ANTHROPOLOGIE • LX/2 • pp. 329–349 • 2022

MARTIN ČUTA, LENKA POLCEROVÁ, ONDŘEJ KLÍMA, ANNA ŠKULTÉTYOVÁ,
PAVEL ZEMČÍK, MIROSLAV KRÁLÍK

RELATIONSHIPS BETWEEN HEIGHT GROWTH IN ADOLESCENCE AND DERMATOGLYPHIC RADIOULNAR RIDGE COUNT CONTRASTS IN THE CHILDREN AND THEIR MOTHERS

ABSTRACT: The prenatal setting/programming of human postnatal growth is an under-researched area even though the effects of prenatal programming on the human body and its functions are considerable. The aim of this association study was to determine whether there is a link between postnatal growth in adolescence and dermatoglyphics as putative markers of prenatal sex differentiation. The sample is represented by data acquired in three subsequent years of a semi-longitudinal study; the total sample included 166 participants. 83 participants were children aged 0–18 years (43 boys). The adults were represented by their mothers. A recently developed method based on Functional Principal Component Analysis was used for prediction of individual adolescent growth milestones, including age at peak velocity, which were correlated with dermatoglyphic between-finger ridge count contrasts of the studied children and their mothers. We found that children's own dermatoglyphic traits correlated more with growth milestones in boys than in girls, while mothers' dermatoglyphic traits correlated more with girls' growth milestones. The strongest correlations were often provided by contrasts calculated from the ridge count of the 2nd or 4th finger, which appear to be most closely related to prenatal sex determination. Despite the limitations of this pilot study, it is the first study of the association between dermatoglyphics and postnatal growth in adolescence. When considered in a biological context, the results provide a promising basis for searching for prenatal origins of variation in some aspects (timing, velocity) of postnatal growth that can be further tested and elaborated in future independent studies.

KEY WORDS: Prenatal sex differentiation – Pubertal growth – Growth modelling – Dermatoglyphics – Radioulnar contrasts

Received 4 February 2022; Received in revised form 7 June 2022; Accepted 8 June 2022. Available online 11 July 2022.

DOI: https://doi.org.10.26720/anthro.22.06.08.1

INTRODUCTION

The human body height or stature is understood as a polygenic trait and, usually, human height is viewed as the result of genetic factors. About 15–32% of the variation in prepubertal age and 30–46% of the variation in final height of children was explained by the variation in parental heights (Sorva *et al.* 1989). Beyond that, however, important properties of the human body are set (programmed) in the prenatal period (Gluckman, Hanson 2006a, b, c) by interactions between genetic factors and environmental conditions. The resulting epigenetic adjustment leads to long-term setting of functionalities of growth, metabolism, reproductive organs, immunity, nervous tissues and psychology. The prenatal environment influenced by maternal characteristics (e.g., size of uterus) and prenatal growth has been, for a long time, considered to be the main determinant of the body size of the newborns (Tanner *et al.* 1956) which may have consequences in its later life (Gluckman *et al.* 2008).

Among the most important factors in development and growth throughout the prenatal period are steroid hormones, particularly sex steroids (testosterone, estradiol) produced by fetal organs. Increased attention was brought to sex steroids as they are accepted to be the factors of prenatal programming of sex-typicality of the human brain and behavior (Cohen-Bendahan *et al.* 2005). Male and female fetuses differ significantly in the production of sex hormones (Baron-Cohen *et al.* 2004). However, their effect is more organizational in terms of setting the properties of cells and tissues in the time, and little is seen in body size. Newborn boys are usually on average slightly larger than girls and the trend continues during the postnatal period, but growth in stature is similar in boys and girls in childhood (Bogin 2021, for review). On the other hand, the timing of sexual development in puberty is certainly an essential aspect of individual adaptation (Hochberg 2011, Del Giudice *et al.* 2018). In the puberty and adolescence periods differences in the timing and levels of sex hormone production in boys and girls cause a large difference in the timing and intensity of the adolescent growth spurt (Malina *et al.* 1988) and even within each sex, differences in sexual maturation (and associated growth) are several years. Thus, if any predispositions resulting from prenatal sex differentiation and adjustment are to be manifested, it should be during puberty and adolescence. We know from well-described pathologies that, e.g., small stature and absence of pubertal growth spurt in individuals suffering from Turner syndrome with missing second X-chromosome (i.e., low dose of feminization factors), and, at the same time, low levels of sex hormones (Sybert, McCauley 2004). The question is whether a part of the variance in pubertal growth within each sex can be linked to prenatal androgenization also in healthy, physiological conditions.

The solution is not methodologically easy. Prenatal sex steroids can be determined as direct measures of maternal (blood) and fetal hormones (from amniocentesis and cordocentesis). However, these invasive measurements can only be studied directly because of a medical indication. As an alternative in a healthy population without medical indications, biological markers used as indirect indicators of prenatal steroids can be used. Among them, digit ratio, especially the ratio between the length of the 2nd and 4th finger or 2D:4D ratio (Králík *et al.* 2019a), otoacoustic emissions (McFadden 2009, Wisniewski *et al.* 2014), dermatoglyphic features (Jantz 2022, Polcerová *et al.* 2022), body side asymmetry (Benderlioglu 2010) and other indicators have been studied. The 2D:4D ratio (Manning 2002) was found to be associated with directly measured steroid hormones from amniocentesis (Lutchmaya *et al.* 2004), although the quality of this indicator is still a matter of debate (Berenbaum *et al.* 2009).

In this study, we focus on a possible relationship of dermatoglyphics (as putative markers of prenatal sex steroids) with prenatal programming of postnatal pubertal and adolescent growth. Dermatoglyphic structures of the skin are formed deeply in the prenatal period from the 10th to 17th week (Okajima 1975, Babler 1991, Wertheim, Maceo 2002, Seidenberg-Kajabova *et al.* 2010), after which they become fixed and do not change significantly in their topology. Because they are sexually dimorphic (Cummins, Midlo 1943: 273, Schwidetzky, Jantz 1977, 1979, Králík *et al.* 2019b), the morphogenesis of dermatoglyphics in the prenatal period is probably influenced by sex-specific factors – genes on sex chromosomes (Holt, Lindsten 1964, Penrose 1967, Jantz, Hun, 1986, Bhalla *et al.* 2005), and sex hormones (Qazi, Thompson 1971, Jamison *et al.* 1994). Thus, systematic sex difference in some dermatoglyphic traits could be used as markers of sex-specific prenatal dispositions/set-up in the features of the human body, behavior, cognition and psychology. Jantz (2022) found that quantitative dermatoglyphic traits (ridge-counts) are related to 2D:4D ratio, which is considered a morphological marker of the degree of body androgenization in the prenatal period (Manning 2002). Most recently it has been shown (Polcerová *et al.* 2022) that rather than the original finger ridge-counts (or their sums), radioulnar contrasts (numerically: differences) between the ridge counts of

individual fingers within the same hand have the potential to act as traits reflecting prenatal sex-specific factors, analogically to 2D:4D ratio in finger lengths. The authors of this study are not aware of any study that has examined the relationship between dermatoglyphic traits as markers of prenatal sexual differentiation and human pubertal growth parameters.

