

## EVIDENCE OF CHILDBIRTH IN THE PELVIS OF PREHISTORIC ANDEAN WOMEN

Bernardo Arriaza\*  
Charles F. Merbs\*

### INTRODUCTION

A study by Arriaza *et al.* (1988) involving mummies from northern Chile gives us some insight into problems of accouchement faced by women of prehistoric Andean populations. Of 128 females of childbearing age, 18 (14%) were judged to have died from childbirth related complications. Death in these cases may have occurred before, during, or after accouchement took place. The majority of these females appear to have died during puerperium, a diagnosis based on the lack of fetal presence in the uterine area and other features (Arriaza *et al.* 1988: 36). Only three (16.6%) died before delivery, one having a full-term fetus in breech position, another probably having twins, and the third having an undelivered fetus of seven to eight months gestation. The average biological age (estimated) of females who faced childbirth-complicated death (CCD) was 30.3 years. In contrast, the average age of the other females was lower, 28.6 years. The youngest woman to die of childbirth complications was 18-20 years of age while the oldest was 40-42 years old.

Intercultural phase comparison indicated a maternal death rate of approximately 25% for the earlier phases through the Tiwanku phase (A. D. 600). The rates decrease after this date, with the later San Miguel (A. D. 1200) and Gentilar (A. D. 1400) phases having the lowest rates, 6.2% and 4.7%, respectively. This decline could be attributed to improvement of delivery methods or better prophylactic techniques in the

\*Department of Anthropology, Arizona State University, EE. UU.

ACKNOWLEDGMENTS: Financial support for this research was provided by the Graduate Student Association and the Department of Anthropology, Arizona State University.

the relatively small sample size ( $n=128$ ) relative to the large time span (2 700 years) covered by the study.

A review of the ethnographic literature of the Andean area shows that care of pregnant females varies with geographic region. Among some groups, for example, a series of ritualistic ceremonies and shamanistic aids were necessary to achieve eutocia (Lastres 1951; Núñez 1965). Subsequently, taboos may be observed during daily activities, or at least until recuperation. In other areas, females regarded childbirth as a normal physiological process and engaged in heavy tasks, or tasks that isolated them from their community, until accouchement occurred. After delivery the baby was wrapped and carried on the mother's back while she continued with her duties (Núñez de Prado 1963; Gavilán, personal communication 1987). According to ethnographic and archaeological records, childbirth in the ancient Andes took place in some type of vertical position such as sitting. The earlier chroniclers, such as Cieza de León, describe childbirth for the Andean females as an easy, uncomplicated physiological process. However, the cases found by Arriaza *et al.* (1988) indicate that Andean women did indeed suffer and face CCD. These maternal deaths were likely increased by circumstances of delivery (sometimes isolated and without support), septic conditions, and acute diseases such as pneumonia (Fontana *et al.* 1983; Arriaza *et al.* 1988). In the case of dystocia, the woman was put into a blanket and four people would repeatedly throw her up and drop her into the blanket hoping that the baby could thus be brought into the correct position (Núñez de Prado 1963: 47).

## PELVIC ANALYSIS

Based upon the results of the previous study, a second study was carried out to examine the ancient pelvis, particularly its size and shape, aspects of pathology that could have affected childbirth, and osteolytic scars possibly related to childbirth. Various kinds of pelvic scarring were tested to determine their possible use as indicators of differential fertility based on the hypothesis that the scarring should increase as the population evolved from a hunting/gathering (pre-agricultural) subsistence to an agricultural/pastoral economy due to demographic explosion.

A total of 269 pre-Columbian skeletons (table 1) from the same collection at the Universidad de Tarapacá, Chile, used for the first study, were examined. The cultural distribution of the material ranges from late Chinchorro (4000 B. C.) to Inca (1500 A. D.). The sample was

TABLE 1. Pre-columbian populations of Arica

<i>Phase</i>	<i>Time</i>	<i>Cases</i>		
		<i>Female</i>	<i>Male</i>	
Late Chinchorro	4000 to 2000 B. C.	24	27	Pre-agriculture
Quiani	1300 B. C.	3	1	Pre-agriculture
Azapa	1300 to 560 B. C.	4	1	Pre-agriculture
Formativo*	200 B. C.	4	5	Pre-agriculture
Alto Ramírez	490 B. C. to A. D. 320	14	13	Agriculture
Cabuza	A. D. 380 to 590	30	14	Agriculture
Tiwanaku	A. D. 500 to 600	3	1	Agriculture
Maitas Chiribaya	A. D. 730 to 1235	39	20	Agriculture
San Miguel	A. D. 1200	16	10	Agriculture
Gentilar	A. D. 1200 to 1400	18	11	Agriculture
Inca	A. D. 1500	6	5	Agriculture
Total (269)		161	108	

