Child abuse in the archaeological context

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Abstract:

Children have been a widely ignored subject in archaeology so it follows that child abuse has not been studied in detail in the archaeological context. This paper combines both forensic anthropology studies and Bioarchaeological studies to see if child abuse is a modern phenomenon. Signs of both non-accidental trauma and neglect have been documented by authors in the archaeological record. The purpose of this paper will be to describe signs of both nonaccidental trauma and neglect. Then examples in archaeological studies will be reviewed. The future of the study of abuse in the archaeological context is also discussed at some length. Can child abuse truly be detected in the archaeological context?
Introduction:

Child abuse was first described in 1946 by John Caffey, before that in many societies people looked at children more as property rather than human beings (Ragan 2011). It has been estimated that children between the ages of 0-4 are at the highest risk of homicide by abuse from a caretaker (Ross et al. 2016). With stats like these in modern times it would be hard to assume that child abuse was not present in the archaeological past.

Archaeology has widely ignored children because they were thought to have insignificant effect on archaeological thinking and methods (Manifold 2015). Children were not viewed as important players in the making of history by archaeologists. In some instances, their bones are also often misidentified as non-human bones because not every archaeologist is knowledgeable in juvenile osteology. At present, there are only a handful of excavations where they have identified potential child abuse so it is possible (with the correct education) to identify abuse in the archaeological context. Archaeologists should learn how to identify the evidence of child abuse.

When looking at any trauma in children there are a few things that need to be kept in mind when evaluating whether the trauma is accidental or non-accidental. The type of fracture, location of the fracture, age of the individual, and level of motor development of a child of that age must be considered when trying to determine whether a fracture is accidental or not. Rib and spiral fractures on any long bones are almost always a result of child abuse. Multiple fractures in different stages of healing should also be considered when looking at potential child abuse.

The aim of this paper is to serve as a methodological overview on how to detect child abuse in the archaeological context. First, the presence of children in the archaeological context is discussed to show that the material is there to study their treatment. Then, a brief osteological
and fracture mechanic overview is provided for context. Signs of both non-accidental trauma and neglect will be examined along with differential diagnoses for both types of abuse. Specific cases will serve as examples for how these can be applied within archaeology. Lastly, I will consider the future of this research.

Children in the Archaeological Context

It is important to address the presence of children in the archaeological context. Is the lack of children present in archaeological studies because they cannot be found or because they are ignored by the archaeologists? It seems to be a mixture of factors. During earlier archaeological studies, children were largely ignored because they were not thought to have any influence on culture (Manifold 2015). Another problem could have been that juvenile skeletons were not recognized as human bones because they do not look the same as fully fused adult bones as seen in figure 1 below. The epiphyses of the bones may not be fused to the diaphyses yet so the bones are almost unrecognizable as human bones.

![Figure 1: Example of a juvenile skeleton without the fused bones](image)

Citation: Wheeler S.M. et al. (2013). Trauma Diagram. Shattered lives and broken childhoods: Evidence of physical child abuse in ancient Egypt.
Taphonomy can affect whether parts of the juvenile skeletons are present in the archaeological context. Taphonomy is the processes that act on the bones after they have been deposited (White et al. 2012). These processes can affect whether the bones are broken down or still whole. Burial practices should be considered because some cultures do not bury their young, or if they do bury them they put them in shallower graves (Manifold 2015). This will affect what elements the bones are exposed to and how much of the skeleton is preserved, because bones preserve differently based on their size, mineral content, and density. The juvenile bones that preserve well are: temporal bones, sphenoid, occipital, zygomatic, mandible, upper and lower limbs, ribs, cervical vertebra, and there is some debate about the scapula (Manifold 2015). This is because they are denser and have a higher mineral content than other bones. Some bones such as the sacrum, coccyx, and sternum might not preserve as well because they are largely cartilaginous in young children (Manifold 2015).

**Growth and Biomechanics**

It is significant to note that in juvenile skeletons many bones will not be fully fused. Growth of bone begins in the fetal stage and full fusion of bones does not happen until about 21 years of age (Schaefer et al. 2009). During excavation, some knowledge of juvenile osteology is needed otherwise some bones and fragments might be mistaken for non-human remains.

Bones are composed of two main substances, collagen and hydroxyapatite (Ubelaker et al 2011). Collagen is the organic matrix of bone that gives the bone it’s tensile strength. Juvenile bones have a higher quantity of collagen than hydroxyapatite, which makes their bones more elastic than adult bones. Hydroxyapatite is the mineral content of the bone. This gives bones their overall strength and helps with compressive forces. The ratio of hydroxyapatite and
collagen determines how a specific bone reacts to a force and what kind of force it takes to fracture bone (Ubelaker et al 2011).

Bones can act differently depending on the characteristics of the bone, and the nature of the stress that is applied to it. Bone morphology also has a vital role in the biomechanics of bones (Ubelaker et al 2011). For example, it would take less force to cause a major fracture to a flat bone than it would a long bone. Since fractures follow a path of least resistance features such as sutures, foramina and bone thickness can affect where the bone fractures. The amount of spongy bone and compact bone can also affect how bone responds to various forces (Ubelaker et al 2011). Juvenile bone is also more vascularized, porous and pliable than adult bones, this causes a lower elasticity and bending strength when it comes to juvenile bones (Gaither 2012). Greenstick fractures are more likely to occur in juveniles than adults because of the more porous nature limits fracture propagation (Ubelaker et al 2012). This must be kept in mind when evaluating the fractures seen in suspected abuse cases.