AIMS AND HYPOTHESES OF THE STUDY

The aim of this pilot exploratory association study is to determine whether any association between prenatally fixed dermatoglyphic features and postnatal growth at puberty can be captured at all. If any associations are found, the aim of the study will be to determine which dermatoglyphic features are related to the timing of pubertal growth.

According to the results of the above-mentioned study (Polcerová *et al.* 2022), it can be presumed that the association with prenatal sex factor should reflect particularly dermatoglyphic radioulnar contrasts (within-hand differences) that include ridge counts of the 2nd and/or 4th fingers of the right hand. In terms of intersex differences in growth, it can be presumed that the timing of growth accelerations should exhibit stronger associations with these prenatal sex-specific factors than the growth rates, and, furthermore, parameters at the peak point of the pubertal growth should be more sensitive than other points of the growth curve. Theoretically, we should find that the rate of expression of some sexually dimorphic traits of dermatoglyphics corresponds to a concordant direction of expression in adolescent growth, i.e., more masculine feature in dermatoglyphics should be connected with more masculine feature in pubertal growth (later and more intensive growth spurt) and *vice versa*. However, the question is whether it is more appropriate to look for associations with the postnatal growth and dermatoglyphic features of the particular individuals (i.e., growth of a child and his/her dermatoglyphics), or with the dermatoglyphic features (i.e., the degree of prenatal influence) of their mothers, in whose *uterus* the prenatal development of the monitored individuals takes place. Therefore, we tested both.

MATERIALS AND METHODS

Studied sample

The tested sample represents the first three years of a semi-longitudinal study which has been initiated in 2018. The project was pre-approved by the research ethics committee of our institution (document number EKV-2018-028). Recruitment of the sample of children during postnatal growth was carried out by approaching potential sub-adult participants or their parents (for young children) based on several contexts, (A) first, in collaboration with pediatricians in Brno, (B) on the basis of long-term previous collaboration with Brno secondary schools, and (C) by randomly searching for volunteers among social contacts of undergraduate anthropology students. Currently, the total number of participants in this research is 166, of which 83 are children aged 0–18 years (43 boys and 40 girls) and the rest are their parents/relatives or other legal representatives. Recruitment took place over three years, so some children were measured only once, and others were measured 3 times. Part of the third measurement (two years after the first measurement) had to be carried out as a home self-measurement due to covid restrictions and the complete closure of the department where examinations were performed. Parents were given detailed instructions and measured several of the most important dimensions of their children themselves, including body height, with the measuring device we supplied. Dermatoglyphic study of this sample was a part of Czech population sample analyzed in the study Polcerová *et al.* (2022). Plot of the body height related to the age of all subjects involved in the new semilongitudinal sample is available in *Figure 1*.

Pubertal growth modelling

The individual growth milestones analyzed in the study were extracted from the measured data using an approach proposed in Králík *et al.* (2021), designed for the prediction of a complete curve of pubertal/adolescent human growth from a sparse set of measurements. The method is based on the curves of girls and boys measured in the Brno Growth Study (BGS) (Bouchalová 1987), which were described using B-splines and further analyzed using Functional Data Analysis and Functional Principal Component Analysis for each sex separately (*Figure 1 B* and *C*, samples on grey background). The fitting of the models to our studied sample (43 boys and 40 girls) and optimization of the model parameters was performed using a Levenberg–Marquardt solver (Kelley 1999: 56–58). This procedure minimizes two sets of residuals; first one is the residual between the raw value and the model estimate of the height measurement, and the second represents the curve probability within the references sample. To secure the second one, FPCA score values of both phase and amplitude parameters were set to ±3 standard deviations