\*The cultural phase has not been determined yet.

divided into two main categories according to the presence or absence of agriculture, the pre-agricultural groups consisting of the Chinchorro, Quiani and Azapa cultural phases, and the agricultural (including pastoralist) consisting of the Alto Ramírez, Cabuza, Tiwanaku, Maitas Charibaya, San Miguel, Gentilar and Inca cultural phases (Muñoz 1981; Santoro 1982; Focacci 1982). The sample includes adults of both sexes, 161 females and 108 males, which are considered from both archaeological and anatomical perspectives. It is important to note that these are skeletons of *known* sex, the sex in each case having been established by the presence of mummified genitalia.

### *Pelvic size and shape*

The varying shapes of the human pelvis are described as gynecoid (round, common female type), android (heart-shaped, common male type), anthropoid (compressed mediolaterally), and platypelloid (compressed anteroposteriorly), based upon a system developed by Caldwell and Moloy (1933). Among the female pelves (n=135) examined in this study, 89% were found to be gynecoid, 7.3% platypelloid, 3.7% android, and 0% anthropoid. Among the males (n=97), 94.8% were found to be

android, 5.2% were gynecoid, and the anthropoid and platypelloid types were absent. No significant differences were found between the pre-agricultural and agricultural groups.

Pelvic inlet size irrespective of shape is also an important factor for delivery. With this in mind, 24 measurements which examined various aspects of size and proportionality of the birth canal (true pelvis) as the false pelvis were taken for each individual (Arriaza 1988: 59-64). When taking these measurements the bones of the pelvis (os coxae and sacrum) were articulated by fitting the sacro-iliac facets together as tightly as possible. No compensation was made in the pubic symphysis for cartilage. The bones were held together using strips of modeling clay (Klean Klay).

According to Langer and Kennedy (1981), over 40% of women today have a gynecoid-shaped (normal) pelvis, 32% have the android type, 23% have the anthropoid type, and 2-3% have the platypelloid type. In contrast, Whitley (1985: 162) found 84.6% gynecoid, 4.5% android, 7.3% anthropoid, and 3.1% platypelloid. Unfortunately, neither study indicates the population being described. In clinical patients, the diagonal conjugate diameter is the most common measurement taken to determine the size of the true pelvis, and if this diameter is found to be much below the normal clinical average (12.5 cm), the pelvis is assumed to be oval-shaped in the transverse axis, or platypelloid. Delivery could be difficult and risky if the other diameters were also low. The diameters of the fetal head must also be taken into consideration although during childbirth the cranial bones of the fetus are unfused and movable, so that they can overlap and thus temporarily modify the shape of the cranium when under pressure. In this way the cranial diameters might be reduced and labor facilitated. Fetal position is another factor which must be considered when evaluating the pelvis. Regardless of these factors, however, women possessing an android-type pelvis, with its converging, funnel-shaped walls, are felt to be most disadvantaged because of disproportionate cephalo-pelvic diameters.

