

# ANALYSIS OF PELVIC MORPHOLOGY AND BIRTHING PRACTICES: COMPARISONS OF MODERN AND PREHISTORIC HUMANS

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Obstetrics has changed drastically with improvements from the scientific community, but there are still many places of the world where modern medicine is underutilized. This study compares cultural practices of childbirth and pelvic morphology in industrialized humans and prehistoric humans. Morphological changes in the female pelvis were investigated using the Paleo-Indian population and Windover samples for the prehistoric data, as well as the Tague and Lovejoy samples and measurements from the Midwife Information and Resource Service for the industrialized data. Investigations of ethnographic accounts illustrate variations in birthing practices and facilitate comparisons for successful birthing. Results suggest a narrowing of the birth canal has occurred when comparing industrialized humans to prehistoric humans; thus, modern females may face more difficulty in labor. Moreover, wide adaptability in practices from culture to culture does not suggest a definite successful method, but highlights common procedures spanning groups that can point towards more effective means of giving birth.

In the last century, practices in obstetrics have drastically changed due primarily to the work of Doctors De Lee and Williams, who revolutionized procedures in childbirth and established obstetrics as a form of surgery and crisis management.<sup>1</sup> Obstetrics with modern humans differs from non-human primates in the space and ease of passage during labor, particularly with the necessary rotation of the neonate, the newborn at the time of birth. This results in humans' increased difficulty and need for attendants during birth, as well as an extension of birthing into a more social context since the time of our early hominid ancestors.<sup>2</sup> The objective of this study is to identify physiological shifts related to childbirth between prehistoric humans and modern humans and to evaluate potential birthing problems from past and current populations.

### Differences amongst prehistoric and postmodern humans

Past studies have assessed early hominid pelvic anatomy as being influenced first by bipedalism and later by brain size.<sup>3</sup> Today, there exist dramatic birth canal differences between humans and non-human primates. Other primates' birth canals are wider anterior-posteriorly, while humans' birth canals are wider medio-laterally. Secondary to this difference and a direct problem in human birth is that neonatal shoulders exhibit greater width than in other primates. Meanwhile, the birth canal in chimpanzees and gorillas is more than spacious enough to allow passage of the infant.<sup>4</sup> In one study, an Australopithecine pelvis was compared to those of a modern human and chimpanzee. Results showed that the pelvic morphology of *Australopithecus africanus* was more similar to the modern female human than to the female chimpanzee. The similar pelvises suggested both the *A. africanus* and modern humans require rotation of the neonate in the birth canal, but these conclusions are still contested. Researchers advocate that human mechanisms in obstetrics are quite dated and have their roots in ancestral origins.<sup>5</sup> Additionally, it seems modern birthing habits have a rather in-depth history. Fossil records suggest that pelvic features of prehistoric and modern humans do not differ that much.<sup>6</sup> However, in Upper Paleolithic groups, women in labor would frequently move and adjust their position by standing, squatting, and leaning forward to best accommodate the labor process. Labor in an upright position versus lying down allows the woman's pelvis to create a much easier and navigable passage for the baby to exit through.<sup>7</sup>

“The cultural concept of a ‘normal birth’ is a relatively contemporary notion...”

### History of Birth Process

Clinical studies have centered on the sweeping surge in caesarian rates, noting the mother's lack of knowledge, familiarity, and ease with the birthing process as primary motivators.<sup>8</sup> The cultural concept of a 'normal birth' is a relatively contemporary notion based on the influx of European and American thought and the introduction of technology. The arrival of the 19th century ended the perception of a birth assisted by a midwife as a natural birth. Intervention by doctors grew to be commonplace, and the implementation of sharp instruments during labor commenced. By the 20th

century, hospital births were most desirable due to the attractive procedures for the birth process, such as general anesthesia.<sup>9</sup>

The main question for this study surrounds how obstetrics has evolved from prehistoric humans to modern humans. Contiguous with this inquiry are the morphological changes that affect the birthing process and what procedures are best suited in obstetrics for modern humans. Thus, we address both the physiological and social aspects of obstetrics simultaneously. The null hypothesis is that the increase in human brain size induces complications on the smooth and swift passage through the birth canal, with maximum difficulty evident in modern humans. Furthermore, the cultural response to these difficulties will demonstrate an increase in medical intervention with both supernatural and clinical elements, and an increase in laissez-faire attitudes for the mother about the birth process, particularly in industrial human populations.