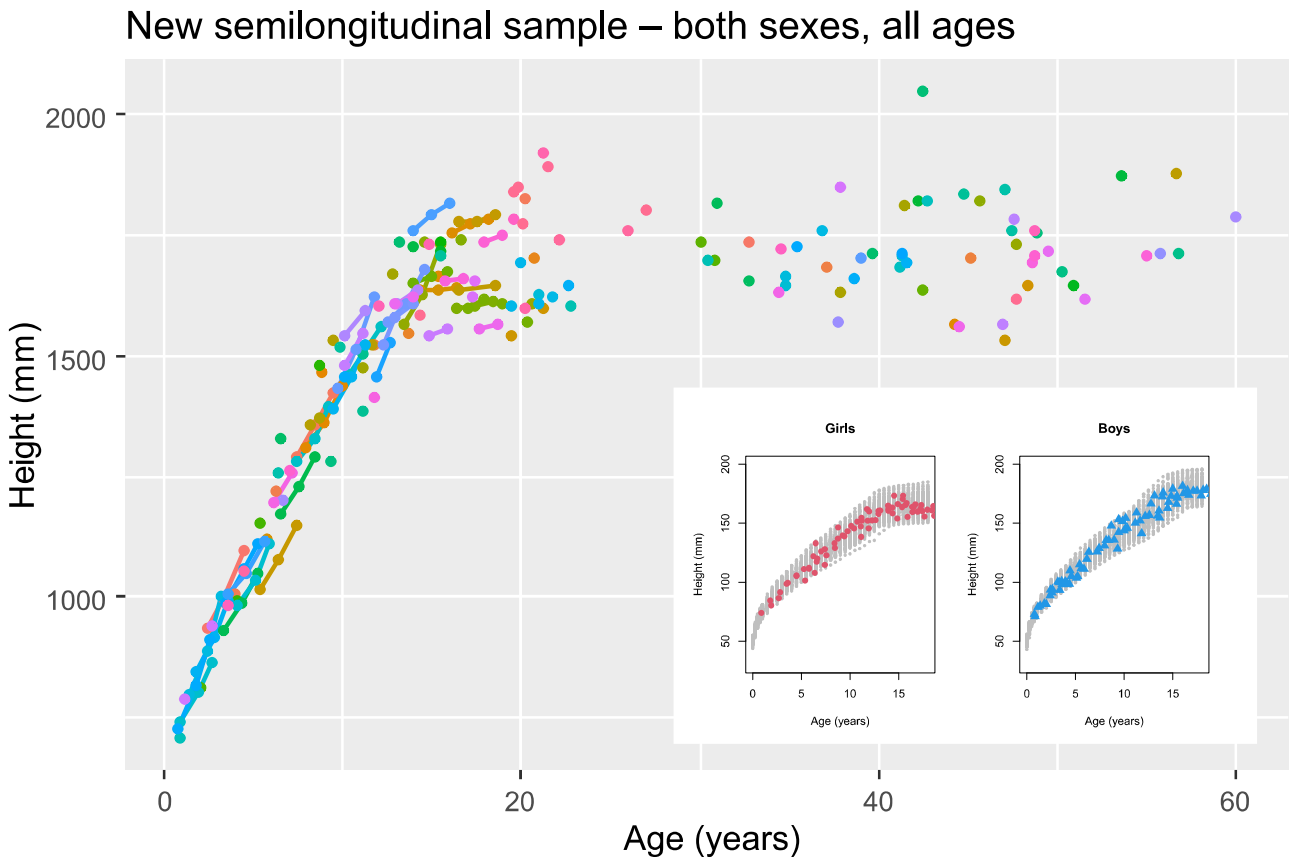

FIGURE 1: Height values of all subjects plotted against their age (n=166, children and their parents) studied in the new semilongitudinal sample, each subject is visualized in different color, in children with repeated measurements the measurements are connected by a solid line of the same color (A); sample of children and subadults of the semilongitudinal study for girls (B) in red and boys (C) in blue separately plotted above references sample of the Brno Growth Study (grey points).

during the optimization. For more details of the estimation method see Králík *et al.* (2021). Finally, using the *getPeak* and *getTakeoff* functions present in the *sitar* package (Cole 2020) the growth milestones were determined on individual growth curves: age at peak velocity in pubertal growth spurt of body height (APV, in years), peak velocity in pubertal growth spurt of body height (VPV, in cm/years), body height at the point of peak velocity in puberty (HPV, in cm), age at take-off before pubertal spurt of body height (ATO, in years), velocity at point of take-off before spurt of body height (VTO, in cm/years), and body height at the point of take-off before spurt in puberty (HTO, in cm).

Dermatoglyphics

The fingerprints of the children and their mothers were acquired using the traditional technique of imprinting with black ink on white smooth paper (Cummins, Midlo 1943: 45–50) and then scanned with a desktop scanner into a 600 dpi electronic image of TIFF format. Dermatoglyphic assessment was performed using the *Dermatoglyphix 1.0* software (Králík *et al.* 2017a, 2017b). In accordance with the standard methodology of Cummins and Midlo (1943), the ridges between the core of the triradius on each side of the dermatoglyphic pattern of the distal finger pad were counted (Cummins, Midlo 1943: 74–76). Thus, we distinguished between radial ridge-count RCr (on the radial side of each pattern) and ulnar ridge-count RCu (on the ulnar side of each pattern), with whorls and composite patterns having two non-zero values, loops having one non-zero and one zero value, and arches (arch and tented arch) having two zero values (Loesch 1978, 1983).

From these raw ridge-counts, all contrasts (differences) between any two ridge-counts within the same hand were calculated for right (R) and left (L) hand separately, always by subtracting the more ulnar ridge-count from the more radial ridge-count (radial minus ulnar). For instance, R1rR1u was the difference between radial ridge-count of the first finger and the ulnar ridge-count of the first (the same) finger of the right hand, and L2rL4u was the difference between radial ridge-count on the second finger and the ulnar ridge-count on the fourth finger of the left hand. In total, 45 such contrasts were computed for each individual hand. For more details of the method see Polcerová *et al.* (2022).

Statistical methods

All computations and statistical analyses were performed in *R* environment (R Core Team, 2020). Descriptive statistics were computed for analyzed variables. The reference BGS sample and the new semilongitudinal sample were described by statistical parameters and their differences in the mean values of the milestones were tested by means of Permutation Welch Two Sample t-test in *R* package *MKinfer* (Kohl 2020). Differences between ridge count mean values between groups (boys vs. girls, mothers of girls vs. mothers of boys), as well as ridge count contrast mean values between groups were tested using a permutation test – function *perm.test* in the *R* package *exactRankTests* (Hothorn, Hornik 2019).

Considering the nature of the observed variables (integer values of ridge counts and their differences, zeros in ridge counts), relationships between pubertal growth milestones and dermatoglyphics radioulnar ridge-count contrasts were studied by means of Spearman rank order correlation coefficient. The correlation analysis and visualization in correlograms were performed for each hand (R, L) and sex of the child separately (boys, girls). Analogical analyses were computed both for dermatoglyphic contrasts of studied children and their mothers. The statistical significance was set at P=0.05 and was computed by means of the algorithm AS 89 (Best, Roberts 1975) available in the *R* package function *cor.test*. Correlograms were visualized by means of the *R* package *corrplot* (Wei, Simko 2017). Realistically it could not have been expected to find any extremely strong correlations between signs of prenatal skin androgenization of children (or even in their mothers) and manifestations of pubertal growth of the children many years later. Rather, we focused on the pattern of correlations and the occurrence of correlations of the sexually dimorphic features of the 2nd and 4th digits mentioned in the introduction. Therefore, we used the *Chi-square* test to assess whether the highest (statistically significant) correlations occur randomly, i.e., evenly dispersed among the various correlated variables and groups, or whether their occurrence is systematically uneven. For the selected strongest correlations, we used a nonlinear regression model using *sm.ancova* function in R package *sm* (Bowman, Azzalini 2021) and tested the difference in position ("equality test") and direction ("parallelism test") between curves for girls and boys by means of nonparametric procedures published by Bowman and Azzalini (Bowman, Azzalini 1997) using the same *R* package.

RESULTS

Descriptive statistics of the growth milestones estimated in the studied sample are available in *Table 1*, including their comparison with reference values of the BGS sample applied as the training set within the FPCA method. The mean values of the growth milestones for the tested sample are similar to those of the BGS reference study, yet we can see some differences. While the APV is virtually identical for both studies, which is true for both girls and boys, the estimated ATO is about half a year later for the tested sample than for the BGS, which is true for both girls and boys. For the growth velocities compared, no such difference was observed between the BGS and the tested sample, with a significant difference only for the VPV in girls, where the growth rate is greater at the peak of pubertal acceleration in the tested sample. Body height at the adolescent growth peak also did not differ between the two samples, either in girls or boys, but height at take-off (HTO) was higher in the tested sample than in BGS, both in girls and boys. However, we observed significantly lower variance for all milestones in the tested sample, with the largest difference in APV for girls.

