fall 2007 to the Spring of 2008. The following sections discuss trauma in general, and detail the types of trauma found in the collection.

3.3.1 Defining Trauma

For purposes of this research, trauma is defined as any bodily injury or wound that affects the bone and/or soft tissues of the body (Roberts 1991:226), or appears as a discontinuity found in bone (Byers 2002:258; Ortner and Putschar 1981). A "discontinuity" refers to any break in a bone or damage evident on a bone. In archaeological collections, trauma is usually represented by bone fractures, dislocations, and deformations with both cultural and environmental origins (Ortner 2003; Roberts 1991). While some forms of trauma such as scalping and certain complications during

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childbirth may not be quite as visible through skeletal observation, other traumatic insults

such as compound fractures, surgeries, and trepanations are easily distinguished and

visible.

      In rare cases, soft tissue trauma might also be visible on the skeleton. When

various tendons and ligaments are damaged, they can often remodel the bone if they do

not heal properly. The bone can gradually reshape over time to accommodate the

changes in muscle attachment.   In the following figure from the CSIA collection (Figure

3.1), the boney "fin" on the posterior or rear portion of the femur is from a soft tissue

injury. At some point during this individual's life, the damaged the soft tissue of the

hamstrings so that one or more muscles pulled on this portion of the bone, leading the

bone to adapt to the pressure.

Figure 3.1: Left femur with evidence of soft tissue damage resulting in a "fin" of bone on the posterior side.

3.3.1 Types of Trauma

Three different types of trauma were considered in the CSIA collection, including fractures, dislocations, and cultural or artificial deformations. Other types of trauma, such as that arising from infectious and chronic disease or from genetic conditions, were not considered. This research specifically focused on trauma caused by physical forces exerted upon the skeleton.

3.3.1.1 Fractures

Fractures are the most common type of trauma found in archaeological collections. Ortner has detailed the formation of fracture types in his work, *Identification of Pathological Conditions in Human Skeletal Remains.* The following discussion is based on Ortner's classifications.

Fractures are traumatic events that result in a complete or partial discontinuity of the bone. They are typically caused by at least one of five types of stress: compression, tension, bending forces, torsion, and shearing (Ortner 2003:120). These stresses can lead to five types of fractures: compression fractures, tension fractures, bending fractures, torsion fractures, and shearing fractures.

Compression fractures are most prevalently found in the vertebrae and occur in response to a sudden increased pressure or weight on the skeletal elements. Occasionally compression fractures can be found in the ankle, such as when an individual has landed on his/her feet after a fall from a great height. Figure 3.2 shows a compression fracture in the vertebrae of an individual who may have experienced heavy lifting at the time of injury. Compression fractures occur more commonly in the elderly and in other individuals who suffer from osteoporosis. Osteoporosis causes decreasing density in

bones, which are then less able to withstand direct pressure. The most likely bones to exhibit compression in individuals suffering from osteoporosis are the thoracic vertebrae, or the vertebrae that connect to the ribs. Because compression fractures are so highly correlated with osteoporosis, it is important for osteologists to consider the age of an individual before assuming that compression fractures are occupation-related (Byers 2002: 349).

Figure 3.2: A slight compression fracture has occurred on the last three lumbar vertebrae on the right. Note how the vertebral bodies on the right are "pinched" and not square.

Compression fractures also occur at the ends of joints (Ortner 2003:121) and might be present in the metacarpals (bone in the palm of the hand) of individuals who experienced physical conflict. Additionally, most fractures of the skull stem from compressive forces (Schinz et al. 1951-1952:1600-1609), such as occurs when the head is

struck by a sharp or blunt object or when the head strikes a hard surface. In the CSIA

collection, compression fractures seem to have been related to senescence, or old age.

Figure 3.3 shows a broken hip in an elderly individual (male), with reformation around

the femoral head, suggesting that he lived several years after the break (Fig. 3.3).

Figure 3.3: Left femur with crushed femoral neck. The individual who suffered this injury lived for years afterwards.

A second kind of fracture, tension fracture, usually occurs when a tendon pulls on

a bone in such a way that the bone breaks. These types of fractures are often associated

with joint dislocation and are less common than other types of fractures.

Bending fractures are the most common of all types of fractures and may be the

result of several other types of stress. In bending fractures, the bone is abnormally bent

past its maximum flexural strength. These types of fractures may result from a fall on the forearms for example, or from blocking blows received to the head and neck by extending the forearms. Children often exhibit partial bending fractures in their more flexible bones; this is called a "green stick fracture." Because the bone is only partially broken, it often realigns naturally. Once healing and remodeling takes place, this type of fracture can be difficult to see in adult skeletons.

Torsion fractures occur when a portion of the limb is fixed and another portion rotates abnormally. In the modern era, these types of breaks are often associated with skiing accidents, where the boot remains in one place while the rest of the body continues its trajectory (Ortner 2003: 122).

Shearing fractures are the result of opposing forces applied to the bone. The most common shearing fractures seen in people over 40 years of age are Colles' fractures (Figure 3.4), which occur when falling on outstretched wrists (Lovell: 1997).

Figure 3.4: Examples of Colles' fractures: This individual broke both distal radii while likely falling on outstretched hands. This fracture almost always results in deformity if not set properly.

Fracture Healing

Healing begins immediately after the initial fracture process and progresses

through various stages, as described by Lovell (1997). Injuries will first form a hematoma

or blood vessel clot in the first 24 hours. A callus is formed 3 to 9 weeks after the break.

The callus consists of woven bone that provides a splint for support and the foundation

on which more mature bone will develop. The bone can take anywhere from a couple of

weeks to many months to fully heal, depending on the age of the individual and the

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severity of the break. Some fractures might never heal due to continued movement in an

area (as is common in rib fractures, when the broken bones move with every breath

taken). In such cases, the body often compensates by sealing off the broken ends of

bone, occasionally forming what is called a pseudoarthrosis - or false joint.   However, in

successful cases of healing, the fracture will continually remodel over the life of the

individual and might eventually appear invisible even to radiographic analysis.

By examining the healing processes of fractures, forensic scientists can

sometimes determine the approximate age of the individual at the time the injury

occurred and, in the case of very serious injuries, whether injury was related to cause of

death. Healed fractures also help researchers determine if skeletal damage occurred

during an individual's life or during excavation.

Skeletal trauma is especially helpful in determining when injuries occurred during

an individual's lifetime. There are three types of temporal divisions for skeletal trauma:

antemortem trauma, perimortem trauma, and postmortem trauma. Antemortem trauma

occurs prior to death. As previously discussed, fractures received early in childhood

often remain visible on the adult skeleton, as evidenced by bone remodeling and healing

of the skeletal tissue. Perimortem trauma occurs around the time of death, as the result of

injuries that likely were the cause of death, or from damage to the body just after death.

Such fractures can be difficult to determine archaeologically because the ends of bones

are more likely to have been eroded by taphonomic forces during internment (i.e.,

moisture or soil quality). These pieces of the skeleton are more likely to be missing from

collections and are likely to be underrepresented.

Postmortem damage occurs after the body has skeletonized. It can be caused during the excavation or exhumation of bones from interment, although it can also result from scavenger modification or from damage during storage and analysis. In the CSIA collection, a vast majority of the skeletons exhibit postmortem breakage due to many causes. This is probably the result of heavy-handed excavation techniques as well as the various lab analyses done by previous researchers.

Of the types of temporal trauma, the two most difficult to distinguish from each other are perimortem and postmortem trauma. In many cases, the damage present on the CSIA collection was judged to be postmortem, because the margins of the incision are a different color (paler) than the surrounding bone. If the incision had occurred around the time of death and before internment, we would expect the edges of the bone to be the same color as the rest of the bone because all portions would have been exposed to the same burial conditions. This is the easiest way to distinguish between the two types of trauma, but often the conclusions are not so obvious.

3.3.1.2 Dislocations

Dislocation trauma occurs when a bone separates from contact with its joint surface. Dislocations are usually confined to the hip and shoulder joints, resulting in a lessening of blood flow to the joint that can lead to arthritis and mobility issues if appropriate care is not taken. In the osteological record, dislocations occur almost exclusively on adult bones, because the force of the trauma usually breaks the joint at the epiphyses in subadults, or results in fractures in the elderly (White 2000: 387). Dislocations might be underrepresented in trauma studies because the ends of bones are often more damaged over the course of a lifetime than are other sections of bone, which

subjects them to increased decay upon internment. Additionally, some examples of dislocation might be mistaken for severe cases of arthritis.

3.3.1.3 Cultural Reformations

Cultural reformations (also called artificial deformations) are defined as trauma inflicted on skeletal elements as a result of various aesthetic or medical interventions or changes in bone growth with a basis in cultural preferences or ideas. Historically speaking, many cultures have engaged in the reformation of children's skulls through such practices as cradleboarding and head wrapping in order to create cranial shapes that conform to cultural ideals of beauty or to increase social status. Chinese foot-binding is another example of long-term skeletal trauma resulting from aesthetic intervention. In modern western societies, the idea that sleeping infants should be positioned on their backs has led to an increase in anteroposterior deformations of the crania.

Amputations and trepanation are two additional types of trauma that result from the actions of healers or medical personnel. Archaeologists often have a difficult time distinguishing postmortem amputations from perimortem amputations because the ends of bone—where healing processes would occur—are often missing. In the CSIA collection, amputations might have been underestimated due to problems that arose during excavation or because of natural decomposition of bone.

Trepanation, or trephination, is often described as the custom of incising, scrapping, drilling, or cutting an artificial hole in the cranium and has been practiced since ancient times in Europe, the Pacific, both Americas, Asia and Africa (Ortner and Putschar 1981; White 2000: 388-9). White (2000) discusses several possible reasons for the procedure, including relief from intracranial pressure (especially from compressive

fractures to the skull), relief from headaches, curing of mental illness, or the excision of evil spirits. In spite of the risks of trepanation, success rates were unexpectedly high as evidenced by subsequent healing around the opening (White 2000: 389). The CSIA collection contains one example of trepanation, which seems to have been performed to alleviate pressure as the result of a cranial fracture previously sustained by the individual. This example is discussed in additional detail later in the paper.

3.4 Cultural Contexts and Importance of Trauma

For scholars, evidence of skeletal trauma leads to hypotheses about the social and cultural contexts of earlier populations. Occupational stresses, accidents, and interpersonal violence can all leave their mark on the human skeleton via fractures and deformations. The kinds of fractures and how they heal provide insight regarding the medical care, or lack thereof, available to individuals in the past, allowing us to infer socio-economic status, proximity to or availability of physicians, and perhaps even personal beliefs about health and medical care, folk wisdom, and psychological trauma. Surgery itself can inflict additional trauma on bones to facilitate their correct healing. Even the location of fractures can provide clues as to the cause of the fracture. Fractures on the nasal bones, zygomatic (cheek) bones, and mandible occur more frequently in cases of interpersonal violence, while fractures on the long bones are more often the result of accidents. Compressed vertebral bones and robust muscle attachments might be seen on an individual who was involved in heavy labor. As discussed earlier, if limbs were used differentially, such as swinging a blacksmith's hammer with the right hand, researchers can determine the handedness of the individual. Conversely, disuse and lack of activity, such as in paralyzed individuals, results in more gracile bones than expected.

Age and gender also affect the frequency and locations where fractures occur in individuals. As previously discussed, children are more likely to break their radius and ulna closer to the elbow than do adults, who are more likely to break their forearms at the wrists (Colles' fractures) when they fall on outstretched hands. Elderly individuals are more likely to break their femur necks than are younger adults (Lovell 1997). Such information can reveal much about the roles of gender and age in the social division of labor or in the cultural views of a given community. Abuse, either by care-takers or by family members, may also be seen in individuals who suffer damage to their head, neck, ribs, and forearms.

In summary, the analysis of human skeletons provides a direct line of evidence to examine the past. Using trauma evidence, archaeologists are able to fill in some of the gaps left by medical records and other historical sources by revealing the daily hazards, violence, and occupational dangers of a population at a given point in history.

3.5 Problems with Trauma

Like all sources of information, the paleopathological analysis of trauma is not without its biases, problems, and assumptions. One particular problem with trauma analysis is the phenomenon of *taphonomy*, or forces that affect preservation, such as soil type, bioturbation (the work of insects and worms), water, moisture, and humidity, all of which can wreak havoc on buried bone. Recently broken bone is also more susceptible to decay and therefore may not be represented in an osteological sampling. Additionally, poor excavation techniques can result in the incomplete recovery of skeletal elements or cause further damage to bones, thus obscuring or obliterating evidence of antemortem trauma.

An additional problem that can confound the results of osteological studies is the "osteological paradox" (Wood et al. 1992). This paradox suggests that although an unbroken skeleton might appear to represent a perfectly healthy individual, in reality that person might have succumbed to some other type of physical insult, such as soft tissue disease or sickness, before his/her bones had a chance to respond to the disease. Thus individuals who appear to have been unhealthy because their skeletons exhibit many injuries might actually represent the most robust individuals in a society because they survived their injuries.

Although various problems can bias the osteological statistics of a population, it is also likely that incidences of trauma are underrepresented in most collections due to taphonomic phenomena. In the case of the asylum collection, we cannot simply assume that internees were well treated, because the particular types of abuse that might be prevalent in a population confined to an institution—including adult fractures—are precisely the ones that would be missing from the sample. But neither can we assume that injury existed and then disappeared from the osteological record. Instead, we have to find supplemental ways to analyze the conditions at the Colorado State Insane Asylum in the 19th century.

This catalog of trauma in the CSIA collection includes only elements that were macroscopically obvious and had evidence of healing or malformation that would suggest intensive remodeling over time. Traumatic elements of interest were photographed and all elements were recorded. Due to limited funds, radiographic analysis was not possible during this study and was not utilized, though this might be an interesting area of study

for future researchers because, if anything, the amount of trauma discovered in the collection would increase.

Chapter 4 – Trauma Analysis

An analysis of the trauma in the CSIA collection was made over several years and includes a total of 166 individuals in both complete and fragmented condition. Each skeletal element was examined macroscopically and each evidence of trauma was recorded and described. Table 4.1 represents the traumatic injuries from the Colorado State Insane Asylum by skeletal element and sex of the individual. It was not possible to determine the sex of some individuals for several reasons: either they were ambiguous or were represented by only a few bones. For reasons of taphonomy, analysis, and excavation methods, the percentages of trauma are likely to be very conservative estimates as many elements on certain skeletons were missing.

The denominators used in this section differ for each element, and represent the number of elements present in the collection for that particular element. For example, in Table 1, only 97 of 107 males in the population had intact crania. Thus 97 is the denominator found for that sex and element, and 4 represents the number of male crania with evidence of trauma. In cases where the elements were not individually counted (nasal bones, ribs, etc.), because of confines within the dataset, the denominator was conservatively set to the number of males, females, or individuals of indeterminate sex present in the entire population. In these cases it is likely that the actual number of trauma for those elements is higher than the data suggest due to the higher denominator.

