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Dermatoglyphics as a possible morphological biomarker in myopia: Analysis of finger ridge counts and fluctuating asymmetry

Ljiljana Sretić¹, Nenad Labus¹, Tatjana Filipović², Milan Filipović³

¹Department of Biology, Faculty of Sciences and Mathematics, University of Priština-Kosovska Mitrovica, Kosovska Mitrovica, Serbia

²Department of Anatomy, Medical Faculty, University of Priština-Kosovska Mitrovica, Kosovska Mitrovica, Serbia

³Department of Surgery, Medical Faculty, University of Priština-Kosovska Mitrovica, Kosovska Mitrovica, Serbia

Address for correspondence: Ljiljana Sretić, Department of Biology, Faculty of Sciences and Mathematics, University of Priština-Kosovska Mitrovica, Ive Lole Ribara 29, 38220 Kosovska Mitrovica, Serbia, Tel: +381638277826, E-mail: lsretic@gmail.com

Abstract

Background: The aim of this study is to provide the first analysis of finger ridge counts and fluctuating asymmetry in myopia, in order to evaluate dermatoglyphic role as a morphological biomarker.

Materials and methods: Study sample consisted of 102 participants recruited from freshman students population of the University of Priština-Kosovska Mitrovica. Prints were taken by standard ink and paper method. Differences in mean ridge counts between examined groups were analyzed by ANOVA analysis of variance. Fluctuating asymmetry assessment was performed by using correlation method (p<0.05).
**Results:** Analysis has identified myopic males as the group with the most prominent differences of examined dermatoglyphic parameters. Myopic males, compared to controls, have significantly higher ridge counts for left and right ring and little finger, as well as total ridge count. Also, this group has recorded significant difference in fluctuating asymmetry correlation score for middle finger, and borderline significance for thumb and ring finger.

**Conclusions:** Overall findings of this study have indicated that dermatoglyphics might serve as a morphological biomarker, especially in myopic males, selecting them as the group with dermatoglyphic differences that might be suggestive of higher developmental instability. Although promising, the present results should be considered as preliminary until future investigations replicate them in a larger sample.

**Key words:** dermatoglyphics, myopia, fluctuating asymmetry, developmental instability

**INTRODUCTION**

Dermatoglyphics is a term that originates from two Greek words, δέρμα-skin and γλύφή-carving, describing a study of a system of cutaneous ridges and furrows flowing in distinctive paths or directions on fingers, palmar and plantar surfaces. Dermal ridges are derived as an evolutionary adaptation that enhances tactile sensation and friction, and are unique characteristic typically found in higher primates or, sporadically, in other mammals [31]. The pattern of ridged skin is established from 6th to 17th week of gestation, when the basal layer of the volar epidermis becomes folded forming primary ridges. This process is influenced by the volar pads, local temporary eminences of the subcutaneous tissue and the sites of ridge formation. Subsequent environmental insults, that follow full maturation of secondary ridges during 24th week, remain basic dermatoglyphic structure unaffected, making them “a history of development” [3].
Heredity of quantitative dermatoglyphic traits conforms to polygenic system, with individual genes contributing a small additive effect, but the prenatal environment may also exert an important influence [2]. Finger ridge count is one of the most heritable anthropometric feature, and has been used as a model trait for the study of human quantitative genetics [7,29]. Since that genetic component affect ridge composition indirectly, through ontogenetic factors such as embryonic pad topography, growth stress, neurotrophic or skeletal factors, it is not the pattern of friction ridge skin that is passed down through heredity, but the shape and location of volar pads [3,21]. As a result of their polygenic inheritance, which makes them less susceptible and less vulnerable to stochastic processes, such as genetic drift, dermatoglyphics are widely used in population studies [1]. Besides, due to their polygenic determination, genes underlying certain disorder may, by pleiotropy, affect dermatoglyphic parameters[12]. This makes them, along with lifetime permanence and the fact that forces that channel ridge differentiation must be operating prior the 19th week of gestation, a sensitive indicator of intrauterine disturbances associated with chromosomal/gene abnormalities, environmental stress, or a combination of these [28]. Altered dermatoglyphic configuration has been proven in numerous multifactorial or chromosomal disorders [22,28,35].