### *Pelvic pathology*

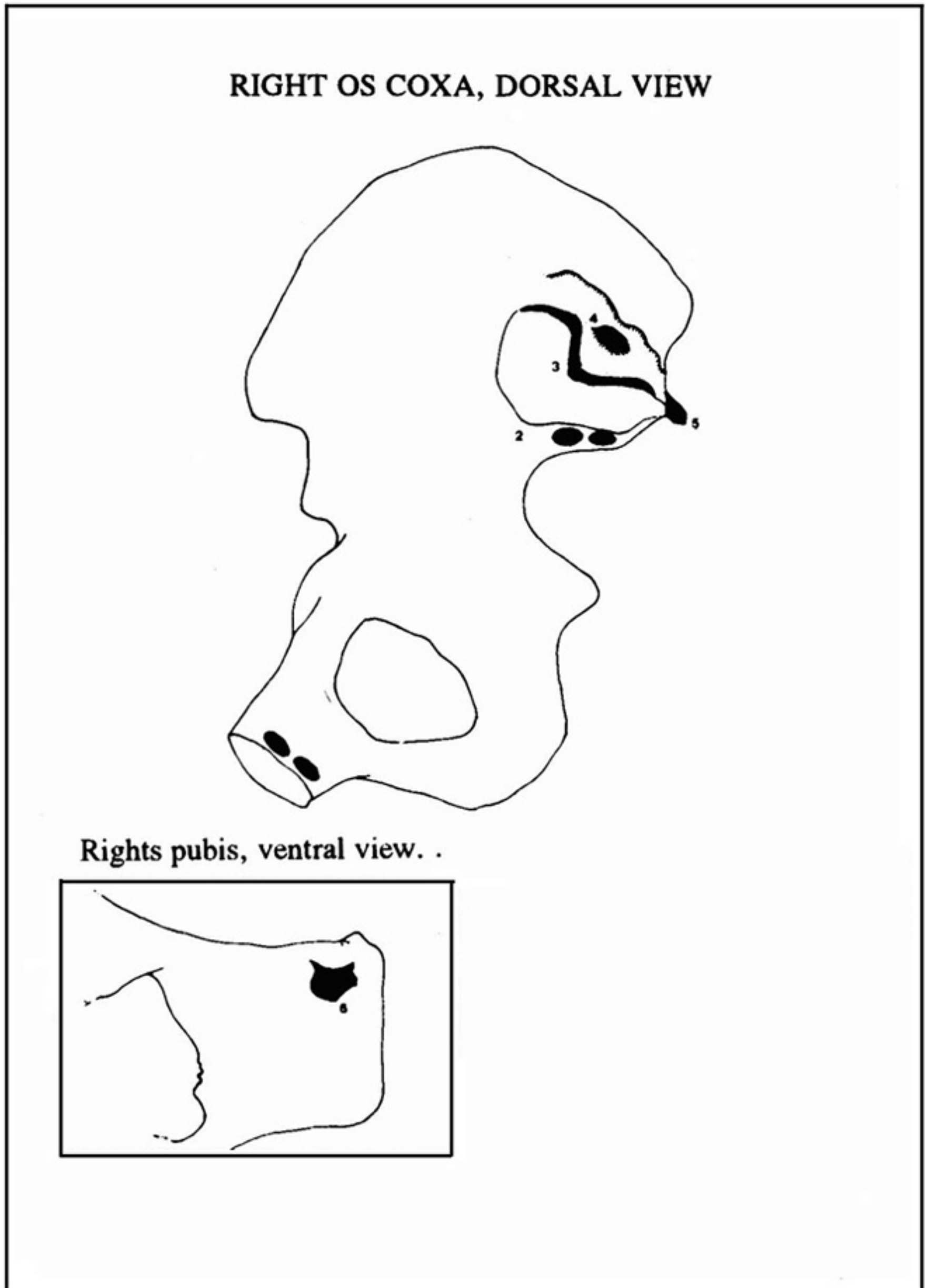
Pelvic diseases that might have increased the risk of death during labor were found to be rare in females of both the agricultural and pre-agricultural groups. Incipient and advanced sacro-iliac ankylosis was found in nine cases (5.1%). One of these, with complete, smooth, bilateral fusion, unfortunately lacked provenience. Of the eight cases with cultural

associations, only two belong to hunting/gathering groups, with the others associated with later, more sedentary, life styles. One of the cases involved a young adult (20-21 years of age) with the remaining seven involving older individuals (over 40 years of age at death). Unfortunately, with these older individuals it is difficult to determine the age at which the fusion began. If ankylosis of the sacro-iliac synchondrosis took place during their childbearing years, as in the case of the younger individual, the risk of death would obviously increase since the diameters of the pelvis would have become fixed. Dislocation and separation could then not occur, making delivery more difficult. Other pathological conditions involving the pelvis were noted, but they appear to have had little if any effect on childbirth.

