

ESTIMATION OF STATURE FROM HAND AND HANDPRINT  
MEASUREMENTS IN THE MONOETHNIC MALDIVIAN POPULATION IN  
MALDIVES

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## DEDICATION

*This dissertation is dedicated to Kaisan Ihsan Mohamed, who is my true strength in everything I do and keep myself to never give up all the way. one motto I held onto for you, everything happens for a good reason, knowledge will teach you to find the good In Sha Allah. My son, if not for you I would have quit this before the start.*

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## **ABSTRACT**

Estimation of stature among a selected specific population may prove useful via anthropometric measurements of hand and handprints. Since studies conducted in several monoethnic countries (e.g. Korea, Bangladesh and China) have reported about its usefulness, and because similar study in Maldives remains unreported, this present research that evaluated such aspect merits forensic significance. Using stratified random sampling, this present research examined the standing height as well as 22 anthropometric measurements from each hand and handprints collected from consented male (n = 191) and female (n = 193) Maldivians living in Maldives. The data were analysed using both the univariate and multivariate statistical analyses for interpreting the obtained anthropometric measurements and its association in estimating stature. The outcomes of simple linear regression analysis provided, significant ( $p < 0.05$ ) and a moderate to highly correlated (range: 0.61 – 0.70) regression equations for hand lengths of both hands and handprints of Maldivian males and females for accurate estimation of their stature. The precision of the estimated stature (Standard Error of Estimate, SEE) using the derived equations of this research ranged between 3.82 - 5.76 cm. Furthermore, stepwise multiple regression analysis provided improved accuracy to the equation (SEE: 3.82 - 5.76 cm). The data gathered here are the first of its kind for the Maldivian population and may prove forensically relevant in crime scene investigation and disaster victim identification, a pragmatic approach for estimating stature from forensic anthropological means.

## ABSTRAK

Anggaran ketinggian dalam kalangan populasi yang spesifik menggunakan ukuran antropometrik tangan dan cap tangan berkemungkinan berguna. Memandangkan kajian dalam kalangan negara monoetnik (seperti Korea, Bangladesh dan China) telah melaporkan kebergunaannya, dan kajian yang serupa di Maldives tidak pernah dilaporkan, kajian terbaharu ini adalah signifikan dalam bidang forensik. Dengan menggunakan persampelan rawak berstrata, kajian ini memeriksa ketinggian dan juga 22 ukuran antropometrik daripada setiap tangan dan cap tangan lelaki ( $n = 191$ ) dan perempuan ( $n = 193$ ) rakyat Maldives yang tinggal di Maldives. Data analisis dilakukan menggunakan analisis statistik univariat dan multivariat bagi memahami ukuran antropometrik yang dicerap dan kaitannya dalam menganggar ketinggian. Hasil daripada analisis regresi linear menunjukkan kaitan signifikan ( $p < 0.05$ ) yang sederhana dan tinggi (Julat  $r: 0.61 - 0.70$ ) bagi ukuran panjang tangan dan cap tangan dalam kalangan rakyat Maldives lelaki dan perempuan bagi menganggar ketinggian mereka secara tepat. Kebersihan dalam menganggar ketinggian (Anggaran Kesilapan Standard, AKS) menggunakan persamaan yang terhasil adalah sekitar 3.82 - 5.76 cm. Tambahan pula, analisis regresi berganda memberikan ketepatan yang lebih baik dalam persamaan yang terhasil (AKS: 3.82 - 5.76 cm). Data yang dicerap ini merupakan data yang pertama bagi populasi Maldives dan berkemungkinan relevan secara forensiknya dalam penyiasatan tempat kejadian jenayah serta pengenalpastian mangsa bencana, suatu pendekatan pragmatik bagi menganggar ketinggian menerusi kaedah antropologi forensik.

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## LIST OF ABBREVIATIONS

DNA	-	Deoxy-ribo Nucleic Acid
U. S	-	United States
SEE	-	Standard Error of Estimation
SD	-	Standard Deviation
cm	-	Centimetre
HS	-	Highly Significant
S	-	Significant
NS	-	Not Significant
HL	-	Hand length
HB	-	Hand Breadth
HP	-	Half Print
A	-	Thumb Finger
B	-	Index Finger
C	-	Middle Finger
D	-	Ring Finger
E	-	Little Finger
A1	-	Thumb Finger Distal Phalange
A3	-	Thumb Finger Proximal Phalange
B1	-	Index Finger Distal Phalange
B2	-	Index Finger Medial Phalange
B3	-	Index Finger Proximal Phalange
C1	-	Middle Finger Distal Phalange
C2	-	Middle Finger Medial Phalange
C3	-	Middle Finger Proximal Phalange
D1	-	Ring Finger Distal Phalange
D2	-	Ring Finger Medial Phalange
D3	-	Ring Finger Proximal Phalange
E1	-	Little Finger Distal Phalange
E2	-	Little Finger Medial Phalange
E3	-	Little Finger Proximal Phalange