One of the most common public health issues in the world is myopia [11]. Eye morphogenesis is extremely precise, genetically determined process [15], involving ectodermal and neuroectodermal derivates [39]. Uncoordinated contribution of ocular components may lead to myopia, a multifactorial eye disorder characterized by blurred vision of distant objects [44]. Strong genetic background of myopia onset has been proven in two recent large-scale GWASs that have identified significant association of several candidate genes, involved in neurotransmission, ion transport, retinoic acid metabolism, extracellular matrix remodeling and eye development, with this type of visual impairment [25].

Bilaterally represented traits demonstrate three types of asymmetry, differentiated by their causes and biological significance: directional asymmetry, antisymmetry and
fluctuating asymmetry. The etiology of directional asymmetry and antisymmetry may be regarded as a part of the developmental plan, and therefore likely to have an adaptive significance [5,13]. Fluctuating asymmetry signifies small, random departures from perfect symmetry between the left and right side of a bilateral trait, where the R-L variation is normally distributed about a mean of zero [32]. It is considered that fluctuating asymmetry stems from inability of the organism to buffer negative influences of disturbing developmental factors, indirectly reflecting the level of stress experienced during development [6,42]. Since that development of bilateral symmetrical traits is under control of identical genes the underlying assumption of fluctuating asymmetry analysis is that nondirectional differences between two sides are of environmental origin, reflecting insults during developmental time [23,37].

The main objective of this study was to investigate effects of myopic visual impairment on finger ridge counts and levels of fluctuating asymmetry, in order to determine possible role of dermatoglyphics as a morphological marker.

MATERIALS AND METHODS

Study sample consisted of 102 participants recruited from the freshman students population of the University of Priština-Kosovska Mitrovica. Among them 51 were diagnosed with common myopia, from -1 to -5 diopters, and 51 composed healthy control group (both groups included 26 females and 25 males). Individuals were aligned by sex and vision as control males, control females, myopic males and myopic females. Prints were taken by standard ink and paper method described by Cummins and Midlo [8]. Scanned nail-to-nail rolled impressions of inked fingertips (CanoScanLiDE 25) were enlarged by image editing software program Adobe Photoshop CS3, and scored. Comparisons were made between control and myopic individuals of the same sex.

Quantitative analysis encompassed finger ridge counts (FRC) and total ridge count (TRC). Finger ridge count is defined as number of ridges intersected with the line drawn from the core, center of a pattern, and triradius, point of three ridge systems confluence
at an angle of approximately 120°. Arch pattern has no triradius, so the score for ridge count is zero, loops have one and whorls two, yielding two counts, but only higher is used for finger ridge or total ridge count. Total ridge count is a common composite trait calculated by summing ridge counts for all ten fingers. Fingers of the left and right hand were designated as FRCL1-5 and FRCR1-5. Mean finger ridge counts were analyzed in relation to their variability between examined groups using univariate analysis of variance (ANOVA).

Fluctuating asymmetry assessment was performed by using correlation method, since that it is not affected by directional asymmetry [36]. Pearson’s product-moment correlation coefficient (r) was applied for the comparison of ridge counts between homologous fingers. r² is a measure of their common variance, 1-r² is an estimate of error variance and thus a measure of fluctuating asymmetry [40]. Statistical significance of differences in correlation coefficients between myopic and control males, as well as females, was calculated using Fischer’s z-transformation [10]. Analysis of correlation was performed by SPSS7 (Statistica for Windows; StatSoft, Inc., Tulsa, OK, USA), while the Fischer’s z transformation was calculated employing a test available on Internet [24]. The level of significance for all reported differences was set at p<0.05.

The protocol and informed consent procedure was approved by Institutional Ethical Committee.

RESULTS

Means and standard deviations for left and right finger ridge counts in control and myopic males and females are shown in Table I.