*Pelvic osteolysis ("scars of parturition") and deformations*

Pelvic stress becomes more pronounced during pregnancy and in this condition the entire female body is undergoing constant change. Hormone release together with the increasing size and weight of the fetus pushing down help to produce relaxation of the pubic symphysis and sacro-iliac joints. Gradual stretching and tearing of ligaments such as the arcuate pubic and sacro-iliac ligaments may thus occur. This can result in hemorrhages with consequent osteitis and osteoclastic reactions producing permanent pits or grooves in and around the joints of the pelvis, a condition common referred to as "scars of parturition" (Stewart 1970; Houghton 1974; Putschar 1976; Kelley 1979; Suchey *et al.* 1979). The bone destruction commonly takes place on the dorsal surface of the pubic ramus, the anterior part of the pre-auricular surface (ilium), and in the interosseous groove posterior to the auricular area (ilium) (figure 1). In this last location, the "scars" are more difficult to detect because of the already irregular morphology of the bone. The term osteitis pubis is sometimes loosely used to describe the dorsal pubic pitting in dry bone. This term is rather misleading, however, since it implies just inflammation of the bone and not a lytic reaction. The term osteolysis would be more appropriate because it indicates that a destructive action took place.

The body's center of gravity is located near the pelvis, thus bringing this bone under constant stress during erect posture and locomotion. Fraser (1958) points out that the sacro-iliac joint is in a direct line of transfer of body weight and is therefore under greater stress than the



*Figure 1.* Potential indicators of parturition (darkened areas): 1. dorsal pubic pitting; 2. pre-auricular groove; 3. interosseous groove; 4. articular facet on iliac tuberosity; 5. protruding post. inf. iliac spine; 6. ventral pubic depression.

symphysis pubis and should thus show greater scarring. Scarring of the symphysis pubis and sacro-iliac joints may form due to childbirth, and it is commonly believed that such scars increase in size with subsequent ligament distention and parturition. Recently, Andersen (1988) concluded that there is no good correlation between scarring of the pelvis and parity status. She suggests that the scars are the result of "excess motion" of the pelvis due to daily stress rather than correlating directly with the number of children born to a female. Females should thus show more scarring than males due simply to a looser fitting pelvic girdle. During pregnancy and childbirth, the separation of the female symphysis pubis may increase with the pelvis thus fitting even more loosely and producing a resultant increase in motion. At the Instituto de Antropología in Arica, as much as 6 cm of separation has been found in female mummies that died during childbirth or puerperium in northern Chile (Arriaza *et al.* 1988). In a normal accouchement, the joints appear to recuperate to their normal anatomical position in a matter of weeks, or sometimes months, after birth, although sometimes not exactly to the prepregnant dimensions (Lange and Kennedy 1981: 743; Young 1940).

Previous scholars have reported studies focusing on a particular area of the pelvis and there is still controversy as to what extent the pelvic osteolysis (scars of parturition) are good indicators of full-term pregnancies and deliveries. According to Holt (1978), the pelvic osteolysis found in the female dorsal pubic surface cannot be attributed to birth alone. The size and shape of the pelvis may affect the location of pelvic osteolysis found in multiparous and nulliparous women, and also in men, but the scarring found in the latter two categories obviously have a different etiology. It is important to note that in men and nulliparous women the scarring tends to be mild in expression and appears to be a product of stress from daily movements of the joints. According to Kelley (1979), there is a 20% chance that nulliparous women have scarring in the sacro-iliac region. Davivongs (1963) also found mild expressions in the pre-auricular surfaces of males in 50% of the Australian aboriginal pelvises he studied. Studies by Suchet *et al.* (1979) show a low to moderate correlation between full-term pregnancy and dorsal pubic pitting (0.383) and pitting versus age (0.375). However, Houghton (1974), Kelley (1979), and others who examined several variables at the same time, such as pre-auricular and interosseous grooves, found that a moderate to strong pre-auricular groove is a good indication of full-term pregnancy. Another controversy involves the stability of the scarring. Suchey *et al.* (1979) reported that women who

gave birth to their last children 15 or more years before death displayed medium to large dorsal pubic pitting, while Kelley (1979) reported that scarring in elderly females became obliterated, losing their definition.

Other factors such as degree of dystocia, size and shape of the pelvis, and position of the woman during accouchement (*e. g.*, squatting versus supine) may also affect the amount of ligament tearing and osteolysis that occurs in the os coxa. A gynecoid pelvis, for example, may show less scarring than an android, platypelloid, or anthropoid pelvis for a given number of births. A disproportionate cephalo-pelvic size ratio could also affect the scarring.

