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Dermatoglyphic Profiles of Competitive Athletes: CrossFit and Ultra-Marathon

Perfiles Dermatoglíficos de Deportistas Competitivos: CrossFit y Ultramaratón

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SUMMARY: In the sports field, sports are usually classified according to the predominance of the energy system used during the competition; sports like Crossfit and ultra-marathon could be totally opposite due to the needs of athletes to achieve good places. Due to the above, the objective was established to compare the dermatoglyphic profiles of CrossFit and Ultra-marathon athletes according to the predisposition of the energy systems, aerobic and anaerobic, used in the competitions. Cross-sectional descriptive study, where the dermatoglyphic profile of 21 athletes of national presence (10 crossfit and 11 ultra-marathon runners) was determined, through the Computerized Dermatoglyphic System, brand Salus Dermatoglifia, according to the Cummins and Midlo protocol, which consists of taking the fingerprints of the 10 fingers of the hands. The fingerprint designs of the human being (arch, loop and whorl) and the elements contained in them (nucleus and delta) were analyzed, differences were established through the Analysis of Variance test in the SPSS V.25 statistical package. The results show significant differences between the average scores of the line count of both disciplines (108 and 165), being higher in ultra-marathon runners, associated with greater aerobic resistance. Another significant and relevant finding was the presence of arch-type fingerprints only in CrossFit athletes associated, along with low line count, with strength and power. It is concluded that Crossfit and Ultra-marathon athletes have dissimilar natural physical characteristics, which is why they participate and excel in different sports where they have enhanced their natural physical abilities through training.

KEY WORDS: Athletes; Elite; CrossFit; Ultra-marathon; Energy systems; Computerized Dermatoglyphics.

INTRODUCTION

Currently, three energy systems are recognized that are deployed in different ways during physical-sports activity, depending on its nature and execution time. In either case, the energy released will deplete the energy reserves produced, destabilizing the state of homeostasis of each individual (Ament & Verkerke, 2009).

The alactic anaerobic system, or also called the phosphagen system, is the shortest duration since the storage of Adenosine Triphosphate (ATP) in skeletal muscle is limited, lasting <10 seconds at maximum effort, with phosphagens being the main source of energy of the body for fast and explosive activities, such as the 100m flat, jump and throw events, springboard diving and weightlifting (Bompa & Buzzichelli, 2017). For its part, the aerobic system, which is related to the oxidative system, will start from 3 min of constant physical activity to become long lasting, allowing energy to be resynthesized through the catabolism of glycogen, fats and proteins in the presence of oxygen, being fundamental in the performance of activities such as triathlon, road cycling, cross-country skiing, open water swimming and marathon (Van Someren, 2006; Bompa & Buzzichelli, 2017). Another intermediate mechanism of both systems called lactic anaerobic or anaerobic glycolysis (anaerobic and aerobic), is triggered after 10 seconds, where the glycolytic system becomes the main source of energy, catabolizing stored glycogen to resynthesize ATP, being of utmost importance in sports such as 200 to 400 m flat, rugby,

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indoor soccer, handball, speed cycling, speed skating, swimming and judo.

The sports of interest in this work and their association with energy systems are briefly described below. CrossFit has aroused great interest in applied sports sciences because it implies a high physiological demand and multiple variations to develop physical abilities due to the nature of the physical tests involved (Peña-Vázquez *et al*., 2023), which is related to energy systems of shorter duration. Ultra-marathons, for their part, are extremely strenuous events that consist of long-distance races on foot and that exceed the marathon (42,195 km) with distances of 60 km, 80 km and 100 km or more, which have exponentially gained great popularity today (Khodaee *et al*., 2021) and which are associated, par excellence, with the aerobic energy system.

In another order of ideas, sports dermatoglyphics as a scientific methodology studies fingerprints, their relationship with people's innate physical potentialities. According to Abramova *et al*. (2013), Del Vecchio & Gonçalves (2011), Nodari-Junior *et al*. (2016) and Zulaev & Abulkhanova (2007) and Bispo *et al.* (2023), the most common digital designs in humans are: arch, loop and whorl.

