HEIGHT ESTIMATION USING 2ND & 3RD METACARPAL BONE AMONG ADULT MALAY POPULATION ATTENDING HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM)

BY:

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To my dear husband,Shahrul Zaman B. Ab Ghani,
Thank you for the understanding,patience and support which enable me to complete this dissertation.

My parents,Mr Abdul Rasid Taib and Mrs Mahnie Daud,
Thank you for the full support and always be there when needed

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ABBREVIATIONS AND TERMS

HUSM-Hospital Universiti Sains Malaysia

PACS - Picture Archiving and Communications System

DICOM- Digital Imaging and Communications in Medicine

PA - Posterior Anterior

MDCT - Multi-Detector Computed Tomography

MCB - Metacarpal bone

SEE - Standard Error of Estimation

ABSTRAK

ANGGARAN KETINGGIAN BERDASARKAN TULANG METAKARPAL KE-2 DAN KE-3 DI KALANGAN POPULASI MELAYU DEWASA DI HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM)

Latarbelakang:

Anggaran ketinggian individu merupakan parameter penting dalam pemeriksaan forensik. Masalah yang selalu dihadapi berkenaan kes-kes bencana besar atau keganasan di mana angota tubuh badan manusia terbahagi kepada beberapa bahagian. Banyak kajian telah dilakukan untuk menentukan ketinggian daripada tulang panjang. Hubungan antara tulang tertentu dan perkadaran boleh digunakan untuk membantu proses identifikasi sekiranya rangka yang lengkap tidak diperolehi daripada tempat kejadian.

Secara keseluruhananya, tidak banyak kajian yang dijalankan mengenai anggaran ketinggian di kalangan rakyat Malaysia. Sehingga kini, tiada kajian yang diterbitkan di kalangan populasi Melayu Kelantan menggunakan tulang metakarpal. Oleh itu, dalam kajian ini usaha telah dilakukan untuk mencari hubungan antara ketinggian dan ukuran tulang metakarpal kedua dan ketiga di kalangan populasi orang dewasa yang hadir ke Hospital Universiti Sains Malaysia (HUSM).

Objektif:

Objektif utama kajian ini adalah untuk menganggar ketinggian menggunakan morfologi tulang tangan kiri di kalangan orang dewasa Melayu yang hadir ke Hospital Universiti Sains Malaysia.

Tatacara:

Ini merupakan kajian rentas yang dijalankan dikalangan populasi Melayu dewasa yang hadir ke Hospital Universiti Sains Malaysia untuk pemeriksaan x-ray tangan kiri. Seramai 124 orang subjek dalam lingkungan umur 19 ke 60 tahun teribat dalam kajian ini. Kepanjangan dan kelebaran tulang metacarpal kedua dan ketiga yang normal beserta ketinggian diukur dan di analisis.. Pengumpulan data dananalisis data menggunakan program (SPSS versi 22). Data demografi dianalisa menggunakan 'independent t-test'. Kaitan antara ketinggian dan parameter tulang metakarpal kedua dan ketiga dianalisa mengunakan kolerasis Pearson. Anggaran ketinggian berdasarkan parameter tulang metakarpal dianalisa menggunakan analisa persamaan regresi linear dan analisa linear regresi berganda.

Keputusan:

Melalui analisis statistik, semua parameter tulang dan ketinggian adalah dikalangan lelaki adalah lebih tinggi berbanding perempuan dengan nilai signifikan ($p<0.001$). Semua parameter tulang metacarpal kedua dan ketiga menunjukkan kolerasi yang signifikan ($p< 0.001$ dan $p<0.05$) dengan ketinggian di kalangan subjek perempuan. Manakala di kalangan subjek lelaki, hanya panjang tulang

metacarpal kedua dan ketiga menunjukkan nilaisignifikan dengan ketinggian (p<0.001). Analisa regresi linier menghasilkan ralat piawaian anggaran dari ±3.94 cm ke ±4.97 cm untuk subjek lelaki dan ±3.92 cm ke ±4.55 cm untuk subjek perempuan. Daripada analisa regresi linear, empat persamaanregresi terhasil untuk setiap kumpulan jantina. Analisa linier berganda pula menghasilkan nilai ralat piawaian anggaran lebih kecil daripada parameter kepanjangan tulang kedua bagi subjek lelaki(±3.94 cm). Untuk subjek perempuan, analisa linear berganda menghasilkan nilai ralat piawaian yang terkecil(±3.78 cm) daripada kepanjangan dan kelebaran tulang metacarpal kedua. Oleh yang demikian, satu persamaan regressi berganda dihasilkan bagi setiap jantina berdasarkan parameter tulang metacarpal kedua.

