การแยกเพศจากลักษณะของกะโหลกศีรษะในคนไทย

Sex Determination by Skull Morphology in Thai Populations

Author : Orawan Kumplien[1], Suda Riengrojpitak[1,2*], Pasuk Mahakkanukrauh[3*], and Sukon Prasitwattanaseree[4]
[1]Forensic Science Graduate Program, [2]Department of Pathobiology, Faculty of Science, Mahidol University, Bangkok, [3]Department of Anatomy, Faculty of Medicine, [4]Department of statistics, Faculty of Science, Chiangmai University, Chiangmai, Thailand.

บทคัดย่อ

การระบุเพศเป็นปัจจัยแรกที่ใช้พิสูจน์อัตลักษณ์ในชิ้นส่วนของมนุษย์ กะโหลกศีรษะเป็นกระดูกชิ้นสำคัญในการระบุเพศรองจากกระดูกสะโพก วัตถุประสงค์ของการวิจัยนี้เพื่อแยกเพศจำนวน 200 กะโหลก (เพศชายและเพศหญิงอย่างละ 100 กะโหลก) จากการศึกษาลักษณะของกะโหลกศีรษะโดยการระบุระดับขั้นเป็น 1, 2 และ 3 และการชั่งน้ำหนักของกะโหลกศีรษะในประชากรไทย การวิจัยครั้งนี้ได้รับความอนุเคราะห์จากภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ ในการใช้ห้องวิจัยกระดูกสำหรับกะโหลกศีรษะจำนวน 200 กะโหลก (แยกเป็นเพศชายและเพศหญิงอย่างละ 100 กะโหลก) การวิจัยใช้น้ำหนักของกะโหลกศีรษะและรูปร่างลักษณะ 5 แบบ (ได้แก่ ขนาดของกะโหลกศีรษะ, กระดูก zygomatic, กระดูก occipital, glabella region และ supraorbital ridge) ทำการวิเคราะห์น้ำหนักกะโหลกศีรษะโดยการเปรียบเทียบค่าเฉลี่ยระหว่างเพศชายและหญิงด้วยการทดสอบทีและทำการวิเคราะห์แยกเพศด้วยลักษณะกะโหลกศีรษะโดยใช้การวิเคราะห์การถดถอยโลจิสติก

ผลการวิจัยชี้ให้เห็นว่าค่าเฉลี่ยของน้ำหนักกะโหลกศีรษะในเพศชายมากกว่าเพศหญิงอย่างมีนัยสำคัญทางสถิติ (P-value < 0.05) และเปอร์เซ็นต์ความถูกต้องในการแยกเพศชาย, เพศหญิง และทั้ง 2 เพศโดยรวมด้วยลักษณะทั้ง 5 ลักษณะของกะโหลกศีรษะเท่ากับ 77.1%, 76 % และ 76.75 % ตามลำดับ เพราะฉะนั้นการศึกษาลักษณะและน้ำหนักของกะโหลกศีรษะจึงเป็นอีกวิธีหนึ่งที่ง่ายในการใช้ระบุเพศในทางคดีด้านนิติวิทยาศาสตร์

คำสำคัญ : การระบุเพศ, ลักษณะของกะโหลกศีรษะ, น้ำหนักของกะโหลกศีรษะ, ประชากรไทย

Abstract

Determination of sex is the first factor that has to be considered for identification in human remains. The skull is one of the important bones for sex determination inferior to pubic bone. The aim of the present study is to determine sex using skull weight and skull morphology by assigning the grades (1, 2, and 3) in a Thai population.

Two hundred Thai skulls (males and females, 100 each), kindly supplied by the Department of Anatomy, Faculty of Medicine, Chiangmai University, were used in this study. Five morphological traits (include size of skull, zygomatic, occipital area, glabella region, and supraorbital ridge) and skull weights were examined. T–test was used to compare mean of skull weights between male and female. Binary logistic regression was used to determine sex by skull morphology.