### **Prehistoric Humans**

Birthing practices in unindustrialized societies of today shine a light on methods that would have occurred in similarly functioning hunter-gatherer societies of the past. Modern medicine has yet to reach all corners of the world, and rituals and herbal remedies fill the need to attend to human health. Similar to modern medicine, an attendant is present during childbirth; however, the assistance provided may also fulfill social and spiritual needs to ensure a successful birth.<sup>10</sup>

In many simple societies, the women will work until they can no longer stand the pains of labor. In most circumstances, the mother will be surrounded by the support and love of female members of her family during the birth. It is also normal for young girls to be present at births to demonstrate what is to come for them. Rituals play a significant role in all stages of the birth, but contrast drastically among groups. Whether it is squatting, kneeling, sitting, or standing, some variation of a vertical position is almost always chosen. This posture provides an easier path for the child to be delivered; thus, delivery is relatively short and less painful.<sup>11</sup>

#### *The Kankanaly- Igorot*

The Kankanaly-Igorot of Northern Luzon, a Philippine island, utilize practices in childbirth derived from a belief in magic. Throughout the pregnancy, the mother wears a chain of snake vertebrae in the belief that it will prevent complications. Additionally, initial movements of the child are

believed to indicative of the sex of the child. For example, movement on the right side indicates a male child, while movement on the left side indicates a female child.<sup>12</sup>

At most births, the husband and a female relative accompany the mother. The mother will frequently use a squatting position and brace herself with a nearby window ledge. In some situations, the father plays a significantly more involved role; the mother will sit on his thighs and he will hold her to provide support. This method closely resembles an obstetric chair. The attendant catches the child upon delivery and helps massage the abdomen of the mother to initiate the placenta's release. The father buries the placenta to ensure wicked spells do not reach the child, thus living a salubrious life. The burial of the placenta is also symbolic for the Igorot perspective on opposites; the child's life depends on the burial, signifying death, of the placenta. In the days that follow, the umbilical cord falls off and is buried in a similar fashion. However, with males, the cord is buried close to the placenta; with females, it is buried near the house, but far from the placenta.<sup>13</sup>

#### *Gold Coast Colony*

In the Gold Coast Colony area of primitive Africa, animal and plant life plays a significant role in the preparation and aftermath of childbirth. Organs from various animals are ingested for ritualistic purposes but cause minimal side effects. Vaginal insertion of the same organs can result in serious scarring and contraction. The mother consumes herbal remedies of various plants to strengthen both her and the child. The maternal grandmother orchestrates the birth, and all other familial female attendants take guidance from her. At the occurrence of a complication, a male priest or herbalist may be summoned; although, his involvement in the process will be strictly non-intrusive and primarily drug based.

Delivery position varies with either squatting or kneeling down, and lubrication with shea butter is implemented upon a slow or tiring labor. Furthermore, assorted berries and animal excrements are placed within the birth canal, which causes the cervix to relax. Yet, there can be serious side effects to this practice; women may suffer sloughing of tissue, bleeding, and blistering. A thick porridge consisting of cassava, corn, or millet provides the mother with strength and is believed to offer more firm contractions. Additionally, ingestion of a form of *Azadirachta indica* roots aids to prevent postpartum hemorrhaging. Children born in this region generally have low birth weights; however, there is no evidence to suggest malnutrition.

Furthermore, these babies increase in weight much faster in comparisons to European babies.<sup>14</sup>

### *!Kung San*

The !Kung San in northwestern Botswana manage birth somewhat differently. A clan of women stress to the mother the importance of staying calm, free of fear, and courageous for the safety of her and her child's lives; yet, she faces the actual birth process alone. The mother is expected to recognize the labor pains and remove herself to a more solitary place. The practice of squatting during the labor process is the most commonly utilized in the !Kung society. From there, she must withstand the pains of labor and deliver her child, including the cutting of the umbilical cord. It is not until the child is fully stabilized that she may even tell anyone that she has gone into labor. In most situations, the first cries of the baby are the alert to the community of the arrival of the child. The exception to this practice is the birth of the first child, during which the mother receives assistance from older female relatives.<sup>15</sup>