**Fractures and Remodeling:**

Two categories of fractures that you see in non-accidental trauma are complete and incomplete. Complete fractures include transverse, oblique, and spiral. Transverse are clean and perpendicular to the bones long axis as in figure 2. Oblique and spiral fractures are complete

![Figure 2: radiograph of a transverse fracture through the humerus. Citation: Heilman, J. (2016). Transverse Fracture. Wikimedia Commons.](image_url)
fractures that are diagonal to the bones long axis. A radiograph of an example of a spiral fracture can be seen in figure 3 below. These are commonly caused by a twisting of the limb. A butterfly fracture is a unique fracture that looks like both a compressed fracture and tension fracture. These occur on long bones when blunt force is used. The incomplete fractures that are common in non-accidental trauma are green stick fractures and buckle fractures. Green stick fractures are where the bone bends on one side and breaks on the other kind of like a fresh tree branch as seen in figure 4 below (White et al 2012). A buckle fracture is when the bone bends and produces a raised buckle on one side, but no break on the other. Incomplete fractures are more common in juveniles because their bones are more ductile than adult bones (Ubelaker et al 2012).

The bones of the skull act differently than long bones when fractured, because they are flatter and there are sutures that interrupt the direction of the fracture. Two common complex fractures that seen in non-accidental trauma is the stellate fracture (star shaped) and compressed

![Figure 3: Radiograph of a spiral fracture to the humerus. Citation: Thompson, RSJ. (2009). Humerus Spiral Fracture. Wikimedia Commons.](image)
fractures (Buckley et al. 2008). Knowledge of the different types of fractures is important because some will point towards non-accidental trauma while others can be caused by accident.

One example is the difference between single, simple linear fractures of the skull and compressed fractures. If the child has a single, simple linear fracture it could have been caused by an accidental fall. Compressed fractures indicate that the child has been hit by something that has a great force (Buckley et al. 2008). The difference in simple fractures and compressed fractures can be seen in figures 5 and 6.

Healing patterns of juveniles is also important for the study of abuse because one of the most important marker of abuse is multiple fractures, in various stages of healing (Abel 2011). Remodeling in children happens at a faster pace than in adults because they are more vascularized and their bodies are programmed for bone growth so they are at the ready when it also

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**Figure 4:** Radiograph of greenstick fractures to the radius and ulna. Citation: Hellerhoff. greenstick fracture. (Sept 3, 2013). Wikimedia Commons.
comes to fixing bones. Healthy infants heal three times as fast as adolescents with the same fracture (3-4 weeks for infants and 12-16 weeks for adolescents) (Jones 1994).

The first stage of bone healing is inflammatory. During this stage a hematoma forms on the outside and inside of the bone. This signals cellular events that are important for repairing the bone. The next stage is the reparative phase and this is where the hematoma is replaced by bone through endochondral ossification. In some literature, this is considered the hard callus. This can take anywhere from 14-90 days after the fracture occurred (Jones 1994, Buckley et al. 2008). Last, there is the remodeling phase. During this phase, more mature bone is created and some extra bone is reabsorbed; the body attempts to achieve anatomical function at this point. This can take anywhere from 2 months to two years.

Several factors can affect the rate at which bone repair happens (Ubelaker et al. 2011). If the fracture is a complete fracture it will take longer than an incomplete fracture to heal. If the two parts of the broken bone are close together it will heal faster (and better) than if they are
separated. If the position of the break is at a mobile part of the body and it is not immobilized it will discourage healing. In some events if the bone fragments are not close in proximity or the person does not immobilize the break, it can cause a pseudoarthrosis (false joint).

**Signs of Non-Accidental Trauma on Skeletons**

When determining whether trauma should be considered non-accidental there are questions that should be addressed. The first question that should be answered is: What is the age of the individual? Individuals between the ages of birth to three years of age are less likely to get certain fractures than older individuals. If an infant has fractures such as long bone fractures they are more likely to be caused by abuse, because they are non-ambulatory these fractures should not be caused by a fall. The second question that should be answered is: What type of fracture is it and the location of the fracture? Some locations or types of fractures can be explained as accidental where others will signify a greater probability of abuse. The last question to be addressed is: How many fractures are there and are they in various stages of healing? Various fractures in various stages of healing signify child abuse.

**Most Common Fractures in Child Abuse**

A good portion of fatal child abuse victims exhibit cranial fractures (Abel 2011). Infants are especially susceptible to cranial fractures because of the thinness of their cranial bones (especially the parietal bones), but because of the open sutures accidental falls are less likely to cause fractures to the skull and are also less likely to be fatal in childhood. The appearance and complexity of fractures on the skull is determined by the force and place of impact. Complex fractures are the result of significant violence and multiple blunt force impacts. Two other types of complex fractures seen in the skull are bilateral and multiple, both cross over sutures and distribute into other bones (Abel 2011). Concentric fractures are caused by high energy impact
with a solid object (White et al 2012). Depressed fractures are caused by the impact of a small object that is going at a high velocity, so it is very unlikely that an accident could cause them in a juvenile especially an immobile one.