Description of the original ridge counts of children can be seen in *Figure 2* and *Table A1*. Data of ridge counts were available in 27 boys and 30 girls. As expected, the highest average values have been recorded on the radial side of the 1st and the 4th fingers, right and left, both in boys and girls. At the same time, mean values of all of the twenty ridge counts are numerically higher in boys than girls, which is a typical sex difference in finger ridge counts. On the left hand, the highest differences between median values, as well as between

TABLE 1: Descriptive statistics (N – number of cases, mean – arithmetic mean, SD – standard deviation) of growth milestones of body height of the Brno Growth Study sample and the tested sample for girls and boys separately; last column represents Monte-Carlo permutation p-value of the Permutation Welch Two Sample t-test (for inequal variances) between mean values of the milestones in the BGS sample and the tested sample.

	GIRLS						
	BGS			Tested sample			
	N	mean	SD	N	mean	SD	p-value
ATO (years)	167	9.03	0.92	40	9.52	0.30	2.0E-16
VTO (cm/year)	167	5.19	0.67	40	5.26	0.35	0.33
HTO (cm)	167	135.44	7.37	40	137.65	4.77	0.023
APV (years)	167	11.61	0.90	40	11.67	0.31	0.46
VPV (cm/year)	167	7.57	0.88	40	7.84	0.47	0.012
HPV (cm)	167	151.50	6.66	40	151.36	4.33	0.87
	BOYS						
	BGS			Tested sample			
	N	mean	SD	N	mean	SD	p-value
ATO (years)	167	10.536	0.89	43	11.10	0.32	2.0E-16
VTO (cm/year)	167	4.7737	0.56	43	4.79	0.22	0.79
HTO (cm)	167	144.27	6.91	43	148.01	4.89	0.0001
APV (years)	167	13.607	0.91	43	13.64	0.51	0.78
VPV (cm/year)	167	9.2129	1.22	43	9.15	0.85	0.70
HPV (cm)	167	164.37	6.18	43	164.63	3.54	0.72

mean values, for boys and girls was recorded for the L2.RCr (radial ridge count on the second finger of the left hand). On the right hand, the highest median sex difference was recorded for radial ridge-counts of the second, fourth and the fifth finger, the highest sex difference in mean values was recorded in the ulnar ridge count of the second finger. None of these differences were statistically significant. Descriptive statistics of the ridge counts for the hands of mothers are available in *Table A2* separately for mothers of boys and mothers of girls, including their differences. As evident from the plot of mean values (*Figure 2*), in most of the twenty ridge counts mean values for mothers of the studied girls were higher than for the remaining groups, including the tested boys, whereas for tested girls the mean values of the ridge counts were the lowest in most cases.

Radioulnar contrasts (differences) of the tested children are described statistically in *Table A3* for the right hand and in *Table A4* for the left, including sex differences for each contrast. A positive value of the difference means that there is a larger value in males, i.e. more lines on the radial side of the contrast in males, negative differences the opposite. If we ranked the differences by size, the largest positive intersex differences (from which we selected only differences higher than 2 lines) were observed for contrasts: R1rR2u (2.67 ridges), R1uR2u (2.33 ridges), L1uL2r (2.05 ridges), while higher negative contrasts were observed R2uR5u (–2.75 ridges), L2rL3u (–2.47 ridges), R2uR3u (–2.39 ridges), L1rL3u (–2.32 ridges), L2rL5u (–2.10 ridges), R5rR5u (–2.05 ridges), and R2uR3r (–2.03 ridges). We can see that the 2nd finger, either its radial or ulnar ridge count, is still frequently present in these contrasts, with the 2nd finger being in the second position in positive differences, while in negative differences it is in the first position of the contrast. That is, the ridge count value on the 2nd finger is relatively smaller in boys

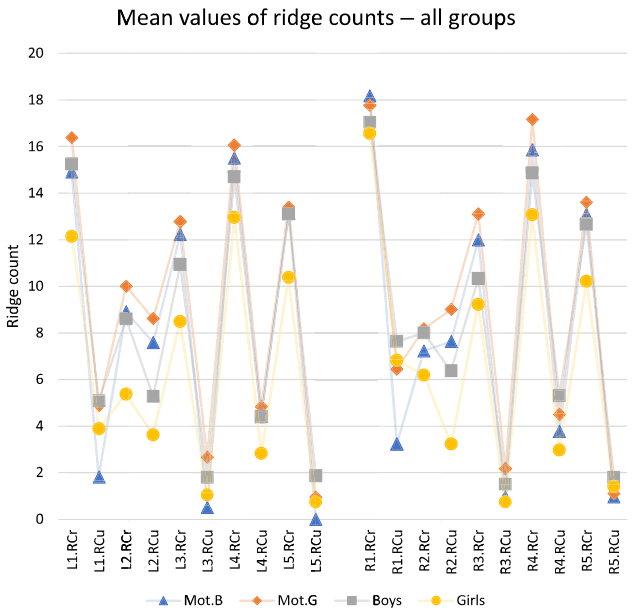

FIGURE 2: Mean values of all analyzed ridge counts in all groups; Mot.B – mothers of boys, Mot.G – mothers of girls; L1–L5 – fingers of the left hand, R1–R5 – fingers of the right hand, r – radial side, u – ulnar side.

(always relative to the second position – other ridge count – of a given intraindividual contrast) than in girls. However, based on the permutation tests, none of these sex differences were statistically significant (thus, significances are not shown in the tables). Radioulnar contrasts (differences) of the mothers are described statistically in *Table A5* for the right hand and in *Table A6* for the left, including differences between the mothers of boys and the mothers of girls for each contrast. Differences between both groups of mothers are relatively small, except for a group of twelve contrasts higher than 2 ridges containing ulnar ridge counts of the first fingers, right or left, which were always higher in mothers of girls. Again, none of the differences were statistically significant.