Within hours of delivery, the mother returns to the village with the child, introduces them to family members, and begins feeding the infant. This method of solitary labor is recognized as having significant dangers. One account describes a woman that gave birth surrounded by a pack of barking stray dogs. Yet, the reasoning behind these practices is relatively sound. The society acknowledges there is only so much an attendant could do for the mother; furthermore, if persistent cries from the mother are heard, older females in the community will come to her aid. Additionally, past experiences have shown the people that interference can directly lead to infections due to the lack of training of the assistant. Moreover, solitary birth instills a significant amount of courage to persevere and enable the safety of mother and child and is initiated only after a mother has birthed her first child with the aid of attendants.<sup>16</sup>

### *Cherokee*

Cherokee Indians hold the role of midwife to a much greater standard. Near the end of the pregnancy, four women are chosen to attend to the mother. This group is comprised of female relatives, including an experienced midwife. When the mother's labor pains start, she is given a warm concoction derived from the bark of Wild Cherry *prunus serotina*. A medicine man or woman is called upon, and the attendants remain available to collect any necessary herbal ingredients.<sup>17</sup>

To begin the process, the attendants may circle the house to ward any interference from witches that may target the child and mother. The mother is normally in some variant of a sitting posture for the birth. In some cases, this involves sitting on the father's legs. A particular species of fungus is spread on the navel of the child after the cutting of the umbilical cord to prevent disease from arising. When the complication of a slow birth develops, a warm remedy of *Impatiens biflora* used to cleanse the mother's external reproductive elements; ultimately it is believed to surprise the child, thus encouraging a speedy delivery. Furthermore, attendants will speak with promises of toys, such as a bow and arrow or a loom, to lure the child out. Once the child is born, one of the attendants will care for and clean the child while the remaining attendants tend to the mother's needs as she prepares to deliver the placenta. Several remedies derived from the roots *Smilax glauca*, *Tsuga caroliniana*, and *Platanus occidentalis* are used for blood clotting. Depending on how many years in the future he would like another child will determine how many mountain ridges away the father buries the placenta. The mother rests for a few days before resuming her duties with some dietary restrictions in place for several weeks. A female elder in the community chooses the child's name.<sup>18</sup>

Ethnographic accounts highlight the unique characteristics evident in each group. Each population, through its own means, strives to utilize traditional practices that will prove most successful for the health and lives of both mother and child. While there are many differences around the world, these women share exceedingly similar skeletal structures; therefore, it will not come as a complete surprise that there are commonalities in practices among populations. Social interaction and attendants are particularly persistent in several of these cultures with an exception in the !Kung San. Herbal remedies and birth postures prove to be the most common aspects of variability in comparing populations. These ethnographic accounts demonstrate birthing practices that are comparable to those of prehistoric humans.

### **Modern Birthing Practices**

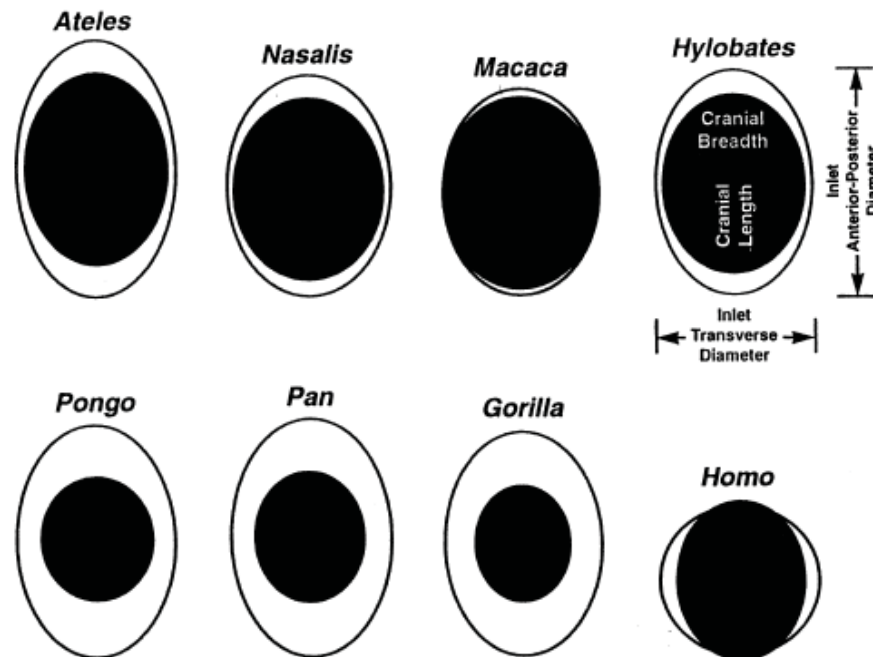
Fertility and childbirth have played major roles in societies for much of human history; however, it was not until the early 1500s that Eucharius Rosslin's *The Rosengarten*, the first obstetric textbook, was available and met great popularity in urban areas. Obstetricians became the primary care facilitator for women in labor, while the midwives were summoned only in complications, contrary to their roles in early history. *The Rosengarten*