Table 4.1: Traumatic Injuries by Element and Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Cranium	4/97 (4.1)	0/34 (0)	0/15 (0)	4/146 (2.7)
Nasal	7/107 (6.5)	0/35 (0)	0/24 (0)	7/166 (4.2)
Mandible	3/94 (3.1)	1/33 (3.0)	0/12 (0)	4/139 (2.8)
Maxilla	6/86 (6.9)	1/33 (3.0)	0/12 (0)	6/132 (4.5)
Zygomatic	1/78 (1.2)	0/29 (0)	0/11 (0)	1/118 (0.8)
Hyoid	2/107 (1.8)	0/35 (0)	0/24 (0)	2/166 (1.2)
Clavicle	2/89 (2.2)	0/32 (0)	1/14 (7.1)	3/134 (2.2)
Scapula	5/94 (5.3)	0/31 (0)	1/12 (8.3)	6/137 (4.3)
Humerus	6/90 (6.6)	0/35 (0)	0/16 (0)	6/141 (4.2)
Ulna	2/85 (2.3)	0/31 (0)	0/14 (0)	2/130 (1.5)
Radius	5/86 (5.8)	0/31 (0)	1/12 (8.3)	6/129 (4.6)
Carpals	2/107 (1.8)	0/35 (0)	0/24 (0)	2/166 (1.2)
Metacarpals	3/107 (2.8)	0/35 (0)	1/24 (4.1)	4/166 (2.4)
Phalanges (hand)	1/107 (0.9)	0/35 (0)	0/24 (0)	1/166 (0.6)
Sternum	2/62 (3.2)	0/23 (0)	0/7 (0)	2/92 (2.1)
Ribs	39/107 (36.4)	6/35 (17.1)	5/24 (20.8)	50/166 (30.1)
Schmorl's node	57/107 (53.2)	14/35 (40.0)	4/24 (16.6)	75/166 (45.1)
Vertebra	5/107 (4.6)	2/35 (5.7)	2/24 (8.3)	9/166 (5.4)
Sacrum	1/82 (1.2)	0/29 (0)	0/12 (0)	1/123 (0.8)
Innominate/Pelvis	4/89 (4.4)	0/30 (0)	0/13 (0)	4/132 (3.0)
Femur	4/93 (4.3)	0/33 (0)	2/16 (12.5)	6/142 (4.2)
Patella	1/46 (2.1)	0/22 (0)	0/6 (0)	1/74 (1.3)
Tibia	7/93 (7.5)	1/31 (3.2)	2/14 (14.2)	10/138 (7.2)
Fibula	12/92 (13.0)	0/29 (0)	2/15 (13.3)	14/136 (10.2)
Tarsals	3/107 (2.8)	1/35 (2.8)	1/24 (4.1)	5/166 (3.0)
Metatarsals	3/107 (2.8)	0/35 (0)	0/24 (0)	3/166 (1.8)

+ = number of individuals affected. N=number of individuals with at least one element present. %=percentage affected.

Of the 166 individuals present (both complete and incomplete), 69% in the collection

show at least one instance of trauma, while 31% show no evidence of trauma. This

trauma rate includes both fractures and dislocations, or acute trauma, in addition to

chronic trauma. Acute trauma is likely represented by a single traumatic episode such as

a slip or fall, or an accident. Additionally, some trauma in the CSIA collection might

have been the result of interpersonal violence between the individual and others. While it

can be difficult if not impossible to determine what caused the trauma seen in this

collection, certain patterns and types of breaks can lead researchers to likely causes. The

next section of the analysis will examine the types of trauma present and the possible

causes that can be determined from the location and siding on the trauma. This section

includes an examination of the different skeletal elements present.

4.1 Analysis of Trauma by Element

This section examines each element in Table 1, detailing the information that can

be gleaned from patterns that result in the CSIA skeletal sample. Fracture patterns that

occur to children, between sexes, and to the elderly are discussed in this section since

some of the fractures present in the sample may have occurred in childhood and remained

evident into adulthood.

4.2 Fractures of the Skull, Face and Throat

4.2.1 Cranial Injuries

The bones of the cranium include the frontal, parietal, temporal, occipital, and

sphenoid bones, and all directly encase the brain. In the modern era, head injuries occur

in a variety of situations including during motor vehicle accidents and falls. The location

of the somewhat weighty head at the end of the neck makes it vulnerable to the rapid acceleration and deceleration of the body (Galloway 1999). Additionally, researchers such as Galloway (1999) describe the head as a focal point for interpersonal violence as the head and face can represent the identity of the individual being attacked to the attacker and thus can bear the brunt of the violent episode.

Skull shape and robustness plays a role in the amount of trauma an individual suffers. Female skulls in general are more gracile than male skulls and so when subjected to the same forces are more likely to fracture. In addition, skull shape has been shown to have an effect on the ease with which the element fractures. Those individuals with a more elongated skull are more likely to withstand fractures on the long axis as compared to individuals with rounder skulls (Gurdjian 1975).

Fracturing on the skull only occurs when the force applied to the skull exceeds the tensile or bending strength of the skull (roughly 3600 psi, though linear fractures can require as little as 450-750 psi on some cranial elements) (Galloway 1999:65). The sharper the item that strikes the skull, the greater the chance of penetration. The most common type of cranial fractures are linear or fissure fractures. Linear fractures are more common in adults as the skulls of children are more flexible than adults. These types of fractures are usually the result of direct impact with an object (Galloway 1999:67).

Diastatic fractures are a type of linear fracture that follows suture lines between bones of the cranium. The amount of fracturing that occurs on a specific individual is subject to the highly variable degree in which sutural closure has occurred. These types of fractures are more common in younger individuals whose sutures have not yet begun to unify. The lambdoidal (between the parietals and the occipital) and coronal sutures

(between the frontal and parietals) are those most likely affected by this type of fracture (Galloway 1999:67).

The cranium is susceptible to three other types of fractures: depressed fractures which are the result of an item penetrating into the skull; stellate fractures, star-shaped fractures that consist of multiple linear fractures expanding out from a single point and; comminuted fractures which occur when heavy-impact forces result in the fragmentation of bone (Galloway 1999:68). It is important to note that in general, people associate skull fractures with intracranial injury, though studies of skull radiography have shown that only 15% of individuals with internal injury show some type of skull fracture and intracranial injury can occur with no external damage (Taveras and Wood 1976). Depression fractures are most likely to be the type of fracture to result in damage to the brain (Given and Williams 2002)

In the CSIA collection only males experienced fracturing on elements of the cranium. Of those, one each of the frontal bones (right and left), and a left parietal each had a fracture recorded, while two left temporal bones were noted to have fractures (Table 4.2). In total, about 4.1 % of males examined showed evidence of cranial fracturing (Table 4.3) with one individual experiencing two of the fractures.

Table 4.2: The Number of Fractures on Individual Elements by Sex.

Skeletal Element	Males +/N (%)	Females +/N (%)	Unknown sex +/N (%)	Total Fractures
Frontal Right	1/92 (1.0%)	0/34 (0%)	0/14 (0%)	1/140 (0.7%)
Frontal Left	1/91 (1.0%)	0/34 (0%)	0/14 (0%)	1/139 (0.7%)
Parietal Right	0/95 (0%)	0/34 (0%)	0/14 (0%)	0/143 (0%)
Parietal Left	1/97 (1.0%)	0/33 (0%)	0/15 (0%)	1/145 (0.6%)
Occipital	0/95 (0%)	0/34 (0%)	0/15 (0%)	0/144 (0%)
Temporal Right	0/91 (0%)	0/32 (0%)	0/13 (0%)	0/136 (0%)
Temporal Left	2/92 (2.1%)	0/34 (0%)	0/14 (0%)	2/140 (1.4%)
TOTAL	**5/653 (0.7%)**	**0/235 (0%)**	**0/99 (0%)**	**5/987 (0.5%)**

Table 4.3: Number and Percentage of Cranium Fractures by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Cranium fractures	4/97 (4.1)	0/34 (0)	0/15 (0)	4/146 (2.7)

No females or indeterminate sex individuals show evidence of skull fractures and of the five fractures present, 80% are located on the left side.

In Tables 4.2 and 4.3 the numbers of skulls or skeletal element for each sex are identified by N. In some cases individuals did not have skulls or skeletal elements present and could not be examined for trauma. Thus it is possible that additional trauma could have occurred to various skeletal elements not present in the collection. These absent elements would not be represented by the statistics.

Modern clinical data show that there are three major sources of cranial trauma: interpersonal violence, sports and accidents (Walker 1997:160). All three of these causes may have played a role in the trauma seen in the CSIA collection. Additionally, there is an example of medically induced intentional trauma.

One individual from the asylum shows evidence of a diastatic fracture that extends from the occipital to the temporal on the left. The location of this injury suggests that the trauma may have resulted from some type of fall. What is interesting about this individual's case is that at some point after the incident, the physician or another health care provider made the decision to trepinate the patient. This surgery resulted in a portion of the left parietal being removed, likely to reduce intracranial pressure. This particular intentional trauma is examined further in Chapter 5.

Sport-caused head injuries can be a source of decline in mental health as has been experienced by boxers. Boxing as a sport may have been increasing in popularity at this time in American history, especially after a highly publicized bare-knuckle match between fighters Corbett and Sullivan in 1892 (Gorn 1986; Walker 1997). After this match boxing becomes increasingly commercialized in the United States.

Boxing inflicts acute and long term neurological trauma on its participants and as boxers continue fighting, 10 to 20 percent are likely to develop neurological disorders including dementia pugilistica or punch drunk syndrome (Förstl et al. 2010). Dementia pugilistica develops over time and includes such symptoms as forgetfulness, tremor, Parkinson's disease, memory disorders, irritability, aggression, depression and a predilection for addiction (Förstl et al. 2010).

Historic primary references also show that accidents were the cause of mental illness in some individuals. One news article from the *Boulder Daily Camera* on August 22, 1894 mentions a case of insanity that resulted from a head injury that was sustained by a fall from a horse. The young man, then 22, experienced behavioral changes described by the article: "His demeanor at home had become such as to lead the family

to fear him. He claims to be head of the house and to own a rich gold mine. He also harbored the hallucination that his parents and brothers and sisters were anxious to poison him, so he refused to eat at home." This patient was determined to be insane and was sent to Pueblo. The admittance records reveal that he was a jewelry manufacturer and that he died in 1924 after a stay of thirty years in the asylum.

Fortunately, cranial injuries are mentioned as a source of insanity in the admittance records; thus an examination of the medical admittance records from the opening of the asylum to the end of Dr. Thombs' tenure in 1899 reveal that of the 1846 individuals admitted, 53 of those were admitted for head injuries (roughly 2.8%). Three of the 53, or 5.6% of those with head injuries were women. The majority (94.4%) were males and of those, 16, or 32%, were miners. Additionally, other hard labor occupations seemed to correspond with head injuries as 10 farmers (20%), 5 laborers (10%), and 4 carpenters (8%) were represented in the types of employment listed. With the exception of two merchants, two housekeepers, a jewelry manufacturer, a harness maker, a locomotive engineer, and three individuals who had no job listed, the remainder of head injury victims were stockmen, sailors, and other laborers. A total of 83% of head injury patients appear to have had more physically demanding jobs where occupation dangers and accidents could have occurred. Twelve individuals admitted during the study period with head injuries died prior to 1900 and seven (58.3%) of those individuals were documented in the asylum records to have died of epileptic seizures or convulsions.

4.2.2. Facial and Throat Injuries

The bones of the face consist of many small, fragile, and light bones that form the scaffolding of the sinuses, the eye orbits and the mouth. Through the structure of the maxillae, mandible, zygomatic, lacrimal, and nasal bones, the genetic variation of an individual is manifested in a unique face. The face is a physical manifestation of our identity as perceived by ourselves and others. As such it can also be the target of interpersonal violence as a strike to the face can symbolically represent an attack on the identity of the victim (Galloway 1999). In addition, the delicate structure of the face suggests that it is often more likely to be damaged in an accident compared to more robust bones of the body. Fractures to the facial bones are rarely fatal (Bone 1985), but are often associated with other types of trauma (Galloway 1999). Along these same lines, the facial bones can be easily damaged during postmortem forces and exhumation.

The face is also an area that helps researchers determine the sex of an individual. Much of human sexual dimorphism is manifest through changes in the morphology of the chin, mandible and eye orbits. In general, female facial bones are likely to be more gracile and less robust, while male faces have more boney protuberances and squarer mandibles.

Galloway states that the maxilla (or upper jaw) is one of the most commonly fractured facial bones (1999) and often results in a depressed or comminuted fracture (Schneider 1985). The degree of fracturing on the maxilla is often dependent on the presence of teeth (Galloway 1999; Gruss 1982). The more teeth present provides more interior scaffolding and increases the ability to withstand impact. Compared to the more

robust cranium, the maxilla bones have been determined by tests on cadavers to fracture at 140-445 psi (Mackey 1984; McElhaney et al. 1976).

In the CSIA collection, six individuals (4.5% total) had a fractured maxilla, all of which occurred on the right maxilla bone. All of these individuals were male and of the total 86 male right maxillae present, 6.9% were fractured. No females or individuals of indeterminate sex had maxilla fractures. Several of these individuals also had additional facial elements, such as the nasal bones, that were fractured (Table 4.4).

Only one individual in the collection showed evidence of broken zygomatic bones, bones that form a portion of the interior scaffolding that makes up the cheek (in his case, both sides, right and left, were broken). Seven males (6.5 %) in the CSIA population evidence a fracture of at least one of the two nasal bones and three males (2.8%) have broken both nasal bones (Table 4.5). The nasal bone number is likely to be a conservative rate as the small nasal bones often are destroyed by taphonomic processes and poor excavation. No females or unknown sex individuals showed evidence of broken noses.

Table 4.4: The Number of Facial and Throat Fractures on Individual Elements by Sex.

Skeletal Element	Males +/N (%)	Females +/N (%)	Unknown sex +/N (%)	Total fractures
Maxilla Right	6/86 (6.9%)	0/32 (0%)	0/13 (0%)	6/131 (4.5%)
Maxilla Left	0/85 (0%)	0/30 (0%)	0/14 (0%)	0/129 (0%)
Zygomatic Right	1/74 (1.3%)	0/29 (0%)	0/10 (0%)	1/113 (0.8%)
Zygomatic Left	1/78 (1.2%)	0/29 (0%)	0/11 (0%)	1/118 (0.8%)
Nasal Right*	6/97 (6.1%)	0/34 (0%)	0/15 (0%)	6/146 (4.1%)
Nasal Left*	4/97 (4.1%)	0/34 (0%)	0/15 (0%)	4/146 (2.7%)
Mandible Right	3/88 (3.4%)	0/33 (0%)	0/11 (0%)	3/132 (2.2%)
Mandible Left	0/94 (0%)	1/32 (3.1%)	0/12 (0%)	1/138 (0.7%)
Hyoid†	2/107 (1.8%)	0/35 (0%)	0/24 (0%)	2/166 (1.2%)
TOTAL	**23/806 (2.8%)**	**1/288 (0.3%)**	**0/125 (0%)**	**24/1219 (1.9%)**

*Nasal bones were not initially inventoried, so denominator is the same as cranium present.

†Hyoids were not counted in the inventory. Few were present, but the denominator has been set to the number of individuals of each sex present in the collection.