Next, the qualitative characteristics of each of the fingerprint designs are described (Fig. 1), their variants and their connection with innate physical potentialities. The arch (A) is a design without a core or deltas, it is related to the physical quality of strength and power. The clip (L), a figure that is composed of three zones, the basilar, the deltal and the nuclear, its appearance represents the physical quality of speed. In this pattern there is a variant (in reverse), the radial loop, which experts directly associate with high performance, since its prevalence is higher in high-performance athletes than in amateur practitioners and in the general population.

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On the other hand, in quantitative terms, the line count of the finger designs, based on the Galton line methodology, which should be performed only with designs that contain at least one nucleus and one delta (Rodríguez, *et al*., 2017) as represented in Figures 1 and 2. The total sum of lines, which is obtained with the Galton Line (Fig. 2), is directly related to the predominant energy system and innate physical capacities in each individual, more specifically to the resistance capacity Bispo *et al.* (2023).

In this sense, according to established parameters (Table I), if there is a low line count (0-120) it is related to the physical capacities of pure strength, power, resistance to speed, that is, those where short-term energy systems (anaerobic) are used. But, if there is a high number in this count (125-200), physical capacities such as aerobic resistance and localized muscular resistance are involved, related to the aerobic energy system (Zulaev & Abulkhanova, 2007; Nodari-Júnior *et al*., 2016).

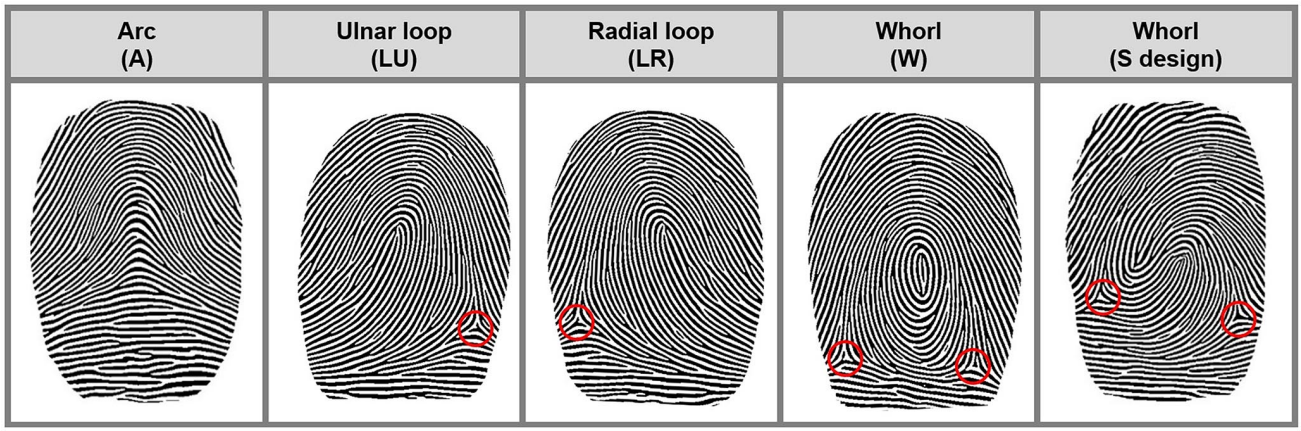

Fig. 1. Classification of common dermatoglyphic patterns in humans and Deltas locations. Source: (Gastélum-Cuadras, 2022).

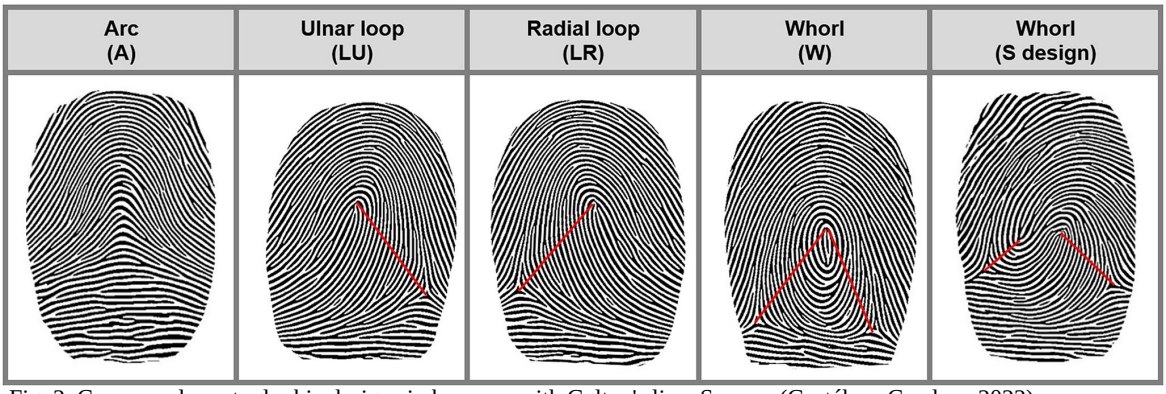

Fig. 2. Common dermatoglyphic designs in humans, with Galton's line. Source: (Gastélum-Cuadras, 2022).

