Science and Justice 57 (2017) 270–275

Contents lists available at ScienceDirect

Science and Justice

journal homepage: www.elsevier.com/locate/scijus

Emerging researcher article

Sex estimation from the scapula in a contemporary Thai population: Applications for forensic anthropology

Tanya R. Peckmann [a,*], Shelby Scott [b], Susan Meek [c], Pasuk Mahakkanukrauh [d,e]

[a] Department of Anthropology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada
[b] Department of Anthropology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada
[c] Department of Biology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada
[d] Excellence Center of Osteology Research and Training Center, Chiang Mai University, Chiang Mai 50200, Thailand
[e] Department of Anatomy, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand

ARTICLE INFO

Article history:
Received 4 September 2016
Received in revised form 16 February 2017
Accepted 22 February 2017

Keywords:
Forensic anthropology population data
Adults
Scapula
Sex estimation
Discriminant functions
Thailand

ABSTRACT

The impact of climate change is estimated to be particularly severe in Thailand. Overall, the country faces an increase in surface temperatures, severe storms and floods, and a possible increase in the number of mass disasters in the region. It is extremely important that forensic scientists have access to sex estimation methods developed for use on a Thai population. The goal of this project is to evaluate the accuracy of sex estimation discriminant functions, created using contemporary Mexican and Greek populations, when applied to a contemporary Thai sample. The length of the glenoid cavity (LGC) and breadth of the glenoid cavity (BGC) were measured. The sample included 191 individuals (95 males and 96 females) with age ranges from 19 to 96 years old. Overall, when the Mexican and Greek discriminant functions were applied to the Thai sample they showed higher accuracy rates for sexing female scapulae (83% to 99%) than for sexing male scapulae (53% to 92%). Size comparisons were made to Chilean, Mexican, Guatemalan, White American, and Greek populations. Overall, in males and females of the Thai sample, the scapulae were smaller than in the Chilean, Mexican, White American, and Greek populations. However, the male and female Thai scapulae were larger than in the Guatemalan sample. Population-specific discriminant functions were created for the Thai population with an overall sex classification accuracy rate of 83% to 88%.

1. Introduction

The role of forensic anthropology is to assist with the identification (i.e. estimation of sex, age at death, stature, ancestry) of skeletal remains within a medico-legal context and mass disasters. The 2004 tsunami catastrophe in Thailand highlighted the lack of forensic anthropology expertise in the country and forced the Thai forensic community to reassess their Disaster Victim Identification strategies. Kahana and Hiss [1] cite that the tsunami DVI team should have included forensic anthropologists to assist with the identification of the deceased. In 2013, the Forensic Osteology Research Centre, Faculty of Medicine, Chiang Mai University began a PhD program which promotes forensic osteology research specifically within Thailand [2].

Sex estimation methods have been developed for the Thai population [3–15]. However, compared to other populations (e.g. Whites and Blacks), the Thai population still remains underrepresented in the published literature. Research has shown that when discriminant functions from other populations are tested on the Thai sample, low sex classification accuracy rates are produced [5]. The Scientific Working Group in Forensic Anthropology suggests that best practice for sex estimation of skeletal remains should include methodologies that utilize population-specific and temporally-specific data [16].

Incomplete or fragmentary bones are frequently excavated at forensic sites and mass disasters due to postmortem damage and taphonomic changes. Therefore, developing methods for sex estimation from preservationally favoured and/or fragmentary bones is essential. The infraspinous and supraspinous fossa of the scapula are more commonly eroded due to taphonomic processes but the spine and the glenoid cavity are often available for forensic analyses [17,18]. Scapular muscle attachments provide protection to the bone making it difficult to fracture or break [19]. Currently, there are no scapular discriminant function equations available for the estimation of sex for Thai populations. The goals of this project are to (1) apply the contemporary Mexican [20]

* Corresponding author at: Saint Mary's University, Department of Anthropology, 923 Robie Street, Halifax, Nova Scotia B3H 3C3, Canada.
E-mail addresses: tanya.peckmann@smu.ca (T.R. Peckmann), shelby.scott@mail.utoronto.ca (S. Scott), susan.meek@smu.ca (S. Meek), pasuk.m@cmu.ac.th (P. Mahakkanukrauh).

http://dx.doi.org/10.1016/j.scijus.2017.02.005
1355-0306/

Table 1
Measurement descriptions.

Measurement	Description[a]
Length of glenoid cavity of the scapula (LGC)	Greatest length across glenoid cavity perpendicular to anterior–posterior axis
Breadth of glenoid cavity of the scapula (BGC)	Greatest width across glenoid cavity measured at a right angle to axis of length of glenoid cavity

[a] (Modified from Frutos 2002).

and contemporary Greek [21] scapular (glenoid fossa) discriminant functions to a contemporary Thai population, and (2) develop population-specific discriminant function equations for sexing scapulae from a contemporary Thai population.