Kesimpulan:

Secara kesimpulannya, ketinggian di kalangan populasi dewasa Melayu Kelantan boleh ditentukan menggunakan tulang metacarpal kedua iaitu kepanjangan tulang bagi subjek lelaki dan bagi perempuan kepanjangan dan kelebaran di kalangan populasi dewasa Melayu di Kelantan.

ABSTRACT

HEIGHT ESTIMATION USING 2ND& 3RD METACARPAL BONE AMONG ADULT MALAY POPULATION ATTENDING HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM)

Background:

Estimation of individual's stature is an important parameter in forensic examination. Problems encountered in cases of mass disaster or assaults where the body was dismembered. Many studies have been encountered to determine stature by taking measurement of the long bones. The relationship between specific bone and proportion can be used to help in the process for identification in the absence of complete skeleton from a crime scene.

In general, there is a scarcity of literature regarding the estimation of stature (height) among Malaysia population. Up to date there was no published study regarding height estimation among Malay population in Kelantan using metacarpal bone parameters. The regression formulae are population specific. Therefore, the aim of the present study was to set a general formula of stature estimation for both adult males and females using anthropometrical measurements of second and third metacarpal bones using AP hand radiograph among Malay adults attending Hospital Universiti Sains Malaysia.

Objectives:

The general objective of this study was to estimate stature from the morphology of left hand radiograph among adult Malay population attending Hospital Universiti Sains Malaysia.

Patients and methods:

This was a cross-sectional study among adult Malay Kelantan population attended HUSM for posterior anterior (PA) view radiograph of left hand. A total of 124 subjects with age ranged from 19 to 60 years old were included. The length and width of the normal 2nd and 3rd metacarpal bones together with their heights were measured.Data entry and analysis were performed usingStatistical Package for Social Sciences (SPSS version 22) software programme. The descriptive demographic data were measured using independent t-test. The correlation between stature and parameters of metacarpal bones were performed using Pearson Correlation. The prediction of stature from the parameters of metacarpal bone were using simple linear regression and multiple (stepwise) regression analysis.

Results:

Statistical analysis revealed that parameters formale subjects were higher than the female subjects (p <0.001). There was significant correlation between all the parameters of second and third metacarpal bones in female subjects (*p* value <0.001 and *p* value 0.05). For male subjects, significant correlation noted between stature and the length of second and third metacarpal bone (*p* value <0.001).

Using simple linear regression analysis, the standard error of estimate (SEE) ranged from ±3.94cm to ±4.97cm for males and ±3.92cm to ±4.55cm for females. From the simple linear regression analysis, four regression equations were established for each gender. The multiple linear regression analysis revealed smallest SEE from the second metacarpal bone length for male (SEE ±3.94). For female subject the multiple linear regression analysis revealed smallest SEE revealed from the second metacarpal bone length and width (SEE ±3.78 cm). Therefore, one multiple regression equation was established for each gender using the second metacarpal bone parameter.

Conclusion:

It was concluded that stature can be determined successfully using 2nd metacarpal bone parameters which were the length for male and both length and width for female among adult Malay population in Kelantan.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

With the increasing frequency of mass disasters and fatal assaults, the identification of isolated extremities and their parts is the ultimate goal in the investigation for identity of victims. The process generally begins with formulation of a biological profile (osteobiography); specifically, estimation of sex, age, ethnicity and stature.

Forensic anthropologists while dealing with skeletal remains have very little choice to use anatomical method for stature reconstruction due to non-availability of complete skeleton from a scene of crime in most of the cases. Thus, they have no choice to use a relatively less precise method of stature reconstruction, i.e. the mathematical method. It is the method for calculating the height by considering the mathematical regression coefficients obtained from the measurements of many bones of the body.

A formula for one population does not necessarily yield reliable results for another due to inherent population variations that may be attributed to genetic and environmental factors as climate, nutrition and lifestyle. Thus, separate regression formulae should be developed in order to determine stature for each population group.

In general, there is a scarcity of literature regarding the estimation of stature (height) among Malaysia population. Furthermore, there is no study for the height estimation from metacarpal bones' dimensions performed among Malaysian especially Malay population in Kelantan. The regression formulae are population specific. Therefore, the aim of the present study was to set a general formula of stature estimation for both adults male and female using anthropometrical measurements of second and third metacarpal bones using AP hand radiograph among Malay adults attending Hospital Universiti Sains Malaysia.