Table I. Parameter of number of lines with endurance level of Abramova, 2009 (Nodari-Júnior *et al*., 2016).

SQTL	Endurance of physical ability
0 a 119	The lower the score, the lower the level of endurance
120	Average endurance score, in athletes of different sports
121	The higher the score, the higher the level of

SQTL= Total sum of finger lines of both hands.

One more element, and of interest in the study of sports finger dermatoglyphics, has to do with the variable D10 directly related to motor coordination. According to Del Vecchio & Gonçalves (2011), who rely on other authors, comment that this arises as a result of the type of digital pattern, the intensity refers to the counts of triradii (or deltas), elementsthat appear in a triangular shape, distributed in specific segments close to the basilar area of the finger figures (Fig. 1), the designs of simple arches have a value of zero, the arches with tent and the loops, one; and the whorls, two.

Based on what has been exposed so far, the study of fingerprints as an epigenetic marker has gained special interest. Well, the contributions on biological individuality are essential for sports characterization, since starting from phenotypic epigenetic markers, such as dermatoglyphs, can provide a diagnosis of potential for high- performance sports at an early age or in competitive athletes, thus being able to initiate a sports preparation process with support in sports sciences, taking into account the natural energy system from the dermatoglyphic profile of each athlete (Aljoe-Fernández *et al*., 2020; Leiva *et al*., 2011; Medellín, 2018).

Due to all of the above, the objective was to compare the dermatoglyphic profiles of CrossFit and Ultra-marathon athletes according to the predisposition of the aerobic and anaerobic energy systems used in the competitions.

MATERIAL AND METHOD

Study type and design. Quantitative, cross-sectional research with a descriptive scope that seeks to compare dermatoglyphic profiles of two samples of highly competitive athletes, sports of an opposite physiological nature, CrossFit and Ultra-marathon.

Participant characteristics. 21 athletes participated, 10 of them CrossFit competitors, belonging to the Rx category, with an average age of 28 years, with participation in national competitions, at the same time 11 ultra-marathon athletes, with an average age of 39 years, who represented Mexico in "The ultra-marathon Backyard World Championship 2022" six of them belonging to the Rarámuri (Tarahumara) ethnic group from the state of Chihuahua.

Instruments and Data Collection Procedure. For the weight variable (in kilograms), the subjects were asked to position themselves on a Tanita® BF-680W model BF-680W digital scale with light clothing and without shoes. Likewise, to measure height (in centimeters) a mechanical stadiometer, SECA model 206, was used, fixed to the wall placing the subject on his back.

The fingerprinting of the sample was carried out using the fingerprint dermatoglyphics technique, according to the protocol proposed by Cummins & Midlo (1961). Methodology that consists of taking the prints of the 10 fingers of the hands, which was carried out with the Computerized Dermatoglyphic System (Nodari-Júnior *et al*., 2014), constituted by an optical scanner of bearing that collects and interprets the image building a binary code, providing real and binary images, in black and white.

After capturing the images of all the footprints, the Dermatoglyphic Reader® (Salus Dermatoglifia brand) was used, which has the option of selecting them one by one to

join the points contained in the loops and whorls, depending on the case, by means of the Galton Line (Figs. 1 and 2), an imaginary line that has as its starting point the center of the nucleus and its arrival point at the center of the delta (loops) or of the deltas (whorls) (Rodríguez *et al*., 2017), providing the number of lines of each finger in relation to the type of drawing of each one of them. Finally, the software gives a report on the qualitative identification of the image of each fingerprint and the quantitative identification of the lines of the fingerprints of each subject, likewise, it generates an Excel sheet with a database of all the evaluated subjects, with which the pertinent statistical analyzes can be carried out.