Correlograms between the growth milestones and dermatoglyphic contrasts for all analyzed groups are available in *Figure 3*. From the plots it is evident, generally, that correlations are relatively low or moderate in size, and lower for the right hand than for the left except for correlations between dermatoglyphics of the mothers of girls with growth of the girls. Correlations of the boys' growth milestones with their radioulnar contrasts show that only two correlations exceeded the five percent significance level on the right hand, while there were 16 correlations on the left. At the same time, *all* of them are composed of some ridge-count of the 2nd or 4th finger. Two of the eighteen correlations contain 2r ridge-count (radial ridge count of the 2nd finger) and 15 of them comprises 4u correlations (ulnar ridge-count of the 4th finger). Correlations of the girls' growth milestones with their radioulnar contrasts, similarly to those of boys, are higher for the left hand than for the right. Ten of the twenty-one significant correlations again involved some ridge count of the second or fourth finger. In radioulnar contrasts of the mothers of boys, overall level of correlation was, similarly, higher on the left hand than on the right (none was significant on the right) and five of ten significant correlations comprises the 2nd or the 4th finger. Finally, correlations in mothers of girls are the highest of all right-hand correlations (including the highest recorded correlation of the study, between the contrast R4rR4u and APV) and 19 out of 22

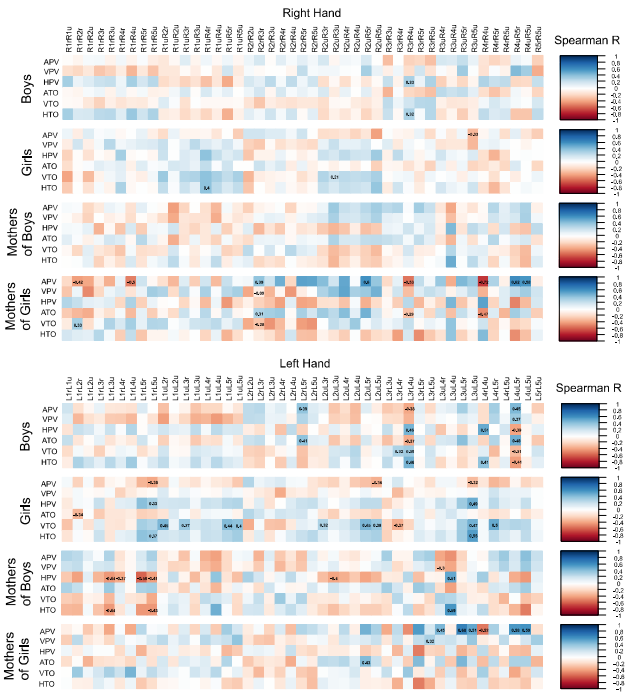

FIGURE 3: Spearman rank order correlation coefficients between estimated growth milestones and radioulnar ridge count contrasts of children and their mothers, divided into groups by body side (Right Hand, Left Hand) and sex of the children (Boys, Girls. Mothers of Boys, Mothers of Girls); values of the correlation coefficients are expressed by color intensity, blue – positive correlations, red – negative correlations, statistically significant correlations (without a correction for multiple testing) are presented numerically.

significant correlations again comprise some ridge count of the 2nd or the 4th finger.

The results of the nonparametric test of differences in the progress of the nonlinear models for boys and girls show that for some of the significant correlations found, the agreement of the progress of the curves for both sexes cannot be rejected at our sample size (*Table A7, Figure 4*), whereas, for example, the relationship of L4uL5r with the timing milestones of the adolescent spurt and maximum growth rates in adolescence is already significantly different between girls and boys even in our pilot sample (*Table A8, Figure 5*); for girls, this contour is virtually unrelated to growth milestones, whereas it is for boys.

DISCUSSION

In this study, we investigated the possible relationship between prenatal sex differentiation, which may be reflected in radioulnar contrasts of dermatoglyphic ridge counts of the fingers of the hand, and growth milestones of the individual pubertal growth curve. We used the fingerprints of children and mothers of our ongoing

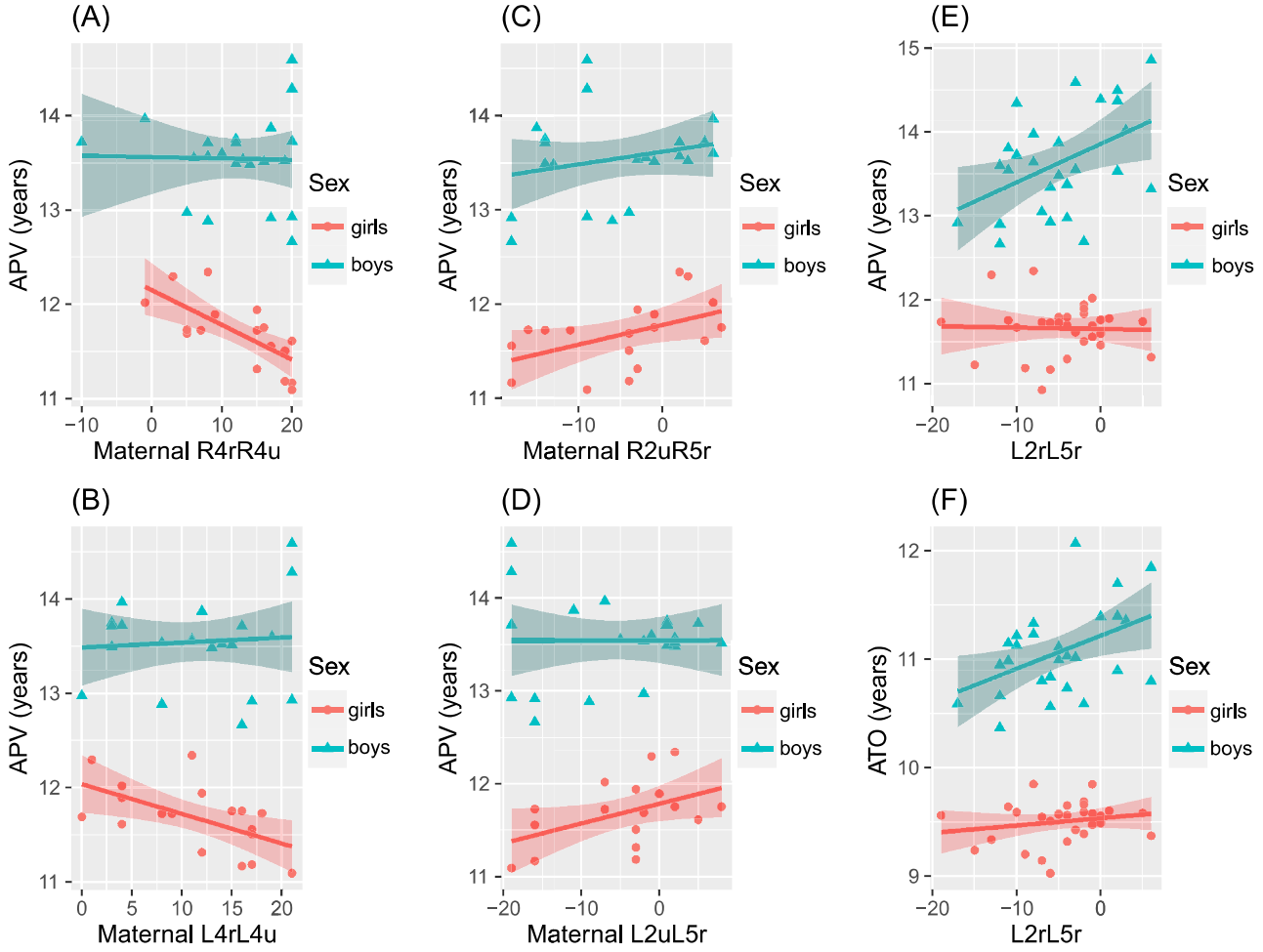

FIGURE 4: Selected relationships between radioulnar dermatoglyphic contrasts and growth milestones; selected contrast of mothers´ 4th (A, B) and 2nd (C, D) fingers, both right and left, and a contrast of the 2nd finger in their children in mothers and growth milestones of their children. In these relationships, the sample for only one of the sexes was always statistically significant; the nonparametric test of the nonlinear models of these relationships also rejected the identity of the curves for girls and boys, but in none of these cases did it reject the identity of the direction (parallelism test) of the two curves (see *Appendix Table A7*).