CHAPTER 2

LITERATURE REVIEW

2.0LITERATURE REVIEW

2.1 OVERVIEW

Forensic radiology was first introduced since 1895's and since then it becomes more popular. In forensic radiology, the personal identification, age estimation and establishing a cause of death is possible. Various radiological methods had been used including plain radiograph, dental and fluoroscopy. Nowadays multidetector computed tomography (MDCT) has become more popular in forensic work (Saunders *et al.*, 2011).

It is well known that difficult to encounter full body parts or skeletal remains in forensic and anthropological investigations especially when the skeletal remains are fragmented or incomplete. Therefore, the degree of expertise is required to perform the analyses(Pretorius *et al.*, 2006).

Many research works have been done on the metacarpal morphology for populations originating from Western countries. It is accepted that studies of stature estimation based on an isolated body part should be population specific(Pelin *et al.*, 2010).The size and morphological shape of metacarpal bones may vary among ethnicity. The reasons for these differences are genetic and environmental factors such as dietary pattern and life style.

There are a few available study on metacarpal bone morphology among Asian population, the nearest among Singaporean population (Basir, 2008). However, no documented study about the morphology of metacarpal bone among Malaysian population has been done.

2.2 ANATOMY& DEVELOPMENT

2.2.1 EMBRYOLOGY OF THE UPPER LIMB

The limbs develop from somatopleuric mesenchyme in the lateral body wall. At a specific site along the main body axis, the regions of the somatopleuric mesenchyme proliferate extensively to give rise to limb buds as viewed at postaxial border (Fig 2.1 A). These buds are the first visible signs of limb development and are rimmed by a longitudinal ridge of high columnar epithelial cells, the apical ectodermal ridge viewed from the postaxial border (Fig2.1B). From the limb buds, (in dorsolateral view) the shoulder and elbow region can be discerned. More distally, a hand plate also has formed (Fig 2.1C). Subsequently, from the hand plate the digital ray will be formed in each digit and the edges of the plate becoming notched (Fig 2.1D). The notch is separated for the formation of fingers and proliferation begins at the distal end of each digitto form nail bed (Fig 2.1E). The nail development continues as each of the fingers has the tactile pad distally (Fig 2.1 F).

The early limb bud contains a mixed population of mesenchymal cells consist of somatopleuric mesenchyme, that gives rise to the connective tissues of the limb, including cartilage, bone, tendon and loose connective tissue, paraxial mesenchyme from the somites gives rise to the myogenic cells of the muscles, and angiogenic mesenchyme produces an extensive vascular network in the early limb bud.

Motor and sensory nerves and the neural crest derived Schwann cells and melanocytes of the skin, migrate into the developing limb somewhat later.

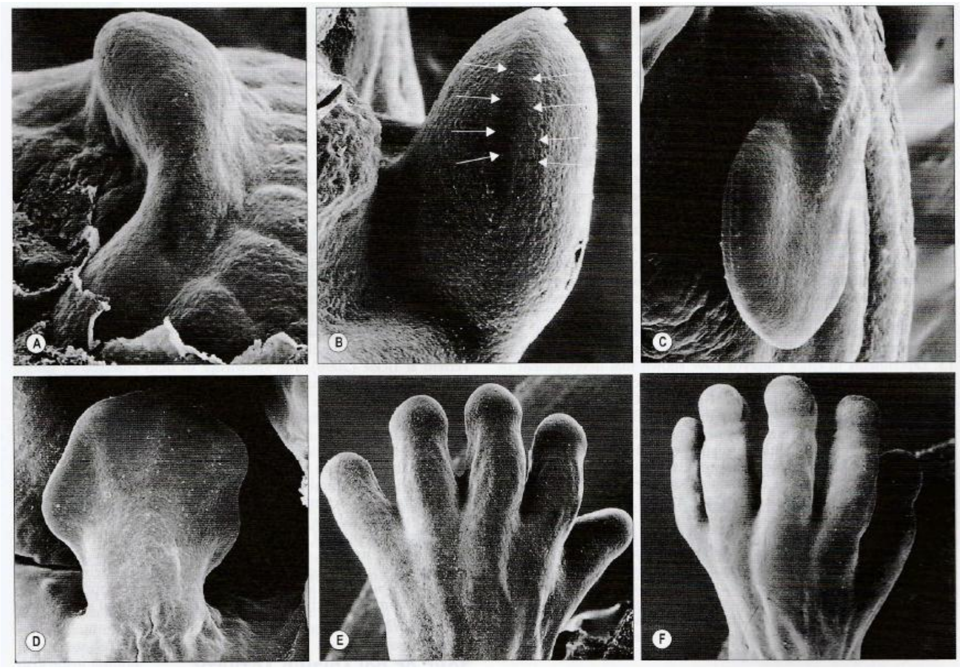

Figure 2.1 (A-F) : Scanning micrographs shows the development of the upper limb

Adapted from Gray's Anatomy: The anatomical basis of clinical practice, expert consult. Aubrey Durkin(Standring, 2008)

(A)The somatopleuric mesenchyme proliferate extensively to give rise to limb buds as viewed at postaxial border.