## LIST OF SYMBOLS

- P - Significance  
R - Correlation coefficient

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# CHAPTER 1

## INTRODUCTION

### 1.1 Problem Background

To solve criminal cases, forensic anthropologists primarily examined skeletonized remains for estimating several useful traits that can be used for individualization (Gordon & Styne, 2012; Ishak *et al.*, 2012; Zulkifly *et al.*, 2018). Beside the conventional crime scene investigations, a great deal of forensic anthropology principles and approach have been utilized for investigating cases involving living individuals, as well as terrorism activities (Zulkifly *et al.*, 2018). In this context, previous researchers have indicated about the common discovery of hand and footprints at crime scenes and suggested that human traits like stature and weight can be estimated from several anthropometric parameters of handprints and footprints (Ahemad & Purkait, 2011; Moorthy *et al.*, 2013).

Researchers have indicated that the process of narrowing down the pool of suspects can be substantially improved when anthropological parameters like stature are considered (Hisham *et al.*, 2012). Upon completion, positive identification using suitable traditional markers like DNA can later be employed for ascertaining individuality (Komar & Buikstra, 2008). DNA analysis as the first step of identification of an unknown body or dismembered body parts is not affordable to many of the countries around the world, regardless of it being highly accurate. Factors such as the inadequate number of trained people, well-equipped laboratories, financial restrictions as well as lengthy analytical process have been attributed as major limitations to the use of DNA technology for screening purposes. Therefore, despite its class characteristic property, forensic anthropological approach continues to become relevant in forensic investigations (Cunha *et al.*, 2006; Kanchan *et al.*, 2010a).

Being an island nation without land mass borders to its closer neighbouring countries (*viz.* India and Sri Lanka), Maldives is one of the biggest tourist attraction countries in the South Asian region with about 344000 monoethnic inhabitants (Ghosh, 2000; Statistics, Treasury, & Male', 2017). Since there is no land mass border, trespassing activities by potential criminals/terrorists *via* the oceans cannot be ignored. Instances like invasion by the Tamil Tigers in 1988 (Ferdinando, 2012) and tsunami in 2004 (Maldives Planning and National Development, MPND, 2007) can negatively affect the economy of Maldives. In view of its status as an important tourist destination, safeguarding peace and harmony has become one of the priorities of the Maldivian government. This is reflected by specific focus to equip the Forensic Service Department of the Maldives Police Service with relevant forensic instruments and expertise, especially for identifying victims and criminals (Retired Assistant Commissioner of Police Hussain Adam, personal communication). Unfortunately, application of forensic anthropological approach has never been reported, limiting its potential for crime solving and victim identification in this country.

## **1.2 Problem Statement**

Generalization of mathematical algorithms for anthropological assessments derived for a specific population to other populations may lead to inaccurate inferences due to variations in nutrition and health care facility conditions (Cardoso & Gomes, 2009) as well as genetic factors (Nunez & Perez, 2015). Previous researchers have reported about several studies conducted on the use of hand (Sanli *et al.*, 2005; Krishan & Sharma, 2007; Rastogi *et al.*, 2008; Agnihotri *et al.*, 2008; Habib & Kamal, 2010; Ahemad & Purkait, 2011; Kanchan *et al.*, 2010; Tang *et al.*, 2012; Zhang *et al.*, 2017; Kim & Yun, 2018) as well as hand prints (Ilmu & Indonesia, 2016; Kornieieva & Elelemi, 2016)(Ishak *et al.*, 2011; Jee & Yun, 2015; Ilmu & Indonesia, 2016; Kornieieva & Elelemi, 2016; Zulkifly *et al.*, 2018). Considering the vulnerability of Maldives to international crimes and Natural disasters, and because the development of forensic technology in this country is at its nascent stage, specific research to provide empirical data for applying forensic anthropological assessments reported here, deserves forensic consideration. For instance, during 2004 tsunami, Maldives

experienced the heaviest loss to the economy and disturbance to the lives of Maldivians through the deaths and damages to their homes (MPND, 2007). Also, the 1988 terrorist attack by Tamil Tigers had killed 19 Maldivians and left several injured (Ferdinando, 2012). These two examples demonstrated the vulnerability of Maldives to international crimes and natural disasters necessitating the development of forensic anthropological means for crime scene investigations as well as disaster victim identification. The conceptual framework of this present research is provided in Figure 1.1.