allowed men, as doctors, to enter the birth process, which before this point was quite rare. Hugh Chamberlen was a doctor stemming from a long family line of obstetricians and was the originator of the Chamberlen forceps. Compared to modern forceps, these had a curve to fit the baby's head but not to fit the pelvis. William Smellie made improvements to the forceps and also established procedures that are still used today for using the tool. In the 19th century, maternal mortality was particularly high; women faced epidemics that made them too weak to survive childbirth. James Young Simpson, the physician to the Queen of Scotland in 1847, developed the model of obstetric forceps that is still used today and experimented with chloroform as a means of anesthesia. Caesarian sections first began to appear in the mid 1700s and were performed without anesthesia, frequently resulting in hysterectomy.<sup>19</sup>

The 20th century drew attention to the need for antenatal care. Additionally, the vacuum extractor was invented in Sweden and was shown to cause less damage internally to the mother. A breakthrough in antibacterial solutions improved childbirth by preventing infections and ultimately saving lives. The implementation of drugs to prevent hemorrhaging was soon to follow. Moreover, the 20th century saw a shift in attention to the child as more technology was developed to monitor the child's progress during the pregnancy.<sup>20</sup>

The shape of the female pelvis exhibits many of the complications women face in childbirth. In comparison to other related species, humans face more difficult birthing biomechanics. The human birth canal is widest in its transverse dimension, while other primates have a wider sagittal dimension (Figure 1). In contrast to the human pelvis, the pelvises of the great apes, labeled in Figure 1 as Pongo, Pan, and Gorilla, show a significant difference in the ratio of infant head size to pelvic size. The head of the infant is at its maximum in the sagittal dimension for both non-human primates and humans. The massive breadth of a human child's shoulders upon delivery poses an additional complication. To allow the child to pass through the outlet of the pelvis, the fetal head must be arched such that the occiput, or the back and lower part of the cranium, lines up with the pubic bone, rather than with the sacrum, the triangular bone at the base of the spine, as in non-human primates. Due to this difficulty, human mothers are unable to catch the child themselves as it is birthed. Consequently, an extreme care of maneuvering in rotation and flexion must occur for the child to make it through the outlet; thus, many children are born facing posteriorly rather than anteriorly, which occurs in other primates.<sup>21</sup>

Figure 1: Comparison of primate pelvic cavity size in relation to the neonatal head



Source: Rosenberg and Trevathan, 2002.

Caesarian rates have seen a significant increase across the world in the last fifteen years, particularly the more industrialized areas. The global caesarian rate was at 25.7% in 2010, with a 43% rate in Mexico and a 33% rate in the United States, and the rate is on a continuously sharp rise.<sup>22</sup> In many cases, caesarian sections were implemented although the mother was not at risk and/or had not approved the procedure. The rise in rate can be attributed to many possible factors, such as an increase in payment and less risk of malpractice for doctors, as well as greater turnover of patients in the hospital. Past studies show that women with private insurance are more likely to have a caesarian section than indigent women. Cases are appearing in the United States where there is no risk to the mother, but a caesarian section is still performed. Furthermore, a caesarian section has the potential for side effects that will affect the mother's next birth, such as rupture of the uterine scar.<sup>23</sup>

Home or "natural" births have re-circulated into western culture, but still face some skepticism. These practices have been labeled as primitive,



feminist, or spiritually based; however, they can represent a holistic approach to childbirth. By World War I, childbirth had acquired a primarily pathological approach. The return of natural childbirth peaked with the belief in an overly civilized world; women had lost touch in their health, and suffered extensive and painful labor as a result.<sup>24</sup> Many women across the world are choosing what they deem to be a more satisfying birth with less medical interference and lower costs. The Netherlands is the current leader in home births, with 30% of all births occurring in a domestic setting. While home birth has a stigma of being less civilized, studies in the United States show no difference in neonatal mortality rates than in a hospital.<sup>25</sup>