(B) The apical ectodermal ridge viewed from the postaxialborder

(C) From the limb buds, (in dorsolateral view) the shoulder and elbow region can be recognized more distally, a hand plate also has formed.

(D) The digital ray will be formed in each digit and the edges of the plate becoming notched.

(E) The notch is separated for the formation of fingers and proliferation begins at the distal end of each digit to form nail bed.

(F)The nail development continues as the each of the finger has the tactile pad distally.

2.2.2 LEFT HAND

Each hand consists of 27 bones, 8 form the wrist, and 19 form the palm. The hand bones consist of the carpal bones, metacarpals and phalanges. At birth, only the shafts of the metacarpals and phalanges are present.

2.2.3. METACARPAL BONE

The metacarpals consist of five cylindrical bones in each hand. They articulate with the carpal bones proximally and distally with the proximal row of phalanges. They are numbered from the lateral or thumb to the medial side as shown in (Fig 2.2), the anatomy of bone of the left hand.

A metacarpal consists of a shaft and two extremities. The base articulates with the carpals and they also articulate on the side with the adjacent metacarpal bones (except for the thumb). The shafts are slightly concave on the palm surface and are triangular in shape.

The first metacarpal is the shortest and thickest of the metacarpals. The second is the longest metacarpal. The third, fourth and fifth metacarpals decrease in size. The articular surfaces on the heads of the metatarsals are restricted laterally and are well marked anterior-posteriorly.

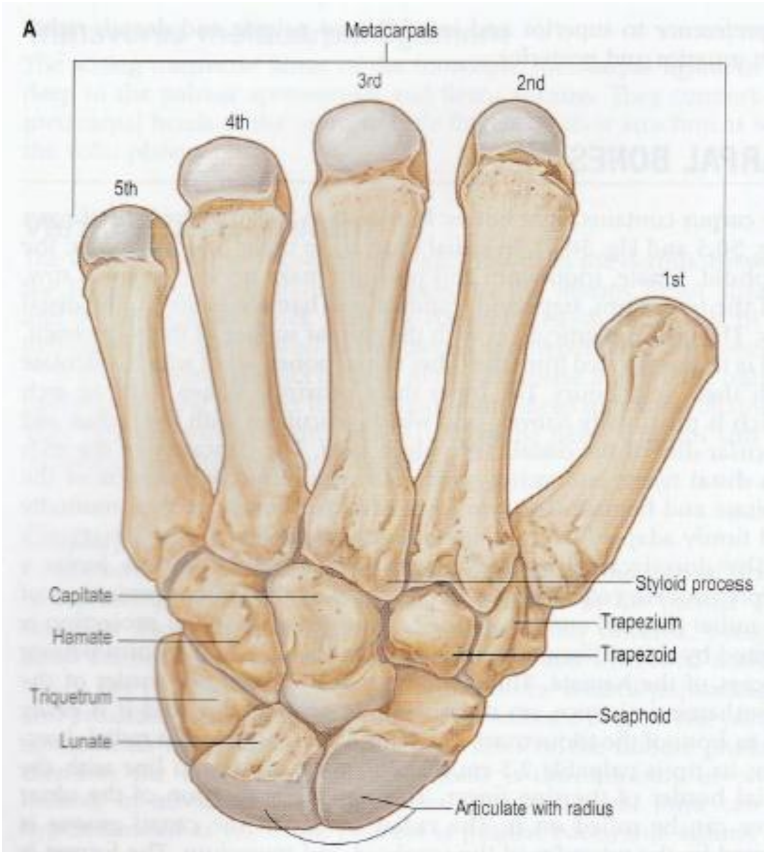

Figure 2.2 : Gross anatomy of bones of the left hand

Adapted from Gray's Anatomy: The anatomical basis of clinical practice, expert consult. Aubrey Durkin (Standring, 2008)

2.2.4GROSS ANATOMY OF THE LEFT 2^{nd} METACARPAL BONE

The second metacarpal bone is the longest of the four remaining bones; it, however, exceeds the third by a very slight difference. It is further distinguished from the third by the diminutive size of the articular facet on the radial side of its carpal extremity. Figure 2.3shows the gross anatomy and Figure 2.5 shows the radiological anatomy of the left second metacarpal bone.