semilongitudinal study as a source of the dermatoglyphic markers. The growth curve milestones at puberty of the children were just estimated according to a published prediction method (Králík *et al.* 2021).

Seventy-one significant correlations in total were observed between growth milestones and radioulnar contrasts of ridge counts. A correction for multiple testing by means of Bonferroni method was performed which resulted in none of the correlations to remain separately significant. This is not surprising, given how distant are the biological relationships we are testing (early ontogeny *in utero* vs. pubertal growth) and the sample size of this semilongitudinal study. However, if all observed statistically significant correlations were to be the result of chance, they should be evenly distributed both between groups (boys, girls, mothers of girls, mothers of boys, right and left hand) and between the correlated variables, i.e. equally present on all fingers and for all growth milestones. It is evident from the results that this is not the case. We found more significant correlations for the left hand (52) than for the right (19) which is clearly different from even distribution between sides (Chi-squared 14.4, 1 degree of freedom, p-value 0.0001). Similarly, if we regard all eight tested groups (*Figure 3*), the significant correlations are distributed unevenly. If we focus on the individual milestones there are also differences in numbers of significant correlations (APV 21, VPV 4, HPV 12, ATO

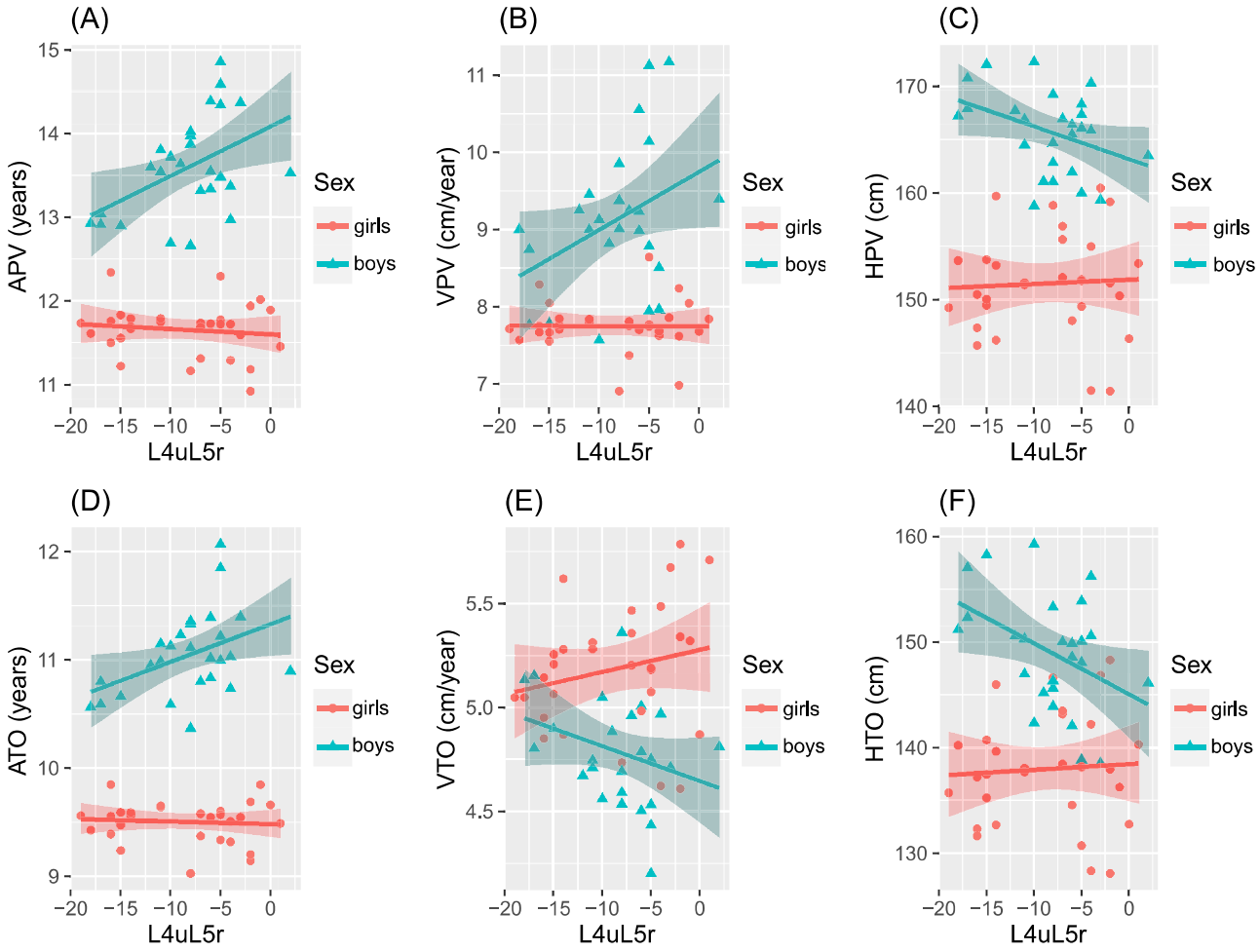

FIGURE 5: Relationships between L4uL5r contrast and all studied growth milestones in tested children; in boys the relationship is positive for age at peak (APV) and take-off (ATO), and negative for both height variables (HPV, HTO), while in velocities the direction differs. No relationships were found in girls and for age and velocity milestones (APV, ATO, VPV, and VTO) nonlinear trends for boy and girls significantly differed, but not for the height milestones (see *Appendix Table A8*).