Childbirth has transformed significantly in more recent history. Improvements in tools and new knowledge have improved medicine, and during this time, childbirth was enveloped into the domain of surgery. Now, even healthy women may face surgical procedures before, during, or after labor. Some women have sought out alternatives methods, such as home births or birthing centers. The ultimate goal is the security of the lives and health of mother and child, but medical professionals debate on which measures are the most successful.<sup>26</sup>

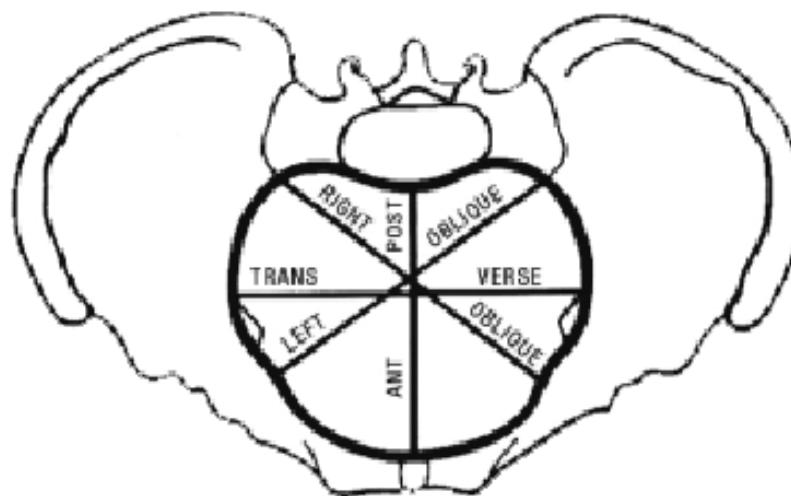
### **Materials and Methods**

This thesis project focuses on the comparison of modern-day humans and prehistoric humans. Pelvises from females in the Windover population, site 8BR246, housed at the Florida State University Anthropology Department were utilized to gather data on a prehistoric population, while ethnographic data on birthing practices was used as a social proxy. In a qualitative approach, a review of ethnographic accounts included as part of the comparison of prehistoric human practices to modern birth practices. This population was a hunter-gatherer society and originates from a site in Brevard County, Florida dating 8,522 to 7,421 years ago. Five fully intact female pelvises, including two young adults, two middle-aged women, and one older woman, were used to gather measurements.

Measurements from this population were collected using a tray and fish tank gravel to provide stability of the subject, and calipers and measuring tape to determine the dimensions. Additional pelvic data were derived from a study by Tague and Lovejoy, and from the Midwife Information and Resource Service. Main dimensions of significance are sagittal and transverse (Figure 2). Measurements were taken from three planes: inlet, midplane, and outlet. The inlet is the most superior plane of the pelvis, the

outlet is the most inferior plane of the pelvis, and the midplane is situated between the inlet and outlet. Sagittal measurement is taken from the most posterior aspect of the sacrum to the most anterior aspect of the pubis. Transverse measurement is taken from one lateral side of the plane and continues through the medial aspect to the other lateral side of the same plane. Pelvic dimensional data was utilized to conduct quantitative analysis.

Figure 2: Diameters of the pelvic brim



Source: Midwives Information and Resource Service.

SPSS software was used to conduct statistical computations and comparisons among the different pelvises. Descriptive statistics were initially run to determine mean, median, and standard deviation of the data. The Mann-Whitney U statistical test was used to conduct a non-parametric test and to examine significance in difference between the groups.

## Results

### *Dimensional Data*

Table 1 shows the descriptive statistics for the pelvic dimensions of the Windover population. Variables below include the sagittal and transverse dimensions of the inlet, midplane, and outlet. The application of the Mann-Whitney U test showed low p-values in each comparison of dimensional plane. Therefore, it can be suggested that there is a relatively significant difference between dimensional planes in the Windover and modern samples. Due to the small sample size, a p value of .10 was used to compensate for standard error.