Ethical considerations. The present project was authorized by the Research Committee of the Faculty of Physical Culture Sciences of the Autonomous University of Chihuahua with registration number 27042022-039. All the participants signed an informed consent where the objective of the study was explained to them, they were informed of total anonymity, as well as that their data would be exclusively used for research. The entire procedure was done based on the Helsinki declaration (AMM, 2019).

Statistical analysis. For data analysis, the SPSS program for Windows XP (V. 25) was used. Carrying out the Shapiro-Wilk test to determine the normality of the data. Subsequently, an analysis of Variance of a Factor was carried out, to the variables that presented normal distribution of data, considering the value of $p \leq 0.05$ as significant.

RESULTS

Descriptive of CrossFit and Ultra-marathon athletes. Table II shows descriptions of: age, weight, height, according to the sport practiced. Significant differences are observed in all the variables, with the CrossFit athletes presenting greater body weight and height.

Table II. Mean scores and standard deviations of age and anthropometric variables, of the groups of CrossFit and Ultra-marathon athletes.

Variables	CrossFit (n=10)	Ultra-marathon (n=11)	p
Age (years)	28.6±6.0	39.5±8.6	0.004*
Weight (kg)	77.7±1.7	62.2±4.7	0.002*
Height (m)	1.70±.05	1.64±.04	0.012*

*=Values with significant differences.

Sum Total Lines (SQTL) of CrossFit and Ultra-marathon athletes. According to the results obtained, there are significant differences between the mean scores of the counting of the lines of fingers of the left hand (56 and 81), right (52 and 84) and the sum of both (108 and 165), being higher in the ultra-marathon runners. The same thing happens with the Delta 10, Ultra-marathon athletes present an average score of 15, significantly differently than CrossFit athletes of 11.7 (Table III).

Table III. Mean scores and standard deviations of left-hand, right-hand, both-hand, and delta ten-line counts; from the analysis of variance of the groups of CrossFit and Ultra-marathon athletes.

Variables	CrossFit (n=10)	Ultra-marathon (n=11)	p
SQTLE	56±20	81±20	0.009*
SQTLD	52±21	84±22	0.003*
SQTL	108±36	165±64	0.003*
D10	11.7±3	15.1±4	0.023*

SQTLE= Total sum of lines, left hand fingers. SQTLD= Total sum of lines, fingers right hand. SQTL= Total sum of lines, fingers both hands. D10= Total number of deltas, ten fingers. *= Values with significant differences.

Fingerprint designs in CrossFit and Ultra-marathon athletes. In relation to the fingerprint designs, the results obtained show significant differences in terms of the arch design (A), although with minimal scores, these favor CrossFit athletes, who present at least one fingerprint of this type on average, ultra-marathoners for their part present absolute absence of this fingerprint design. Another type of fingerprint that resulted in significant differences was the whorl, adding the two variants (W+S), now it was the Ultra-marathon athletes who presented twice as many of these designs, reaching an average of five whorls per athlete, meaning that this fingerprint type is present in 50 % of the fingers of their hands. Not so CrossFit athletes who only present 25 % of this design on average. No significant differences were found in the radial loop design, being very few in both groups. Lastly, regarding the design of the ulnar loop, although no significant differences were found, the average number was higher in the CrossFit athletes, they practically had six ulnar loops, the Ultra-marathon only four on average (Table IV).

Table IV. Mean scores and standard deviations of the finger designs of both hands; from the analysis of variance of the groups of CrossFit and Ultra-marathon athletes.

Variables	CrossFit (n=10)	Ultra-marathon (n=11)	p
A	1.1±1	0.0±0	0.004*
LR	0.6±0,6	0.4±0,6	0.636
LU	5.9±2	4.3±3	0.216
W(+S)	2.4±2	5.1±3	0.040*

A= Arch design. LR= Radial Loop Design. LU= Ulnar loop design. W(+S) = Sum of Whorls with concentric design and "s" type. *= Values with significant differences.