Table 4.5: Number and Percentage of Facial and Throat Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Maxilla	6/86 (6.9)	0/32 (0)	0/14 (0)	6/132 (4.5)
Nasal	7/107 (6.5)	0/35 (0)	0/24 (0)	7/166 (4.2)
Mandible	3/94 (3.1)	1/33 (3.0)	0/12 (0)	4/139 (2.8)
Zygomatic	1/78 (1.2)	0/29 (0)	0/11 (0)	1/118 (0.8)
Hyoid	2/107 (1.8)	0/35 (0)	0/24 (0)	2/166 (1.2)
One or more facial element	14/107 (13.0)	1/35 (2.8)	0/24 (0)	15/166 (9.0)

The mandible or lower jaw is a slightly stronger bone, fracturing at between 184-620 lbs. of pressure, due to its arch shape. Today many mandibular fractures occur because of fistfights, motor vehicle accidents, and falls. In the CSIA population, there were a total of 3 males (3.1%) with fractured mandibles (Table 4.5). Interestingly,

studies have shown that women are more likely than men to fracture the mandible in a fall (Edwards et al. 1994). However, in the CSIA collection, only one female showed evidence of a mandibular fracture (3.0%) and it appears to have broken as a direct result of a tooth abscess.

The hyoid bone (commonly thought of as the Adam's apple) and cartilaginous portions of the thyroid and cricoid cartilages that ossify over time are considered the boney structures of the throat and are susceptible to fracturing due to damage sustained from direct blows or compression (such as strangulation). Because they ossify at different rates and were possibly not collected during excavation, the throat cartilages were not examined for this study, but two males show evidence of fractured hyoids (1.8%). No females showed any evidence of fractured hyoids, though the presence of this element in the sample was sparse.

In total, 15 individuals in the collection (9%) showed at least one facial or throat fracture and five males (4.6%) showed more than one facial fracture. In the CSIA collection, men were much more likely to have facial or throat fractures (14:1) than were women, and the single female fracture was not because of blunt trauma, but poor dental health.

The fractures in the CSIA collection appear relatively similar to the results from a study by Erdmann et al. in 2008 that discusses the etiology of facial fractures in a modern population. Like the modern study, the CSIA collection shows nasal fractures as the most common type of facial fracture. Erdmann and coworkers' study lists the main causes of facial trauma as assault (36%), motor vehicle collision (32%), fall (18%), sports (11%), and occupational (3%). Erdmann and associates (2008) also found that isolated

mandible fractures were a significant predictor for assault as a trauma cause, and that

falls were a common cause of injury to the extremities, but an uncommon cause of facial

fracture even in individuals of older age.

Phillip Walker examined patterning of violence in skeletal populations worldwide

and examined over 2300 crania (1997). In this study he noted that nasal fractures were

the most common with 7% of his sample having at least one nasal fracture. This number

is very close to the 6.5% of males with nasal fractures in the CSIA collection but slightly

higher than the total 4.2%. Walker's study found a nearly equal balance between men

and women who showed evidence of nasal fractures, but in the CSIA collection, it is

definitely males who are more likely to have broken noses. In fact, the females of the

CSIA collection do not seem to show signs of domestic violence or abuse in patterns of

fractures in the face and throat.

If we discount the possibility of motor vehicle collisions, it is likely that a similar

etiology would be found in the CSIA collection--with the exception of occupational

causes since modern workplaces, due to regulations and government oversight, are likely

more safe then were the workplaces of late 19th century Colorado. Given the

environmental situation and alcoholism present in individuals admitted to the Colorado

State Insane Asylum, it is likely that many of the facial fractures sustained by male

patients are the result of interpersonal violence, though whether that occurred within or

outside the institution would be impossible to determine.

4.3. Fractures of the Axial Skeleton

The axial skeleton consists of the vertebral column, the sacrum, the ribs, and the

sternum. The axial skeleton in humans assists in helping us maintain our bipedal upright

posture, protects our spinal cord and the nerves associated with it, and protects many of our most important internal organs such as the heart and lungs.

4.3.1. Vertebral and Sacral Fractures and Trauma

Vertebrae are composed of two portions, the body and the neural arch. The bodies are separated by intervertebral disks that provide cushioning from compressive forces, while the neural arch provides a conduit for the spinal column. The vertebral column is divided into three different types of vertebrae based on their morphology: the cervical, thoracic and lumbar vertebrae. The topmost cervical vertebrae are in the neck and are the seven bones (C1-C7) responsible for providing the support for the muscles that hold up and rotate and nod the head. The thoracic vertebrae (T1-T12) have less flexibility than the cervical vertebrae, mostly due to the restriction of the ribs for which the thoracic vertebrae provide support. The lumbar vertebrae (L1-L5) are large and located at the bottom of the spine just above the sacrum. The size of the vertebrae is a function of the weight these bones are supporting.

Fractures in the vertebrae are largely the result of compressive forces, and in excess of 500 lbs. of pressure can cause the vertebral body end plates to fracture and force the intervertebral disks into the bodies of the vertebrae (Galloway 1999: 83). These types of fractures are subject to the age and bone mass of individuals, and can magnify over time and further the collapse of the vertebral column. Rotational forces can also cause fractures to the vertebrae which usually manifest in the neural arches and spinal processes. Spinal fractures tend to occur in three main areas: C1-C2, C5-C7 and T12-L2 (Galloway 1999: 84). Spinal fractures in children occur mostly in the midthoracic region and are often the results of falls while the elderly can experience spinal fractures with

minimal or no associated trauma (Cooper et al. 1993; Horal et al. 1972). Galloway

(1999) also notes that studies have shown that women aged 50-54 years old show a 7.6%

prevalence of spinal fractures while women aged 90 and over show a 64.3% incidence,

indicating a direct correlation between fractures and age-related bone density and bone

mass loss.

The sacrum is a wedge shaped bone (actually many fused vertebrae) that forms

the base and supports the weight of the vertebral column and the posterior portion of the

pelvic girdle. At the inferior tip of the sacrum is located the coccyx, which is the

homologous equivalent of a remnant set of tail bones in human beings. The sacrum has

sets of parallel foramina, or holes, through the body of the sacrum that allow for the

passage of nerves.

The sacrum, due to its position at the base of the spine, is well adapted to handle

compressive forces, but it can be susceptible to twisting motions. Injuries to the sacrum

increase with age as bone mass decreases. Galloway (1999) states that isolated injuries to

the sacrum are rarer and usually the sacrum is involved in cases where there is trauma to

the spine or the pelvic basin. When isolated fractures are present, they are usually the

result of a direct blow to the sacroiliac joint (Kane 1984).

The position of fractures on the sacrum can reveal clues to the anthropologist as to

the amount of force and from which direction it was applied. Transverse fractures of the

sacrum are usually associated with high-energy trauma, with S1-S2 (the top two fused

vertebrae of the sacrum) being the most likely damaged (Galloway 1999). Direct blows

to the sacrum can result in transverse fractures on the lower portion of the sacrum

(commonly S3-S4) (Galloway 1999). The coccyx is difficult to measure because of

taphonomic issues, and though they are uncomfortable, coccygeal fractures are not life-threatening. Coccyx fractures and trauma were not analyzed in this collection.

In the CSIA population 9 individuals (5.4%) showed evidence of a vertebral fracture on either the body or the neural arch of one or more vertebrae. Five individuals were male (4.6%), 2 were female (5.7%) and 2 were of indeterminate sex (8.3%) (Table 4.6). Seven other individuals had two or more vertebrae fused together, but these were not counted as fractures or trauma unless definitive fracture evidence could be seen. It is possible that future radiographic study might reveal the fusions to be based on fractures, but the fusions might also have occurred in response to other injuries that adjusted the posture or mobility of an individual.

Table 4.6: Number and Percentage of Vertebra and Sacrum Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Vertebra	5/107 (4.6)	2/35 (5.7)	2/24 (8.3)	9/166 (5.4)
Sacrum	1/82 (1.2)	0/29 (0)	0/12 (0)	1/123 (0.8)

The most common vertebrae with fractures in the CSIA population are T12 (2 cases), L2 (3 cases), and the thoracic vertebrae (T1-T9) in general with 7 cases represented in the population (Table 4.7).

Table 4.7: The Number of Vertebra and Sacrum Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown sex (x/N)	Total fractures
C1	0/71 (0)	0/29 (0)	0/8 (0)	0/108 (0)
C2	1/69 (1.4)	0/25 (0)	0/9 (0)	1/103 (0.9)
C3-C6	1/286 (0.3)	0/103 (0)	0/47 (0)	1/436 (0.2)
C7	1/70 (1.4)	0/21 (0)	0/8 (0)	1/99 (1.0)
T1-T9	4/685 (0.5)	3/245 (1.2)	0/116 (0)	7/1046 (0.6)
T10	0/72 (0)	0/28 (0)	0/12 (0)	0/112 (0)
T11	0/76 (0)	0/27 (0)	1/11 (9.0)	1/114 (0.8)
T12	0/72 (0)	0/29 (0)	2/11 (18.0)	2/112 (1.7)
L1	0/81 (0)	0/27 (0)	0/12 (0)	0/120 (0)
L2	2/81 (2.4)	0/26 (0)	1/10 (10.0)	3/117 (2.5)
L3	0/83 (0)	0/27 (0)	0/10 (0)	0/120 (0)
L4	0/77 (0)	0/26 (0)	0/11 (0)	0/114 (0)
L5	0/77 (0)	0/26 (0)	0/10 (0)	0/113 (0)
Sacrum	2/82 (2.4)	0/29 (0)	0/12 (0)	2/123 (1.6)
TOTAL	**11/1882 (0.5)**	**3/668 (0.4)**	**4/287 (1.3)**	**18/2837 (0.6)**

Most of the fractures present in the CSIA population appear to be the result of compression forces and affect older individuals, though one individual (B-2) who shows evidence of interpersonal violence has two broken vertebrae (C2 and L2) that appear to have been the result of blunt trauma instead of compression. In addition to the acute vertebral trauma in this collection, many individuals seem to have suffered from osteophytes or boney growths on their vertebrae, which may have contributed to chronic back pain.

Only one individual, a male, showed a sacrum fracture (1.2% of male population). The fracture was a transverse fracture on the lower portions of the sacrum, so it was

likely due to direct trauma. The individual with the sacrum fracture (B-2) was also the individual with the greatest amount of trauma in the collection. An additional sacrum was noted to be compressed to the right which likely resulted from the individual leaning to that side for a long time before death.

4.3.2. Schmorl's Nodes

Schmorl's Nodes, named for the physician, Georg Schmorl (Schmorl 1926; Schmorl and Junghanns 1959), who first noted them, are lesions that appear on the centrum or bodies of the vertebrae and are caused by herniations of the intervertebral discs. The level of pain caused by Schmorl's nodes is heavily debated, but they are often seen as a sign of vertebral degeneration and are most commonly located in the lumbar and lower thoracic regions (Resnick and Niwayama 1978). Faccia and Williams (2008) state that Schmorl's nodes have been found in populations throughout time and across geographic regions, and are common in modern populations. Additionally, they note that men usually show greater amounts of Schmorl's nodes then do women, which may be related to the types of labor performed in various societies (Faccia and Williams 2008).

The presence of Schmorl's nodes in the CSIA collection was noted, and they likely represent long term degenerative trauma. These lesions are significant in that they could have contributed to chronic back pain that may have affected quality of life much like fractures. In the CSIA population, 57 males show evidence of one or more Schmorl's nodes (53.2%). Females have slightly less incidence, with only 14 individuals showing Schmorl's nodes (40.0%). Individuals of indeterminate sex were the least likely to show Schmorl's nodes with only 4 cases present (16.6%) (Table 4.8).

Table 4.8: Number and Percentage of Vertebra and Sacrum Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Schmorl's node	57/107 (53.2)	14/35 (40.0)	4/24 (16.6)	75/166 (45.1)

As expected, individuals in the CSIA collection showed a similar distribution to Resnick and Niwayama's study (1978), in that the lesions were present mainly in the lower thoracic and upper lumbar vertebrae, with the majority occurring in T10-T12. Schmorl's nodes were present as high up as T3 and as low as L5. The occurrence of the high rate of Schmorl's nodes in this population (45.2%) likely resulted from the hard labor and physically challenging occupations that corresponded with early Colorado frontier life.

4.3.3. Ribs and Sternum

The average human being has twelve paired ribs, though occasional anomalies such as 11 or 13 ribs on a side do occur. The ribs make up a major portion of the thorax and provide protection for the major organs of respiration and circulation: the heart and lungs. Attached to the 12 thoracic vertebrae, the ribs are flexible bones that are always in motion during respiration. The first seven pairs are known as true ribs and connect with cartilage to the sternum, which provides frontal support and support for the shoulder blades, clavicles, and upper limb. Ribs eight, nine, and ten, and the floating ribs are known as the "false ribs" and consist of three pairs of ribs that connect to cartilages which then connect to the sternum and the floating ribs. Pairs 11 and 12 are called "floating ribs" since they connect only to the lowest thoracic vertebra and their anterior ends float freely in the body. The floating ribs can be permanently altered in position by corseting, though evidence of this was not noticed in the CSIA collection. Rarely, some

individuals have been known to have smaller ribs known as cervical or lumbar ribs, and this can impact the health of those individuals. One cervical rib was found in this study.

Ribs are inherently flexible based on their curved shape and involvement with breathing. Excepting in cases of abuse, most childhood rib fractures manifest as greenstick, or incomplete fractures. Additionally, rib fracturing may occur to larger infants as sequelae of birth trauma (Barry and Hocking 1993).

In adults, rib fracturing is most commonly the result of falls, accidents, and direct blows to the chest (Galloway 1999:107). Modern seatbelts have led to an increase in rib fractures but a noticeable decrease in soft tissue damage. Galloway (1999) states that rib fractures occur most commonly in the largest ribs (the sixth through eight ribs) and these occur more frequently on the left side of the body. The upper ribs (1-3) are usually protected by the pectoral girdle and fractures to these ribs usually indicate more extensive injuries that often include the brachial (arm) nerves and vessels. Surprisingly, the floating ribs (11 and 12) often do not suffer from compaction like the larger ribs. It is interesting to note that the elderly are more likely, due to bone mass loss, to suffer rib fractures from coughing than are younger people. These fractures most often occur on ribs 4-9 (Begley et al. 1995).

When the rib cage is compressed, fractures rarely occur at the point where force is applied because of their curved morphology (Watson-Jones 1941). Compression from the front to the back or vice-versa (anteroposterior) often results in fractures occurring laterally or on the sides of the ribs (DiMaio and DiMaio 1989). Impaction from the sides of the body most often results in fractures along the spine and sternum (Galloway 1999). Rib fractures are classified as either transverse, resulting in a straight break, or oblique, a

diagonal type of fracture (Gonzalez et al. 1954). Transverse are the more common of the two and result from direct blows to the chest while oblique fractures occur during a crushing, bending or grinding situation, such as occurs in an automobile accident, or fall from a height (Galloway 1999). In the recent paleopathological literature, ribs have received more discussion as a means of determining more about a population's society and culture through studies of class and overall health (Brickley 2006).

A total of 2946 ribs (with at least ¼ of the rib bone present) were present in the CSIA collection. Of those, 178 show evidence of at least one fracture (6.0%). For males, a total of 1953 ribs were present and of those 148 or 7.5% had at least one fracture. Women in the population experienced less rib trauma with a total of 691 ribs, 14 of which were fractured (2.0%). Indeterminate sex individuals had 302 ribs, 16 of which were fractured (5.2%) (Table 4.9).