8, VTO 16, HTO 10) which is also divergent from an even distribution (Chi-squared 17.4, 5 degrees of freedom, p-value 0.0038). Thus, according to this formal assessment, most of the observed correlations do not appear to be completely random. Moreover, many of them are not negligible correlations regarding to their size, many are low, but a number of them reached moderate size (0.5 and more) and one is high in size (0.7 and more). Checking the relationship of the correlated variables of the few highest correlations recorded on the plots (*Figure 4*), it is also interesting to note that correlations of the same contrasts that are significant on one hand have a similar direction of dependence on the other hand (independently measured values of ridge counts of the same individual), although perhaps not as strong or statistically significant. This also formally supports the interpretation that not all correlations found are due to pure chance as a result of the large number of correlations calculated.

In addition to these formal considerations, a number of significant correlations contain some ridge count of the 2nd or 4th finger, which have been found to be crucial in assessing the dimorphism of radioulnar contrasts (Polcerová *et al.* 2022). But the most important aspect of the interpretation is the assessment of the biological meaning of the observed correlations. The strongest correlation observed was a negative correlation between the R4rR4u difference on the left hand of the mothers and the APV of their daughters (r=–0.72, p-value=0.0009, N=18). In a previously published study (Polcerová *et al.* 2022) this contrast has been found to be higher in females than in males (negative dimorphism), so the higher the value, the more feminine features should be the features related to a common factor of prenatal sex differentiation. Since early APV could be regarded as a feminine feature (as compared with the later APV in boys), the *higher* (i.e. the more feminine) is the R4rR4u difference the lower (the more feminine) should be the APV. And precisely this relationship was recorded in the study (*Figure 4*). But these relationships have not always been so clear-cut. For example, the L4uL5r contrast was correlated with all six milestones in boys, the sense of the observed relationship (positive) was the same for APV and ATO, as well as being the same (negative) for HPV and HTO, while it was discordant for velocity (VPV and VTO), which is also consistent with the nature of the relationships between these two growth rate variables (the higher VTO is the lower relative to it the VTO can be). However, the sense of this relationship went against the sense of sexual dimorphism in this contrast; the dimorphism in L4uL5r was negative (Polcerová *et al.* 2022), i.e., higher values (less negative) were observed in the Czech sample for females, so increasing values should be related to feminization of growth milestones, which in our case is consistent with the direction of the association with HPV and HTO (i.e. more feminized growth, lower height in both milestones), but not with the direction of the association with APV and ATO. It should be added, however, that the dimorphism of this contrast (L4uL5r) is relatively small, its sense/direction differs on the right and left hand even in all tested populations, and thus it was not evaluated (Polcerová *et al.* 2022) as a suitable indicator of prenatal sex differentiation.

Overall, the radioulnar ridge count contrasts of the assessed children themselves appear to be more related to growth milestones in boys, whereas maternal contrasts are more related to growth milestones in girls (i.e., their daughters). The reason for these sex differences could hypothetically be that boys produce significantly higher levels of testosterone prenatally (Baron-Cohen *et al.* 2004, Cohen-Bendahan *et al.* 2005, Berenbaum, Beltz 2011); this factor influences the sexual differentiation of many body regions (presumably their dermatoglyphics and postnatal growth predispositions) and these are then related to some extent (e.g. stronger relationship of L4uL5r contrast to all growth milestones in boys than in girls, example in *Figure 5*). The influence of maternal hormonal factors affecting sexual differentiation may then be relatively minor. On the contrary, it can be hypothesized that in girls the prenatal production of their own steroid hormones is lower, especially in case of testosterone, and the possible influence of maternal sex-differentiating factors may be relatively greater, which would then be reflected in stronger relationships between the dermatoglyphics of mothers (given by maternal ontogeny and sex differentiation) and the postnatal growth of their daughters.

A striking aspect of our results is the prevalence of significant correlations on the left side (except for contrasts in the mothers of girls). Despite a strong tendency for "mirroring" of features on the fingers (the same/similar value on the right and the left side), dermatoglyphics recorded many systematic side differences for different features, generally with thicker ridges on the fingers of the right hand, higher quantitative pattern values (ridge counts), and more whorl-type patterns and fewer arch-type patterns on fingers (Cummins, Midlo 1943). At the same time, however, females are known to have overall lower side differences

(are more symmetrical) than males in the frequencies of patterns on the fingers and in other features. Sex differences in dermatoglyphics are usually greater on the right hand than on the left (Králík *et al.* 2019b), which is true not only for dermatoglyphic features, but also digit ratio (Hönekopp, Watson 2010). This could mean that the characters on the right hand are under a stronger influence of population-universal sex-determining factors, whereas the characters on the left hand may be influenced by more external factors (Králík *et al.* 2019b). In this respect, the preponderance of correlations on the left hand in our results could be interpreted as a prenatal adjustment of the organism's growth characteristics under the influence of external conditions.

We are aware that our study has several clear limitations. The main one is the sample size, which results both from the semilongitudinal study itself (only in its third year) and from the fact that dermatoglyphics were not available for all children and mothers due to voluntarily basis of the recruitment and data collection. This also reflected the nature of the pubertal and adolescent growth milestones that were correlated with dermatoglyphic contrasts. Since complete individual growth curves are not yet available, we used estimates based on predictions (extrapolations) by means of a newly published prediction method combining Functional Data Analysis, Functional Principal Component Analysis and Levenberg–Marquardt optimization algorithm (Králík *et al.* 2021). As already shown by testing of this method in the original paper by the original authors, predictions of growth milestones (e.g., APV) are reliable in terms of mean value, but unless the empirical data being modeled (here, height measurements) are on both sides of the predicted milestone in terms of age, the variance of the estimates is significantly reduced relative to reality. The more distant the data are in time from the revealed milestone, the more conservative the model is in providing estimates closer to the average growth curve. This trend can be observed in our data and is likely to increase. Such assumption is based on the fact that in the original study estimates from five measurements were tested (Králík *et al.* 2021), whereas in the present study a maximum of three measurements is available with only two or even one single measurement being available from several participants. The question is therefore to what extent a reduction in the variance in growth milestone readings can affect the ability of the tests to detect any statistical relationship. On the other hand, observing the superposition of the tested sample on the BGS reference data (*Figure 1 B* and *C*), we see that the tested sample does not only deviate from the reference sample, but the newly measured values are even mostly along the middle of the distribution of the reference sample. Thus, the lower variance of the growth milestone estimates may not be solely due to the conservatism (a tendence towards mean) of the estimation method but may partly result directly from the measured data. Therefore, it will be advisable to complete the curves of these children in the following years or to verify the findings on other data where both complete individual growth curves and dermatoglyphic imprints are available. However, dermatoglyphic records are usually not available for other data from complete longitudinal studies which was also the reason we used this semilongitudinal sample.

