RESEARCH ARTICLE

Dermatoglyphics and abdominal resistance in female children and adolescents: a cross-sectional study [version 1; peer review: awaiting peer review]

Renan Souza[1], Adriano Alberti[2], Gabriel Gastélum Cuadras[3], Rodrigo Gomes de Souza Vale[4], Eliton Marcio Zanoni[1], Eloel Benetti Zavorski[1], Josiane Aparecida De Jesus[1], Ben Hur Soares[5], Fabiane Pertille[1], Gracielle Fin[1], Bruna Becker da Silva[2], Leoberto R. Grigollo[2], Aline D. Schlindwein[2], Viviane Freiberger[2], Leticia Ventura[2], Luana Quadros[2], Ramón Alfonso González Rivas[3], Oscar Núñez Enríquez[3], Samuel Alfredo Islas Guerra[3], Felipe Valenzuela Jurado[3], Arturo Iván Chávez Erives[3], Arturo Martínez Treviz[3], David Arnoldo García Fernández[3], Graziela Marques Leão[2], Clarissa Martinelli Comim[2], Rudy José Nodari Junior[1,6]

[1]Laboratory of Exercise Physiology, Postgraduate Program in Biosciences and Health, University of West Santa Catarina, Joaçaba, Santa Catarina, 89600-000, Brazil
[2]Research Group on Neurodevelopment of Childhood and Adolescence, Laboratory of Experimental Neuroscience, Postgraduate Program in Health Sciences, University of South Santa Catarina, Palhoça, Santa Catarina, 88137-270, Brazil
[3]Faculty of Physical Culture Sciences, Autonomous University of Chihuahua, Chihuahua, Chihuahua, 31000, Mexico
[4]Physical Education department, Estacio de Sá University, Cabo Frio, Rio de Janeiro, 28909-800, Brazil
[5]Physical education department, University of Passo Fundo, Passo Fundo, Rio Grande do Sul, 99052-900, Brazil
[6]Research Department, Salus Dermatoglifia, Luzerna, Santa Catarina, 89609-000, Brazil

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Abstract

Background: Dermatoglyphics is considered, in the scientific milieu, to be an epigenetic marker. The objective of this study was to analyze the presence of dermatoglyphic marks characteristic of neuromotor capacity and abdominal resistance in children and adolescents.
Methods: This is a cross-sectional study. The sample consisted of 1,002 individuals, female children and adolescents between the ages of 10 and 16, from public and private schools in the city of Joaçaba, Santa Catarina, Brazil. The protocol selected for analyzing the fingerprints was dermatoglyphics, proposed by Cummins and Midlo using a Dermatoglyphic Reader. The Brazilian Sports Project Manual - PROESP 2015 was used to collect data on muscle strength motor tests.
Results: The results showed the presence of a dermatoglyphic mark

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characteristic of abdominal motor capacity and muscle strength in females. A higher frequency of arches was identified in MET4 and whorls in MET5 and MDT4 in the Risk Zone group. In the Healthy Zone group, ulnar loop was found to be more frequent in MET4, MET5, and MDT4 fingers.
Conclusions: The results demonstrated a predictive marker for abdominal motor capacity and strength in females through dermatoglyphics.

Keywords
Dermatoglyphic, Mark, Strength, Female.

Corresponding author: Adriano Alberti (adrianoalberti90@hotmail.com)

Author roles: Souza R: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Alberti A**: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Gastélum Cuadras G**: Conceptualization, Investigation, Resources, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **de Souza Vale RG**: Conceptualization, Formal Analysis, Investigation, Methodology, Supervision, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Marcio Zanoni E**: Formal Analysis, Investigation, Methodology, Resources, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Benetti Zavorski E**: Formal Analysis, Investigation, Methodology, Resources, Supervision, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Aparecida De Jesus J**: Formal Analysis, Methodology, Resources, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Hur Soares B**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Pertille F**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Fin G**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Becker da Silva B**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **R. Grigollo L**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **D. Schlindwein A**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Freiberger V**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Ventura L**: Formal Analysis, Methodology, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Quadros L**: Formal Analysis, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Alfonso González Rivas R**: Data Curation, Formal Analysis, Methodology, Resources, Visualization, Writing – Review & Editing; **Núñez Enríquez O**: Data Curation, Formal Analysis, Methodology, Resources, Visualization, Writing – Original Draft Preparation; **Islas Guerra SA**: Data Curation, Formal Analysis, Methodology, Resources, Software, Validation, Visualization; **Valenzuela Jurado F**: Formal Analysis, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Iván Chávez Erives A**: Formal Analysis, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Martínez Treviz A**: Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Arnoldo García Fernández D**: Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Marques Leão G**: Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Comim CM**: Conceptualization, Formal Analysis, Methodology, Project Administration, Resources, Supervision, Validation, Visualization, Writing – Original Draft Preparation; **Nodari Junior RJ**: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation