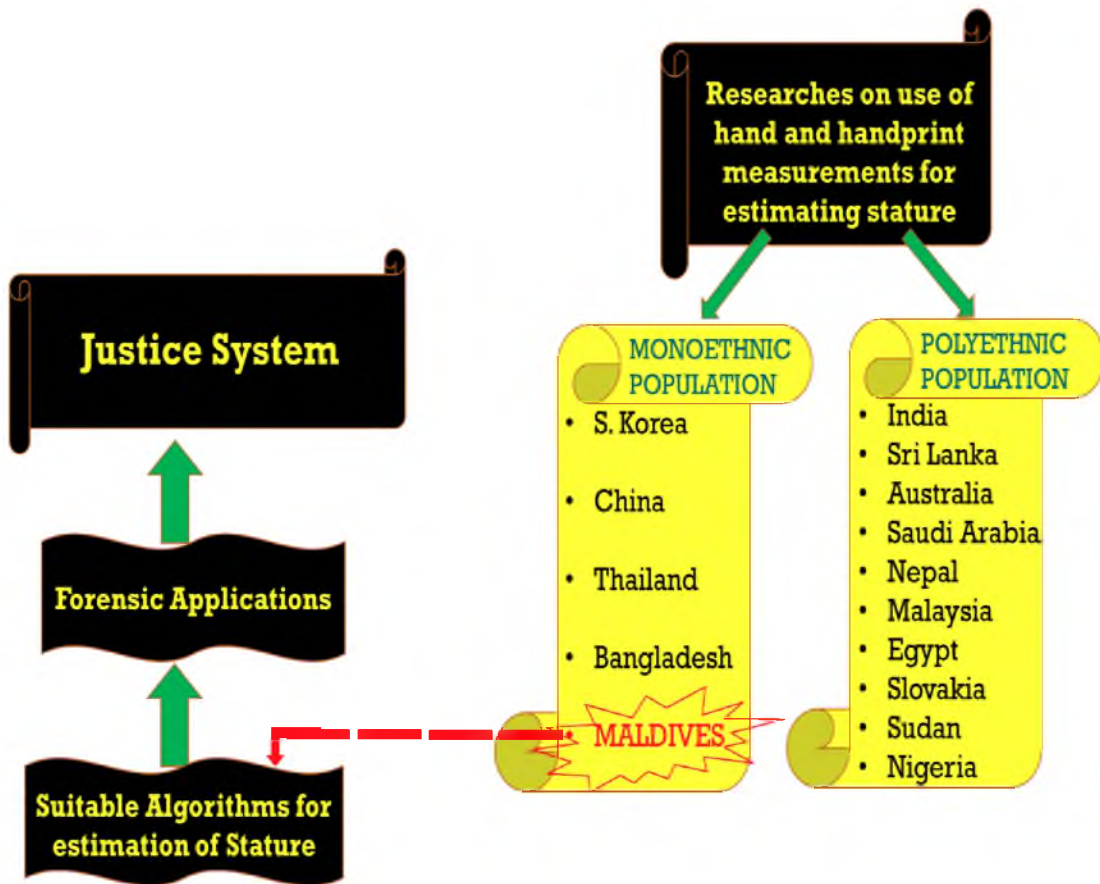


Figure 1.1 Conceptual framework of this research. Dotted arrow indicates the present research on Maldivian population in Maldives.



### **1.3 Scope of study**

This present research examined 384 Maldivian subjects (191 males, 193 females) from various locations in Maldives. Upon measuring the different traits of hand and handprints on each consented subject (aged 18 - 60), estimation of stature and weight was made by regressing the data using the appropriate algorithms. For reducing biases, pregnant individuals, those having any diseases and/or injuries that may affect stature, hand morphology as well as metabolic and/or developmental disorders were excluded from participating in this present research.

### **1.4 Significance of the Study**

Because of the frequent observation of handprints at crime scenes, as well as dismembered limbs during mass disasters and/or terrorism attacks, this present research that reported, for the first time, empirical data for estimating stature and weight from hand and handprints specifically for the often-neglected Maldivian population, merits forensic significance. The data gathered in this present research would serve as a means for excluding the innocents from the list of suspects, and hence, optimizing the available resources for identifying perpetrators during forensic search. The fact that the data would be indigenous to Maldives, they would pave the way for further exploration in this aspect in the South Asian region.

### **1.5 Objectives and Hypothesis**

This present research was aimed at examining the feasibility of estimating human stature from hand and handprints among male and female Maldivians in Maldives for its practical value in forensic investigation. Considering the pertinence of this present research for the Maldivian population in Maldives, the following objectives were articulated:

1. To associate the measurements of hand and handprints with that of stature among males and females by providing suitable mathematical algorithms.
2. To compare the bilateral asymmetry in hand and handprint measurements between male and female subjects.

It was hypothesized that:

1. Significant association between the traits of hands and handprints with that of stature shall be observed among male and female subjects.
2. Significant differences in the bilateral asymmetry in hand and handprint measurements between male and female subjects were expected.

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