Table 4.9: The Number of Rib Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown sex (x/N)	Total Fractures
Rib 1 – Right	0/74 (0)	0/28 (0)	1/11 (9.0)	1/113 (0.8)
Rib 1 – Left	0/79 (0)	0/30 (0)	0/11 (0)	0/120 (0)
Rib 2 – Right	0/71 (0)	0/26 (0)	0/10 (0)	0/107 (0)
Rib 2 – Left	1/66 (1.5)	0/24 (0)	0/12 (0)	1/102 (0.9)
Rib 3-10 – Right	59/721 (8.1)	5/249 (2.0)	7/114 (6.1)	71/1084 (6.5)
Rib 3-10 – Left	78/697 (11.1)	9/232 (3.8)	7/112 (6.2)	94/1041 (9.0)
Rib 11 – Right	0/68 (0)	0/25 (0)	0/7 (0)	0/100 (0)
Rib 11 – Left	4/74 (5.4)	0/27 (0)	1/9 (11.1)	5/110 (4.5)
Rib 12 – Right	2/53 (3.7)	0/26 (0)	0/9 (0)	2/88 (2.2)
Rib 12 – Left	4/50 (8.0)	0/24 (0)	0/7 (0)	4/81 (4.9)
TOTAL	**148/1953 (7.5)**	**14/691 (2.0)**	**16/302 (5.2)**	**178/2946 (6.0)**

There are definite sex differences in the incidence of rib trauma. Thirty-nine of 107 males show at least one rib fracture (36.4%). Six females out of 35, or 17.1%, show evidence of trauma, and five of 24 or 20.8% of individuals of indeterminate sex. In total, 30.1 percent, or 50 of the 166 individuals in the CSIA collection, have at least one rib fracture (Table 4.10). As expected only one first rib and one second rib were found fractured (occurring in one individual of indeterminate sex and one male). The majority of the fractures occurred in the 3rd-10th ribs. Additionally, the only perimortem damage found in this population was on the ribs, but as mentioned in the Chapter 5, this can be problematic for researchers. Normally, this would be indicative of trauma occurring near death, but ribs are tricky in this respect.

Table 4.10: Number and Percentage of Rib Fractures in Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Ribs	39/107 (36.4)	6/35 (17.1)	5/24 (20.8)	50/166 (30.1)

Sternum fractures were relatively rare in comparison to rib fractures. Only two sternum bodies (both belonging to males) were fractured. There were a total of 62 male sterna recovered from the collection, with 3.2% showing trauma. No trauma was found on any of the 23 recovered female sterna or on the seven indeterminate sex recovered sterna (Table 4.11). Sternum fractures are most often produced from direct trauma to the chest or indirectly via flexion of the thoracic cavity. Currently they most often occur during automobile accidents, and about 2/3 of modern sterna fractures occur to women, especially older women (Brookes et al. 1993).

Table 4.11: Number and Percentage of Sternum Fractures in Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Sternum	2/62 (3.2)	0/23 (0)	0/7 (0)	2/92 (2.1)

4.4 Fractures of the Appendicular Skeleton

The appendicular skeleton includes the upper and lower limbs or appendages. The bones of the upper limb include the scapula, clavicle, humerus, radius and ulna, the carpals, metacarpals, and hand phalanges. The bones of the lower limb include the pelvis, femur, tibia and fibula of the lower leg, the tarsals, metatarsals, and the foot phalanges or toes. The following section discusses each element and the incidences of trauma for each found in the Colorado State Insane Asylum collection.

4.4.1. The Shoulder Girdle: Clavicle and Scapula

The clavicle is a slightly s-shaped, tubular bone that articulates with the sternum and the scapula and provides for support and structure for the upper limb. The scapula forms the posterior portion of the shoulder girdle and is a large, flat triangular bone to which many muscles of the back and shoulder connect.

The clavicle is a frequent site of fracture in difficult childbirths and throughout childhood and adolescence (Blount 1955; Buhr and Cooke 1959; Galloway 1999; Many et al. 1996; Neer 1984; Pavlov and Freiberger 1978; Rogers 1992; Roberts et al. 1995; Rubin 1964; Watson-Jones 1941). Stanley et al. (1988) note that about half of all clavicular fractures occur in children under 10 years old and most typically result from falls on the shoulder.

In adults, studies show there is not much of a sex difference in clavicular fractures, but men do have a slightly higher risk throughout life (Nordqvist and Petersson

1994). Over age 70, more breaks occur at the sternal end of the clavicle (Galloway

1999), though most fractures generally occur in the middle third and are usually complete

transverse fractures (Eskola et al. 1986; Nordqvist and Petersson 1994; Pavlov and

Freiberger 1978; Rowe 1968; Stanley et al. 1988; and Watson-Jones 1941). Allman

(1967) and Stanley et al. (1988) postulate that the majority of adult mid-clavicular

fractures are from falls on an outstretched hand, blows occurring at the point of the

shoulder, or an object falling or striking the shoulder directly.

Sternal end fractures of the clavicle are the most uncommon and result when force

is applied medially to the bone. They require support from the opposite side of the body

to occur (Galloway 1999; Neer 1984; Nordqvist and Petersson 1994). Fractures in the

acromial (lateral) portions of the clavicle are the next most common after the middle

section breaks (Nordqvist and Petersson 1994) and most likely result from downward

blows to the shoulder (Allman 1967; Horn 1954; Hoyt 1967; Neer 1984).

In the CSIA population, two males had evidence of broken right clavicles,

resulting in a total of 2.3% with trauma (Table 4.12). One left clavicle from an individual

of indeterminate sex (1 of 14 or 7.1%) was also recorded. The two males show evidence

of falls, as they have additional shoulder girdle damage in addition to the clavicular

break. The first, specimen C-8, has a fractured sternum in addition to the mid-clavicular

break, while the second individual (F-22), an elderly man, had an acromial fracture of the

clavicle and a dislocated shoulder. For both individuals, these events happened long

before death. The individual of unknown sex (probable male) had a mid-clavicular

fracture in addition to a rib fracture.

Table 4.12: Number and Percentage of Clavicle Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Clavicle	2/89 (2.2)	0/32 (0)	1/14 (7.1)	3/134 (2.2)

The scapula is a flat, triangular-shaped bone that serves as support for the upper limb. Due to its floating nature and protection given it by the large back muscles that cover it, fractures on this bone are relatively uncommon and mostly occur in individuals between the ages of 40 and 60 (Galloway 1999:117; Neer 1984). The scapula has three main places where fracturing may occur: the flat, blade like body; the posterior fin-like projection that forms the attachment site for the *deltoideus* muscle; and the glenoid and coracoid process that enclose the head of the humerus.

The body of the scapula is the most commonly broken portion, comprising about one third of scapular breaks, while the other portions each form about 10% of breaks. The scapular neck is the remaining location for breaks at about 25% occurrence (Miller and Ada 1992). Most scapular breaks are the result of direct and major accidents and are often accompanied by clavicular (19%-39% of cases) and rib fractures (27%-54%) (Galloway 1999; Stephens et al. 1995; Zuckerman et al. 1993). Glenoid fractures most often occur from direct impact from the humeral head while acromial fractures have multiple causes stemming from direct blows, forces projected through the humerus, or due to stress or fatigue (Galloway 1999). Breaks on the body of the scapula might be the result of forces striking the back that cause the scapula to bend over the first rib, though these types of situations often result in the underlying ribs being damaged as well (Galloway 1999).

In the CSIA collection, five males (5.3%) and one individual of indeterminate sex (8.2%) had scapula fractures (Table 4.13). Two of those fractures are on the body of the scapula (28%), coracoid process (28%), and glenoid (28%) (Table 4.14), and one is on the acromium (16%). Generally, the individuals with scapular fractures in the CSIA are those individuals who show evidence of greater trauma. The individuals who had broken scapulae also commonly had broken ribs (four of the individuals), broken clavicles (one individual) and broken humeri (two individuals). Individuals in the collection that were both young and old had scapula breaks, and there did not seem to be a pattern of the fracture occurring more often in individuals between the ages of 40 and 60. Interestingly, no females experienced scapula fractures.

Table 4.13: Number and Percentage of Scapula Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Scapula	5/94 (5.3)	0/31 (0)	1/12 (8.3)	6/137 (4.3)

Table 4.14: The Number of Scapula Fractures on Individual Elements by Sex.

Skeletal Element	Males (+/N)	Females (+/N)	Unknown Sex (+/N)	Total Fractures
Scapula body L	1/91 (1.0)	0/31 (0)	0/12 (0)	1/134 (0.7)
Scapula glenoid L	2/91 (2.1)	0/29 (0)	1/12 (8.3)	3/132 (2.2)
Scapula body R	1/94 (1.0)	0/31 (0)	0/12 (0)	1/137 (0.7)
Scapula glenoid R	2/94 (2.1)	0/31 (0)	0/12 (0)	2/137 (1.4)
TOTAL	**6/370 (1.6%)**	**0/122 (0%)**	**1/48 (2.0%)**	**7/540 (1.2%)**

4.4.2. Bones of the Upper Limb

The upper limb consists of the humerus or upper arm, the two bones of the forearm, the ulna and the radius, the wrist or carpal bones, and the bones of the hand

which consist of the metacarpals and the fingers or phalanges. The upper limbs of

humans are more specialized to allow for increased dexterity, and they have a wider

range of motion compared to the lower limbs. The humerus is the bone that serves as the

support and muscle attachments of the upper arm and is the most robust of the upper

limb. The rounded proximal end allows the joint to rotate in almost all directions.

The humerus has two stages of fracture vulnerability: 1) the older an individual is,

due to bone loss, the more prone they are to humeral fractures from falls; 2) younger

individuals who are still growing and developing are more prone to ephiphyseal breaks,

or breaks along the growth plates of the bone (Buhr and Cooke 1959; Galloway 1999;

Horak and Nilsson 1975; Norris 1992).

On the proximal portion of the humerus (the portion that connects to the shoulder

girdle) the two stages of vulnerability show slight sex differences, with the early

vulnerability in children most often affecting males as the result of sports injuries or falls

(Williams 1981). After age 45, due to bone loss during and after menopause, women are

three times more likely than men to fracture their humerus. These fractures can result

from moderate trauma, unlike younger individuals who must experience severe trauma

before breaks occur. Additionally, less healthy older women are more likely to sustain

fractures than their healthy counterparts (Kelsey et al. 1992). Fractures on the proximal

humerus are most often sustained from a fall on an outstretched hand (Galloway 1999),

though direct blows can also cause damage to this area (Chadwick and Kyle 1992;

Galloway 1999; Neer 1984; Norris 1992; Pavlov and Freiberger 1978). Compression

fractures can also occur on the proximal end of the humerus, and they are often present

with fractures occurring on the glenoid portion of the scapula. These types of fractures are most commonly associated with a fall on an abducted arm.

Fractures that occur in the shaft of the humerus most often occur in the midshaft and are often the result of falls, or in the modern age, automobile accidents, though fractures in this area also occur less commonly as sequelae of birth trauma (Blount 1955; Watson-Jones 1941) or even during arm wrestling (de Barros and Oliveira 1995).

Fracturing patterns in the distal humerus, or end closer to the hand, are interesting in that they are relatively common in young individuals, but rare in adults and older individuals (Buhr and Cooke 1959; Galloway 1999). This is the location of approximately 30%-50% of elbow fractures in children (Bensahel et al. 1986). Except for the first three years, where girls are at higher risk of fracturing (Henrikson 1966), male children are slightly more likely to incur these fractures. Galloway (1999) states that the peak ages for this injury in boys is between the ages of 7 and 9, while in girls the peak is between 5 and 7 years. The fracture pattern for the distal humerus changes as skeletal growth continues. In adults, older women are the most likely group to sustain fractures in this area (Miller 1964).

In the CSIA population, six humerus fractures were found on six males (6.6%) (Table 4.15). Four of the six fractures (66%) were located on the distal portions of the humerus. Two breaks (28%) occurred in the midshaft and one on a proximal end (15%) (Table 4.16). The right humerus was the site of 57% of the fractures in this collection. All the distal fractures appeared to occur on the growth plate, so they had to occur when the individual was younger and still experiencing skeletal growth. Two of the individuals also had damage to the scapula that attached to the humerus that was also fractured, and

two had fractures on the radius (larger forearm bone) on the same side. Four of the

individuals showed evidence of many other fractures and thus had higher amounts of

trauma. Additionally, one of the individuals who suffered a distal fracture (near the

elbow) experienced a deformation because of the break so that his arm was stunted. The

change in shape of the humerus on that side resulted in deformation and change of shape

of the ulna (smaller forearm bone).

Table 4.15: Number and Percentage of Humerus Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Humerus	6/90 (6.6)	0/35 (0)	0/16 (0)	6/141 (4.2)

Table 4.16: The Number of Humerus Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total Fractures
Left Humerus Proximal 1/3	0/83 (0%)	0/31 (0%)	0/13 (0%)	0/127 (0%)
Left Humerus Middle 1/3	2/86 (2.3%)	0/31 (0%)	0/15 (0%)	2/132 (1.5%)
Left Humerus Distal 1/3	1/85 (1.1%)	0/31 (0%)	0/13 (0%)	1/129 (0.7%)
Right Humerus Proximal 1/3	1/87 (1.1%)	0/31 (0%)	0/11 (0%)	1/129 (0.7%)
Right Humerus Middle 1/3	0/90 (0%)	0/33 (0%)	0/16 (0%)	0/139 (0%)
Right Humerus Distal 1/3	3/88 (3.4%)	0/33 (0%)	0/14 (0%)	3/135 (2.2%)
TOTAL	**7/519 (1.3%)**	**0/190 (0%)**	**0/82 (0%)**	**7/791 (0.8%)**

4.4.3. Radius and Ulna

The radius and the ulna comprise the two bones of the forearm. The radius is

unique in that it has a head that articulates with the distal portion of the humerus. The

radial head is a round condyle whose movement against the humerus allows for the

pivoting motions that can occur in the forearm when an individual flips their palm up and

then flips their palm back down. The ulna is the stationary bone in the forearm around

which the radius pivots. The proximal end of the ulna forms the point of the elbow (the olecranon process).

The radius and ulna are most likely to become fractured during falls on the outstretched hand. However, in direct blows, the ulna is more susceptible than the radius, because if there is a defensive movement in the form of raising the arm to protect the head or face, the ulna would receive the brunt of the blow. These "parry" fractures usually affect the distal third of the ulna. Isolated radius fractures from direct blows are relatively rare (Galloway 1999).

Children are most likely to be affected by forearm breaks, which account for 45% of all childhood fractures (Gandhi et al. 1963). During falls, children typically break both bones, and when a single bone is broken, it is much more likely the result of a direct blow (Armstrong et al. 1994). The most frequent location of fractures on these elements is the distal third of the bones for both children and the elderly (Bauer 1960; Galloway 1999). After age 45, women are more likely to break one or both of these bones, because of loss of bone mass.

Both children and adults fracture the mid-shaft of the radius, though children's fractures often result in greenstick or incomplete fractures, while adults are most likely to experience complete fractures (Galloway 1999). The most common causes in adults for fractures in this location are motor vehicle accidents, industrial accidents, and assaults (Putnam and Fischer 1993).

The distal ends of the radius and ulna are the most commonly broken portions of the forearm. Alffram and Bauer (1962) find that the distal end of the radius is broken in 75% of all forearm fractures. As women age, they are more likely to incur injuries to the

distal radius from mild trauma, such as a fall (Galloway 1999), and researchers have

noticed in elderly women that distal forearm fractures occur with proximal femur

fractures (Alffram and Bauer 1962).

