

Efficiency of sex determination by using external morphology of the pelvis in Thai population

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Objective To study the efficiency of sex determination in a Thai Population by using external morphology of the pelvis.

Methods A sample of 300 skeletons from the Forensic Osteology Research Center, Faculty of Medicine, Chiang Mai University were studied. They comprised 150 males and 150 females with an age range from 15 to 96 years. Eleven morphological traits of the pelvis were used for the external morphology as follows: greater sciatic notch, subpubic angle, preauricular sulcus, postauricular sulcus, iliac fossa, acetabulum, ischiopubic ramus ridge, composite arch, ventral arc, pubic bone shape, and dorsal pubic pitting. The score for sex determination by each morphological trait of the pelvis was; 1 = male, 2 = probably male, 3 = sex indeterminate, 4 = probably female, 5 = female. All scores of each morphological trait of the pelvis were analyzed for the accuracy of sex determination.

Results The results showed that eleven morphological traits of pelvis were present, with a mean accuracy for sex determination of between 72.5% and 98.7%. Subpubic angle, greater sciatic notch, and pubic bone shape were the three most efficient morphological traits for determining sex, with a mean accuracy of 98.7%, 98.6%, and 98.2%, respectively.

Conclusion The most efficient morphological traits of the pelvis for sex determination were the subpubic angle, greater sciatic notch, and pubic bone shape. These traits should provide an accurate, a rapid and simple determination of sex, which would be beneficial in the forensic context of Thailand. **Chiang Mai Medical Journal 2014;53(4):175-79.**

Keywords: sex determination, external morphology, pelvis, Thai population

Introduction

Human skeleton remains are considered as important evidence in identifying individuals at a crime scene. Biological identification consists

of sex, age, stature, and race^[1], with sex considered one of the most important in identifying humans^[2]. Typically, morphological and metric

methods are two techniques for estimating sex, with the morphological method being simpler and quicker than the metric one. In previous studies, the pelvis^[3] and skull^[4] were highly reliable in estimating sex, with an accuracy of more than 95% and 92%, respectively.

The pelvis is the most common bone for sex estimation because its differences between males and females are obvious in terms of size and functional morphology. For example, the female pelvis is wider than the male one, making it more suitable for pregnancy and childbirth^[5].

A related study regarding sex estimation using external morphology of the pelvis was carried out in a South African population^[6]. However, racial differences may exist when applying this in other populations^[7], and there were insufficient reports on this aspect in the Thai population. Therefore, this study was carried out to examine sexual dimorphism by investigating the external morphology of the pelvis in the Thai population. This study will be useful for forensic cases in Thailand.

Materials and methods

This study was performed on 300 skeletons (150 male and 150 female), with known sex and age at death, from the Forensic Osteology Research Center (FORC), Faculty of Medicine, Chiang Mai University. The ages at death ranged from 22 to 96 years with a mean age of 65.90 years for males and 15 to 93 years with a mean age of 64.21 years for

females. Fractured, pathological, or incomplete pelvises were excluded from this study.

Eleven morphological traits from each individual were taken on the left and right pelvises; i.e. greater sciatic notch^[8], subpubic angle^[9,10], preauricular sulcus^[10], postauricular sulcus^[11], iliac fossa^[12], acetabulum^[13], ischiopubic ramus ridge^[8], composite arch^[10], ventral arc^[8], pubic bone shape^[9,14], and dorsal pubic pitting^[9,14]. A list of the eleven morphological traits in both male and female pelvises is given in Table 1. In this study, each morphological trait of the pelvis was applied by using a numerical score of 1 to 5; 1 = male, 2 = probably male, 3 = sex indeterminate, 4 = probably female, 5 = female.

All data were analyzed using the SPSS program Version 20. The Wilcoxon test calculated the scores of each morphological trait in both left and right pelvises from all individuals by using a significance level of 0.05. All scores of each pelvic morphological trait were then analyzed for the accuracy of sex determination.