Apart from being the longest, its base is also the largest. Its base is prolonged upward and medial ward, forming a prominent ridge. It presents four articular facets: three on the upper surface and one on the ulnar side. Of the facets on the upper surface the intermediate is the largest and is concave from side to side, convex from before backward for articulation with the lesser multangular; the lateral is small, flat and oval for articulation with the greater multangular; the medial, on the summit of the ridge, is long and narrow for articulation with the capitate. The facet on the ulnar side articulates with the third metacarpal.

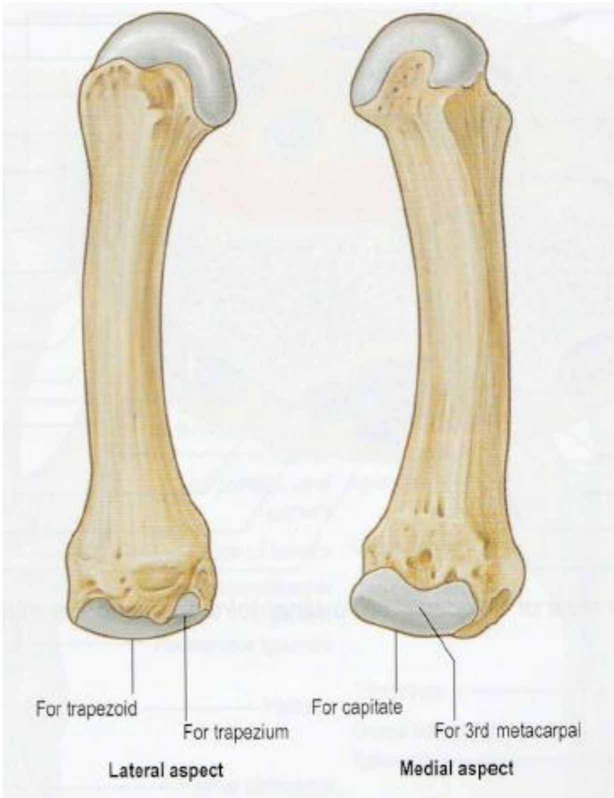

Figure 2.3: Gross anatomy of the left 2nd metacarpal bone

Adapted from Gray's Anatomy: The anatomical basis of clinical practice, expert consult. Aubrey Durkin(Standring, 2008)

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2.2.5 GROSS ANATOMY OF THE LEFT 3rd METACARPAL BONE

The third metacarpal bone, though shorter than the second, is manifestly thicker and stronger. It has a short styloid process, projecting proximally form the radial side of dorsal surface. Its base with a convex anterior facet for articulation with the capitate. A strip-like facet, constricted centrally articulates with the base of second metacarpal bone on the lateral part and fourth metacarpal bone on the medial side. Figure 2.4 shows the gross anatomy and Figure 2.5 shows the radiological anatomy of the left 3rdmetacarpal bone.

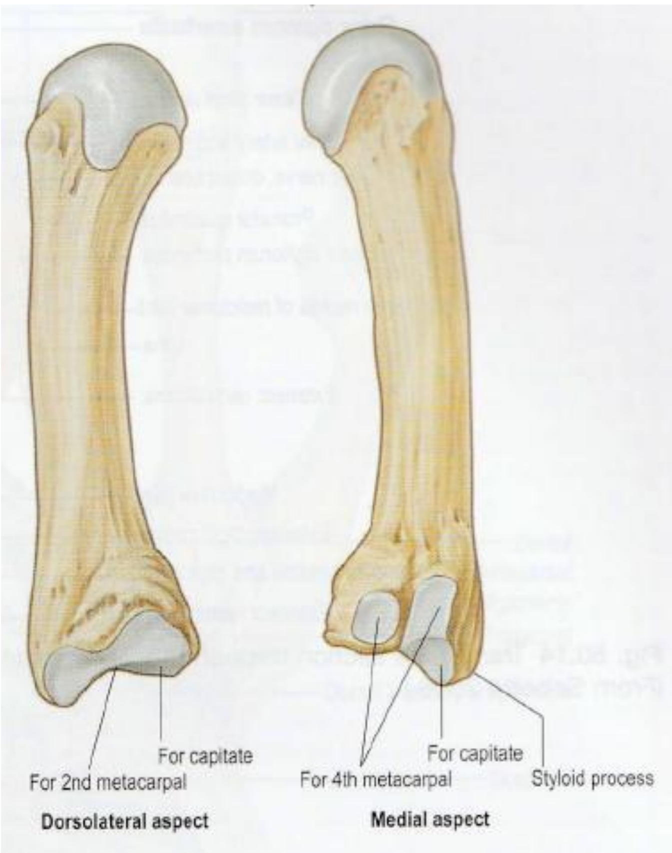

Figure 2.4 : Gross anatomy of the left 3rd metacarpal bone

Adapted from Gray's Anatomy: The anatomical basis of clinical practice, expert consult. Aubrey Durkin(Standring, 2008)