In the CSIA collection, a total of five males (5.8%) and one indeterminate

individual (8.3%) had a radius fracture to make a total of 4.6% of the population (Table

4.17). Five of the six radius fractures occurred on the distal end (the remainder occurred

on the proximal radius and was associated with a broken humerus -- this individual

damaged his elbow) (Table 4.18).

Table 4.17: Number and Percentage of Radius Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Radius	5/86 (5.8)	0/31 (0)	1/12 (8.3)	6/129 (4.6)

Table 4.18: The Number of Radius Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total Fractures
Left Radius Proximal 1/3	1/84 (1.1%)	0/31 (0%)	0/11 (0%)	1/127 (0.7%)
Left Radius Middle 1/3	0/85 (0%)	0/30 (0%)	0/12 (0%)	0/126 (0%)
Left Radius Distal 1/3	2/85 (2.3%)	0/30 (0%)	0/11 (0%)	2/126 (1.5%)
Right Radius Proximal 1/3	0/86 (0%)	0/30 (0%)	0/10 (0%)	0/126 (0%)
Right Radius Middle 1/3	0/85 (0%)	0/31 (0%)	0/11 (0%)	0/127 (0%)
Right Radius Distal 1/3	2/84 (2.3%)	0/30 (0%)	1/10 (10.0%)	3/124 (2.4%)
TOTAL	5/509 (0.9%)	0/182 (0%)	1/65 (1.5%)	6/756 (0.7%) 0.8

Only two males had an ulna fracture (2.8% of males) (Table 4.19). Two ulnar

fractures occurred, one on the distal end and one in the mid-shaft (Table 4.20). The

individual with the distal ulna break also had a distally broken radius. Thus only one

break, the single ulna mid-shaft break may be a candidate for a parry fracture. The ulna

fracture was the only trauma that that elderly male showed.

Table 4.19: Number and Percentage of Ulna Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Ulna	2/85 (2.3)	0/31 (0)	0/14 (0)	2/130 (1.5)

Table 20: The Number of Ulna Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total fractures
Left Ulna Proximal 1/3	0/84 (0%)	0/31 (0%)	0/14 (0%)	0/129 (0%)
Left Ulna Middle 1/3	1/85 (1.1%)	0/31 (0%)	0/13 (0%)	1/129 (0.7%)
Left Ulna Distal 1/3	1/126 (0.7%)	0/31 (0%)	0/13 (0%)	1/170 (0.5%)
Right Ulna Proximal 1/3	0/85 (0%)	0/31 (0%)	0/11 (0%)	0/128 (0%)
Right Ulna Middle 1/3	0/81 (0%)	0/30 (0%)	0/13 (0%)	0/124 (0%)
Right Ulna Distal 1/3	0/76 (0%)	0/31 (0%)	0/12 (0%)	0/119 (0%)
TOTAL	2/537 (0.3%)	0/186 (0%)	0/76 (0%)	2/799 (0.2%)

All but one individual showed evidence of additional trauma, mostly including

damage to ribs and other bones of the upper limb (humerus and scapula), and much of the

trauma appeared to be the result of falls. One individual's entire left arm, from humerus

to phalanges was affected by a traumatic accident such as a fall. Some individuals

exhibited a pathological condition that caused their skeletons to appear unusual, but the

cause was unknown. One of these individuals appeared to have suffered many falls,

perhaps due to some type of deformation or debilitating disease. More research will have

to be done by others to determine if some of the skeletons in the collection show evidence

of cerebral palsy and other diseases.

4.4.4. The Wrist and Hand

The bones of the wrist and hand are numerous with eight carpal bones, five metacarpal bones, and 14 phalange bones. The carpal bones consist of the scaphoid, lunate, triquetral, pisiform, trapezium, trapezoid, capitate, and the hamate. Each of the carpal bones are distinctively shaped and together they provide the wide range of motion that is achieved at the wrist. The metacarpals and phalanges are numbered depending on the digit on which they are found and make up the bones of the hand and fingers.

Fracture patterns in the wrist and hand bones can indicate some of the activities that may have caused the trauma. The carpals are most likely to be fractured by a fall, but which elements are affected can tell researchers about how a person fell, or how their hand was positioned. The most commonly broken carpal is the scaphoid (70% of carpal fractures (Galloway 1999)) which is positioned next to the radius. Scaphoid fractures have also been reported as the result of punching (Horii *et al.* 1994), but in these cases it is almost always the dominant hand that receives the injury, and none of the injuries were reported by professional boxers, suggesting that perhaps the incorrect hand position of amateurs contributed to the injury. Interestingly, carpal fractures are very rare in children (Galloway 1999). After the scaphoid, the lunate and triquetral are the most likely to be fractured. Fractures in the remaining carpals bones are relatively rare unless they are broken as part of a major traumatic episode. Falls, again, are the most common cause of trauma to this area.

The bones of the hand, the metacarpals, are relatively unprotected by large muscle groups as the focus of these bones is on fine manipulation. Because of this fragility, it is not surprising that fractures of the metacarpals are fairly common, especially for

metacarpals one, two, and five (McElfresh and Dobyns 1983; Rogers 1992). Fractures to metacarpals one and five account for 20% of hand fractures (Hunter and Cowan 1970).

Falls and direct trauma are the most common causes of fractures to the hands, though fractures might also come from defending oneself by thwarting off blows or through punching others with a clenched fist (Ashkenaze and Ruby 1992; Bowman and Simon 1993; Galloway 1999; Jupiter and Belsky 1992). Fractures that occur to the necks of the fifth, and sometimes the fourth, metacarpal are known as Boxer's Fractures and are often the result of punching with a clenched fist. This type of fracture is also seen in motor vehicle accidents, in sports, and by catching the hand in a closing door (Dobyns et al. 1978; Hunter and Cowen 1970; Lowdon 1986; McCue et al. 1979; McKerrell et al. 1987; Rider 1937). Interestingly, Jupiter and Belsky (1992) indicate that professional boxers are much more likely to fracture the second or third metacarpal, while amateurs are more likely to damage the fifth.

Damage to the phalanges, or bones of the finger, are most commonly found in falls when the individual "jams" their finger or from direct blows to the tips of the fingers (Galloway 1999; Wehbe and Schneider 1984). Galloway states that fractures to the phalanges are often missed because they are difficult to recover archaeologically. Taphonomy also plays a part in destroying evidence of these elements and the fractures that may be found within them.

In the CSIA collection there are two males (1.8%) with fractured carpals (Table 4.21), three males (2.8%) and one indeterminate sex individual (4.1%) with fractured metacarpals (Table 4.22), and one male (0.9%) with fractured phalanges (Table 4.23 and Table 4.24).

Table 4.21: Number and Percentage of Carpal Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Carpals	2/107 (1.8)	0/35 (0)	0/24 (0)	2/166 (1.2)

Table 4.22: Number and Percentage of Metacarpal Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Metacarpals	3/107 (2.8)	0/35 (0)	1/24 (4.1)	4/166 (2.4)

Table 23: Number and Percentage of Hand Phalanges Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Phalanges (hand)	1/107 (0.9)	0/35 (0)	0/24 (0)	1/166 (0.6)

Two of the males suffered both carpal and metacarpal fractures, and both of these individuals experienced fusion of the carpals to each other and to adjoining metacarpals, rendering those hands and wrists either immobile or very limited in motion. The more severe fractures on the wrists and hand in this collection occurred on the left side, and while the number of elements on the left side was greater (7 of 11 occurrences of trauma), most of the individuals with fractured hands had them occur on the right side (3 of 5 individuals). It was undetermined on which side the phalanges were fractured, so they are not included in the aforementioned statistics. Two of the males had additional distal radius fractures so it is likely that both experienced a bad fall that permanently affected their mobility. Additionally, three of the individuals had isolated fractures to the metacarpals, without additional arm injury. These are the more likely cases for boxer's fractures in the collection. No females had any recorded hand or wrist injuries, though this might be more because of taphonomy than a lack of fractures, as the bones of the

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wrist and hand are largely underrepresented in what was recovered during the

excavations of the burials.

Table 4.24: The Number of Carpal, Metacarpal and Phalange Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total Fractures
Left Carpals	8/193 (4.1%)	0/76 (0%)	0/10 (0%)	8/279 (2.8%)
Right Carpals	2/175 (1.1%)	0/89 (0%)	0/17 (0%)	2/281 (0.7%)
Unsided Carpals	0/5 (0%)	0/1 (0%)	0/1 (0%)	0/7 (0%)
Left Metacarpals	4/323 (1.2%)	0/119 (0%)	0/36 (0%)	4/478 (0.8%)
Right Metacarpals	3/303 (0.9%)	0/126 (0%)	0/34 (0%)	3/463 (0.6%)
Unsided Metacarpals	0/10 (0%)	0/1 (0%)	1/1 (100%)	1/12 (8.3%)
Left Phalanges	0/103 (0%)	0/21 (0%)	0/7 (0%)	0/131 (0%)
Right Phalanges	0/124 (0%)	0/12 (0%)	0/8 (0%)	0/144 (0%)
Unsided Phalanges	0/791 (0%)	0/369 (0%)	3/112 (2.6%)	3/1272 (0.2%)
TOTAL	**17/2027 (0.8%)**	**0/814 (0%)**	**4/226 (1.7%)**	**21/3067 (0.6%)**

In conclusion, most of the fractures to the upper limb in the Colorado State Insane

Asylum collection appear to be the result of falls, with a few individuals possibly having

Boxer's Fractures (fractures to the metacarpals) which might indicate that they had hit

something hard enough to fracture. There is only one possible candidate for a parry

fracture, though it would be expected for that injury to occur more closely to the proximal

end of the ulna than it did. There were decidedly fewer "parry fractures" found in the

collection than I expected. The implications of these finds will be explored in the next

chapter.

4.5 Bones of the Lower Limb and Pelvic Girdle

The pelvic girdle is composed of the sacrum and two paired innominate bones (Latin for nameless) which are composed of the ischium, pubis and ilium. The ischium is the portion that one sits on while the two halves of the pubis form what is called the pubic bone on the anterior portion of the pelvis. The ilium is the large wing-like flat portion of the innominates (or where you rest your hands when they are on your hips). The sacrum and its fracture patterns were addressed above, in the discussion of the axial skeleton.

The innominates, along with the sacrum, form a rigid ring of bone. This means that when enough force is applied to fracture a portion of the pelvis, a fracture will very often occur in another location concurrently (Galloway 1999). Understandably, pelvis fractures are often associated with high levels of trauma and additional fractures (Poole et al. 1992). Pelvis fractures can often be life threatening and thus are an element of concern for forensic anthropologists and others that are reconstructing injury.

The most common age groups at risk for pelvic damage are young adult males, a group more likely to be exposed the high-energy impacts, and older men and women who suffer from a combination of falls and lower bone density (Buhr and Cooke 1959; Failinger and McGanity 1992; Ragnarsson and Jacobsson 1992). Children are less susceptible to innominate fractures (Ismail et al. 1996).

Studies show that the pubic bones are the most commonly broken portion of the pelvis (Lüthje et al. 1995; and Ragnarsson and Jacobsson 1992) while the acetabulum is the second most frequent location for fractures (Galloway 1999). Fractures of the iliac wing, as well as the other portions of the pelvis are the least common (Galloway 1999). Stable pelvic fractures, or fractures that do not result in multiple breaks across the pelvic

ring are usually the result of falls, while more serious trauma like automotive accidents are the cause when multiple fractures occur (Rogers 1992).

Four males in the CSIA (4.4%) show evidence of innominate fractures (Table 4.25). The ilium was the most commonly fractured element (75%) with the pubis representing the other fracture (Table 4.26). Interestingly, three of the fractures (two ilia and the pubic fracture) appear to be isolated. The studies mentioned above would suggest that the fracture to the ilia would have been the result of falls. The pubic fracture, also known as a *saddle* fracture might have been the result of impacting that area with direct trauma. The remaining fracture appears to affect both the ilium and the sacroiliac joint, which fused the sacrum to the innominate in that individual. This last case was likely the result of direct trauma to the area. One individual was still healing from his trauma at the time of his death, which suggests that he experienced the incident either at the CSIA or shortly before admittance. Unfortunately no medical or admittance records discuss previous injuries, though some mention injuries that patients sustained while hospitalized.

Table 4.25: Number and Percentage of Pelvis Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Pelvis	4/89 (4.4)	0/30 (0)	0/13 (0)	4/132 (3.0)

Table 4.26: The Number of Pelvis Fractures on Individual Elements by Sex

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total Fractures
Left Ilium	2/86 (2.3%)	0/30 (0%)	0/13 (0%)	2/129 (1.5%)
Right Ilium	1/89 (1.1%)	0/30 (0%)	0/11 (0%)	1/130 (0.7%)
Left Ischium	0/83 (0%)	0/30 (0%)	0/10 (0%)	0/123 (0%)
Right Ischium	0/81 (0%)	0/30 (0%)	0/10 (0%)	0/121 (0%)
Left Pubis	0/65 (0%)	0/20 (0%)	0/8 (0%)	0/93 (0%)
Right Pubis	1/69 (1.4%)	0/19 (0%)	0/6 (0%)	1/94 (1.0%)
TOTAL	**4/473 (0.8%)**	**0/159 (0%)**	**0/58 (0%)**	**4/688 (0.5%)**

4.5.1. The Femur

The femur is the most robust limb bone in the human body, and the density of the shaft often protects the element from damage. It is able to support the majority of the body, and its unique angles on the neck of the femur combined with the orientation of the knees also allow for bipedal locomotion. Like all elements, fractures increase as individuals age and lose bone mass, and femur fractures are uncommon in healthy young adults (Buhr and Cooke 1959; Galloway 1999; Rogers 1992). Fractures in younger individuals are often the results of high energy trauma incidents such as a fall from great heights or a motor vehicle accident (Galloway 1999). Hip dislocations and fractures of the femoral neck increase in frequency particularly in older women.

When high energy trauma results in a femoral fracture, associated elements often break as well, including the long bones, pelvis, spine, patella, and tibia (Bergman et al. 1987; Galloway 1999; Russell and Taylor 1992).

The CSIA collection has six individuals (4.2% of the total population) with femur fractures (four males [4.3%] and two indeterminate sex individuals [12.5%]) (Table 4.27). Three of the individuals had additional long bone injuries to the fibula, which

would suggest more severe trauma. Only one of the individuals has no additional

fractures or traumatic episodes. Interestingly, in spite of its robustness, the middle of the

bone, or the diaphysis was the most common location of occurrence for fractures with

four of the individuals (66%) experiencing mid-femur fractures (Table 4.28). Fractures

in this area are rare and only result from considerable force (Galloway 1999).