Results

The results of this study showed that the scores of each morphological trait from all individuals had no statistically significant difference ($p > 0.05$) between left and right pelvises. In Table 2, all scores of each pelvic morphological trait were analyzed from each individual for the accuracy of sex determination. The three most accurate pelvic morphological traits for sex estimation were the subpubic angle, greater sciatic notch, and pubic bone shape, with a mean accuracy of 98.7%, 98.6%, and 98.2%, respectively. Dorsal pubic pitting was the least accurate of all

Table 1. List of each morphological trait expressed in both male and female pelvises

Morphological trait	Male expression	Female expression
Greater sciatic notch	Narrow	Wide
Subpubic angle	Closed angle, V-shaped	Obtuse angle, U-shaped
Preauricular sulcus	Complete absence	Wide and deep groove
Postauricular sulcus	Absence, narrow, and smooth transition (no elevation)	Wide and elevated from the plane of the ilium
Iliac fossa	Deeper	Shallower
Acetabulum	Faces more laterally and larger	Faces slightly anteriorly and smaller
Ischiopubic ramus ridge	Broad and flat	Narrow, crest like ridge
Composite arch	Absent (single curve)	Present (double curve)
Ventral arc	Arc absent	Arc present
Pubic bone shape	Narrow and triangular	Broad and rectangular
Dorsal pubic pitting	Rarely present	Present

Table 2. The accuracy levels of sex determination for each pelvic morphological trait

Morphological trait	Male			Female			Total (%)
	Left	Right	Avg. (%)	Left	Right	Avg. (%)	
Subpubic angle	97.4	98.7	98.1	99.5	99.0	99.3	98.7
Greater sciatic notch	98.2	98.0	98.1	99.0	99.1	99.1	98.6
Pubic bone shape	98.5	97.0	97.8	99.0	98.3	98.7	98.2
Ischiopubic ramus ridge	95.6	95.6	95.6	98.0	98.0	98.0	96.8
Preauricular sulcus	96.0	96.0	96.0	96.0	96.5	96.3	96.1
Postauricular sulcus	92.0	92.0	92.0	94.5	95.0	94.8	93.4
Iliac fossa	91.0	92.0	91.5	92.5	92.5	92.5	92.0
Ventral arc	91.0	91.3	91.2	92.0	91.0	91.5	91.3
Composite arch	90.3	90.7	90.5	90.0	89.4	89.7	90.1
Acetabulum	87.5	87.3	87.4	91.3	90.0	90.7	89.0
Dorsal pubic pitting	72.5	74.0	73.3	71.0	72.5	71.8	72.5

the pelvic morphological traits, with a mean accuracy of 72.5% for sex determination.

Discussion

In a previous study, Rogers and Saunders^[9] researched sex determination using morphological traits of pelvic samples from a 19th century cemetery in Canada. They found that the pubic bone, greater sciatic notch, and subpubic angle had an accuracy of 86.2%, 85.7%, and 83.8%, respectively. In a study on the subpopulation of both black and white South Africans, Patriquin *et al*^[6] found that the highest accuracy for sex estimation was 87.5% from the greater sciatic notch in the black subpopulation, followed by 84.5% from the pubic shape; but the greater sciatic notch had far less accuracy for estimating sex in the white subpopulation. In addition, Duric *et al*^[15] reported accuracy of 79.15% for sex estimation from the greater sciatic notch in males, while the subpubic angle had accuracy of 99.22% in their sample from the Balkan population. These results indicated that population differences affect the expression of sexual dimorphism^[6,7]. Thus, populations and the differences between them must be considered.

The results of this study showed that the subpubic angle, greater sciatic notch, and pubic bone shape were the three most accurate pelvic morphological traits for determining sex in the

Thai population, with accuracy of 98.7%, 98.6%, and 98.2%, respectively. Sexual dimorphism in these traits is due mainly to size, sex hormones, and function-related morphology, including accommodation for childbirth in females^[5,7,16]. The male pelvis is formed by triangular pubic bones that have a narrow or V-shaped subpubic angle, whereas the female pelvis is made up of rectangular pubic bones that form a wider or U-shaped subpubic angle, including a wider greater sciatic notch that enlarges the female pelvic outlet for childbirth^[18].