Table 1: Statistics for Windover Population

	Minimum	Maximum	Mean	Standard Deviation
Inlet- Sagittal	95.25	127.00	108.59	12.78
Inlet- Transverse	119.00	144.00	131.63	8.96
Midplane- Sagittal	101.60	127.00	114.30	9.79
Midplane- Transverse	123.83	146.05	133.99	9.09
Outlet- Sagittal	95.25	120.65	111.76	10.63
Outlet- Transverse	111.13	152.40	129.16	18.02

The following scatterplots (Figures 3, 4, 5) display the sagittal dimension on the y-axis and transverse dimension on the x-axis. The plotted points represent each individual in the data set. Individuals are given abbreviated labels distinguishing their source. Labels with the abbreviation “WS#” denote samples of the Windover population, while “MIDRIS” and “Lovejoy” are modern human samples from the Midwife Information and Resource Service<sup>27</sup> source and Tague and Lovejoy<sup>28</sup> source.

In studying pelvic morphology, samples from the Windover population and previous studies were utilized for comparison. As seen in Figure 3, the inlet dimensions of the modern pelvises are relatively similar to those of the Windover population. Yet, figures 4 and 5 show distinct differences in midplane and outlet dimensions between the two groups. Figures 4 and 5 show an increase in sagittal dimension and a decrease in transverse dimension in the midplane and outlet for the modern population. The Windover population demonstrates a larger sagittal dimension and a larger transverse dimension in the midplane; the outlet measurements are relatively distributed in low and high sagittal and transverse dimensions. These results suggest a decrease in the transverse dimension and a narrowing of the modern human pelvic cavity from inlet to outlet. As seen in Figure 1, the size of the neonatal head already makes for a tight fit through the birth canal. The cranial breadth is pushing the capacity of the sagittal dimension of the female pelvis. Any decrease in size of the canal would initiate more complications and put both mother and child at risk.