Table 27: Number and Percentage of Femur Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Femur	4/93 (4.3)	0/33 (0)	2/16 (12.5)	6/142 (4.2)

Table 4.28: The Number of Femur Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown sex (x/N)	Total Fractures
Left Femur Proximal	1/93 (1.0%)	0/33 (0%)	0/13 (0%)	1/139 (0.7%)
Left Femur Middle	2/93 (2.1%)	0/32 (0%)	1/14 (7.1%)	3/139 (2.1%)
Left Femur Distal	0/92 (0%)	0/31 (0%)	0/13 (0%)	0/136 (0%)
Right Femur Proximal	0/93 (0%)	0/31 (0%)	0/16 (0%)	0/140 (0%)
Right Femur Middle	0/91 (0%)	0/31 (0%)	1/16 (6.2%)	1/138 (0.7%)
Right Femur Distal	1/91 (1.0%)	0/31 (0%)	0/15 (0%)	1/137 (0.7%)
TOTAL	4/553 (0.7%)	0/189 (0%)	2/87 (2.2%)	6/829 (0.7%)

One femur in the CSIA collection was unique in that it did not have a fracture, but

instead illustrated an example of soft tissue damage that was manifested in the

remodeling of the bone. The result was a long boney fin that projected out from the

posterior portion of the femur shaft (See Figure 3.1). It was likely the result of a

damaged adductor muscle which affected the attachment point on the femur and pulled it

in such a way that the shape of the bone changed permanently. This unique instance is a

rare reminder of the soft tissue injuries that would likely have occurred in this population and are not normally reflected in the osteological record.

4.5.2. The Patella

The patella is a small, triangular-shaped sesamoid bone that forms what is commonly called the knee-cap. The largest sesamoid bone in the human body, the patella serves as protection for the knee joint and is located within the *quadriceps femoris*, the largest muscle of the thigh (White 2000). The patella touches the distal femur, but does not connect directly with any other bone.

Fractures to the patella occur through either direct blows or through too much tension being generated by the *quadriceps* muscle (Galloway 1999; Hohl et al. 1984; Manaster and Andrews 1994; Rogers 1992; Sanders 1992; and Templeman 1992). One male (2.1% of males with patella present) from the CSIA had a fractured patella (Table 4.29). The fracture was vertical and occurred on the side of the knee joint. This type of injury is not consistent with injuries that occur because of muscle tension, but rather from a fall or direct blow. This male had no additional skeletal trauma.

Table 29: Number and Percentage of Patella Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Patella	1/46 (2.1)	0/22 (0)	0/6 (0)	1/74 (1.3)

4.5.3. The Tibia

Galloway (1999) describes the location of the tibia as "unfortunate…being a weight-bearing bone attached to two vulnerable joints," the knee and the ankle. The tibia is the main weight-bearing bone of the lower leg and forms the ridge on the leg that is referred to as the shin; it also provides half of the support for the ankle. The diaphysis of

the tibia is rather dense which can protect it from injury, but both the proximal and distal ends of the tibia are made of cancellous bone and can be prone to twists and breaks (Galloway 1999). The tibia is a common site for sport injuries and injuries from falls.

The proximal end of the tibia is prone to avulsion from pulls on the multitude of ligaments of the knee joint and can be often related to sports injuries, thus affecting younger individuals usually between the age of 10 and 20 (Watson and Jones 1941). The top of the tibia, or the tibial plateau, can be prone to crushing and depression fractures, most often occurring when the tibia is pulled away from the body while the femur is still supported by it, as in the case of a slip or stumble (Galloway 1999; Kennedy and Bailey 1968; Rogers 1992). These types of fractures become more common as people age, usually starting in the fourth or fifth decade.

Children and adolescents can fracture their tibial tuberosity (the bump on the lower leg below the patella) from contraction of the thigh musculature during jumping activities or from a bicycle fall (Galloway 1999; Hand et al. 1971; Nance and Kaye 1982; Ogden et al. 1980; and Schwobel 1987). These fractures occur less in adults when the tubercle fuses to the rest of the tibia (Rogers 1992; Watson-Jones 1941).

The shaft, or diaphysis, of the tibia is the location of many sports and vehicular accidents and other situations where an individual attempts to brace prior to the incident (Galloway 1999). There are two age ranges when the tibia is more commonly fractured: in younger adults (usually sports injuries) and in individuals between the ages of 45 and 65 (Buhr and Cooke 1959; Johner and Wruhs 1983). Thirty percent of individuals who fracture the tibia shaft have associated injuries (Trafton 1992), and males are nearly twice

as likely as female to fracture this portion of the tibia, although women's rates drastically increase at around age 70 (Galloway 1999).

Footwear can affect the location of tibia and fibula shaft fractures and fractures in both these bones are frequently found just above the top of the supporting boot or footwear (Galloway 1999). Galloway discusses how patterning of the tibial shaft fracture can lead to some clues regarding the types of trauma that occurred. For example, oblique fractures of the shaft are rare and tend to form when bending forces combine with compressive forces, while transverse fractures usually do not occur in car-pedestrian accidents, but do occur in sport activities.

Ten individuals in the CSIA collection experienced one or more tibial fractures, totaling 7.2% of the population. Seven males (7.5%), one female (3.2%) and two individuals of unknown sex (14.2%) had fractures (Table 4.30). Eight of the fractures were found on the distal (ankle) portion of the tibia and three fractures were proximal fractures (Table 4.31). One individual had both a proximal and distal fracture on the same tibia. Six individuals had additional foot or leg injuries or fractures in addition to the tibia fractures. The tibia is one of the most commonly fractured long bones in the Colorado State Insane Asylum collection.

Table 4.30: Number and Percentage of Tibia Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Tibia	7/93 (7.5)	1/31 (3.2)	2/14 (14.2)	10/138 (7.2)

Table 4.31: The Number of Tibia Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown sex (x/N)	Total Fractures
Left Tibia Proximal	0/90 (0%)	1/31 (3.2%)	0/12 (0%)	1/133 (0.7%)
Left Tibia Middle	0/91 (0%)	0/30 (0%)	0/12 (0%)	0/133 (0%)
Left Tibia Distal	3/90 (3.3%)	1/30 (3.3%)	2/13 (15.3%)	6/133 (4.5%)
Right Tibia Proximal	2/92 (2.1%)	0/31 (0%)	0/14 (0%)	2/137 (1.4%)
Right Tibia Middle	0/92 (0%)	0/31 (0%)	0/13 (0%)	0/136 (0%)
Right Tibia Distal	2/93 (2.1%)	0/30 (0%)	0/14 (0%)	2/137 (1.4%)
TOTAL	**7/548 (1.2%)**	**2/183 (1.0%)**	**2/78 (2.5%)**	**11/809 (1.3%)**

4.5.4. The Fibula

The fibula is a thin long bone that is located on the lateral portion of the lower leg. It forms the outer side of the ankle joint and articulates with the tibia at both the proximal and distal ends, but bears very little weight and does not even touch the femur on its superior portion (White 2000). Galloway (1999) states that the fibula is susceptible to direct blows, but it is rarely fractured in isolation, and is instead linked to damage in the knee or ankle joint. Some fractures of the proximal fibula may occur due to forces from the *biceps femoris*, and isolated fibula fractures have been linked to epileptic seizures (Rawes et al. 1995) and parachute jumping accidents (Hohl et al. 1992).

Fibula shaft fractures can be caused by rotational forces and direct blows, but it is the distal fibula that is the most prone to breakage (Galloway 1999). Based on the type of break found on the fibula, an osteologist or anthropologist can determine if the fracture was caused by supination or pronation of the foot, though this is most helpful if the entire ankle joint can be studied, which can be difficult in this collection because of taphonomy and excavation practices.

The fibula is the most commonly fractured bone element in the CSIA collection

after the ribs, with 10.2% of individuals exhibiting at least one fractured fibula. Of those

10.2%, 12 are male (13%) and two are individuals of indeterminate sex (13.3%) (Table

4.32). No females showed evidence of fibula fractures. There was an equal distribution

between breaks on the right or left fibula, and the majority of fractures (11 of 14) were

located on the distal end of the fibula. One individual had a fractured shaft and two had

proximal fractures (Table 4.33). Six of the individuals with a broken fibula also showed

additional leg fractures in either the tibia or femur.

Table 4.32: Number and Percentage of Fibula Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Fibula	12/92 (13.0)	0/29 (0)	2/15 (13.3)	14/136 (10.2)

Table 4.33: The Number of Fibula Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown sex (x/N)	Total Fractures
Left Fibula Proximal	0/87 (0%)	0/29 (0%)	2/14 (14.2%)	2/130 (1.5%)
Left Fibula Middle	0/92 (0%)	0/28 (0%)	0/14 (0%)	0/134 (0%)
Left Fibula Distal	5/88 (5.6%)	0/26 (0%)	0/14 (0%)	5/128 (3.9%)
Right Fibula Proximal	0/89 (0%)	0/27 (0%)	0/15 (0%)	0/131 (0%)
Right Fibula Middle	1/89 (1.1%)	0/29 (0%)	0/12 (0%)	1/130 (0.7%)
Right Fibula Distal	6/87 (6.8%)	0/28 (0%)	2/83 (2.4%)	6/129 (4.6%)
TOTAL	**12/532 (2.2%)**	**0/167 (0%)**	**2/83 (2.4%)**	**14/782 (1.7%)**

4.5.5. The Tarsals

The tarsals are composed of seven irregularly shaped bones that provide the

gliding movement and range of motion for the ankle and include the talus, calcaneus,

cuboid, three cuneiforms, and the navicular (White 2000). The talus is the tarsal bone

located immediately below the tibia and is important for extension and flexion of the foot

and also is essential in the push-off action that occurs during bipedal locomotion (Galloway 1999). The talus is the second most commonly fractured foot bone (Rogers 1992).

The largest and also the most commonly broken tarsal bone is the calcaneus, which is a major weight bearing bone that forms the heel. Fractures to the calcaneus often occur with other fractures that show evidence of axial compression (such as vertebrae fractures) (Hansen 1992). The calcaneus accounts for about 60% of all tarsal fractures (Cave 1963), the majority occurring when an individual falls and lands on their feet or during motor vehicle accidents (Galloway 1999). Fractures of the calcaneus are often linked to additional trauma in the spine and on the base of the skull. A study by deSouza (1992) showed that most calcaneal fractures occurred to males and were work related. Children were less likely to fracture both the talus and the calcaneus in spite of their falls from heights while climbing or jumping from swings. The additional tarsals can be broken when the foot is twisted under the body in high-energy impacts or accidents, or when an object such as a weight or a rock are dropped on the foot (Galloway 1999).

Five individuals in the CSIA exhibited a tarsal fracture (Table 4.34). Sixty percent of the fractures occurred on the calcaneus, with an additional 20% occurring on both the talus and a cuneiform bone (Table 4.35). The recordation of tarsal bones in the collection was incomplete and so the percentages were figured conservatively from the total numbers of males, females, or indeterminate sex individuals, because the total number of tarsals present in the collection is unknown. The actual rates of trauma for the tarsals would likely be higher if the excavations had carefully recovered these small

bones. Three males (2.8%), one indeterminate sex individual (4.1%) and one female

(2.8%) had tarsal fractures. A total of three percent of the CSIA collection population

had a tarsal fracture.

Table 4.34: Number and Percentage of Tarsal Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Tarsals	3/107 (2.8)	1/35 (2.8)	1/24 (4.1)	5/166 (3.0)

Table 4.35: The Number of Tarsal Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total Fractures
Left Talus	0/68 (0%)	0/26 (0%)	0/8 (0%)	0/102 (0%)
Right Talus	0/75 (0%)	1/26 (3.8%)	1/9 (11.1%)	2/110 (1.8%)
Left Calcaneus	1/75 (1.3%)	0/27 (0%)	0/10 (0%)	1/112 (0.8%)
Right Calcaneus	2/70 (2.8%)	0/27 (0%)	2/7 (28.5%)	3/104 (2.8%)
Left Tarsals	0/225 (0%)	0/26 (0%)	0/6 (0%)	0/257 (0%)
Right Tarsals	1/226 (0.4%)	0/22 (0%)	0/8 (0%)	1/256 (0.3%)
TOTAL	**4/739 (0.5%)**	**1/154 (0.6%)**	**3/48 (6.2%)**	**7/941 (0.7%)**

4.5.6. The Metatarsals

The bones of the metatarsals form the body of the foot and include five bones, the

first metatarsal through the fifth metatarsal, numbered medially to laterally. The

ligaments and muscles that attach to the metatarsals form the arch of the foot and assist in

bipedal locomotion with an inherent flexibility.

Fractures occur to metacarpals in a few different scenarios: falls from a height,

high impact accidents (such as motor vehicle accidents), and stress fractures related to

activities such as marching or dancing (Galloway 1999; Jansen 1926; and Volger et al.

1995). The most commonly fractured metatarsals are, in order of highest frequency, the

fifth, fourth, and third metacarpals (Galloway 1999).

There are a total of three metatarsal fractures present in the CSIA collection (Table 4.36). Two are located on the right first metatarsal and are on males (1.0%) while the third fracture is on a left metatarsal on an individual of unknown sex (3.4%) (Table 4.37). The phalanges of the foot were not examined in this analysis due to taphonomy issues.

Table 4.36: Number and Percentage of Metatarsal Fractures on Individuals by Sex.

Area of Body	Male +/N (%)	Female +/N (%)	Indeterminate +/N (%)	Total +/N (%)
Metatarsals	3/107 (2.8)	0/35 (0)	0/24 (0)	3/166 (1.8)

Table 4.37: The Number of Metatarsal Fractures on Individual Elements by Sex.

Skeletal Element	Males (x/N)	Females (x/N)	Unknown Sex (x/N)	Total Fractures
Left Metatarsals	0/309 (0%)	0/115 (0%)	1/29 (3.4%)	1/453 (0.2%)
Right Metatarsals	2/298 (1.0%)	0/102 (0%)	0/33 (0%)	2/433 (0.4%)
Unsided Metatarsals	0/7 (0%)	0/6 (0%)	0/3 (0%)	0/16 (0%)
TOTAL	**2/614 (0.3%)**	**0/223 (0%)**	**1/65 (1.5%)**	**3/902 (0.3%)**

4.6. Trauma Analysis Conclusion

Of the 166 individuals present in the asylum skeletal sample, 69% show at least one instance of trauma and 31% show no evidence of trauma. Males have the highest traumatic injury rates, with 40% of the sample having one or more fractures or dislocations. Females show a rate of 29% for acute trauma, while indeterminate sex individuals have a rate of 38%. This high trauma rate includes individuals with only fractures and dislocations (acute trauma: 51% of the population), in addition to individuals who exhibit only chronic trauma such as Schmorl's nodes (18% of the population). The most frequent trauma includes: Schmorl's nodes which affect 42.7% of

the population, rib fractures at 30.1%, and the fibula at 10.2%. The incidence of Schmorl's nodes in this population likely indicates that many of these individuals had more physically demanding lives than is seen in contemporary populations. The frequency of broken ribs might indicate that this sample was exposed to higher amounts of trauma in their lives overall or perhaps at the hands of others. Because ribs are always moving during their healing process, they can be problematic to assess. The fibula, the most frequently injured long bone in the collection, might indicate that slips and falls were more common for this population, perhaps in response to Colorado's wintery climate or from the use of intoxicants or other medications that may have impaired motor ability.

One individual shows evidence of a trepanation, or intentional trauma, performed to relieve intracranial pressure from a previous fracture. In this instance, we see evidence of a medical system that tried to help a patient. Additionally, some fractures appear to have healed well, which likely indicates that some patients, either in the asylum or in their prior lives, had access to bone setters or medical professionals who could help with fractures. There is also evidence that other individuals had no such medical help. Most of the individuals in this collection had healed from their injuries, and some injuries were very old. Few peri-mortem instances of trauma were present, and those mostly affected are ribs.