Fractures to the ribs is the number one red flag when it comes to child abuse and are the most common fractures that happen in child abuse cases (Abel 2011; Cadzow et al 200). Juvenile’s ribs are pliable so it would take a good amount of force to fracture them. While some bones have specific areas that signify non-accidental trauma, if a rib is broken anywhere it is almost always non-accidental trauma. The most common place to find fractures are the anatomical head, neck, and the costotransverse process (Abel 2011). In the event of non-accidental trauma there are often multiple fractures on multiple contiguous ribs. The most common cause of rib fractures in juveniles is from holding the child by the chest and shaking it. Unfortunately, healed and healing fractures on ribs are hard to see on radiographs but are easier to see using a microscope.

The most common fracture to the humerus in non-accidental trauma cases is the spiral fracture; this is caused by grabbing and twisting the arm of the child (Abel 2011). Fractures to the medial condyle should be studied also because this can be caused by violent torsion on the arm and it is rare in accidental trauma.

Any trauma to the lower limbs is suspicious if the individual is non-ambulatory, so age and motor development is important to consider (Abel 2011; Ross et al 2016). Spiral fractures to the femur can be caused by grabbing and twisting the leg. While transverse and oblique fractures can be caused by both accidental and non-accidental trauma. Trauma to the tibia and fibula in non-ambulatory children is highly suspicious and the most common fracture found is the spiral fracture and this is caused by grabbing and twisting of the limb (Abel 2011).
Traumas that mean Non-Accidental Trauma

In children, the sternum is more pliable and less likely to fracture, so if there is a fracture to the sternum it is most likely not an accident and should be studied further by looking at the rest of the skeleton. Most scapula fractures are caused by high impacts but a fracture to the acromial process can occur if there was severe shaking and pulling of the arm. Since it takes a high impact to break the scapula, it is more likely that it was created by non-accidental trauma (Abel 2011).

Trauma is rare to the vertebral column in abuse cases. The most common injuries to the vertebral column are compression fractures to the body of the vertebra, spinous process fracture, dislocation, and subluxation of the vertebra (Abel 2011). These types of injuries are mostly seen in the thoracic vertebra and the superior lumbar vertebra. Vertebral fractures are commonly caused by high impact forces and therefore if it is seen in the archaeological context should be labeled as probable abuse (Abel 2011). In cases of where the child was shaken, it is possible to find lower thoracic and upper lumbar fractures.

Injury to this section of the skeleton is rare because a significant impact is needed to injure the bones of the pelvic girdle (Abel 2011). Trauma to the pelvic girdle is not necessarily attributable to child abuse so other parts of the skeleton should be considered when injury is seen here. There have been some reports of disruption or fracture to the pubic rami and sacroiliac joint in some child abuse cases, especially sexual assault cases (Abel 2011).

Injury to both the hands and feet are unusual for any scenario and should be considered evidence of abuse (Abel 2011). In the instance of this, the diaphysis of the metatarsals, metacarpals and phalanges are usually affected. There are usually multiple bones that are affected, and multiple stages of healing may be seen.
Trauma that can Signify Accidental or Non-Accidental Trauma

Simple linear fractures on the skull are caused by impact with a large flat surface (Abel 2011). These fractures are mostly seen in falls but are also one of the common forms of fractures in child abuse cases. On the endocranial portion of the skull there could be endocranial bone deposition. This can be caused by an endocranial hemorrhage that is either produced by trauma to the brain or from any type of sickness that affects the brain such as meningitis (White 2012). A similar phenomenon to this is called cribra orbitalia; this is bone deposition on the orbital bone. Cribra orbitalia has been connected abuse and neglect but can be caused also by sickness such as rickets (White et al 2012). It is important to take in the shape of the rest of the bones of the skeleton before determining that the bone deposition is from child abuse.

While fractures to the skull are common in abuse cases, fractures to the face are less so. The face bones are less likely to fracture because the cranium and the mandible absorb most of the force (Abel 2011). If there are facial fractures the determination of non-accidental trauma cannot depend just on facial fractures alone but should be considered with other skeletal trauma.

Trauma to the sternum, clavicles and scapulae are less likely to be seen. If there is trauma to the clavicle there is a good chance that it was caused by trauma at birth. There are some cases where violent shaking can cause a clavicle to break but other aspects of the skeleton should also be looked at.

When looking at the humerus it is important to consider the age of the individual for two reasons: the fracture could have been from birth trauma or the fracture could have been from a fall. The closer the individual is to the age of birth the more likely the fracture was caused by some sort of birth trauma, the older the individual is the less likely it is to be from birthing trauma (Abel 2011; Heldrich 2011). Fractures to the midshaft of the humerus in children over 15
months should be studied further. On the other hand, supracondylar fractures and fractures to the lateral condyle of the humerus is almost always caused by accident and happens when the individual falls and lands on an extended arm or elbow (Abel 2011). That is why it is important to consider the age and mobility of the individual when studying fractures to the humerus.