Figure 3: Scatterplot showing dimensions of the pelvic inlet

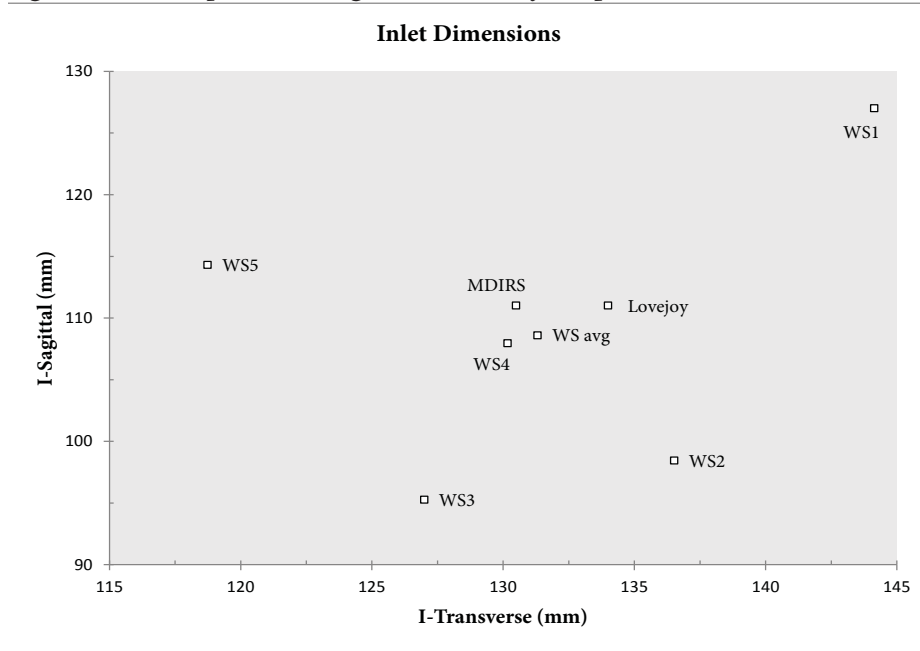


Figure 4: Scatterplot showing dimensions of the pelvic midplane

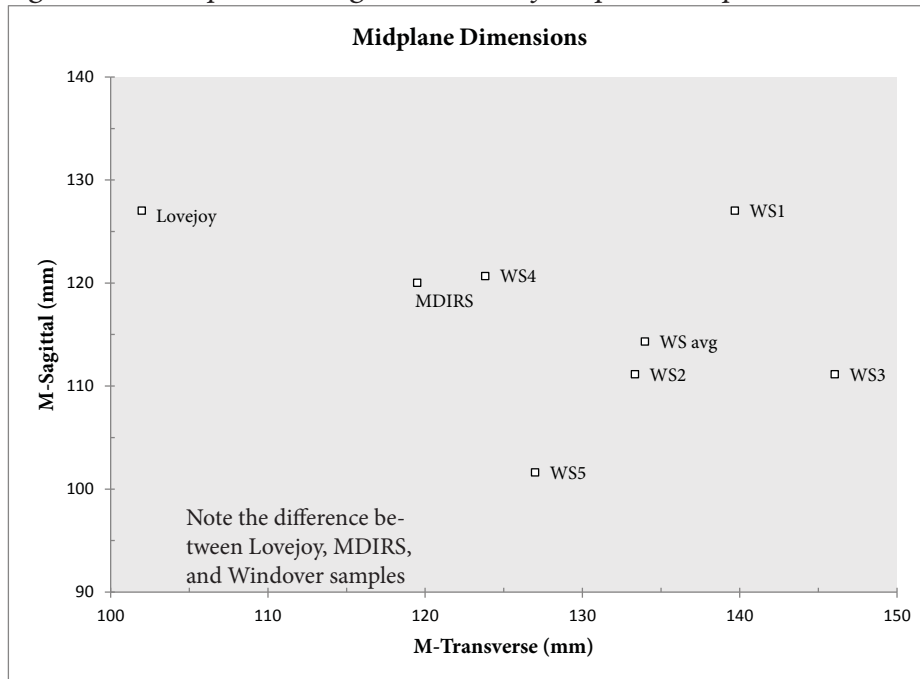
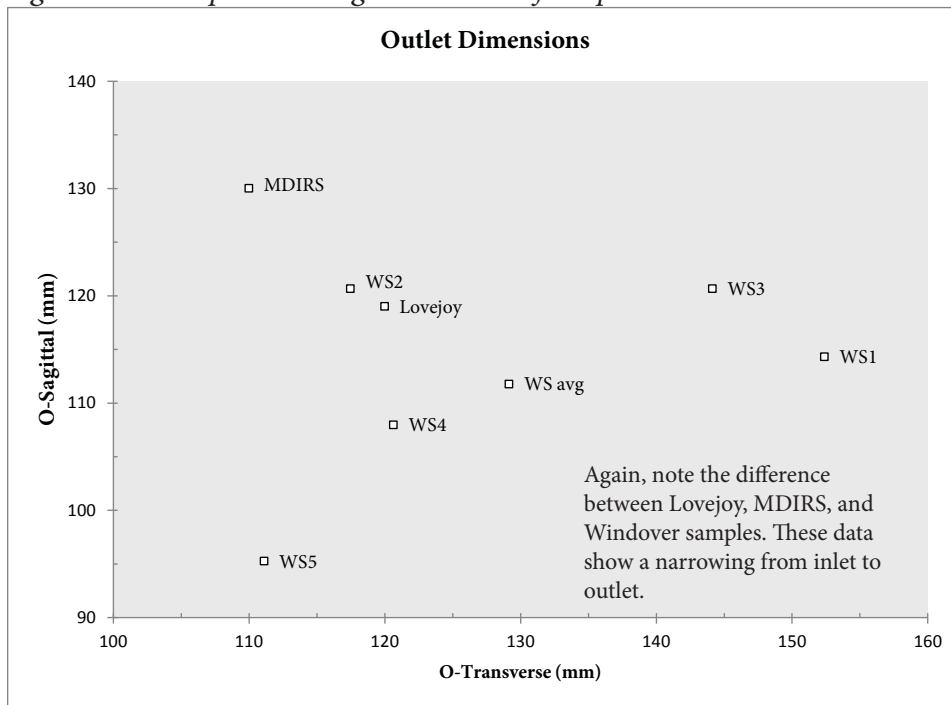


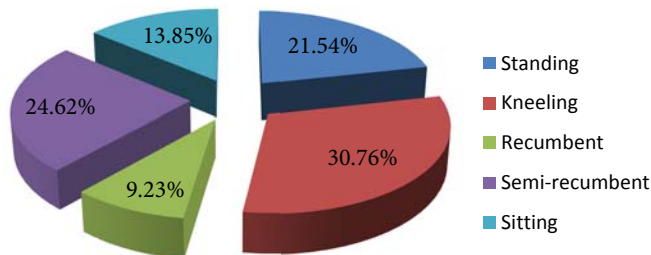
Figure 5: Scatterplot showing dimensions of the pelvic outlet