Though not analyzed in depth, dental health in this collection was poor, though some individuals had gold fillings that were well done, indicating they had at one time had access to decent dental care.

The following chapter will discuss possible causes of trauma in this population and explain why a determination of whether trauma occurred during institutionalization is problematic. Additionally, ideas for further avenues of research on this collection will be discussed.

Chapter 5 – Discussion - Trauma in the CSIA Collection

An analysis of trauma can reveal much about the social and historical context in which individuals lived. Factors such as occupation, gender, age, and environment lead to differential rates and types of trauma. This process helps researchers better understand the hazards that individuals experienced in their society and the health sequelae that followed when they were hurt. Many of the examples of trauma in this collection would have resulted in debilitating health effects such as difficulty or pain while walking, or infections that could have been lethal. Some bones were poorly aligned and had healed badly, suggesting a lack of professional medical help or a lack of knowledge on the part of the physician to properly set a break (or perhaps surgical means of adjustment were simply not possible at that time).

The trauma present in the Colorado State Insane Asylum is unique in comparison to many other historic cemeteries because of the high rates exhibited (69% or 51%, depending if the rate includes chronic trauma). Ultimately, the analysis of trauma provides another line of evidence to better understand and contextualize the health and health risks of individuals and populations from the nineteenth-century American West, and even more specifically, those in institutionalized care in that setting.

This chapter will discuss the trauma results in the historic and cultural context of the Colorado State Insane Asylum, utilizing demographics and historical information

gleaned from scholars, admission records, and newspapers in order to better understand

the high level of trauma present in this population.

5.1. Causes of Trauma

5.1.1. Interpersonal Violence in the West

The myths centered around the American West often include violence as an

important part of western culture. The West was a place where men in white hats had

gunfights with men in black hats; a place where drunken brawls in saloons were

quotidian and expected. With its icons of rugged ranches and lawless mining towns, the

Old West is usually envisioned as a violent, ruthless place. Though media may have

exaggerated the amounts of violence in the past, skeletal and historical evidence show

that violence against men, women, and children did occur in the West.

Historian David Peterson Del Mar suggests that violence in the West was related

to complex ideas of power, identity, and status. Masculinity was exalted, and the beating

of wives and children was condoned--and in some instances expected, such as in the

cases where women acted assertively (Peterson Del Mar 2002:60). An interesting and

contradictory dynamic has been noted during this era, in that violence was often used to

force women into subordinate positions, but according to the popular media views of the

late nineteenth century, wife-beating was also viewed as the "cowardly" practice of

brutes (Peterson Del Mar 2002:59).

During this time, children were also beaten for misbehaving, and it was often

considered the right and duty of parents to include corporal punishment into their family

lives. Parents used items like switches and straps to whip their children (Peterson Del

Mar 2002:63), and community members only intervened on the child's behalf in severe cases. Teachers were also known to employ physical punishment in the classroom.

Interpersonal violence also occurred between grown men. Cultural tensions and conflicts over power and status could lead to fighting between Euro-Americans and Native Americans, though violence was also perpetuated against other groups such as Chinese emigrants (Peterson Del Mar 2002:59).

Alcohol was often involved in cases of interpersonal violence, and Dr. Thombs estimated in 1883 that 10% of the individuals in the Colorado State Insane Asylum were admitted for intemperance (Thomann 1884). Alcoholism and intemperance could have greatly increased the likelihood that an individual might become angry and violent towards others or be the victim of such violence.

Interpersonal violence is likely to show up as trauma in a skeletal sample in the face, hands and arms, neck, and ribs (Lovell 1997; Walker 1997:160). In cases where domestic violence occurs, the head and neck are clearly favored as a target (Hussain et al 1994; Kjaerulff et al. 1989; McDowell et al. 1992; Shepherd et al. 1990; Walker 1997:160). Walker suggests that the face is both a symbolic and strategic target, as well-placed blows to the head are conspicuous and produce a highly visible symbol of the aggressor's social dominance (1997:160).

Broken noses (Figure 5.1), broken zygomatic and maxilla bones, and broken jaws are often a result of receiving blows to the face. Broken nasal bones are the most common manifestation of violence to the face (Walker 1997:154). Skull fractures are possible if one is struck in the head with a weapon, and parry fractures of the ulna are often thought to be a result of blocking an attack to the head. However, some researchers

(e.g., Lovell 1997) warn against the use of the term "parry fractures," stating that Colles'

fractures, which occur when an individual falls on their extended arms, might look like a

parry fracture; she cautions that it is important to look for multiple lines of evidence to

confirm traumatic abuse. The distal ends of metacarpal bones, if compressed (Boxer's

fracture), might suggest that the individual hit something hard with his or her hands,

possibly another individual (Lovell 1997).

Young men are the most common victims of violent assault (Aalund et al 1990;

Allan and Daly 1990; Hussain et al 1994; Kraus 1987; Walker 1997). In the Colorado

State Insane Asylum collection, where a majority (64%) are known males, male skeletons

showed facial fractures to either the cranium (4.1%), the nasal bones (6.5%), the

mandible (3.1%), zygomatic (1.2%) or maxilla (6.9%) bones. Only one female (3.0%, or

1 in 33 females with mandibles present) had a broken mandible, and no individuals of

indeterminate sex had any broken facial or cranial bones. A total of 9.0% (15

individuals) of the collection experienced some form of facial trauma and 93% of that

group were males (N=14). Thus a strong relationship exists in this study between facial

or head trauma and sex.

Figure 5.1: Skull of Specimen E-17 from the Colorado State Insane Asylum. Note the broken and healed nasal fracture.

Richard Nisbett (1993) suggests that a "culture of honor" among southerners, and in western regions of the United States initially settled by southerners, might have endorsed physical violence in response to insults, though skeletal collections vary tremendously in their frequencies of facial violence and do not seem to be correlated with southern culture (Walker 1997:165). Walker suggests that cultural conditioning might be involved in using the face as a target, since other targets such as the groin or knees are more likely to disable opponents (1997:168). He notes that populations with obvious exposure to interpersonal violence actually show a lower rate of facial injuries, including the contemporaneous skeletons from the San Francisco Legion of Honor cemetery, where nasal fractures are low. The rate of nasal fractures in the Colorado State Insane Asylum is similar to that of a contemporaneous group of individuals of lower socioeconomic status from San Francisco at 3.8% (Walker 1997:157). However, the CSIA facial fracture rate is lower than in the Terry and Hayman-Todd collection (~27%) which is made up of mostly homeless and unclaimed individuals from the early to mid twentieth century in Cleveland and St. Louis (Walker 1997: 149).

The popularity of boxing might offer clues regarding the numbers of nasal fractures in men in the Colorado State Insane Asylum. In 1892, a fight between two fighters named Corbett and Sullivan marked a turning point in the sport, after which it became increasingly commercialized (Gorn 1986; Walker 1997). Some of the individuals in the Colorado State Insane Asylum seem to fit the "wild west" stereotype of two-fisted fighting, and 3 of the 107 (2.8%) male skeletons and one of the individuals of indeterminate sex (4.1%) have at least one broken metacarpal, a break commonly referred to as a "Boxer's" fracture (Figure 5.2).

Figure 5.2: A broken and healed metacarpal fracture or "Boxer's fracture". These commonly occur when an object or person has been struck with a closed fist.

Mental illness or alcoholism could also have led to interpersonal violence or self-inflicted violence. The fact that many of the Colorado patients were admitted for intemperance might suggest that they spent many nights at the local saloon and therefore could have been involved in violent altercations. But researchers must also examine the individual's entire pattern of trauma, since facial trauma can be the result of accidents as well. However, one individual, burial B-2, was very obviously the victim of interpersonal violence.

5.2. Case Study: Burial B-2

Of all of the burials from the Colorado State Insane Asylum, B-2 is the most obvious example of interpersonal violence. This adult male has a fractured nose, maxilla, zygomatic bone, mandible, and numerous broken ribs. All these injuries were healing, so it is obvious that he survived for a time after the encounter or incident. In addition to the facial injuries, this individual also sustained a broken sacrum, scapula, and hyoid bone. The hyoid is often broken during a strangulation attempt, though it could also be damaged from a direct blow to the neck (Maples 1986). If this individual had a violent accident, one would expect to find major long bones broken as well. Instead, this individual is affected in every area consistent with interpersonal violence (Figure 5.3) and in many ways has the skeletal profile of a boxer.

Figure 5.3: broken and healing ribs from individual B-2. The subsequent infection at this site was fusing three ribs together.

5.3 Asylum Life

Considering the historical context in which the individuals from the asylum lived,

it is evident that the CSIA was dealing with issues of understaffing and a lack of

supervision and funding. In addition, the CSIA was used to house immigrants and the

elderly and "incurable" mentally ill. It is therefore likely that some individuals in the

study were victims of institutionalized violence, and it is possible that some injuries were

received from nurses, orderlies, guards, or other patients, or were perhaps even self-

inflicted. While the use of "moral treatment" encouraged kindness and patience on the

part of the health care providers, corporal punishment might have been used on the

patients of the hospital, especially as CSIA employees had to cope with large numbers of patients and were allowed to become negligent in their duties.

Over 36% of male individuals in the collection have at least one rib fracture and some have over 10. Females also showed a high rate of rib fracturing: 17.1% of females and 20.8% of indeterminate sex individuals have broken ribs. Could these trauma rates be the result of restraining devices, and strait jackets or abuse? While some of the breaks were old fractures that had remodeled over the years, many were newer breaks that were just beginning to heal and occurred closer to the time of death. To complicate the matter, ribs are notoriously difficult to work with in trauma analysis as ribs can remain broken throughout life, because the bones are never fully immobilized due to the necessity of breathing. As such rib fractures can often manifest as peri-mortem damage, looking like fresher unhealed breaks, when in reality they may be quite old. Without historical accounts and descriptions and only limited comparisons with other collections, we can only guess that these individuals were abused by their care-takers. The high frequency of rib trauma in this collection (30.1% or 50 of 166 individuals), and the social and historical contexts in which the employees and patients were living, make this collection's rib trauma the most suspicious evidence for potential institutional violence.

Rib fractures were mentioned in an 1887 book, *Ten Days In a Mad-House*, written by investigative journalist Nellie Bly during her brief stay in New York's Blackwell's Island Insane Asylum. A patient named Bridget McGuinness related to Ms. Bly an incident in which she described being choked, kicked, and beaten by the nurses, who warned her that further punishment would ensue if she told the doctors. On one occasion the nurses jumped on her, breaking two of her ribs (Bly 1887). Bly also

mentions that often abuse to patients occurred in areas that were less visible to doctors who would be briefly examining patients. The face in particular was avoided as those injuries would be easily visible (1887).

It is possible that, due to the financial strains and lack of oversight at the Colorado State Insane Asylum, patients could have been exposed to abusive and frustrated staff. However, if institutional violence was occurring at high rates in this population, the sample probably would have exhibited more evidence of peri-mortem damage in other aspects and on other elements. So-called "parry" fractures are rare in this collection and occurred on a single male skeleton. Additionally, many of the patterns of trauma in the sample are indicative of bad falls or trauma episodes that might have resulted from occupational accidents rather than from interpersonal or institutional violence.

5.3. Occupational and Accidental Trauma

Trauma in the long bones (femur, tibia, fibula, humerus and the radius and ulna) is often caused by accidents or occupational hazards (Lovell 1997). Breaks of the long bones, especially the legs, require great physical force or stress. In elderly individuals a gradual weakening of the bone and decrease in collagen can cause increased weaknesses in the bones, especially the bones of the hip joint, which can lead to damage and eventual breakage (Figure 5.4).

Figure 5.4: Two femoral heads and necks from individual C-20. The left femur's (specimen on the right side) neck has collapsed and extensive bone remodeling has affected the joint.

The scant existing medical records and newspapers for individuals in the asylum reveal that these patients did lead physically demanding lives prior to their institutionalization. The men were generally farmers, laborers, blacksmiths, miners and ranchers, or cattlemen prior to admittance. These careers would have exposed them to various hazards. Livestock such as horses and cattle could have posed a variety of physical threats. Kicks and falls would have been common or at least a risk of the occupation. Falls might create such damage as broken ribs, or even broken innominate (pelvis) bones (Figure 5.5). Limbs might be crushed (Figure 5.6) on mining sites, and carrying heavy objects over time might lead to compression fractures in the vertebrae.

Several newspapers of the period noted that some of the men who were committed to the asylum were veterans of the Civil War, providing another potential reason for the high trauma rates found in some of the older men.

In contrast, the women who were admitted to the CSIA had jobs that exposed them less to occupational hazards. Many were housekeepers or domestics. The term housekeeper was probably related to our current term of homemaker, an individual who cares for children and other family members at home in addition to household duties. Possibly due to these less risky occupations, women in the sample had an acute trauma rate (includes only fractures and dislocations) of about 29% when compared to males at 40%, or to the 38% rate of indeterminate sex individuals. However, perhaps due to the physically demanding nature of housework during that time, females showed a greater number or Schmorl's nodes (23%) when compared to males (18%) and indeterminate sex individuals (13%), though this might also be a function of female anatomy.

Figure 5.5: Two left innominate bones from different individuals. Individual E-9, on the right has broken their iliac crest on the superior portion of their hip. Extensive bone remodeling was occurring.

Figure 5.6: These matching broken femur and humerus would have been the result of a major traumatic event. The bones healed in a misaligned position and the limbs were quite shortened as a result.

Colorado's cold climate and the uneven terrain of muddy frontier towns could have also played a role in the trauma found in this collection. Accidents such as twisting an ankle on uneven terrain would cause damage to the lower leg bone and tarsal bones. For example, the broken tibia in Figure 5.7 was accompanied by subsequent damage to the calcaneus and talus. Individuals living in mountainous areas are more likely to sustain these types of injuries. The CSIA collection shows 18% of individuals (23% of males, 5.7% of females, and 12.5% of indeterminate sex) having a leg injury, versus 8.2% in the San Francisco Legion of Honor cemetery. This was probably not the result of physical violence, but of icy winters and laborious rural occupations in Colorado. It is interesting to note that men in this collection were four times more likely to fracture a leg than women.

Figure 5.7: Normal distal end of right tibia (on the left) and fractured left tibia distal end on the right. This damage is likely from a twisted ankle.

5.4. Chronic Trauma

Some trauma from the collection was the result of multiple stressors over time. Schmorl's nodes were present on 75 individuals (45% of the collection). Fifty-five men, 14 women, and six individuals of indeterminate sex evidenced this type of chronic trauma. Schmorl's nodes are typically associated with slipped disks or the extrusion of nucleus pulposus material of the cartilage disk onto the vertebral bodies (Ortner 2003:464). These traumatic scars were likely the result of continual heavy lifting or labor, and were probably associated with chronic back pain during life (Figure 5.8).

Figure 5.8: Three lumbar vertebrae with Schmorl's nodes in the center representing necrosis of the vertebral bodies.

5.5. Intentional Trauma

Trauma can also be culturally determined and manifested, as evidenced in Fig.
5.9. This most interesting example from the Colorado State Insane Asylum, an individual
(C-2) has a healed trepanation on the left posterior portion of his skull. A fracture seems
to have occurred along the occipital and temporal bones on the left side of his skull, and
the trepanation might have been performed to relieve intracranial swelling as a result of
the fracture. Trepanation was also used to treat mental illness (Broca 1876:572) or
"mental weakness" (Hershkovitz et al. 1991; Ortner 2003), and this could have been the
case for this individual. It is important to consider the cultural reasons for trepanation
when analyzing a population (Figure 5.9).