Furthermore, this study revealed that dorsal pubic pitting was the least accurate of all the pelvic morphological traits determined, with an accuracy of 72.5% for sex determination. This was similar to a previous study by Rogers and Saunders^[9], which found that the dorsal pitting was 35.7% accurate, since not all females acquire dorsal pits from parturition or childbirth^[19,20]. Snodgrass and Galloway^[21] suggested age and body size as factors in pit formation. They found that in females younger than 50 years old, dorsal pitting correlated with their number of births, whereas in female more than 50 years old, dorsal pitting correlated with body mass index (BMI). Furthermore, there are several factors that could affect the presence of dorsal pubic pitting in females, including levels of relaxin production, interval since last pregnancy, infant size,

obstetric practices, body shape, weight gain, and activity levels during pregnancy.

In conclusion, this study found that the three most accurate morphological traits of the pelvis were the subpubic angle, greater sciatic notch, and pubic bone shape. These traits were good candidates for simple and rapid parameters for sex determination. This method would be very helpful in utilizing external morphology as a first step when finding a pelvis at a crime scene, and it can contribute to the context of forensics in Thailand.

Ethics

This study was exempted from reviewing the research ethics in humans by the Ethics Committee, Faculty of Medicine, Chiang Mai University.

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Conflict of interest

There are no conflicts of interest.

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ประสิทธิภาพของการแยกเพศโดยใช้ลักษณะภายนอกของกระดูกเชิงกรานในกลุ่มประชากรไทย

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วัตถุประสงค์ เพื่อศึกษาประสิทธิภาพของการแยกเพศโดยใช้ลักษณะภายนอกของกระดูกเชิงกรานในกลุ่มประชากรไทย

วิธีการศึกษา ศึกษาจากโครงกระดูกจำนวน 300 โครง แบ่งเป็นเพศชาย 150 โครง และเพศหญิง 150 โครง ซึ่งมีอายุระหว่าง 15-96 ปี ณ ศูนย์วิจัยนิติวิทยากระดูก คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ โดยสังเกตลักษณะภายนอกของกระดูกเชิงกรานจำนวน 11 ลักษณะ ได้แก่ greater sciatic notch, subpubic angle, preauricular sulcus, postauricular sulcus, iliac fossa, acetabulum, ischiopubic ramus ridge, composite arch, ventral arc, pubic bone shape และ dorsal pubic pitting และกำหนดเกณฑ์การให้คะแนนในการแยกเพศของแต่ละลักษณะ ดังนี้ คะแนน 1 หมายถึง เพศชาย, คะแนน 2 หมายถึง น่าจะเป็นเพศชาย, คะแนน 3 หมายถึง ไม่สามารถระบุเพศได้, คะแนน 4 หมายถึง น่าจะเป็นเพศหญิง และคะแนน 5 หมายถึงเพศหญิง จากนั้นนำคะแนนที่ได้ในแต่ละลักษณะมาวิเคราะห์หาค่าเฉลี่ยร้อยละความถูกต้องเพื่อใช้ในการแยกเพศจากกระดูกเชิงกราน

ผลการศึกษา พบว่าลักษณะภายนอกของกระดูกเชิงกรานทั้ง 11 ลักษณะ มีค่าเฉลี่ยความถูกต้องในการแยกเพศร้อยละ 72.5-98.7 โดยลักษณะภายนอกของกระดูกเชิงกรานที่มีประสิทธิภาพมากที่สุดในการแยกเพศคือ subpubic angle, greater sciatic notch และ pubic bone shape โดยมีค่าเฉลี่ยความถูกต้องร้อยละ 98.7, 98.6 และ 98.2 ตามลำดับ

สรุปผลการศึกษา pubic bone shape, greater sciatic notch และ subpubic angle เป็นลักษณะภายนอกของกระดูกเชิงกรานที่มีประสิทธิภาพมากที่สุด โดยมีความแม่นยำ รวดเร็ว และง่ายในการแยกเพศซึ่งจะเป็นประโยชน์อย่างมากต่อวงการนิติวิทยาศาสตร์ในประเทศไทย **เชียงใหม่เวชสาร 2557:53(4):175-179.**

คำสำคัญ: แยกเพศ ลักษณะภายนอก กระดูกเชิงกราน ประชากรไทย