2.2.6 RADIOLOGICAL ANATOMY OF METACARPAL BONE

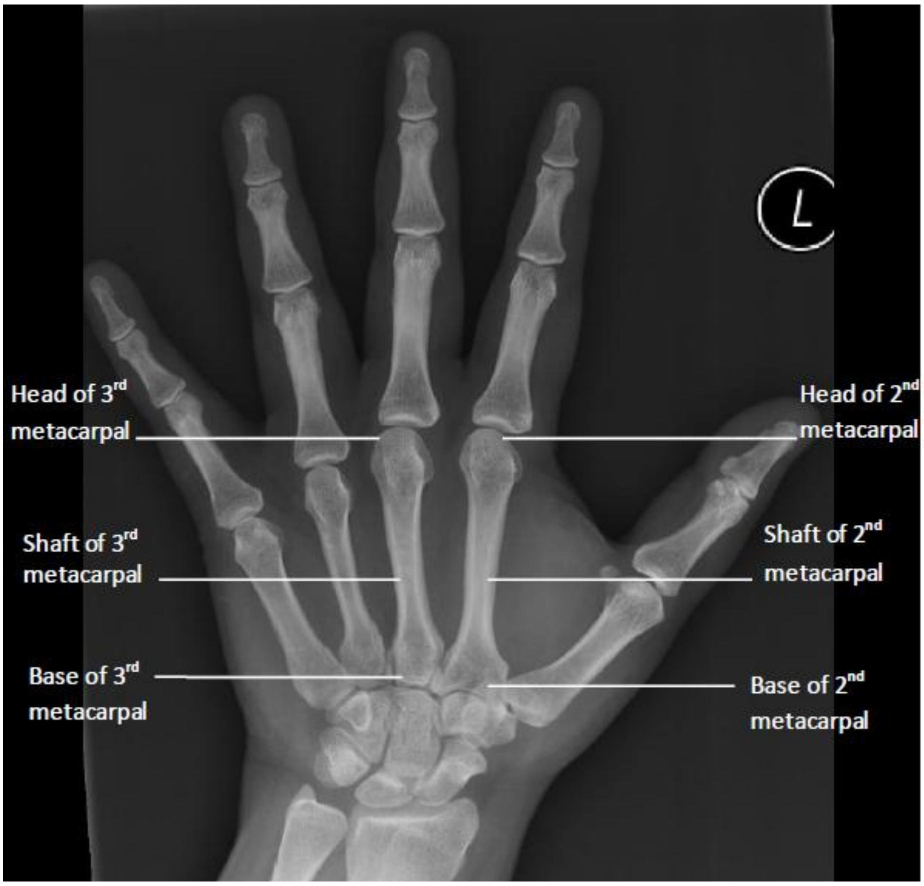

Figure 2.5: Left hand radiograph (posterior anterior view)

2.3HISTORY OF STATURE ESTIMATION

2.3.1 OVERVIEW

Various methods have developed in the last few centuries for stature estimation either the anatomical or mathematical. The mathematical method make use of one or more bone of length to estimate the stature of individual.

The first study is by Rollet 1888, assesed the correlation between stature and long bone lengths. He measured the length of radius, ulna, humerus, femur, fibula and tibia and table of stature estimation.

Then, (Pearson, 1899a), used the data to creat regression formulae for estimating stature.The advantage of mathematical method is, a single bone can be used to estimate stature. The bone length is substituted into regression equation. The outcome of the equation calculated gives the total skeletal height of the living stature. However, the disadvantages is that, different formula is required for a different population, for each different bone and also saperately for each sex (Sanli *et al.*, 2005).

2.3.2 IMPORTANCE OF REGRESSION EQUATION

Stature determination is one of the earliest values needed in identifying human. In the 20th century with more mass disaster happen from homicides activities to war victims and mass accidental disaster, most of the victim's body parts are capitulated. In forensic sciences and medicine the stature of an individual can be determined from anatomical measurement or mathematical method (Bhasin *et al.*, 2002).