The results indicated that mean of skull weight in male was significantly higher than those in female (P-value < 0.05). The percent accuracies of sex determination are 77.1% for male, 76.4% for female, and 76.75% overall with the combination of these five traits. Therefore, the morphology and the weight of skull can be used for sex determination in forensic cases.

Keyword (s): sex determination, skull morphology, skull weight, Thai population

* Corresponding authors

Introduction

Forensic anthropology is a science concerned with postmortem identification of human remains by using human osteology, skeletal biology, dental anthropology, archeology, genomics, and scientific inquiry in general. A need for this most frequently arises following an investigation of human remains resulting from an unexplained natural death, homicide, suicide, or mass disaster, or following allegations of war crimes or genocide.

Sex determination is a key factor to establish a biological profile of unknown human skeletal remains. Most methods of estimating age, assessing ancestry, and calculating the stature of unidentified remains are sex-dependent, becoming less accurate and precise when sexes are pooled, or unknown. Sex can be established from a gross examination of the skeleton using either metric or morphological techniques. Many sections of the skull have been studies such as size, architecture, supraorbital ridges, glabella region, zygomatic bone, mastoid processes, occipital condyles and nasal bone, etc. (Celbis et al., 2001; Graw, 2001; Walrath et al., 2004; Rogers, 2005; Williams and Rogers, 2006; and Gapert et al., 2009). The present study was to investigate the morphology by grading as 1, 2, and 3.

Objectives

The aim of this study is to discriminate between male and female using the weight and the morphology of skull by assigning the grades in Thai populations.

Materials and Methods

Two hundred Thai skulls (males and females, 100 each), the age between 15 to 93 years were used in the present study. The weight of skulls was examined. Five skull morphological traits (included general size of skull, zygomatics, occipital area, glabella region, and supraorbital ridge) were used and modified (Sangvichien et al., 2008; and Graw, 2001). The morphological approach was applied by using grading method as 1, 2, and 3, as follow:

1. Size

1.1 General size of skull

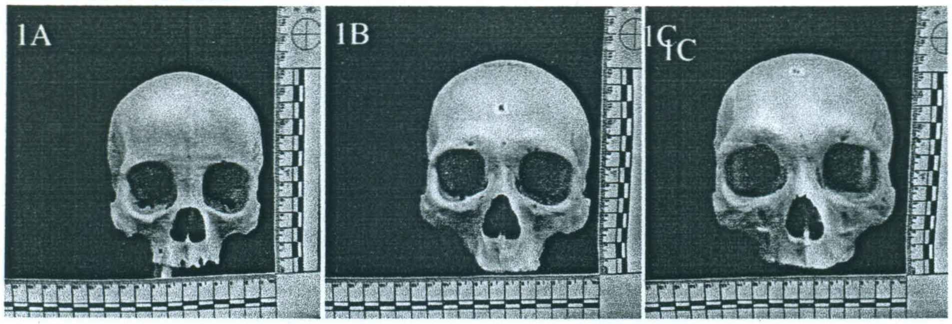

Fig. 1. Size of skull (frontal view): level 1 (1A), level 2 (1B), and level 3(1C)

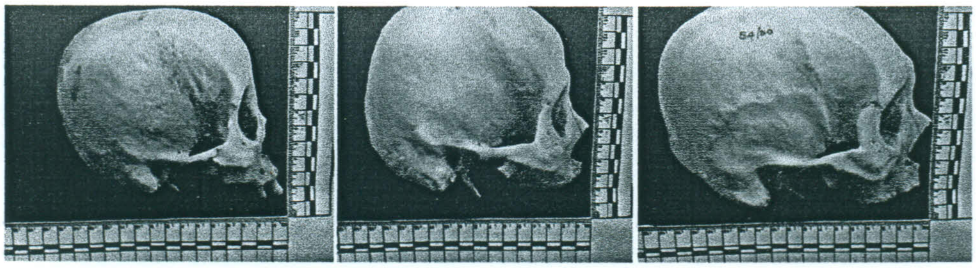

Fig. 2. Size of skull(lateral view): level 1 (2A), level 2 (2B), and level 3(2C)