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Introduction

In childhood and adolescence, in addition to physiological implications related to biological maturation, the body is influenced by environmental and behavioral factors acting positively or negatively (Guedes, 2011). Childhood comprises the period between two and 10 years of age and adolescence from 10 to 20 years of age (Gallahue *et al.*, 2013).

In terms of the development and improvement of motor skills, there is an interaction of factors inherited before birth and environmental factors (Barros *et al.*, 2017). The factors inherited before birth are directly linked to the individual's genetics, or to fetal development, which is the period of development over the nine months of gestation, and the parents' lifestyle will be the major influencer in this process (Nodari *et al.*, 2014b). The environment and maternal lifestyle are influential in the development of fingerprints, so dermatoglyphics is considered, in the scientific milieu, to be an epigenetic marker (Garufo *et al.* (2017).

Studies on dermatoglyphics have investigated factors related to the prognosis and diagnosis of diseases in fields such as anthropology, legal medicine, and health, in which fetal developmental markers are compared and related to different physical fitness variables (Santos *et al.*, 2007). This is another tool that may identify or even help health professionals in guiding patients towards a better quality of life. Therefore, the objective of this study was to analyze the presence of dermatoglyphic marks characteristic of neuromotor strength capacity and abdominal resistance in children and adolescents.

Methods

Population and sample

This was a cross-sectional study. The participants of the current study were female children and adolescents between the ages of 10 and 16, from public and private schools in the city of Joaçaba, Santa Catarina, Brazil. The sample consisted of 1,002 individuals, belonging to the database of the Laboratory of Exercise Physiology and Evaluation Measures, from the University of the West of Santa Catarina (Unoesc), Joaçaba campus. Only female were studied, as women have different dermatoglyphic showing fewer lines compared to men (Nodari & Fin, 2016).

The data is available in (Souza & Alberti, 2021). The database has 3,074 individuals investigated in the school census in 2013 and 2014, according to the National Institute of Educational Studies and Research Anísio Teixeira (INEP). The sample constituted only of individuals who met the inclusion and exclusion criteria.

All participants who had dermatoglyphic and strength data collected and stored in the database were included in the study. Participants who failed to perform abdominal strength and resistance tests, as well as those with anomalous or invalid fingerprints, which are scarred fingerprints or excessive sweating, were excluded. For the participants who participated in the research in both years, 2013 and 2014, the data collected from 2013 and 2014 was the data taken into account.

Procedures

For the collection, processing, and analysis of the fingerprints, the computerized process of dermatoglyphic reading validated by Nodari *et al.* (2014b) was used. The Dermatoglyphic Reader from Salus Dermatoglyphic Luzerna-SC/Brasil. Consists of an optical scanner that collects and interprets the image and constructs, in binary code, a dermatoglyphic drawing, which is processed by the reader's specific software for the treatment and reconstruction of real and binarized images in black and white, as validated by Nodari Júnior *et al*. in 2008. This study can also be performed with the traditional dermatoglyphic method of paper ink and magnifying glass.

The Brazilian Sports Project Manual - PROESP 2015 was used to collect data on muscle strength motor tests. The instrument is composed of a set of tests, set of criteria and evaluation standards. It is used to evaluate patterns of body growth, nutritional status, physical fitness and sports performance (Gaya *et al.*, 2015). In the abdominal resistance test, classification was done using established cutoff points (Table 1) and later stratified, by age and sex, into two categorical scales: health risk zone (values below the cutoff point) or healthy zone of fitness (values above the cutoff point) (Gaya *et al.*, 2015).

At the time of fingerprinting collection, the individual under study held the phalange (ulna side) on the scanner of the Dermatoglyphic Reader, performing a bearing, in its longitudinal axis, to the lateral (radio) side (Nodari, 2009). The collection of the

Table 1. Classification in the abdominal strength test male and female.