Besides examining traditional pelvic scarring, this study also looked at new variables. One of these is the presence of a raised facet on the iliac tuberosity which articulates with the sacral tuberosity (figure 1, 4, and figure 2, left arrow), and can vary in size, shape, and location

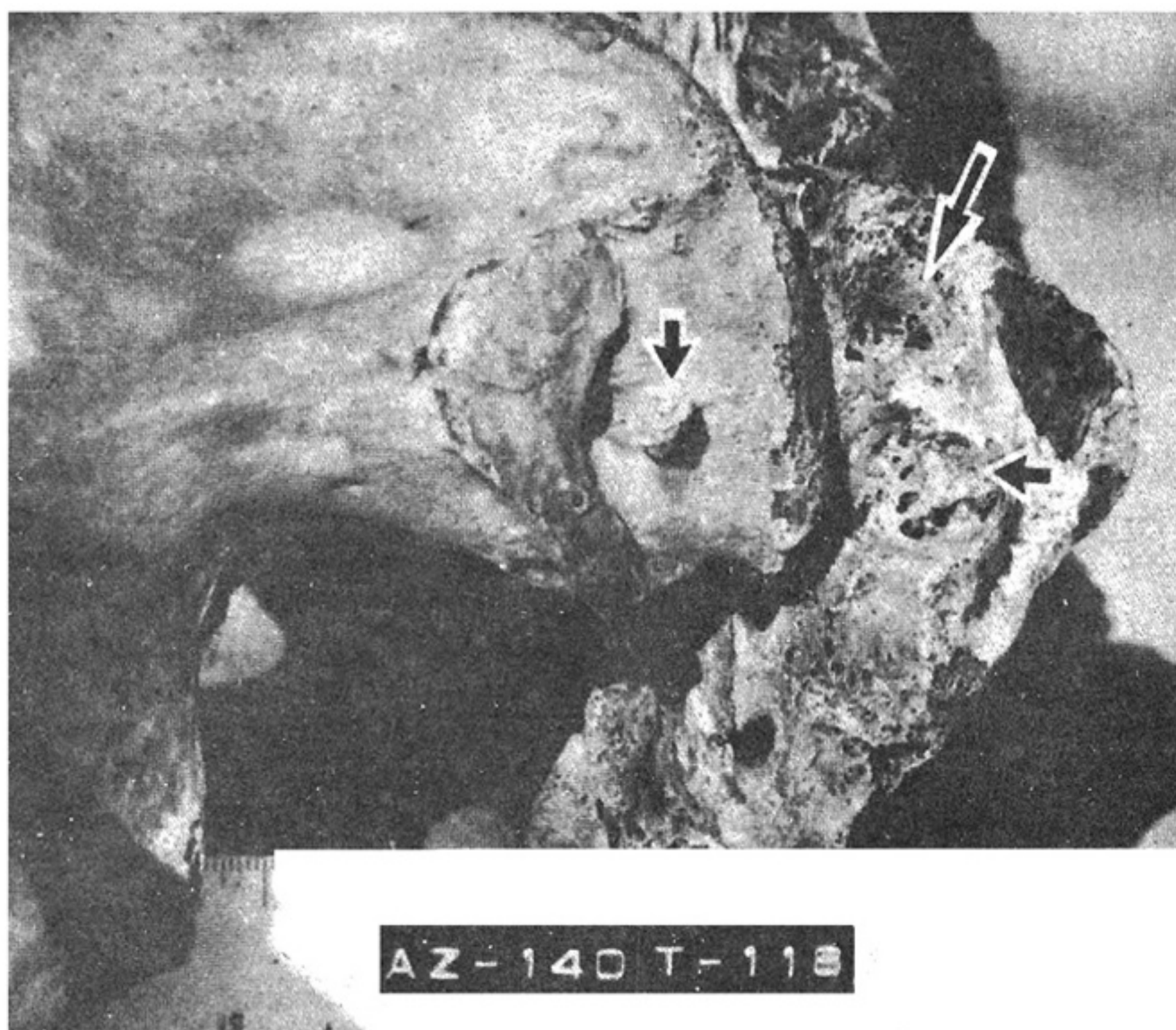


Figure 2. Right os coxa and sacrum showing facet on iliac tuberosity, left arrow; depression on sacral tuberosity, upper arrow; and facet on sacral tuberosity, right arrow.



along the iliac tuberosity. Another is a protruding posterior inferior iliac spine represented by a deformation and osteophytosis of this spine (figure 1, 5), and a third is the ventral pubic depression, a pit in the anterior surface of the pubic ramus below the pubic tubercle (figure 1, 6). These variables were tested for possible sexual dimorphism and correlation with pelvic size.