Fractures to the radius and the ulna are less likely in child abuse cases and most likely caused by falls (Abel 2011). There could be injury to the radius and ulna from trying to block a blow. In older children being grabbed by the arm can cause trauma to the olecranon process of the ulna (Abel 2011).

Modern Case of Non-Accidental Trauma

In chapter four of the book *The Juvenile Skeleton in Forensic Abuse Investigations* (2011), Ann H. Ross discusses a child abuse case that she was involved in. A mother stated that her 19-month-old child had died from falling off a couch and hitting its head on a coffee table. The mother had hidden the body in a closet for several weeks before it had been discovered. The child was in an advanced stage of decomposition with some skeletonization.

On examination of the skeleton they found two healed rib fractures; one on the eleventh rib and the other on the seventh rib. The amount of healing on these ribs indicated that they occurred at about 4 weeks to 3 months prior to death. A more recent fracture was found on the tenth rib that had occurred seven to fourteen days prior to death. They concluded that because these fractures were in two various stages of healing, they were from two separate events. The areas of the rib that were fractured indicated that the chest had been compressed. The mother’s story obviously did not corroborate with the injuries that were present and the cause of death was determined to be homicidal violence.
This case has a few of the red flags that signal non-accidental trauma. First, the mother’s story did not match the injuries. In forensics, this can be a powerful tool but unfortunately it is not that helpful in archaeological cases. The infant had fractures to the ribs which are one of the most commonly fractured areas in child abuse cases (Abel 2011). The infant also had fractures in various stages of healing.

**Signs of Neglect on Juvenile Skeletons**

Neglect is the intentional act of a care taker who fails to provide necessities for a child. It is the number one form of abuse in the modern age (Cardoso et al. 2011) and can involve not seeking necessary medical care for a child, not giving them proper education, or physical neglect in general. Most fatal cases of neglect happen to children between the ages of birth and 3 years old (Cardoso et al. 2011). Physical neglect is the one form of neglect that leaves evidence on bones so it can in some instances be found in the archaeological context.

The presence of Harris lines is sometimes used to determine if a child was possibly neglected (Cardoso et al. 2011; White et al. 2012). Harris lines are lines that occur on the long bones near the growth plates when growth is stunted for an extended period. The problem with this is that neglect is not the only thing that can cause harris lines; sickness and famine can also cause them (White et al. 2012). To use Harris lines to prove neglect more investigation should be done to ensure that the individual did not have a sickness that inhibited growth or that there was any sort of famine that affected the rest of the population.

One of the more accurate ways to assess if a juvenile was a victim of neglect is to compare their dental age to their skeletal age (Cardoso et al. 2011). Bones strongly react to environmental stressors, whereas teeth can withstand more environmental stress. The individual should be aged by their teeth first, which will give a more accurate age of the
individual. Then skeletal age should be assessed and compared to the age obtained by looking at the teeth. The greater the differences in the age the more likely the juvenile was subjected to neglect (Cardoso et al. 2011). It is important to note that other samples within the population should be looked at to examine whether the data from the individual is anomalous or if there could be some other factor besides neglect that has caused the delayed age of the skeleton.

Isotope ratio testing has also been done to determine whether an individual has been neglected. This can be done in instances of good preservation, which is not always the case. Using hair and skin researchers can obtain Carbon-13 and Nitrogen-15 ratios. Decreased levels of these two isotopes (compared multiple individuals in the rest of the population) could be an indicator that the individual was neglected (Wheeler et al. 2013).

**Differential Diagnosis**

It is important to consider differential diagnoses when studying child abuse because you do not want to misinterpret a disease as child abuse. Three important terms that deal with differential diagnoses are osteopenia, osteomalacia, and osteomyelitis. Osteopenia is the general loss of bone quality without a clear understanding of the specific nature of that loss (Ortner 2003). It is also considered a sign of other bone pathologies. Osteomalacia is the malformation of bones from bone pathologies. Osteomyelitis is an infectious condition that begins in the bone marrow, it primarily affects the inner surface of the bone. This is also a symptom of other bone pathologies (Ortner 2003).

Scurvy is a vitamin C deficiency that occurs after six months of age (Heldrich 2011). This causes impaired mineralization which can affect the strength and the ability of bones to repair. The signs of scurvy on bones include: diaphyseal fracture, osteopenia, new bone formation, flared metaphysis, and metaphyseal fracture (Heldrich 2011; Wheeler et al. 2013).
Scurvy can be a result of neglect, to determine if neglect is the case the rest of the population should be looked at. If it is common in the rest of the population the scurvy is less likely to be a symptom of neglect.

Rickets is a vitamin D deficiency that affects the strength of the bones. The signs of rickets include: new bone formation, flared metaphysis, osteopenia, bowing of weight bearing long bones (Wheeler et al. 2013). Radiographic evidence includes fraying of the metaphysis and sharply defined symmetric, transverse stress fractures in the long bones (Heldrich 2011). This is another pathology that can be caused by malnutrition and therefore neglect. Like scurvy, the rest of the population should be looked at before determining whether the child’s rickets was caused by neglect.