Age	Men	Woman
6	18	18
7	18	18
8	24	18
9	24	20
10	31	26
11	37	30
12	41	30
13	42	33
14	43	34
15	45	34
16	46	34
17	47	34

Gaya *et al.* (2015).

fingerprints began with the little finger AKA 'pinky' of the left hand, followed by the left ring finger, left middle finger, left index finger and left thumb, in sequence to the right thumb, right index finger, right middle finger, right ring finger, ending in the right little finger (Nodari, 2009).

On the other hand, the evaluation of the motor capacity (muscle strength) was performed using the abdominal resistance test, according to the protocol (Gaya *et al.*, 2015). The test consists of performing the highest number of abdominal exercise within the given time of one minute. The participant must be lying supine on a mat, knees bent at a 45 degree angle and arms crossed over the thorax. The participant should flex the trunk until the elbows touch the thighs and then return to the initial position. The largest number of complete repetitions should be recorded within an established time (Gaya *et al.*, 2015).

Statistical analysis

To analyze genetic potential and fetal development through fingerprints, the chosen protocol was dermatoglyphic protocol proposed by Cummins & Midlo (1961) On the collection of the fingerprints obtained using the Dermatoglyphic Reader®, the evaluator marks the core and delta points and consequently, the software qualitatively identifies the image and quantifies lines, generating a computerized worksheet resulting from the processed data (Nodari, 2009).

The data (Souza & Alberti, 2021) was processed using Statistical Package for the Social Science (SPSS), version 20.0, allowing the calculation of descriptive and analytical statistics. In the comparison between the two groups and their quantitative variables, the Kolmogorov-Smirnov test was used to observe the distribution of normality. After the test was applied, a non-normal distribution of the data was observed. The non-parametric test, called Mann-Whitney (two independent samples in the case of the abdominal strength test - Risk Zone and Healthy Zone) was used as the inference for comparisons among the following numerical variables: sum of the number of lines in left hand finger 1 - thumb (MESQL1), sum of the number of lines in left hand finger 2 - index (MESQL2), sum of the number of lines in left hand finger 3 - middle finger (MESQL3), sum of the number of lines in left hand finger 4 – ring finger (MESQL4) and sum of the number of lines in left hand finger 5 - little finger (MESQL5); sum of the total number of left hand lines (SQTLE); sum of the number of lines in right hand finger 1 – thumb (MDSQL1), sum of the number of lines in right hand finger 2 - index (MDSQL2), sum of the number of lines in right hand finger 3 - middle finger (MDSQL3), sum of the number of lines in right hand finger 4 - ring finger (MDSQL4) and sum of the number of lines in right hand finger 5 - little finger (MDSQL5); sum of the total number of right hand lines (SQTLD); sum of the total number of lines in both hands (SQTL), with a significance level of $p < 0.05$.

For the comparison of categorical variables: arch, radial loop, ulnar loop, whorl, on the following fingers: left hand drawing finger 1 (MET1), finger 2 (MET2), finger 3 (MET3), finger 4 (MET4) and finger 5 (MET5), and right hand drawing finger 1 (MDT1), finger 2 (MDT2), finger 3 (MDT3), finger 4 (MDT4) and finger 5 (MDT5) the Chi-square test was used.

When a significant difference between the patterns expressed by the two groups was observed based on the Chi-square test, the recommendation made by Pereira (2001) is to perform an analysis of adjusted residuals. In this case, the data were compared with each other, observing the standard value of 1.96, that is, all the results found above the standard demonstrate the presence of a significant difference between the groups and which of the pictures in the fingerprints is more frequent.

Ethics statement

The data used in this research is part of the research project: the kineanthropometric profile, motor development and socio-economic profile of children and adolescents, led by Prof. Dr. Rudy José Nodari Júnior. The research was approved with under protocol number 449.924 of the Research Committee on Human Beings of Unoesc/HUST (CEP), in accordance with the ethical standards of norms and regulatory directives of research involving human beings, in accordance with Resolution 466, 2012, of the National Health Council and the Declaration of Helsinki. All participants and their parents or guardians were informed about the study procedures, possible risks, and benefits. Free and informed written documented consent was obtained from the parents or custody holders.