Three new variables involving the sacrum were also added. These include a] osteolysis on the anterior lateral part of the sacrum consisting of a groove or sulcus in the portion of the auricula where the anterior sacro-iliac ligament attaches in juxtaposition to the pre-auricular groove, b] a depression on the sacral tuberosity along the superior dorsal margin of the lateral sacral crest (figure 2, upper arrow), and c] facets on the sacral tuberosity (figure 2, right arrow) which are in contact with the facet of the iliac tuberosity.

The dorsal pitting, pre-auricular groove, interosseous groove, and sacral groove were recorded for both right and left bones on a scale from absent through mild, moderate, and severe. To some extent this scale is arbitrary because the size of the features, as pointed out by Suchey *et al.* (1979), "fits a continuum model." An interval/ratio variable is thus being converted into an ordinal variable. This four point grading system was modified from Stewart (1970), Houghton (1974), and Kelley (1979), and is based on the degree of severity of osteolysis, with the moderate/severe category separated into two parts. The facet on the iliac tuberosity, protruding posterior inferior iliac spine, ventral pubic depression, depression on the sacral tuberosity, and facet on the sacral tuberosity were recorded as present or absent. All traits were recorded bilaterally and the maximum score was used.

### *Pelvic osteolysis and sex*

The general hypothesis that osteolytic features considered in this study are expressed differently in the two sexes was found to be true, with females showing significantly higher frequencies than males at the  $p \leq 0.05$  level of significance. An exception is the depression on the sacral tuberosity (table 2). It seems likely that the higher percentages of these traits seen in females can be attributed to stress experienced during pregnancy and childbirth, but other cultural and mechanical factors cannot be ignored. As a general rule, females tend to have better demarcated grooves, depressions, deformations, and facets than males.

The variable having a higher degree of association with sex proved

TABLE 2.  $\chi^2$  and measures of association using sex as the independent variable

<i>Y</i>	$\chi^2$	<i>deg. of freedom</i>	<i>P</i>	% <i>Ef &lt; 5</i>	<i>Ho</i>	<i>Lambda</i> <i>Y dep.</i>	<i>Lambda</i> <i>sex dep.</i>	<i>Cramer's</i> <i>V</i>
<i>Dep. var.</i>								
Dorsal pubic pitting	136.8	3	0.0000	none	R	0.13	0.60	0.72
Ventral pubic depression	52.0	1	0.0000	none	R	0.07	0.27	0.47
Pre-auricular groove	168.0	3	0.0000	none	R	0.26	0.70	0.80
Interosseous groove	206.1	3	0.0000	none	R	0.41	0.84	0.89
Sacral groove	59.8	3	0.0000	none	R	0.00	0.35	0.49
Facet iliac tuberosity	41.5	1	0.0000	none	R	0.00	0.15	0.41
Facet sacral tuberosity	24.2	1	0.0000	none	R	0.00	0.00	0.33
Protruding post. inf. iliac spine	99.8	1	0.0000	none	R	0.61	0.53	0.63
Depression sacral tuberosity	36.0	1	0.0563	none	A	0.00	0.00	0.13

*Ho*: There are no significant differences between the sexes and the frequency of osteolysis or deformation in the pelvis. *R*: *Ho* is rejected,  $p \leq 0.05$

to be the pre-auricular groove and the interosseous groove, with lambda values of 0.70 and 0.84 respectively. Put in another way, if information on these grooves is available, there is a 70%-80% reduction in error in predicting the sex of an individual. The association is not perfect because the prehistoric males analyzed in this study sometimes showed mild, and in a few cases even moderate, osteolysis. Pelvic osteolysis is usually more severe in females than in males, but caution is still recommended when using these variables to assess parity or assign sex on the basis of fragmentary pelvic remains. It must be kept in mind that some males possess these "female traits".

#### *Pelvic osteolysis and age*

Analysis of pelvic osteolysis and deformation relative to age in the females of Arica produced only three variables with statistically significant differences: pre-auricular groove, facet on the iliac tuberosity, and facet on the sacral tuberosity. Each of these features shows an increase with age ( $p \leq 0.05$ ). The magnitude of this association, however, is low to moderate (gamma = 0.3, 0.3, and 0.45 respectively). The Spearman rho statistic also gives a low correlation for osteolysis with age, although that for dorsal pubic pitting is somewhat higher (rho = 0.27). The positive value of gamma and Spearman rho means that as one variable increases the other variable also increases. For example, as a female gets older, the pre-auricular groove also gets larger. This may be due to increases in the number of children she has had relative to age, to an accumulation of daily activity-type stresses in these joints, or both. The occurrence of pelvic osteolysis in males has a low frequency and the grooves tend to be mild in expression. A slight increase with age is also observed in male individuals.