*Ethnographic Accounts*

A review of ethnographic accounts was included in this study. The recordings of George Julius Engelmann in *Labor Among Primitive Peoples* were utilized to illustrate the percentage of birth postures in use across the world. Engelmann’s data demonstrates the usage of five different birthing postures as recorded in *Labor Among Primitive Peoples*. His recordings are somewhat dated since they were published in 1882. These percentages are inclusive of populations from all continents and include surrounding islands (see Figure 6).<sup>29</sup> Engelmann’s work provides a thorough summary of practices witnessed in ethnographic accounts.

Figure 6: Birthing postures, worldwide



Source: Engelmann’s *Labor Among Primitive Peoples*, 1882.

## Discussion

This study set out to look at changes in birthing practices, morphological changes to the pelvis over time. Ethnographic accounts were gathered for comparisons of birthing practices and postures.

Pelvic data demonstrates differences between the Windover and modern human samples. Comparison of the transverse dimensions showed decreases in the modern samples, resulting in a more narrow shape. This transformation in form would obstruct a smooth neonate passage and intensify the labor process. The size of the infant's head poses evident problems for ease of fitting through the mother's pelvis. Rotation and flexion would have to be implemented to squeeze the child through such a constricted passageway.

The ethnographic data derived from Engelmann's work suggest the largest percentage of the global population delivered their children in a kneeling posture, with standing posture coming in second.<sup>30</sup> A recumbent posture, meaning lying down dorsal inferiorly, was found to be used least often of the birthing postures. Ethnographic accounts also place a strong contrast between mothers in primitive settings and mothers employing modern medicine. In many primitive cultures, close family or female relatives support the birth process; however, the success of the birth is in the hands of the mother. On the contrary, birth in modern hospitals is completely at the hands of the physicians and nurses. The mother is not always aware of what is occurring within her body. When a complication arises, she may not be informed or may not be asked her opinion on the matter. The medical staff frequently makes a quick decision on how to best handle the risk at hand. Births in primitive societies are relatively shorter, and mothers can resume their normal lives reasonably soon.<sup>31</sup> Primitive societies also value superstitions and ritualistic practices unique to their group that they deem crucial to the success of the birth and ultimately the life of the child and the mother.<sup>32</sup> Births in hospitals can provide more security for the mother and child; necessary equipment and medicines are readily available at the time of a complication.

Other ethnographic accounts illustrate practices unique to several dissimilar and spatially contrasting populations. Some methods hold distinct and somewhat appalling measures to a western perspective. In some instances, plant extracts are applied orally or vaginally to alleviate initial and prolonged pains resulting from the birth, as seen in the Cherokee Indians<sup>33</sup> and the Gold Coast Colony.<sup>34</sup> An additional, remarkable tradition is the

husband's role as not only emotional encouragement, but also as physical support as his thighs function as a chair for his wife to sit on during birth, as seen in the Kankanaly-Igorot.<sup>35</sup> The placenta and fluids from the birth also hold a particular stigma to the community and must be disposed of in accordance with each group's unique rituals. Attendance and personal responsibility in the process are extremely important themes across differing cultures.

### Conclusion

The success of the birthing process is fundamental to the continuation of our species. It is a topic that attracts a great deal of attention with recent increases in cesarean rates and with some families' choice for natural births. This study was effective in identifying variations in practices for a prosperous birth. Quantitative analysis of pelvic dimensional data was also able to show variations in the birth canal size. Therefore, it can be suggested that morphological changes in the female pelvis may add to increased complications. It is inconclusive as to what specific practices, if any, are most beneficial to mother and child. Variability in mother's health, infant's health, mother and neonatal body size, and birthing posture can all play significant roles in the feat of a birth.

### *Limitations of the Study and Future Research*

Due to the limited data sample size, an analysis with more extensive data of prehistoric and modern human pelvises would provide for an improved study in the future. Based on Bergmann and Allen's rules, an additional interesting variable could be implemented on how populations in fluctuating climates may possess differing pelvic dimensions. Qualitative data in the form of interviews with currently practicing physicians and midwives would be beneficial. Furthermore, maternal interviews would provide tremendous additional insight into childbirth complications and female involvement in births.

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