Familial hypophosphatasia is a genetic disease that is also known as vitamin D resistant rickets, it causes the structural integrity of bones to be altered, which causes bones to be more likely to fracture. Children are normal up until six months of age and then after that time growth retardation develops, phosphate levels fall and phosphatase becomes elevated. Radiographic evidence seen in these cases include: cupping of the metaphyseal ends, defective bone and teeth mineralization, short stature, and osteomyelitis (Wheeler et al. 2013). The worst cases may cause a lack of calcification of the frontal, parietal, and occipital bones and milder cases can present with fractures (Heldrich 2011). Familial hypophosphatasia could be possibly confused with regular rickets and misclassified as neglect.

There are a few congenital diseases that symptoms can be misclassified as physical abuse. Copper deficiency is the inadequate absorption of copper. This causes “sunken” chest, abnormal sternum and sternal ribs, diaphyseal and periosteal reactions, and metaphyseal spurring and widening (Wheeler et al. 2013). This could be confused with healing fractures from abuse.
Another disease that could be confused with abuse is infantile cortical hyperostosis (Caffey’s disease). This disease presents in infants younger than six months of age. It causes severe new bone formation, cortical thickening in the mandible, clavicle and ulna, diaphyseal fracture, and exuberant bony calluses. These can be confused with fractures and healing fractures that are caused by abuse. With idiopathic juvenile osteoporosis, the individual's bone is normal growth anatomy but the spongey bone loses its density. This leads the spongey bone to be more brittle and more likely to fracture (Ortner 2003). The evidence of idiopathic juvenile osteoporosis is: vertebral crush fractures, and fractures of the metaphysis of the long bones (Heldrich 2011).

Congenital Insensitivity to pain is an x-linked genetic disease so it is seen more often in males. These children appear to be normal except for the fact that they are insensitive to pain and temperature. Because they cannot feel pain they are more prone to injure themselves. The signs to look for with this disease are multiple fractures and epiphyseal separations in various stages of healing.

**Archaeological Cases:**

The five cases below show evidence that it is possible to find the evidence of child abuse in the archaeological context. In Puruchuco-Huaquernos, Peru a child was found with multiple fractures in various signs of healing (Gaither 2012). Sandra Wheeler and her research team found a child that had evidence of both child abuse and neglect in Dakhleh, Egypt that can be dated to 50 A.D.-450 A.D. (Wheeler et al. 2013). One of the oldest signs of child abuse and neglect can be dated back to the fourth century A.D. This case was found in Calvados, France where a child was found with multiple fractures in various stages of healing and pathologies that are most likely caused by neglect. In Palpa, Peru Elsa Tomasto-Cagigao (Tomasto-Cagigao 2009) studied a population of skeletons from a cemetery and found two probable cases of child
abuse. At a Roman aged site in Dorchester, Dorset (Lewis 2009), there were three individuals that were found to have rib fractures caused by non-accidental trauma. Lastly, at St Oswald’s Priory in Gloucester, England, Bernadette Manifold (Manifold 2012) studied a young individual that shows a fracture that is common in child abuse cases.

*Puruchuco-Huaquernos, Peru*

Puruchuco-Huaquernos, Peru is located near modern day Lima. In the research, Catherine Gaither looks at pre-Spanish contact and post-Spanish contact Puruchuco-Huaquernos (around AD 1470-1540) to see if there is a difference in non-accidental trauma to children during times of conflict in a population (Gaither 2012). She looks at two spatially distinct cemeteries (Huaquerones and 57AS03) and focuses on juvenile skeletons from the two different time periods (pre-Spanish contact and post-Spanish contact). This gave her a sample of 242 non-adults, 169 individuals were from the pre-contact era and only 73 individuals were from the post-contact era. Only one individual (from the post-contact) was found to have probable non-accidental trauma caused by a care giver.

The individual was marked as 57ASO3E261 and following an analysis of their teeth they were found to be about three years of age. This child had multiple injuries in various stages of healing. Gaither found partially healed antemortem rib fractures (as seen in figure 7 below),

![Figure 7 (Left): Healing rib fractures in individual 57ASO3E261](image)

Citation: Gaither C. (2012). Partially Healed Rib Fractures. Cultural conflict and the impact on non-adults at Puruchuco-Huaquernos in Peru: The case for refinement of the methods used to analyze violence against children in the archeological record.
perimortem vertebral fractures consistent with compression of the thorax, presence of endocranial bone deposition that was likely from an intracranial hemorrhage. She also saw sclerotic periostitis (rough looking patch), on a long bone, which is indicative of healing as seen in figure 8.

![Image of healing femur fracture](image)

**Figure 8:** Healing femur fracture in individual 57ASO3E261

Citation: Gaither C. (2012). Femur Fracture. Cultural conflict and the impact on non-adults at Puruchuco-Huaquernos in Peru: The case for refinement of the methods used to analyze violence against children in the archeological record.

Her interpretation that this morphology probably resulted from non-accidental trauma is believable. The individual is a young child with multiple fractures in various stages of healing. First, the individual exhibits multiple rib fractures which are rare in an individual of that age. The child also has a vertebral fracture which is hard to mark as accidental especially in a child that is that young. Then there is the healing long bone and intracranial bleed that is added to the fractures strongly suggests the fact that these injuries were non-accidental.