Table 1. Grading system for size of skull

Feature (Size)	Level of grading
Small	1
Medium	2
Large	3

1.2 Zygomatic

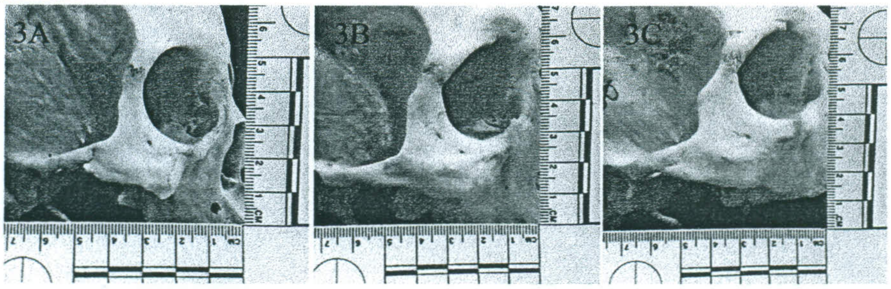

Fig. 3. Zygomatic: level 1 (3A), level 2 (3B), and level 3 (3C)

Table 2. Grading system for zygomatic

Feature (Size of zygomatic)	Level of grading
Small	1
Moderate	2
Large	3

2. **Architecture**

2.1 Architecture of occipital area

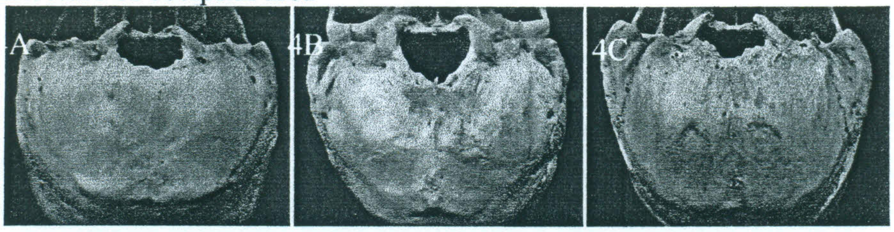

Fig. 4. Occipital area: level 1 (4A), level 2 (4B), and level 3 (4C)

Table 3. Grading system for architecture of occipital area

Feature (Occipital area)	Level of grading
Not mark	1
Slightly mark	2
Well muscle	3

Percentage of "muscle marking of occipital area"
Not mark = less than 30 %
Slightly mark = between 30 – 70 %
Well muscle = more than 70 %

2.2 Architecture of glabella region

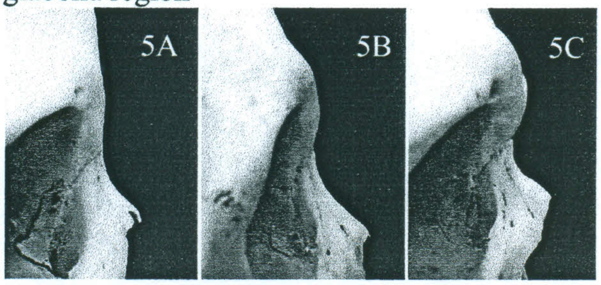

Fig. 5. Glabella region (lateral view): level 1 (5A), level 2 (5B), and level 3 (5C)