DISCUSSION

In the total sum of lines (SQTL), the CrossFit athletes present a low count (108) that leaves them in the parameter of 0-119 (Table I), a situation that corroborates the predominance of the anaerobic energy system and therefore a trend towards a low level of resistance. For their part, Ultra-marathon athletes have a high number of lines (165) that puts them in the parameter of 125 to 200 lines, with a natural predominance towards the aerobic energy system manifested in physical capacities such as aerobic resistance and localized muscular resistance (Zulaev & Abulkhanova, 2007; Nodari-Júnior *et al*., 2016; Nodari-Júnior, 2022) and studies in the field of physiology such as that of Ahmetov *et al*. (2022) in relation to the expression of strength and power of CrossFit athletes.

On the other hand, one of the finger designs in which the athletes presented differences was the arch design (A), which is related to the physical capacity of absolute strength and power (Abramova *et al*., 2013; Bispo *et al*., 2023) and which favored CrossFit athletes, who present at least one fingerprint of this type on average, with an absolute absence in ultra-marathon runners. In addition, these athletes presented a low line count, a situation that the scientific literature associates with strength and power, which would be expected according to the nature of the motor actions demanded by their sport.

According to Abramova *et al.* (2013) the presence of whorls and a high Delta 10 are related to motor coordination. Also, Vieira *et al*. (2004) and Nogueira, *et al*. (2005) express that the high index of SQTL and D10 characterize the sports that developed coordination and resistance, being the Ultra-marathon athletes who presented double these designs and a D10 of 15. Furthermore, this situation is corroborated with the total sum of lines that has already been discussed, since Ultra-marathon athletes are in the range of 125 to 200 lines (Table I) that is associated with coordination (Nodari-Júnior, 2022).

Corroborating these findings, which expresses the theory of sports dermatoglyphics on dermatoglyphs as biological indicators of sports performance, so they can be used in the detection, selection and development of sports talent; as well as to support training planning in elite athletes (Zulaev & Abulkhanova, 2007; Del Vecchio & Gonçalves, 2011; Abramova *et al*., 2013; Nodari-Júnior *et al*., 2016; Nodari-Júnior, 2022; Gastélum-Cuadras *et al*., 2021).

It is concluded that it is feasible, from the study of dermatoglyphs, to establish dermatoglyphic profiles of athletes in sports, based on the sports fingerprint dermatoglyphic methodology, therefore, this research provides a non-invasive and easy-to-use methodology in its computerized version (Nodari-Júnior *et al*., 2014), as an important contribution to applied sports sciences in Mexico.

Study limitations: It is recognized that more research is necessary in this regard, with the intention that the results present a higher level of generalization. As well as with research designs, where dermatoglyphic variables are related such as those in this study, with variables from DNA analysis.

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RESUMEN: En el ámbito deportivo, los deportes suelen clasificarse según el predominio del sistema energético utilizado durante la competición; Deportes como el Crossfit y la ultramaratón podrían ser totalmente opuestos debido a las necesidades de los deportistas de conseguir buenos lugares. Debido a lo anterior, se estableció como objetivo comparar los perfiles dermatoglíficos de atletas de CrossFit y Ultramaratón según la predisposición de los sistemas energéticos, aeróbico y anaeróbico, utilizados en las competencias. Estudio descriptivo transversal, donde se determinó el perfil dermatoglífico de 21 deportistas de presencia nacional (10 crossfit y 11 ultramaratonistas), a través del Sistema Dermatoglífico Computarizado, marca Salus Dermatoglifia, según el protocolo Cummins y Midlo, el cual consta de tomando las huellas dactilares de los 10 dedos de las manos. Se analizaron los diseños dactilares del ser humano (arco, asa y verticilo) y los elementos contenidos en ellos (núcleo y delta), se establecieron diferencias mediante la prueba de Análisis de Varianza en el paquete estadístico SPSS V.25. Los resultados muestran diferencias significativas entre las puntuaciones medias del recuento de líneas de ambas disciplinas (108 y 165), siendo superiores en los corredores de ultramaratón, asociado a una mayor resistencia aeróbica. Otro hallazgo significativo y relevante fue la presencia de huellas dactilares tipo arco sólo en atletas de CrossFit asociadas, junto con un bajo número de líneas, con fuerza y potencia. Se concluye que los atletas de Crossfit y Ultramaratón tienen características físicas naturales disímiles, por lo que participan y destacan en diferentes deportes donde han potenciado sus capacidades físicas naturales a través del entrenamiento.

PALABRAS CLAVE: Atletas; Élite; Crossfit; Ultramaratón; Sistemas energéticos; Dermatoglifos computarizados.

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