*Dakhleh Oasis, Egypt:*

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Sandra M. Wheeler and her research team studied the Kellis 2 cemetery, located in the Dakhleh Oasis in Egypt (Wheeler et al. 2013). There are an estimated 4,000 burials located in this cemetery that date between A.D. 50 and A.D. 450. 701 have been analyzed and of these 158 are between the ages of birth to 15 years. The burial that they study in detail in this case is burial 519. Figure 9 shows a diagram that accompanied the article showing an overview of the injuries and pathologies of this individual.

Figure 9: Diagram of injuries and pathologies the individual in burial 519 sustained
Citation: Wheeler S.M. et al. (2013). Trauma Diagram. Shattered lives and broken childhoods: Evidence of physical child abuse in ancient Egypt.

Burial 519 contained an individual between the ages of two and three. The child was excellently preserved so even their hair, nails, and skin are still present. The individual has multiple fractures, in different stages of healing, and possible signs of neglect. The individual has transverse fractures to both humerii that is estimated to have happened about 2 weeks prior to their death. Two ribs show signs of once being fractured with some hard callus formation,
meaning that they are well healed. The location on the ribs shows signs of a direct impact, not shaking. Both bones of the os coxa have multiple fractures with signs of healing. This suggests non-accidental trauma since it is often difficult to fracture the pelvis accidentally. The right clavicle has a transverse fracture with no evidence of healing, meaning this fracture was perimortem. The scapula also shows signs of fracture. Fractures to the os coxa, clavicle, and scapula can be seen in figure 10 below. There was slight new bone formation on the temporal bone, zygomatic processes, along with the medial and lateral portions of the mandibular condyles. This individual also appears to have cribra orbitales (but so does a large portion of the population in the cemetery). There are fractures with early signs of healing on the right transverse process of the 1\textsuperscript{st} lumbar vertebra and the right lamina of a lower thoracic vertebra. New bone formations are also found on the medial diaphysis of the left tibia, anterior border of

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**Figure 10:** (a) Shows the fracture to the individual in burial 519. (b) Shows the fracture to the scapula. (c) Shows a healing fracture to the os coxa. Citation: Wheeler S.M. et al. (2013). Fractures to clavicle, scapula, and os coxa. Shattered lives and broken childhoods: Evidence of physical child abuse in ancient Egypt.
the right fibula, the calcanei, and proximal part of the metatarsals. There seemed to be no sign that these injuries could be caused by an underlying illness.

Using the individual’s hair Wheeler et al. (2013) performed stable isotope testing to assess diet of the individual. The carbon-13 values for the hair were depleted in relation to the rest of the population setting. It decreased over the 2-5-month period prior to death, followed by an enrichment of 1.5% over the month prior to death. This depletion did not seem to be explained by seasonal changes from C_3 grains to C_4 grains, and appears to be caused by starvation of the individual and possibly neglect. There was an enrichment of nitrogen-15 four to five months prior to death and then a rapid decrease in nitrogen-15 levels one to three months prior to death (these values were compared to the rest of the population). The enrichment happened around the same time as the decrease in carbon-13, this could indicate that there was a severe decrease in protein. The enrichment happened because if an individual suffers from prolonged decrease in protein it could produce a trophic level effect in the individual’s body (Wheeler et al 2013). The body using up the increased nitrogen supply to help heal it eventually caused the decreased stores of nitrogen-13.

Based on the extensive list of injuries, their locations, and evidence of multiple stages of healing this individual appears to have been abused. Wheeler et al. (2013) also conduct isotope testing to examine if there is a chance that this individual was also neglected a few months prior to death. The presence of cribra orbitalia does not seem to help in this regard since a large portion of the population also has it, and is, therefore inconclusive in the support of neglect.

Calvados, France

This study by Guillaume Blondiaux et al. (2002) looks at a site called Lisieux-Michelet in Calvados, France. This cemetery dates to the 4th century AD, with consistent burial practices
that can trace back to what period the graves were placed in the cemetery. Twenty percent of the graves contained juveniles. Both adults and juveniles were treated the same in funerary practices and artifacts. Burial 703 stood out though because it was a child without any coffin or artifacts.

Burial 703 was a girl about two and a half years old who showed signs of not only skeletal malformations but multiple traumas. The girl had two healed fractures on her right parietal that formed a right angle and an area of porosity on the external surface of that same parietal as seen in figure 11. She also had a porous area on the left parietal from a fracture that was completely remodeled. On the endocranial portion of her skull she exhibited extensive bone deposition in multiple areas, including: near the sagittal sulcus of the frontal bone, right temporal, right upper orbital, right parietal, and the right greater wing of the sphenoid. They concluded that this was most likely from cranial hemorrhage (Blondiaux et al, pg 214). Some of her incisors were missing with one of the sockets remodeled and practically closed. The sternal...
ends of her ribs are enlarged and thickened and there is deformation to the rest of her ribs. Her long bones show enlarged metaphases and diaphyses. Her femur, tibiae, and fibulae are slightly curved. Last, there seems to be a band of porous bone found on the one of her tibia diaphyses.