6A 6B 6C

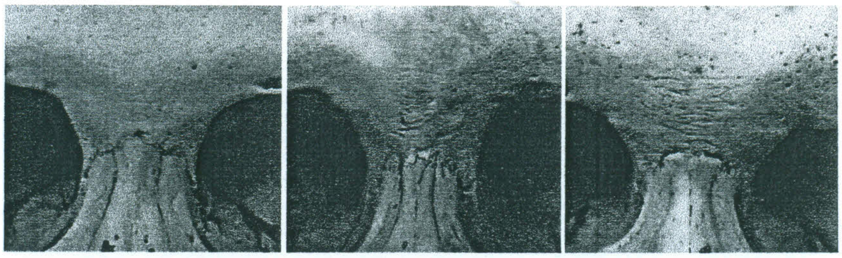

Fig. 6.Glabella region (frontal view): level 1 (6A), level 2 (6B), and level 3 (6C)

Feature (Glabella region)	Level of grading
Missing or only faintly develop	1
Moderate shaped	2
Extremely pronounced	3

2.3 Architecture of supraorbital ridges

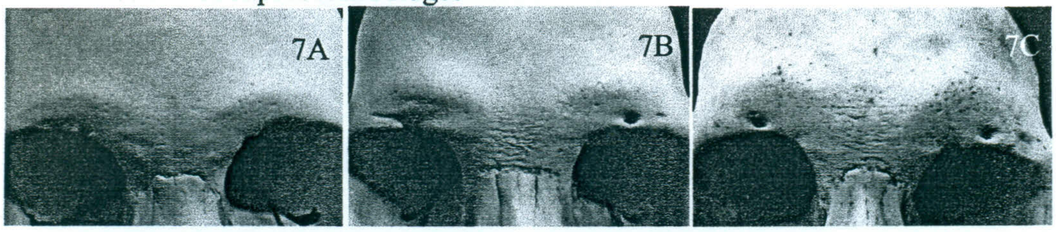

Fig. 7. Supraorbital ridges: level 1 (7A), level 2 (7B), and level 3 (7C)

Feature (Supraorbital torus)	Level of grading
Less prominence	1
Average prominence	2
Very prominence	3

3. **Skull weight**

Digital scale was used to weigh the skulls in triplicate.

Statistical analysis

Descriptive statistic was used to explore all samples. Comparing between male and female in weight of skull measurement was analyzed by t-test. Mann-Whitney-U test was used to test difference between male and female in each morphological trait. The fitted equations to determine sex from morphological trait were developed by Binary logistic regression. All data were analyzed by using a statistical package SPSS for Windows (Kaiwan, Yuth, 2007; Busaba, Kamol, 2008). The significant level for hypothesis testing in this study was 0.05.

Result / Conclusion

The mean ages at death of 200 samples, male and female, are 69.84 and 67.81 years, respectively (Table 1).

Table 1. Age distribution by sex

Sex	n	Age (yrs)	
		Mean	SD
Male	100	69.84	11.637
Female	100	67.81	14.583

For each morphological trait, there was significant difference between male and female by using Mann-Whitney U test.

Table 2. Mann-Whitney U test for five morphological traits and t-test for weight measurement

Morphological Trait		Male	Female	p-value
size of skull	- median	2.00	1.00	< 0.001
	- IQR	1.00	1.00	
Size of zygomatic	- median	2.00	1.00	< 0.001
	- IQR	1.00	1.00	

Occipital area	- median	2.00	1.00	< 0.001
	- IQR	.00	1.00	

Morphological Trait		Male	Female	p-value
Glabella region	- median	2.00	1.00	< 0.001
	- IQR	2.00	.00	
Supraorbital ridge	- median	2.00	1.00	< 0.001
	- IQR	1.00	.00	
Weight of skull (g)	- mean	651.80	558.29	< 0.001
	- sd	113.76	118.57	

Since the weight of skull in male and female were normality, we used t-test to compare mean weight of skull between male and female. The mean weights (± sd) of skull in male with 651.80 g. (±113.762) and in female with 558.29 g. (±118.57) were significantly difference (p-value < 0.001).

