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Sex determination from fingerprint ridge density and white line counts in Filipinos

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ABSTRACT

Fingerprints are distinct physical characteristics that remain unchanged throughout an individual's lifetime. This study derived Filipino-specific probability formulae from fingerprints to be used for sex discrimination in human identification cases. Ridge density from three different areas – distal radial area, distal ulnar area, and proximal area – as well as white line counts from fingerprints of 200 male and 200 female Filipinos were collected and analyzed statistically. Ridge densities of radial and ulnar areas emerged as displaying significant differences between the sexes, with 16 ridges/25 mm^2 or more in radial area and 15 ridges/25 mm^2 or more in ulnar area being more likely to be female, whereas 13 ridges/25 mm^2 or less in radial area and 12 ridges/25 mm^2 or less in ulnar area were more likely to be male. A white line count of 0 was more likely to be male while a white line count of 2 or more was more likely to be female. The results of this study show sex differences in Filipino fingerprints and support the observation of previous studies that females have finer ridges than males.

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Introduction

Fingerprints have been used extensively to establish human identity. This is because no two persons, even pairs of monozygotic twins, have the same prints. The possibility of sex differentiation using fingerprints has been attributed to the observation that females have fine epidermal ridge detail while males have coarse ridge detail (Cummins et al., 1941; Mi et al., 1982; Moore, 1994). This suggestion remained purely anecdotal until Acree's (1999) introduction of quantitative method in 1999, which verified sex differences among European and African descent Americans with empirical data.

Similar results have been achieved and confirmed in Indian (Gungadin, 2007; Kapoor and Badiye, 2015; Krishan et al., 2013; Nayak et al., 2010b; Nithin et al., 2011), European Spanish (Gutiérrez-Redomero et al., 2008), Mataco-Mataguayon (Gutiérrez-Redomero et al., 2011), Argentinian (Gutiérrez-Redomero et al., 2013), Chinese and Malaysian populations (Nayak et al., 2010a). Gutiérrez-Redomero et al. (2008) extended the chosen area of fingerprint analysis by adding two more regions, namely the ulnar and the proximal. Sex differences were found to be significant in the distal (radial and ulnar) but not proximal regions, with females having greater ridge density compared to males. Gutiérrez-Redomero et al. (2014) noted significant differences in ridge density in different areas, and also from the different recording methods (rolled and plain) of fingerprint impressions.

Meanwhile Badawi et al. (2006) introduced counting white lines as a reliable method for sex determination using fingerprints, with females having a greater number of white lines than males. White lines are skin folds in the friction ridges that appear as white lines in print, hence the name, and they increase in frequency later in life or when subcutaneous body fat changes (Ashbaugh, 1999; Cummins and Midlo, 1943).

Hand morphology and fingerprint patterns of Filipinos have never been the subject of any published journal article. Likewise, Filipino-specific sex determination techniques in the forensic sciences have never been a topic of scientific inquiry except for Taduran's (2012) formulae derived from canine measurements. The aim of this research, therefore, was to derive Filipino-specific probability formulae from fingerprints that could be used as a primary tool for sex discrimination in human identification. This was accomplished by employing the method developed by Gutiérrez-Redomero et al. (2008), based on the work of Acree (1999), to identify sex differences in ridge densities from different fingerprint locations (radial, ulnar, and proximal). Furthermore, the appearance of white lines on each of the ten fingerprints was included as a classifier. The results obtained were compared with other populations from similar studies.

This research is the first of its kind to be conducted and the data collected should prove useful in disaster, forensic and human rights cases within the Philippine setting.

Materials and methods

This research underwent the necessary ethical, legal and procedural scrutiny before being approved by Philippine National Police (PNP) officials. Fingerprint samples were obtained and scanned in the PNP Crime Laboratory Fingerprint Division located in Camp Crame, Quezon City, Philippines. A fingerprint sample refers to a single standard PNP ten-print card containing all inked fingerprint impressions of an individual when applying for police clearance.

Significant inclusion criteria for the sample were:

1. Full finger rolling for all ten impressions; and
2. No scarred patterns for any of the ten fingerprints.

Samples were obtained of ten-prints of 200 males and 200 females aged 18–57 years. All samples were classified according to fingerprint classes as loops, whorls or arches.

Three different fingerprint ridge locations, namely, distal radial area (R), distal ulnar area (U), and proximal area (P) of all ten fingerprints from each individual were chosen as areas for analysis. The Acree's method (1999) of measuring ridge density (RD) and, indirectly, the breadth of the ridges, was used. A ridge count was performed diagonally on a square measuring 5 mm × 5 mm on the three locations to isolate ridges within a well-defined area and because most fingerprint classes show a