Blondiaux et al. (2002) determined that some of these morphological problems could be caused by vitamin D resistant rickets from x-linked hypophosphatemia. Some of the missing teeth and bone malformations are most likely caused by rickets; however, they conclude that the cranial fractures, the extraneous bone deposition, and the healed tooth socket are from multiple, successive traumas (mandible can be seen in figure 12). Due to the location and number of

![Figure 12: Mandible of the individual in burial 703. Shows multiple missing teeth and healed tooth sockets. Citation: Blondiaux G. et al. (2013). Mandible of individual. Rickets and child abuse: the case of a two-year-old girl from the 4th century in Lisieux (Normandy)](image)

traumas the most probable cause of the injuries is abuse.

This case is a good example of child abuse in the archaeological context because of the multiple healing fractures. Some of the fractures that were found were on the parietal of this individual. The head is one of the places for injury that is common in abuse cases. It is also highly suspicious because there are fractures on the skull that are in various stages of healing. There was also evidence of intracranial hemorrhaging which could signify traumatic brain injury.
The healed tooth socket is highly suspicious also but as they stated the loss of some of the teeth could be from the congenital form of rickets that this individual had.

*Palpa, Peru*

In the study “Talking to Bones: Bioarchaeological Analysis of Individuals from Palpa”, Elsa Tomasto-Cagigao (2009) discusses a sample of bones from a cemetery near Palpa, Peru. The sample contains 198 individuals of varying ages that date between the years of 3,800 BC to 900 AD. Out of the 198 individuals 72 had malformations or trauma and out of these 72 individuals there are two probable cases of child abuse.

The first case is a child between the ages of 6 to 12 months. They have a transverse fracture to the right femur near the proximal diaphysis. The fracture was in the process of healing and could have occurred up to two weeks prior to the death of the infant. The second probable case of child abuse is an individual that is between the ages of 8 to 10 months of age. The individual had five fractured ribs that are in multiple stages of healing. The various stages of healing can be seen in figure 13.

![Figure 13: Ribs in various stages of healing found in an individual in Palpa. Citation: Tomasto-Cagigao E. (2009). Healing Rib Fractures. Talking to Bones: Bioarchaeological Analysis of Individuals from Palpa.](image-url)
The first case can be labeled of probable child abuse because the child would have been non-ambulatory so there would be a very low chance of the fracture being caused by an accident. It would have been better if there were more fractures that were present than just the one. The second case is highly suspicious for child abuse because the infant is non-ambulatory and has five fractures to the ribs. The most common cause of fractures in infants under 3 years of age is abuse (Tomasato-Cagigao 2009). Multiple fractures in various stages of healing also point to the trauma being from probable abuse.

Dorchester, Dorset

In the study “Life and Death in a Cititas Capital: Metabolic Disease and Trauma in the Children from Late Roman Dorchester, Dorset”, Mary E. Lewis (2009) looks at a population of burials that date from the first century BC to the third century AD. In total there were 404 non-adult skeletons present in the cemetery and this study specifically looked at 364 non-adult skeletons. In this population, there was a high prevalence of scurvy and rickets, that was thought to be caused by feeding practices for infants and the overall health of the mother (Lewis 2009). Both rickets and scurvy can affect the density of bone and can lead to bones being fragile.

Of the 364 non-adult skeletons looked at in this study 12 children exhibited rib fractures (both single rib fractures and multiple fractures). These fractures were diagnosed through healed and healing legions that were found on the ribs. Six of the individuals with rib fractures had other pathologies (scurvy or rickets) which could have made the bones fragile enough to break at even the smallest accidental pressure. Three of these children were too poorly preserved to determine if the rib fractures were caused by a pathology or abuse. This leaves three individuals with no pathologies that can explain the presence of rib fractures. These individuals were aged at 44 weeks, two years, and seven years old.
The individuals that were aged at 44 weeks old and two years old are the most suspicious of probable child abuse. The 44-week-old infant is non-ambulatory so there should be little reason that an infant with no pathologies would have rib fractures. The two-year-old individual also looks suspicious because children’s ribs are more pliable than older individuals, so there would need to be significant force applied to break the rib. For the seven-year-old to be ruled as possible abuse it would be better if there were more fractures to be seen or fractures in multiple stages of healing. This individual should be studied more or more information should be given to rule the case as a probable abuse.

Gloucester, England

In the article “A Probable Case of Child Abuse from Historic Gloucester”, Bernadette M Manifold (2012) presents the study of a 7-month-old infant from the cemetery at St Oswald’s Priory in Gloucester, England. The skeleton was named skeleton B376 and dates to roughly 1120 to 1230 AD. This infant has a mid-diaphyseal fracture to the right humerus. There was the presence of a callous at the site of the fracture, showing that the infant survived several weeks after the injury. This is a possible case of abuse because transverse fractures are caused by direct forces (Manifold 2012) and the individual would have been non-ambulatory so it would not have been from an accidental fall. If there was multiple fractures or fracture that were in various stages of healing this case would have been a better example for child abuse in the archaeological context.