#### *Pelvic osteolysis and subsistence*

No statistically significant differences in pelvic osteolysis and deformity were found between Arica females of the pre-agricultural versus the agricultural populations. One exception is the protrusion of the posterior inferior iliac spine which occurs more commonly in the agricultural period. The general hypothesis that agricultural female populations should present more scarring as a consequence of increased childbearing can therefore not be substantiated. This may relate to the

overall moderate correlation found between pelvic osteolysis and parity as reported by others. The males, regardless of subsistence category, tended to be homogeneous, clustering high in the absent category, except for the pre-auricular groove where the mild category reaches 54.5% in the pre-agricultural and 63.5% in the agricultural groups. Perhaps a better way of defining degree of pelvic osteolysis, since its manifestation is continuous, would be to measure the length, width and depth of the grooves. A more rigorous data set might be obtained when the variables are dealt with in this manner.

Practically no studies on pelvic osteolysis have been carried out in the southern Andes. Working with Peruvian mummies, Ashworth *et al.* (1976) found pubic scars in 72.3% of the pre-Columbian females and in 57.6% of colonial females, a difference they attribute to racial variation between the two groups. The percentages of dorsal pubic pitting found in the present study, 82.4% for the pre-agricultural females and 71% for the agricultural females, are close to those found in previous studies.

#### *Pelvic osteolysis and pelvic size*

Osteolysis and pelvic measurements were not correlated in males because not enough variation exists in the osteolysis/deformation variables for this sex. In females, Spearman's correlation between osteolysis and deformity versus age and pelvimetry produced low values for the majority of the variables. Using these pelvic measurements, one could not predict with accuracy the degree of scarring a female would have. The better correlations were obtained for the bi-iliac width versus dorsal pubic pitting (0.33) and pre-auricular groove (0.39) at  $p \leq 0.001$  level of significance, a surprising result considering that the bi-iliac diameter is part of the false pelvis and thus does not appear to play any role during the birth process. The subpubic angle, depth of the true pelvis, bispinous and bi-ischial measurements were expected to show high correlations since they are directly involved during the baby's passage. However, their correlations are extremely low, except for depth of the true pelvis versus pre-auricular groove (0.23). Under these circumstances, the size of the true pelvis itself does not seem to influence the degree of pelvic osteolysis. Age was also found to have only a low correlation, the maximum being just 0.27 for dorsal pubic pitting (compared with 0.375 in Suchey *et al.* 1979). Suchey *et al.* (1979) found a moderate correlation (0.383) when testing dorsal pubic pitting against pregnancies.

## CONCLUSIONS

Since there is no evidence that cesarean section was practiced by the pre-Columbian inhabitants of northern Chile, changes in the female pelvis should reflect some record of childbirth in these people. As expected, most of the females included in this study were found to have the gynecoid type of pelvis considered normal for women, thus ruling out pelvic size and shape as significant factors in maternal mortality. Pelvic pathology, which could have put childbearing-age females at risk during delivery, was found to be rare, except for sacro-iliac ankylosis which occurred in nine cases, but only one in an individual of childbearing age. Among the various kinds of pelvic osteolysis considered in this study, interosseous groove and pre-auricular groove showed the best association with sex. These two features may thus serve as reliable sex determinants in prehistoric pelvises. There was no significant difference between pre-agricultural and agricultural females with respect to degree of pelvic osteolysis thus preventing any assessment of differential fertility. The results of this study also indicate that pelvic dimensions do not play a significant role in determining the frequency and intensity of pelvic osteolysis. Other variables must therefore be considered such as size and weight of the full-term fetus, cephalo-pelvic proportions, position of engagement of the fetus during birth, position of the mother, eutocia versus dystocia, single birth versus multiple births for one pregnancy, weight of the parturient, and routine activities that the female may engage in during her daily routine. Multiple factors may account for the size and variation of the pelvic osteolysis, thus producing interference in assessing parity status, fertility rates, and even sex.