Figure 5.9: Trepanation on individual C-2. White arrow points to healed cranial fracture.

5.6. Comparison to Other Historic Cemetery Populations

At the onset of this project, it was assumed that the trauma rates at the Colorado State Insane Asylum would be similar to contemporaneous 19th century cemeteries containing individuals of lower socioeconomic status. The number of individuals in the CSIA collection who have one or more elements with trauma is higher (69%) than in the San Francisco Legion of Honor sample (38%), a very similar population. The CSIA numbers are noticeably higher than in other Euroamerican samples (20%) and in the African American subsets (9%) of the Western Hemisphere database[2] (Buzon et al. 2005:10[2]). Other civilian cemeteries, such as the Dunning Cemetery (Grauer et al. 1999), had 24% of burials with evidence of trauma, and some Texas nineteenth-century cemeteries show trauma at various rates, all lower than the CSIA cemetery: 41DT105 = 30%, Tucker Cemetery = 25%, and Five Cemeteries = 7.7% (Winchell et al. 1995). The only non-institutionalized cemetery with a similar rate of trauma when compared to the CSIA is the Snake Hill military cemetery in New Jersey, at 56% (Owsley et al. 1991).

The Colorado State Insane Asylum also differs from other historic cemeteries in that there is no skeletal evidence of gunshot wounds in any of the burials. This runs counter to the myth of western gunslinger-filled streets. Additionally, there are difficulties in the other data sets in that none of the other cemeteries have reported all their raw trauma data, so it is not possible to determine the similarities and differences between specific elements and sex. It is also a problem that many researchers do not discuss what exactly they are looking for or what they consider to be "trauma." For example, the CSIA asylum trauma rate of 69% includes both acute trauma and chronic

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[2] The Western Hemisphere database was created by Richard Steckel and Jerome Rose and other statisticians in the late 1980s to organize health data from archaeological skeletal collections.

trauma (Schmorl's Nodes). The other cemeteries might not include chronic trauma in their rates. To adjust for that possibility, we determined the CSIA's acute trauma rate to be 51%. The remaining 18% consisted of chronic trauma.

It would be interesting to gain access to researchers' notes to make a more thorough comparison. This gap demonstrates the need for a systematic and standard study of trauma across collections among biological anthropologists.

5.6.1 Comparison with Oneida Asylum and Albany Almshouse in Upstate New York

Few historic skeletal collections are available for researchers and even fewer institutionalized populations have been studied for comparative research. One exception is a study that details trauma information from upstate New York for both the Oneida Asylum collection and the Albany Almshouse collection (Phillips 2001).

The Oneida Asylum collection is similar to the CSIA collection in several ways. The individuals in the Oneida collection were buried in the 1880s putting them in the timeframe of the 1880-1900 burial dates for the CSIA collection. Like the CSIA group, the Oneida group was atypical of nineteenth-century cemetery populations in that they contain only adults. Approximately 100 individuals were found both in individual graves and commingled in the Oneida burials.

The Oneida and the CSIA collections are also unique among historic cemeteries in that they represent individuals who lived, at least for a period of their lives, in an institutional setting that exposed them and their fellow patients to similar environments, similar diseases, and similar diets until their deaths. In this way, the institutionalization acted as a type of bioarchaeological laboratory that reduced some of the variation in people's lives through institutional control. Phillips (2001) notes that the Oneida Asylum

was a custodial facility in which patients, once admitted, typically spent the rest of their lives. No information could be found on the opening date of the Oneida facility, so it is difficult to determine exactly how many years patients spent in the institution.

The Colorado State Insane Asylum opened in 1879, and interments on the grounds occurred during the first 21 years of the asylum. Unlike the Oneida asylum, where individuals were admitted as young adults and remained in custodial care, patients who were eventually admitted to the Colorado asylum would have spent a greater portion of their lives outside of the asylum. This disparity between the amounts of time that patients were institutionalized may account for some of the differences in trauma rates between the collections

Additionally, Phillips studied the Albany Almshouse collection, which represents approximately 100 adults (80 individual burials and 20 commingled) who were poor but lived generally un-institutionalized lives. Almshouses were considered temporary housing and in some cases the final places of poor individuals who were mortally ill. The Albany Almshouse serves in this study as a contemporaneous lower class and poorer population that was not under institutionalized care.

Table 5.1 compares the percentage of individuals with one or more fractures on individual skeletal elements in the three populations that were studied by both Phillips (Oneida Asylum and Albany Almshouse) and this author (CSIA Collection).

Table 5.1: Frequency of Fractures Per Skeletal Element for Three Skeletal Collections: Albany Almshouse*, Oneida Asylum*, and the Colorado Asylum.

Skeletal Element	Albany Almshouse	Oneida Asylum	Colorado Asylum
Temporal	1.9	0	0.7
Nose	4.0	0	4.2
Ribs	1.4	1.2	6.0
Vertebra	1.8	1.7	0.6
Innominate	0	0.7	2.8
Humerus	1.7	0.7	2.6
Ulna	0	3.5	0.8
Radius	2.0	2.1	2.4
Femur	1.8	1.2	1.7
Tibia	4.0	3.9	4.0
Fibula	0	5.2	5.3

*Taken from Phillips (2001).

From the table it is evident that the Colorado State Insane Asylum collection is comparable to both the Oneida Asylum and the Albany Almshouse for fractures on the radius, femur, and tibia. However, the CSIA collection shows higher rates of fractures to the pelvis, humerus, and most notably the ribs—with nearly four times as many rib fractures as the next highest population. Conversely, the frequency of fractures on the vertebrae was lower in the CSIA collection. The fibula, the most commonly broken long bone in the CSIA collection, showed fracturing at a rate nearly identical to that of the Oneida Asylum population, but entirely absent in the non-institutionalized population.

Chronic trauma was also analyzed for the New York populations. Figure 5.10 shows the percentages of Schmorl's Nodes present in all three collections.

Figure 5.10: Percentages of Individuals with Schmorl's Nodes in Three Collections.
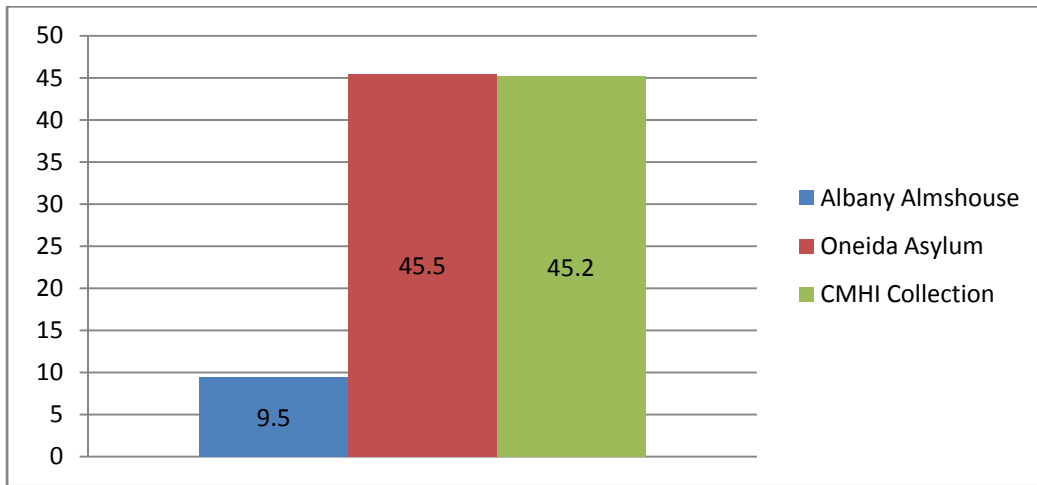

The percentage of individuals with Schmorl's nodes in the institutionalized collections is nearly identical to one another. Phillips (2001) notes that patients in the Oneida Asylum were subjected to labor therapy, or a multitude of physical labor tasks including chopping wood, washing, gardening, scrubbing, farming, and livestock care. All able patients were involved in this type of therapy and some tasks were segregated by sex. The women patients in the Oneida Asylum made all of the clothing for the patients at the asylum. This amounted in a cost savings for the asylum as many of the daily tasks were performed by the patients themselves. Many of the tasks were physically laborious and Phillips argues that the high number of Schmorl's nodes in that population reflects that hard labor.

It is unknown if the Colorado Insane Asylum employed labor therapy on its initial inmates, but the similar skeletal manifestation of the chronic trauma is compelling. The Colorado system eventually employed patients as groundskeepers, and there were even extensive gardens, orchards, and a dairy at one time on the grounds. It seems likely that in a similar attempt to reduce expenditures patients may have supplied some of the hard labor of the early Colorado institution.

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Lastly, Figure 5.11 shows the frequency of individuals with one or more traumatic injuries. Though the CSIA collection, with the exception of ribs, showed similar frequencies of trauma on the individual skeletal elements when compared to both the Albany Almshouse and the Oneida Asylum, the number of individuals with trauma at CSIA is nearly double that of the other populations.

Figure 5.11: Percentage of Individuals with One or More Traumatic Injuries.
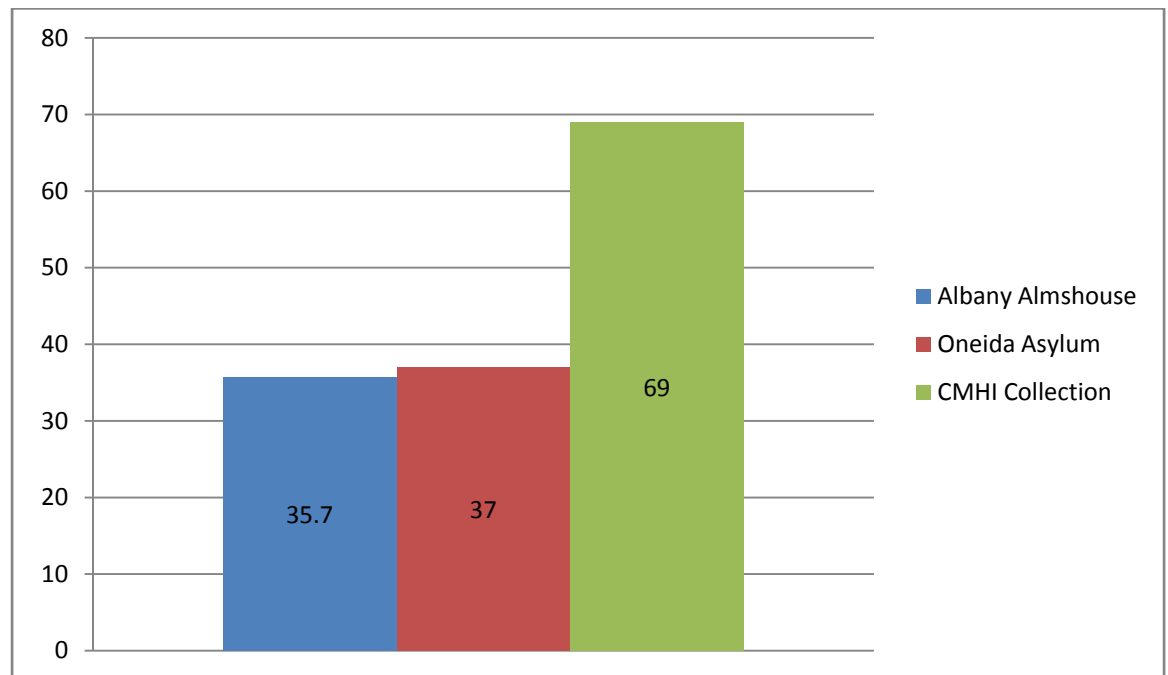
This seems to indicate that people in the Colorado State Insane Asylum were nearly twice as likely to have a fracture than their contemporaneous counterparts in New York. It also indicates that individuals in New York who did experience fractures were likely to experience more of them. In other words, fewer individuals in New York had traumatic skeletal events, but when they did, the injuries were more severe or resulted in more broken bones. Nevertheless, the high rate of individuals with fractures in the CSIA population cannot be ignored. The CSIA population is unique in both its high amount of

trauma for a non-military population as well as for the high frequencies of rib fractures that occurred to that population.

This study does not provide the necessary evidence to definitively determine the cause of the high trauma rates present in the CSIA skeletal sample. Many factors such as risky and physically difficult occupations (mining, livestock raising and laboring), the challenging mountainous and cold Colorado climate, frontier life, alcoholism, mental illness, and institutionalization each played a part in the rates of trauma found at the Colorado State Insane Asylum. Additionally, without the use of radiography, the current estimate of 69% trauma is probably conservative. Future research would benefit from the use of radiography on this population.

As additional historic skeletal populations are examined, researchers may be able to parse out the effects of various potentially traumatic factors found in the CSIA. For example, a similar skeletal population that was not institutionalized from a Colorado frontier time period would provide a control group to better determine the effects of institutionalization on trauma rates for people living in frontier Colorado.

Chapter 6 – Conclusion

Trauma is the physical culmination of the hazards and hardships experienced by an individual's physical body while interacting with his/her socio-cultural and physical environments. Though the connection might not initially seem obvious, the individuals who were buried on the grounds of the Colorado State Insane Asylum -- men and women of varying ethnicities, backgrounds, descent, occupations, and ages – were all brought together by a society that deemed them to be mentally ill. They were individuals who didn't fit into the prevailing cultural attitudes regarding productivity and normalcy—i.e., they were a physical manifestation of the wrongs of society.

These individuals were also members of the lower working class who labored in difficult and challenging jobs and suffered physically as miners, laborers, Civil War veterans, housekeepers, domestics, and stockmen. Many of them suffered from syphilis and other physical diseases, including alcoholism. Colorado frontier life was challenging and especially so for individuals who might have suffered from mental illness.

Using evidence from historical research, historic medical textbooks, CSIA medical records, historic newspaper accounts, and trauma analysis, I was able to reconstruct and learn a little more about a group of people who were disenfranchised and judged by their own society to be outsiders. The multifaceted biocultural approach used here with the CSIA collection enhances interdisciplinary scholarly understanding and forces us to view the collection as more than simply an archaeological or osteological resource. As demonstrated here, the background information available through primary

historical sources adds considerably to trauma analysis. Bioarchaeologists working with historical populations would undoubtedly benefit by dedicating a little time to the historical archives and records whenever possible.

Although I hoped to determine whether the institutionalization of this particular population led to higher trauma rates, the honest answer is that more research must be undertaken with comparable non-institutionalized frontier collections before the institutionalization factor in trauma can be accurately determined. Though one always hopes to produce a definitive work, this research will serve as a small piece in the body of literature and research on the subject of trauma analysis in institutionalized largely Euroamerican populations.

It is important to use bioarchaeological research in context. An initial glance at the high amount of trauma in this collection could lead one to believe that life in the American West was more violent or traumatic than life today when in reality that could not be said with certainty. With the ubiquitous use of automobiles and the emphasis on sports it is likely that in the future our contemporaneous period will be filled with greater trauma rates than those of Colorado in the late nineteenth century.

Ultimately, the analysis of trauma as undertaken in this research provides yet another line of evidence to better understand and contextualize the health and health risks of individuals and populations from the nineteenth-century American West, and more specifically, those in institutionalized care during that time.

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