The results of univariate analysis of variance (ANOVA), presented in Table II, point to significant heterogeneity in ridge counts between myopic and control males for both left and right ring (p=0.0198, p=0.0009 respectively) and little finger (p=0.0026, p=0.0005 respectively), and total ridge count (p=0.0353), as a consequence of elevated values in
myopic males. The only significance in ridge counts between myopic and control females was recorded for left little finger (p=0.027), being lower in myopic females.

Data presented in Table III, displaying fluctuating asymmetry indices (1-r²), Fisher's z transformation (z) and significance (p), reveal higher levels of fluctuating asymmetry in myopic males and females compared to controls. The only significant variation was found in myopic males for middle finger (p=0.017), but there was also a clear tendency to significance for thumb and ring finger (p=0.058, p=0.054 respectively).

DISCUSSION

Current paper is, to the best of our knowledge, the first attempt to investigate finger ridge counts and fluctuating asymmetry in myopia.

Dermatoglyphic alterations obtained in this study, manifested by the degree of variations in measured parameters—ridge counts and fluctuating asymmetry, identified myopic males as the group with the most pronounced differences. The variables that have been highlighted for their significant scores between myopic and control males were higher ridge counts on left and right ring and little finger. Consequently, this group also recorded significant increase of total ridge count. On the contrary, the only significant variation found in females stemmed from the lower finger ridge count on the left little finger of myopic females in relation to control females. Since that morphogenesis of some dermatoglyphic features is associated to specific stages of prenatal development, it has been suggested that total ridge count may be considered as an index of early fetal growth rate [34], influenced by stimulating or inhibiting factors [20]. According to Meier [30] males late maturers, due to the later than average ridge formation, along with a delay in volar pad regression, are found to have larger and more complex dermatoglyphic patterns, such as whorls, and increased digital ridge counts.

Fluctuating asymmetry is a concept first described by Ludwig [27] as a sign of ontogenetic stability. Ever since it is one of the most common used tool in measuring
developmental stability, i.e. ability of an organism to moderate its development against genetic or environmental stresses. Increasing fluctuating asymmetry is in human populations linked to some indicators of developmental stability such as morbidity and number of offspring [43] or length of gestation [26], as well as to specific multifactorial disorders [9,38].

Our analysis of fluctuating asymmetry between homologous fingers showed that myopic individuals of both sexes have higher degree of fluctuating asymmetry in comparison to controls, but the only significance refers to middle finger in myopic males along with significance of borderline level for thumb and ring finger. This might implicate somewhat greater developmental instability in myopic males, i.e. greater vulnerability to adverse environmental influences, and thus be in agreement with a hypothesis that males may be less canalized in their growth and development than females [41]. The earliest paper concerning environmental impact on males development appear to be Greulich’s [14], who found that among children who survived the atomic bombing of Hiroshima and Nagasaki growth and maturation of males had been affected more adversely by environmental stress than that of females.

Asymmetry between the dermatoglyphic characteristics, as postulated by Naugler and Ludman [33], may signify relatively unstable genetic control during embryogenesis, identifying males as more subjected to influences of intrauterine environment [4,19]. One of the theories that might shed more light on the hypothesis that males are more sensitive to prenatal insults, which may be followed by atypical morphological traits and higher asymmetry, suggests the influence of prenatal circulating hormones, specifically prenatal testosterone. Prenatal testosterone might be related to slowed maturation, exposing dermatoglyphic morphogenesis longer to adverse influences. Possible mechanism by which testosterone modificate developmental rate might be through its stimulating effect on both epidermal (EGF) and nerve growth factor (NGF) [16,17,18].

Our results, although modest considering fluctuating asymmetry, might be suggestive to an underlying vulnerability that interacts with oculogenesis and environmental
factors, contributing to the later onset of myopia in males. The limitation of this study is relatively small sample, which may cause missing of some differences due to the lack of statistical power.

CONCLUSION

Considering the overall findings of this study we may point to dermatoglyphics role as morphological biomarker, especially in myopic males, selecting them as the group with major alterations in finger ridge counts and fluctuating asymmetry score, which might be suggestive of delayed maturation and higher developmental instability. Although promising, the present results should be considered as preliminary until future investigations replicate them in a larger sample.

REFERENCES


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Table II  Differences in mean ridge counts between examined groups (ANOVA)

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