Table 3. Compare mean value of weight measurement (g.) for each gender (n = 200)

Sex	n	Mean	SD	Std. Error Mean	t	df	P-value
Male	100	651.80	113.762	11.376	5.691	198	.000
Female	100	558.29	118.572	11.857			

p-value < 0.05

Binary logistic regression was used to determine sex from morphological trait. The results obtained are shown in Table 4.

Table 4. Logistic regression from each morphological trait in sex determination

Models	Independent variables	Coefficient logistic regression	se.	p-value
Model I	Size of skull(1)	1.574	0.320	.000
	Size of skull(2)	3.689	1.055	.000
	intercept	-0.916	0.224	.000
Model I	Zygomatic(1)	-2.714	0.388	.000
	Zygomatic(2)	-3.899	0.680	.000
	intercept	1.739	0.301	.000
Model I	Occipital area(1)	-1.571	0.325	.000
	Occipital area(2)	-22.257	8987.421	.000
	intercept	1.054	0.242	.000
Model I	Glabella region(1)	-2.226	0.411	.000
	Glabella region(2)	-22.176	7218.871	.000
	intercept	0.973	0.201	.000
Model I	Supraorbital ridge(1)	-2.472	0.397	.000
	Supraorbital ridge(2)	-5.515	1.052	.000
	intercept	1.730	0.290	.000

(1) morphological traits in level 2
(2) morphological traits in level 3

The percent of corrected classification or percent accuracies in each logistic regression model are showed in table 5. The results indicated that glabella region in female gave the highest accuracy (90%). Percent accuracies of zygomatic and supraorbital ridge in male are 86.5% and 86% respectively. The percent accuracies are 77.1% for male, 76.4% for female, and 76.75% with the combination of these five traits.

Table 5. The percent accuracies in five individual traits in sex determination

Traits	n = 200	n_1 = 100	n_2 = 100	P-value
Size	71	70	72	.000
Zygomatic	81	86.5	75.5	.000
Occipital area	71.5	77	66	.000
Glabella region	78	66	90	.000
Supraorbital ridge	82.25	86	78.5	.000
Overall	76.75	77.1	76.4	

p-value < 0.05

In conclusion, binary logistic regression models fitted in the present study can be used to discriminate sexes by using skull morphology and skull weight in a Thai population especially in the forensic case work and the court of law.

Discussion

In the present study, morphology observation and skull weight were derived from 200 Thai craniums (male and female, 100 each). The mean value of weight in male was significantly greater than those of female (P-value < 0.05). Five morphological traits (included general size of skull, zygomatic, occipital area, glabella region, and supraorbital ridge) can determine sex with percent accuracies of 77.1% for males, 76.4% for females, and 76.75% for overall compared with the previous study (Graw, 2001). The results of the present study showed visual assessment (1 to 5 levels in each trait) of seventeen primarily morphological characteristics and used to differentiate between sexes. Five traits which had correct classification at 70 to 80% are glabella, supraorbital ridge, mastoid process, supramastoid crest, and mandible. Different population could have high percent accuracy in different skull morphological traits depended on physical activities, nutrition, climate condition, or lifestyle. Celbis et al., 2001) examined the morphological variation in glabellar region for sexual dimorphism in Turkish population by using the degree of smoothness (0) to roughness (3) of glabella into four. About 84% of males were in prototype 2 or higher. Most males were in Prototype 1 or above, whereas females in 1 or below. In the present study, percent accuracies of glabella region in sex determination were 66% for males, 90% for females, and 78% for mixed gender. Glabella region frequently gave a high accuracy in many populations. Krogman's cranioscopy and the modified Krogman's cranioscopy traits by grading (Sangvichien et al., 2008) were fitted to modify in the present study because of high accuracy (95.5% for males, 82.9% for females, and 91.1% overall in the first method and males had larger supraorbital torus, rougher glabella region and external occipital protuberance than females for the second method. Incomplete teeth might affect the mean value of skull weight due to age (elderly people) and procedures during bone collection.

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