The anatomical method was noted more reliable in the presence of the complete individual body (Bidmos, 2005; Pearson, 1899b). However, in the absences of the completed human body or skeleton, the mathematical method was preferred.

The mathematical method was created to determine the regression equation and estimating stature of an individual or person (Pearson, 1899a).When a full skeletal or complete human body were presented, the role of mathematical method in estimation height becomes second. The role of mathematical method in estimating stature in Asian country was pioneered by India(Badkur *et al.*, 2011).

Malay race had occupied the portion of adjacent island in Southeast Asia (SEA), Sumatera, coast of Borneo as well as islands in between these area and particularly peninsular Malaysia. Malays were traced by the anthropologist as originated from north-western part of Yunnan in China. The earlier Malay noted as proto-Malay were people probably from coastal Borneo who lengthened to Sumatera as consequence of trading and ocean-going activities. Malay today known as modern Malay of Peninsular Malaysia and coast of the Malay Archipelago were results of mixture of other different races such as modern India, Thai, Arab and Chinese. As for Kelantan, a state in the region of Peninsular Malaysia has 95.7 % of Malay population(Negara, 2012).

Due to specific genetically distribution among Modern Malay, a specific regression analysis must be performed for specific estimation stature formula. This make the estimation of stature from human skeletal remains is a major challenge in every country(Menezes *et al.*, 2009).The limb length to stature proportions differ between human populations(Krishan and Sharma, 2007)

Other than that, previous study noted that specific gender and population need specific equation for estimation that derive from specific simple liner regression or multiple linear regression analysis(Bidmos and Asala, 2003).

Many studies have been carried out to estimate stature by taking measurements from radiographic materials. There are different methods in obtaining metacarpal measurements, generally categorized into invasive and non-invasive. Plain radiograph is anon-invasive, practical and more accessible mode of measurement, and delivers the minimum radiation dose to subjects(MOU *et al.*, 2011). These provide the suitability tool for metacarpal measurement in this study.

2.3.3 EFFECT OF AGIENG ON STATURE

It is generally accepted that stature declines with age. According to Giles and Hutchinson (1991), it is a reasonable assumption that populations, particularly those in the United States, will begins to decrease in stature starting in their midforties. This minimal decrease begins for males at about 1mm/year and for female at about 1.25mm/year. These factors must be accounted when estimating in an older individual, generally including over the age of 45 years old (Giles and Klepinger, 1988). Galloway found that height reduces average by 0.16 cm per years after age 45 (Galloway, 1988). She suggested correction of the maximum height -0.16 cm (age 45), incorporated into the stature estimation equation when analysing older individuals. Trotter stated that stature decrease from age 30 by 0.06 cm per year (Trotter and Gleser, 1977).

2.3.4ESTIMATION OF STATURE FROM VARIOUS PARTS OF HUMAN BODY

Estimation of stature in victim is a one of the major concern in Forensic Investigation and anthropology. Every part of the human body is unique in its determination ration to the height. It is amazing to discover that every part of the body is different in its own way for a similar body component in other person. There is also relationship between each part of the body and the whole body.

Nothing represents this truth more than the relationship that various parts of the body have to stature and gender identity on a person. Many authors have studied estimation from mutilated body parts can be done based on ratio of the body part concerned in relation to entire body.

Kate and Majumdar 1976, sucessfully estimated stature from the length of femur and humerus by regression method and outometry is an Indian sample. A study by Boldsen in 1984 statistically evaluated the prediction of stature from length of the long bones in different European population. A study done among Indian population done measuring 12 anthropometric parameters on ulna and multi-linear regression equation were computed for stature estimation(Badkur and Nath, 1990).

A study done in Japan, proved that stature estimation can actually be derived not only form the long bones but also from the somatometry of the skull(Chiba and Terazawa, 1998). Theys carried out a study to detemine the stature from the somatometry ofthe skullamong 124 Japase cadavers.

The regression equations calculated for both sexes with SEE (standard error of estimation) (S.E= 6.59cm) and (S.E= 6.96) . These are noted to be larger than other parts of the body. However, usefull in cases where indentification is required by means of only the skull is available.

In the year of 2002, (D.Radoinova *et al.*, 2002) performed a study for stature estimation among the Bulgarian population. In this study, the statures and lengths of humerus, tibia and fibula were measured in 416 forensic cases.

The stature of a person can be determined by employing the software system of multivariate regression statistic to analyze data from the hand. A study performed in China involving 52 adult males whereby they measure the upper limb. Measurement of hand length, hand width, length of palm, width of palm, length of thumb, index finger, middle finger, ring finger and little finger, which , after analysis has turned out to have applicable value to determine person's height (Xian-yue, 2004).