Archaeological Considerations

There are some factors that need to be considered when considering archaeological abuse cases. The first factor is whether child maltreatment is cultural. One culture that has reoccurred on this topic is the ancient Romans (Wheeler et al. 2013; Blondiaux et al. 2002). The Romans
believed that childhood was a special stage in life where you had to mold the child and maltreatment was considered beneficial. They believed that if they did not try to harden the child, they would become weak and immoral. A strong body was equated to strong morals. To determine whether this is the case, it is important to look at the rest of the population. If this is a cultural aspect you would expect to see widespread maltreatment and not just a sole case.

Differential causalities can make multiple fractures look like non-accidental trauma. Differential diagnosis should be ruled out before deciding whether an archaeological case was indeed child abuse. Child abuse is a heavy subject and should not be considered lightly and carelessly. When differential diagnosis can be ruled out then it can be more likely interpreted as child abuse.

Another crucial factor to consider is whether the fractures found are from around the time of death and from abuse or possibly from sometime after the body had been deposited and accidental. Perimortem (around time of death) fractures will usually have a straight edge with sharp, linear edges (White et al. 2013). The color of the fractured part of the bone will also be the same color as the rest of the bone. Postmortem (after time of death) fractures will look rougher and more jagged. The coloring of the fractured part will be lighter in color than the rest of the bone because it was not exposed to the elements as long.

Not all abuse cases will be visible in the archaeological context. Neglect is hard to see in skeletonized remains and it may not be evident in all cases. Also, not all non-accidental trauma is visible on the skeleton. If the trauma is not bad enough to break any bones of the individual, it will not be seen in the archaeological context. Taking into consideration where the trauma is, the age of the individual, and the characteristics of the fracture might help in this instance.

Future Research:
The main purpose of this thesis is to pull together information about child abuse in the archaeological context. In the future, hopefully there will be more studies looking at children, not only in the context of abuse, but also in general. The cultural factor would be another interesting factor to study. Do certain cultural factors lead to a higher incidence of abuse? Gaither (Gaither 2012) tried to look for evidence that points to whether cultural strain could be a factor that led to abuse in Puruchuco-Huaquernos, Peru but it was inconclusive. There could be other cultural or social factors that could be explored such as socio-economic status.

It would be interesting to see more isotope ratio analysis. Isotope analysis can help assess a person’s diet and can show changes in their diet (Wheeler et al. 2013). Since neglect is hard to detect in skeletonized remains, this could be a way to help assess whether an individual had been neglected. This could be a big step in studying child abuse in the archaeological context.

Conclusion:

Child abuse and children in general are not a highly-studied subject in archaeology. One of the reasons is that in the past children were not considered important to culture and they were overlooked by archaeologists (Manifold 2015). Also, their bones are not as recognizable as adults because they are not fully formed. A person who is not trained to recognize juvenile osteology can easily misinterpret the bones as something else. Some of their bones do not preserve as well as adult bones so their bones may not be as well represented as adult bones.

Along with a general knowledge of juvenile osteology, it is important to have some knowledge about fractures and remodeling. The type of fracture will help distinguish whether something could have been accidental or not (Abel 2011). Multiple fractures in various stages of remodeling could point to possible abuse, barring that there are not any other possible diagnoses.
These paired with the age and possible mobility of the individual can help to determine if trauma to a juvenile skeleton can be labeled as abuse. Fatal abuse happens most commonly in children under four years of age, these children are unable to protect themselves and cannot escape from their abuser (Abel 2011).

An assay of trauma to the juvenile skeleton is obviously required. Certain bones and fractures can point to non-accidental trauma. Complex fractures to the skull of an immobile child are a big sign that the child was abused (Buckley et al. 2008). Another fracture that is most common in abuse cases is fractures to the ribs (Abel 2011). A young child who is barely mobile would not have any reason to have broken ribs. Trauma to the long bones in immobile children is also a strong indicator of non-accidental trauma.

Neglect is another form of abuse that is used. This is harder to see on skeletal remains because it leaves little markers. Two markers on bones that can be attached to neglect are Harris lines and cribra orbitales (Cardoso et al. 2011). These can also be caused by famine and sickness, so it is important to see if they are present in the rest of the population (White et al. 2012). Failure to thrive is another way to determine whether a child was neglected. This looks at the child’s teeth age and compares it to their bone age (Cardoso et al. 2011). Isotope ratio analysis has also been used to determine whether a child was neglected. Decreased Carbon-13 and Nitrogen-15 ratios may indicate that a child had been neglected (Wheeler et al. 2013).

Before saying an individual was abused it is important to rule out a differential diagnosis. There are some diseases that cause bone remodeling that could look like healing fractures or injuries. Also, some diseases like osteogenesis imperfecta can make bones weak and more likely to break, increasing incidences of broken bones (Heldrich 2011). Then there is congenital
insensitivity to pain which can make the individual not feel pain and therefore they are more likely to injure themselves more often (Heldrich 2011).

Based on the five studies described above, there is good evidence that child abuse was around in the archaeological context. Child abuse in the archaeological context can be an important study in archaeology. It can help to determine the child’s place in society and the cultures thoughts on children. Were they thought of as little adults, things to be molded, or fragile beings? As studies are studying the importance of children in past societies, child could be an interesting topic to study further. This thesis could open the possibilities to more people when studying children and child abuse.
Works Cited:


List of Figures:

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