2. Materials and methods

This research utilized 191 individuals (95 males and 96 females) from the Chiang Mai skeletal collection housed at the Forensic Osteology Research Centre, Faculty of Medicine, Chiang Mai University. The collection consists of 475 (291 males and 184 females) documented skeletons, i.e. sex, age at death, occupation, and cause of death. The individuals used for this project ranged in age from 19 to 96 years old. The collection consists of individuals who donated their bodies for research and teaching purposes. This collection represents a contemporary Thai population as all of the individuals lived the majority of their life during the twentieth century; all individuals used in this study were born between 1914 and 1995 and died between 2006 and 2014.

Following the protocol of Hudson et al. [20] and Frutos [22], the length of the left glenoid cavity (LGC) and breadth of the left glenoid cavity (BGC) were recorded using a standard Vernier caliper to the nearest 1/100 of a millimeter (Table 1, Figs. 1 and 2). A comparison of the measurements taken from 30 paired male scapulae and 30 paired female scapulae showed no statistically significant side differences with all $p > 0.05$. Therefore only the left scapula was measured. In cases where the left scapula showed evidence of trauma, damage, pathological changes or was absent measurements were taken using the right scapula. Intra- and inter-observer rates were calculated by re-measuring 60 randomly selected scapulae (30 males and 30 females) for each measurement variable. These sample sizes are appropriate as previous studies have shown that a subsample of 10% to 20% of the total population should be used to test for intra-observer and inter-observer error [23]. There were two observers. The intra- and inter-observer measurements were collected one week apart.

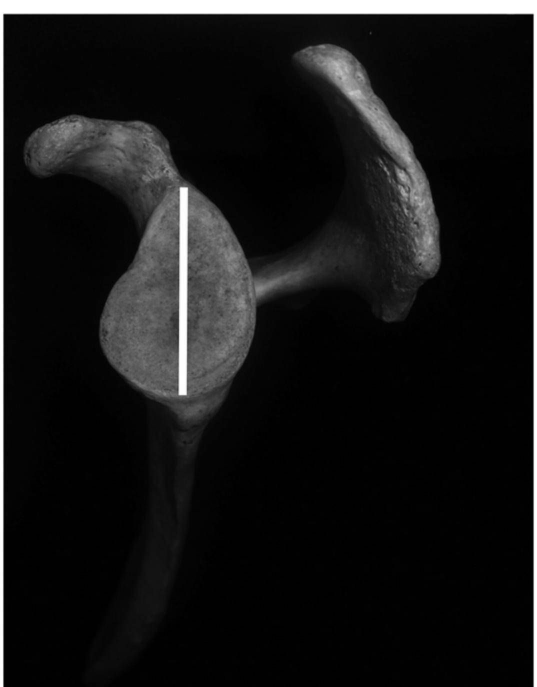

Fig. 1. Length of the glenoid cavity measurement as described in Table 1.

Fig. 2. Breadth of the glenoid cavity measurement as described in Table 1.

All statistical analyses were performed with the SPSS (version 22.0) software program with a level of significance $\alpha = 0.05$. Parametric (normally distributed) data were analyzed using a paired *t*-test and non-parametric (not normally distributed) data were analyzed using a paired Wilcoxon test. Descriptive statistics were obtained for each measurement. Males and females were analyzed separately. Using a two sample *t*-test for the parametric data and a Mann-Whitney *U* test for the non-parametric data the mean values of the two measurements were compared between the sexes to determine if statistically significant differences existed. The contemporary Thai scapulae measurements were compared with other populations using two sample t-tests: Chilean [24], contemporary Mexicans [20], indigenous Guatemalans [22], contemporary White Americans [25], and contemporary Greeks [21]. The contemporary Mexican [20] and Greek [21] discriminant functions were applied to the contemporary Thai sample to determine their accuracy for sex classification. Population-specific discriminant functions were created for the contemporary Thai population.

Table 2
Statistical analyses for intra-observer and inter-observer error.

Measurement	*n*	Test	Test statistic	p-Value*
Intra-observer error				
Male LGC	30	*t*-test	−0.297	0.769
Male BGC	30	*t*-test	1.367	0.182
Female LGC	30	*t*-test	0.511	0.613
Female BGC	30	*t*-test	0.511	0.613
Inter-observer error				
Male LGC	30	*t*-test	−1.327	0.195
Male BGC	30	*t*-test	−1.327	0.195
Female LGC	30	*t*-test	−1.817	0.080
Female BGC	30	*t*-test	−0.541	0.593

* $p > 0.05$.