Results

Dermatoglyphics, as a scientific study of fetal development markers, makes it possible to carry out investigations based on the potential of each individual, according to the approach and results found in this study through dermatoglyphic marks. A total of 1,002 individuals were analyzed in this study. Table 2 shows the sociodemographic characteristics, age, height and weight of the individuals investigated.

When analyzing the abdominal resistance test scores in relation to the quantitative variables, no differences were found when comparing the Risk Zone and Healthy Zone groups (Table 3).

However, when analyzing the qualitative variables (types of patterns) in females, differences were observed between the Risk Zone and Healthy Zone groups in the fingers MET4, MET5, and MDT4 (Table 4).

After the analysis of adjusted residuals, a higher frequency of arches was identified in MET4 and whorls in MET5 and

Table 2. Mean values and standard deviation for age, height and weight of individuals.

Sex	Age (years) Mean±SD	Height (m) Mean±SD	Weight (kg) Mean±SD
Female	12.3±1.26	1.5±0.08	49.2±11.60

Table 3. Mean of the total number of fingerprint lines, when comparing the Risk Zone and Healthy Zone groups according to the abdominal resistance test in females.

	Risk Zone (Mean±SD)	Healthy Zone (Mean±SD)	p
MESQL1	12.76±5.239	12.79±5.439	0.873
MESQL2	8.98±5.606	8.50±5.505	0.226
MESQL3	10.09±5.591	9.80±5.514	0.394
MESQL4	12.37±5.605	12.75±5.663	0.649
MESQL5	10.88±5.047	10.98±4.979	0.944
SQTLE	55.08±21.775	54.82±20.187	0.627
MDSQL1	14.66±5.412	14.89±5.168	0.526
MDSQL2	9.41±5.601	8.85±5.863	0.125
MDSQL3	10.38±4.940	9.91±4.933	0.131
MDSQL4	12.50±5.459	12.95±5.309	0.373
MDSQL5	10.95±5.079	11.04±5.019	0.936
SQTLD	57.90±20.649	57.63±19.439	0.554
SQTL	112.97±41.145	112.45±38.416	0.559

Table 4. Difference between patterns when comparing the Risk Zone and Healthy Zone groups according to the abdominal resistance test in females.

MET1	MET2	MET3	MET4	MET5	MDT1	MDT2	MDT3	MDT4	MDT5
0.737	0.380	0.519	0.045*	0.038*	0.632	0.661	0.576	0.025*	0.645

*p <0.05.

MDT4 in the Risk Zone group. In the Healthy Zone group, ulnar loop was found to be more frequent in MET4, MET5, and MDT4 fingers. The obtained results may point to the presence of a dermatoglyphic marker for different levels of abdominal strength/resistance, related to the physical fitness for health, in the study population (Table 5).

Discussion

Genetic studies may provide an additional method of predicting genetically predisposed performance characteristics of pre-full-length adults in untrained children by considering the profile of combinations of genetic variants associated with a particular trait. Dermatoglyphics follows this premise by being able to refer people according to their performance characteristics through dermatoglyphic marks (Guth & Roth, 2013). Research is being directed to verify dermatoglyphic marks including traces, patterns, and lines in fingerprints that are related to certain pathologies.

An example of the evolution of research in dermatoglyphics related to health is the study of Nodari *et al.* (2014a), with a sample consisting of 400 individuals, of which 200 were women with a positive diagnosis of breast cancer (clinical and mammography) and 200 women who represented a control group and were healthy in relation to cancer. This study showed a significant difference in all fingers of the left hand between the control group and the group with breast cancer; the radial loop tag was more frequent in the control group, which could comprise a marker of protection against breast cancer. This is in addition to other studies conducted with dermatoglyphics that show a link with diabetes and middle age (Kahn *et al.*, 2009) and obesity (Alberti *et al.*, 2019; Alberti *et al.*, 2021) in diseases such as cancer (Chintamani *et al.*, 2007). All identified a strong dermatoglyphic relation with the pathology.

For the present study, we sought to identify the level of abdominal strength and resistance in the test performed, so that we could predict health levels, physical conditioning and relate those to the dermatoglyphic patterns found. The results showed significant differences in the qualitative dermatoglyphic characteristics (types of dermatoglyphic drawing) in females of the Risk Zone and Healthy Zone groups.

Table 5. Types of fingerprint patterns when comparing the Risk Zone and Healthy Zone groups according to the abdominal resistance test in females.