The study has proved that predicting the stature from the length of the limb long bones taking into account sex- and age-related changes. Mubarak Bidmos(2005) reported that adult stature estimation can be measured by calcaneus measurement on cadaver with the standard error of estimation around 4 to 5 cm. The stature estimation can be calculated from the individual bone measurement or using combination of variables (Bidmos, 2006).

The relationship between humerus, radius, ulna, femur, tibia, fibula and clavicle with the stature estimation have been a topic of research for decades (Nath and Badkur, 2002; Oberoi *et al.*, 2006).

Among the North Indian population, a study to determine the relationship between stature and various dimensions of hands and feet was performed. The hand length, breadth, foot length and foot breadth were taken independently right and left for each 246 subjects. The linear and multiple regression equations for stature estimation were calculated and found to be positive and statistically significant. The highest correlation coefficient noted between stature and foot length with lowest SEE (standard error of estimation). These provides the reliability and accuracy in estimating stature of unknown individual among the North Indian Population (Krishan and Sharma, 2007).

In the year of 2010, a study to evaluate the correlation between stature of an individual with six parameters; hand length, hand-width, foot-length, foot-width, forearm length and knee-to ankle length among healthy individual in local population of Mumbai was performed. From the sample of 300 medical students, it was found that all six parameters showed correlation with stature. However, the best was forearm-length (r=0.6) followed by foot-length (r= 0.6). The mathematical formulae for estimating stature were performed through basic linear regression for stature estimation in the population of Mumbai (Chikhalkar *et al.*, 2010).

2.3.5ESTIMATION OF STATURE FROM METACARPAL BONE

Formula for the estimation of stature from metacarpal bone length are presented by (Meadows and Jantz, 1992). Developed regression equation from two samples of metacarpals specimens. In this study, two samples of metacarpal specimens were employed in the analysis: one of 212 individuals from the Terry Collection, and one of 55 modern males, all of whom had measured statures. The midline length was taken on each metacarpal bone. The stature was regressed on the basis of the metacarpal length to derive equations. Comparisons between the Terry Collection male and the modern sample showed the latter to have longer metacarpals and greater statures. In spite of the differences noted, the Terry equations perform acceptably on modern individuals and performance was slightly better for whites than for blacks.

A study conducted in 372 radiographs of hand from 186 adults was performed to find correlation with body height. The length and mid-width of proximal, middle and distal phalanges and metacarpal bones were measured. It was reported, that the body-height index of metacarpal bones and phalanges provide definite assistance in judgment of the height and gender of a person in forensic medicine. was gender difference among them (SUN and CHEN, 2005)

In the year of 2006, a study to estimate the stature from x-rays of metacarpal bone was performed among Turkish population (Sağir, 2006).
It is a study of 100 female and male patient's hand radiograph. From the study, five regression models has been set up base on 5 metacrapal

bones.The best regression model noted in this study, to estimate stature from x-rays of metacarpals were using the measurement of 2nd and 3rd metacarpals bone.

Not only this, another study performed in Japan results in similar findings. (MOU *et al.*, 2011)study the association between the metacarpal and height of population in Gaomi City. This study involving a total of 280 men and 331 women respondents had their metacarpal bone measured and correlate with their height. From this study, the best correlation noted between the second metacarpal length and height followed by the third metacarpal bone length.

Another study performed among 157 Egyptians adults using multi-detector computed tomography (MDCT) of the left handto measure the 2nd and 3rd metacarpal bone length and width. Their stature were determined. Statistical analysis revealed that all variables are significant for female. As for the male population, the Pearson's correlation found to be significant between the stature and second metacarpal width, third metacarpal bone length and width. Linear regression equations were calculated with standard error (SEE) 4.53cm to 4.71 for male and 5.45cm to 5.87cm for female. Not only that,the multiple regression equations were also calculated resulting into the best model for both gender (Zaher *et al.*, 2011)

CHAPTER 3

OBJECTIVE

3.0 OBJECTIVES

3.1 GENERAL OBJECTIVE

To estimate stature from the morphology of left hand radiograph among adult Malay population attending Hospital Universiti Sains Malaysia.

3.2 SPECIFIC OBJECTIVES

1. To compare the stature-metacarpal bone parameters (length and width) of left hand between female and male.
2. To determine the correlation between stature and the parameters (length and width) of left metacarpal bones.
3. To predict stature from the parameters (length and width) of left metacarpal bones based on equation formula.