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Fingerprint ridge density in the Argentinean population and its application to sex inference: A comparative study

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ABSTRACT

Fingerprint ridge density (RD) is known to vary according to sex and population, and such variation can be used for forensic purposes. The aim of this study was to analyze the fingerprint RD of two samples of the Argentinean population in order to assess their topological, digital, bilateral, sexual, and population differences for subsequent application in the inference of sex. Data were collected from the fingerprints of 172 individuals from the Buenos Aires province and 163 from the Chubut province. RD was assessed for three different count areas for all 10 fingers of each individual. In both sexes and both samples, significant differences among areas were obtained, so that radial-RD > ulnar-RD > proximal-RD. Females presented greater RD than males in all areas and on all fingers. Regarding population differences, no significant differences were found between the Buenos Aires and Chubut samples (except

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for proximal RD in males). However, both samples showed RD significantly different from that of the Jujuy province. The application of Bayes' theorem allowed for the identification of an RD threshold for discrimination of sexes in these Argentinean samples.
In conclusion females consistently exhibit narrower epidermal ridges than males, which may evidence a universal pattern of sexual dimorphism in this trait that can be useful in forensics in the identification of individuals.

Introduction

Epidermal ridges and their arrangement are formed very early in embryonic development, and from the 26th week of gestation the dermatoglyphic patterns retain their configuration essentially unchanged during the lifetime of an individual and even after death if the tissues are preserved (Seidenberg-Kajabova et al., 2010; Wertheim, 2011). However, although the number of ridges is independent of age, their size will increase to accommodate the overall growth of the body, particularly on the hands and feet, until adult size is reached.

The formation of these patterns is determined by both environmental and genetic factors. They are considered polygenic traits with multifactorial inheritance, where the environmental influences are limited to the first months of intrauterine life (Holt, 1968; Loesch, 1983). Some of these features, such as the number of epidermal ridges, are highly heritable and almost entirely genetically determined (90–95%), while others, such as *minutiae*, are mainly determined by the environment (Chakraborty, 1991; Wertheim, 2011). Therefore, dermatoglyphics are a reflection of the environment during an early period of gestation, and their study opens a window onto an important time period for tissue differentiation and organogenesis (Holt, 1973; Schaumann and Alter, 1976). Because of these characteristics, dermatoglyphics have been widely used to study the variability in human populations at both the intra- and intergroup levels, demonstrating their usefulness for understanding the evolution and genetic structure of human populations and the characterization of syndromes and diseases, as well as for personal identification (Arrieta et al., 1987; Champod et al., 2004; Fañanas et al., 1996; Figueras, 1993; Rosa et al., 2000; among others).

Therefore, the forensic interest in dermatoglyphic traits lies in the fact that the configuration of epidermal ridges, after their early formation, remains unchanged for the remainder of life. Moreover, dermatoglyphics display a high variability that, however, can be classified, which has allowed their use in personal identification for over a century (Champod et al., 2004; Dankmeijer et al., 1980; Faigman et al., 2008; Galton, 1892; Holder et al., 2011; Jamieson and Moenssens, 2009). In this field, and even with the increasing role of forensic genetics, dermatoglyphics still enjoy a pivotal role. However, despite the great interest in the study of fingerprints in the field of forensic science, most studies focus on pattern type (arch, loop, and whorl) and size (ridge count from triradius to core), while some of fingerprints most relevant characteristics, such as the *minutiae* or the epidermal ridge breadth, have been less studied (Champod, 1996; Champod et al., 2004; Gutiérrez-Redomero et al., 2011b, 2012; Gutiérrez et al., 2007; National Research Council (NAS), 2009; Neumann et al., 2007, 2006). Regarding ridge breadth, surprisingly, few systematic studies have been carried out on the changes that these undergo during pre- and postnatal development (Babler, 1990; David, 1981; Gutiérrez-Redomero et al., 2011a; Hotz et al., 2011; Králík and Novotný, 2003; Loesch and Czyżewska, 1972; Loesch and Godlewska, 1971). In addition to age, variation in ridge breadth has been shown to be related to sex, hand size, adult body size, and ethnicity. All these variables are interrelated, since variation in body size and its parts (hands and feet) is largely determined by the sex and ethnicity (Cummins et al., 1941; Cummins and Midlo, 1943; Loesch and Lafranchi, 1990; Ohler and Cummins, 1942; Penrose and Loesch, 1967; Plato et al., 1991).

The ridge count on fingerprints has been a focus of the classic studies on dermatoglyphics. Thus the ridge count between the *triradius* and core (or Galton line) has been the foundation for the classification