## REFERENCES

- ARRIAZA, B.  
1988 Childbirth in Pre-Columbian Arica, Chile: A bio-anthropological and archaeological approach, M. A. thesis, Arizona State University, Tempe.
- ARRIAZA, B., M. ALLISON AND E. GERSZTEN  
1988 "Maternal mortality in pre-Columbian Indians of Arica, Chile", *American Journal of Physical Anthropology* 77: 35-41.
- ANDERSEN, B. C.  
1988 "Pelvic scarring analysis: Parturition or excess motion?" Paper presented at the *Fifty-Seventh Annual Meeting of the American Association of Physical Anthropologists*, Kansas City, Missouri.
- ASHWORTH, J. T., M. J. ALLISON, E. GERSZTEN AND A. PEZZIA  
1976 "The pubic scars of gestation and parturition in a group of pre-Columbian and colonial Peruvian mummies", *American Journal of Physical Anthropology* 45: 85-89.
- CALDWELL, W. E. AND H. C. MOLOY  
1933 "Anatomical variations in the female pelvis and their effect in labor with a suggested classification", *American Journal of Obstetrics and Gynecology* 26: 479-505.
- CIEZA DE LEÓN, PEDRO  
1553, *La crónica del Perú* (primera parte, cap. LXV), Lima, Universo.  
1973
- DAVIVONGS, V.  
1963 "The pelvic girdle of the Australian aborigine: Sex differences and sex determination", *American Journal of Physical Anthropology* 21: 443-445.
- FOCACCI, G.  
1982 "Nuevos fechados para la época de Tiahuanaco en la arqueología del norte de Chile", *Chungará* 8: 63-76.
- FONTANA, D., M. ALLISON, E. GERSZTEN AND B. ARRIAZA  
1983 "Enfermedades respiratorias agudas en los habitantes precolombinos del Norte Grande Chileno", *Chungará* 11: 153-160.
- FRASER, J. E.  
1958 *Anatomy of the human skeleton*, A. S. Breathnach (ed.), London, J. & A. Churchill.
- HOLT, A. C.  
1978 "A re-examination of parturition scars on the human female pelvis", *American Journal of Physical Anthropology* 49: 91-94.
- HOUGHTON, P.  
1974 "The relationship of the pre-auricular groove of the ilium to pregnancy", *American Journal of Physical Anthropology* 41: 381-390.
- KELLEY, M. A.  
1979 "Parturition and pelvic changes", *American Journal of Physical Anthropology* 52: 541-546.

- LANGER, A. AND K. W. KENNEDY  
 1981 "The normal pelvis", in L. Iffy and H.A. Kaminetzky (eds.), *Principles and practices of obstetrics and perinatology* 2: 733-745, New York, John Willey & Sons.
- LASTRES, J.  
 1951 *Historia de la medicina peruana*, Lima, Universidad Nacional Mayor de San Marcos, vol. 1.
- MUÑOZ, I.  
 1981 "La aldea de Cerro Sombrero en el periodo del desarrollo regional de Arica", *Chungará* 7: 105-141.
- NÚÑEZ, L.  
 1965 "En torno al culto de la reproducción humana en el norte de Chile", separata de la *Revista Universitaria*, Universidad Católica de Chile, año LLI, fascículo 2.
- NÚÑEZ DE PRADO, W.  
 1963 *El parto en Andahuaylas*, Lima, Serie Monográfica núm. 13, Ministerio de Trabajo y Asuntos Indígenas.
- PUTSCHAR, W. G. J.  
 1976 "The structure of the human symphysis pubis with special consideration of parturition and its sequelae", *American Journal of Physical Anthropology* 45: 589-594.
- SANTORO, C.  
 1982 "Formativo temprano en el extremo norte de Chile", *Chungará* 8: 33-62.
- STEWART, T. D.  
 1970 "Identification of the scars of parturition in the skeletal remains of females", in T. D. Stewart (ed.), *Personal identifications in mass disasters*: 127-135, Washington, National Museum of Natural History.
- SUCHEY, J. D., D. V. WISELEY, R. F. GREEN AND T. T. NOGUCHI  
 1979 "Analysis of dorsal pitting in the os pubis in an extensive sample of modern American females", *American Journal of Physical Anthropology* 51: 517-540.
- WHITLEY, N.  
 1985 *A manual of clinical obstetrics*, Philadelphia, J. B. Lippencott Co.
- YOUNG, D.  
 1950 "Relaxation of the pelvic joints in pregnancy: Pelvic arthropathy of pregnancy", *Journal of Obstetrics and Gynaecology of the British Commonwealth Empire* 47: 493.