		Fingerprint patterns			
		A	LR	LU	W
MET1	Risk Zone	0.1	-0.9	-0.5	0.7
	Healthy Zone	-0.1	0.9	0.5	-0.7
MET2	Risk Zone	-1.1	1.4	-0.9	0.4
	Healthy Zone	1.1	-1.4	0.9	-0.4
MET3	Risk Zone	0.4	-1.4	-0.1	0.5
	Healthy Zone	-0.4	1.4	0.1	-0.5
MET4	Risk Zone	2.3	0.5	-2.1	1.1
	Healthy Zone	-2.3	-0.5	2.1	-1.1
MET5	Risk Zone	0.6	-0.8	-2.4	2.7
	Healthy Zone	-0.6	0.8	2.4	-2.7
MDT1	Risk Zone	0.5	-0.8	-0.9	0.8
	Healthy Zone	-0.5	0.8	0.9	-0.8
MDT2	Risk Zone	-1.2	0.5	0.2	0.2
	Healthy Zone	1.2	-0.5	-0.2	-0.2
MDT3	Risk Zone	-1.1	-0.8	0.7	0.2
	Healthy Zone	1.1	0.8	-0.7	-0.2
MDT4	Risk Zone	1.4	0.1	-2.9	2.5
	Healthy Zone	-1.4	-0.1	2.9	-2.5
MDT5	Risk Zone	0.2	0.7	-1.2	1.0
	Healthy Zone	-0.2	0.7	1.2	-1.0

It is observed in the study by Vialle *et al.* (2014) that a low level of physical fitness can lead to health problems. When diseases such as lower back pain occur, it can lead to frequent visits to the doctor, which in turn leads to an increase in medical leave from work. Kumar *et al.* (2010) state that this is due to a lack of strengthening in primary abdominal muscle groups and low levels of flexibility.

The higher frequency of ulnar loop observed on the MET4, MET5 and MDT4 fingers in the Healthy Zone group found in the present study. It cannot be stated, but it can serve as a potential dermatoglyphic marker for healthy individuals. In addition, studies have demonstrated a relationship between the ulnar loops and high performance and speed among track athletes (Linhares *et al.*, 2009; Nodari & Fin, 2016). It is also possible to analyze that the greater presence of (LU) characteristic of activities or exercises of short duration and high intensity, coincides with the one found in the present research for the group Healthy Zone that had the results within the established standards.

The greater presence of the arch and whorl patterns in the Risk Zone group of the present study may point to a new predictive marker of individuals with abdominal strength/resistance. The need for such motor conditioning is a major factor in the fight against diseases related to physical inactivity, such as obesity (Ronque *et al.*, 2007). Abdominal fat can be a major health risk factor, since it is observed that when it is deposited on a large scale as intravisceral fat, this can lead to greater chances of terminal diseases, such as cancer (Dutra *et al.*, 2016).

The present research aimed to verify kineanthropometric and dermatoglyphic variables in children and adolescents at the stage of puberty when great and constant changes take place. The knowledge of the greater number of variables and their tendencies as a function of growth and development facilitates a better understanding of the moment when the young person is present and provides more effective work with this audience (Kumar *et al.*, 2016). Moreover, it may be possible for both, the quieter and the more adequate insertion in the competitions, as well as the orientation of talents consistent with the level of development of each individual which can lead to fewer prognostic errors Dermatoglyphics can help in this process as a hallmark of fetal development.

Limitations

As a limitation, the present study did not perform comparisons with different ethnic groups, because in the present study it was not possible to analyze this due to the ethnic limitation of the sample. Different ethnic groups may have different dermatoglyphic marks.

Conclusion

The results showed the presence of dermatoglyphic marks that may be characteristic of motor capacity and abdominal muscle strength in females. But it can be said, but dermatoglyphia can be a marker that can help. Thus, dermatoglyphics is an effective method that allows the observation of the neuromotor potentials, such as muscular strength, predisposed in an individual from the genetic and fetal development marks present in their fingerprints.

Data availability

Underlying data

Zenodo: Dermatoglyphic and abdominal resistance of children and adolescents of female sex https://doi.org/10.5281/zenodo.5048427 (Souza & Alberti, 2021) This project contains the following underlying data:

- Dermatoglyphic and abdominal resistance of children and adolescents of female sex.xlsx

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