As a further limitation, it should be noted that the effect of prenatal androgens may vary depending on some factors besides sex, the influence of which we have not tested. For example, it has been found that birth order, the interbirth interval an sex of older sibling can influence the value of 2D:4D ratio (Saino *et al.* 2006, Králík *et al.* 2019a), even outweighing the effect of sex; e.g. boys born in the 3rd and higher order may have had a higher (more feminine) 2D:4D ratio than first-born girls and vice versa (Králík *et al.* 2019a). If dermatoglyphic radioulnar contrasts are related to prenatal androgens in a similar way to 2D:4D ratio, as suggested by the above recent study (Polcerová *et al.* 2022), birth order and interbirth interval could also influence them and their association with postnatal growth. Although these familial variables were available for the children in our sample, we could not subdivide the study into other groups because of the sample size.

CONCLUSIONS

In this study, we focused on the previously unstudied relationship between dermatoglyphic radioulnar ridge count contrasts of the fingers of the hand (sexually dimorphic traits fixed prenatally and thus likely influenced by prenatal sex-differentiating factors) and adolescent body growth milestones, which are also markedly sexually distinct. We consider this pilot exploratory study as the first attempt to find associations between dermatoglyphic contrasts and postnatal growth. We are still far from a clear interpretation of all the findings, let alone understanding the true causality behind the observed associations. Some consistent groups of results suggest their bio-logic. For example, a clear association of the L4uL5r contrast with indicators of growth timing and velocity in adolescence

was seen only in boys, who have a much more pronounced growth of the ulnar side of the hand (4th and 5th fingers), which is under a stronger influence of testosterone than the radial fingers, but no relationship of this contrast at all was observed in girls.

Despite the limitations noted above, the results suggest that the variance of growth milestones in puberty and adolescence (especially APV) could be related to predispositions set (programmed) prenatally. We believe that the main trends we have observed are real, i.e., that pubertal and adolescent growth of boys is more related to their own dermatoglyphic contrasts, whereas the growth of girls is more related to the dermatoglyphic contrasts of their mothers. However, the findings require independent verification on a larger sample of children using complete growth curves.

ACKNOWLEDGEMENTS

This research was funded by Technology Agency of the Czech Republic, grant number TL01000394 (Počítačová podpora pro analýzu a predikci růstu a vývoje dítěte). The authors thank Tomáš Mořkovský, MSc., for administrative support, and the students who assisted in the data recording and preparation of the computer archives.

REFERENCES

BABLER W. J., 1991: Embryologic Development of Epidermal Ridges and Their Configurations. *Birth Defects Original Article Series* 27: 95–112.

BARON-COHEN S., LUTCHMAYA S., KNICKMEYER R., 2004: *Prenatal Testosterone in Mind. Amniotic Fluid Studies*. MIT Press, Cambridge, Massachusetts – London, England.

BENDERLIOGLU Z., 2010: Fluctuating Asymmetry and Steroid Hormones: A Review. *Symmetry* 2: 541–553. DOI: 10.3390/sym2020541

BERENBAUM S. A., BELTZ A. M., 2011: Sexual differentiation of human behavior: Effects of prenatal and pubertal organizational hormones. *Frontiers in Neuroendocrinology* 32: 183–200. DOI: 10.1016/j.yfrne.2011.03.001

BERENBAUM S. A., BRYK K. K., NOWAK N., QUIGLEY C. A., MOFFAT S., 2009: Fingers as a marker of prenatal androgen exposure. *Endocrinology* 150: 5119–5124.

BEST D. J., ROBERTS D. E., 1975: Algorithm AS 89: The Upper Tail Probabilities of Spearman's Rho. *Journal of the Royal Statistical Society*. Series C (Applied Statistics), [Wiley, Royal Statistical Society] 24: 377–379.

BHALLA A., MARWAHA R., SHARMA A., TREHAN A., MURALIDHARAN R., BAGGA R., 2005: Dermatoglyphics in turner syndrome. *International Journal of Anthropology* 20: 111–125.

BOGIN B., 2021: *Patterns of Human Growth*. Cambridge University Press.

BOUCHALOVÁ M., 1987: *Vývoj během dětství a jeho ovlivnění. Brněnská růstová studie*. Avicenum, Zdravotnické nakladatelství, Praha.

BOWMAN A. W., AZZALINI A., 1997: *Applied Smoothing Techniques for Data Analysis: The Kernel Approach with S-Plus Illustrations*. Oxfod, Clarendon Press.

BOWMAN A. W., AZZALINI A., 2021: R package sm: nonparametric smoothing methods (version 2.2-5.7). University of Glasgow, UK and Università di Padova, Italia.

COHEN-BENDAHAN C. C. C., VAN DE BEEK C., BERENBAUM S. A., 2005: Prenatal sex hormone effects on child and adult sex-typed behavior: methods and findings. *Neuroscience & Biobehavioral Reviews* 29: 353–384.

COLE T., 2020: sitar: Super Imposition by Translation and Rotation Growth Curve Analysis.

CUMMINS H., MIDLO C., 1943: *Finger prints, palms and soles*. Dover Publications, Inc., New York.

DEL GIUDICE M., BARRETT E. S., BELSKY J., HARTMAN S., MARTEL M. M., SANGESTEDT S., KUZAWA C. W., 2018: Individual differences in developmental plasticity: A role for early androgens? *Psychoneuroendocrinology* 90: 165–173. DOI: 10.1016/j.psyneuen.2018.02.025

GLUCKMAN P. D., HANSON M. A., 2006a: *Developmental origins of health and disease*. Cambridge University Press, New York.

GLUCKMAN P. D., HANSON M. A., 2006b: Changing times: The evolution of puberty. *Molecular and Cellular Endocrinology* 254–255: 26–31.

GLUCKMAN P. D., HANSON M. A., 2006c: Evolution, development and timing of puberty. *Trends in Endocrinology & Metabolism* 17: 7–12.

GLUCKMAN P. D., HANSON M. A., COOPER C., THORNBURG K. L., 2008: Mechanisms of Disease: Effect of In Utero and Early-Life Conditions on Adult Health and Disease. *The New England Journal of Medicine* 359: 61–73.

HOCHBERG Z., 2011: Developmental plasticity in child growth and maturation. *Frontiers in endocrinology* 2: 41–41. DOI: 10.3389/fendo.2011.00041

HOLT S. B., LINDSTEN J., 1964: Dermatoglyphic anomalies in Turner's syndrome. *Annals of Human Genetics* 28: 87–100.

HÖNEKOPP J., WATSON S., 2010: Meta-analysis of digit ratio 2D : 4D shows greater sex difference in the right hand. *American Journal of Human Biology* 22: 619–630. DOI: 10.1002/ajhb.21054

HOTHORN T., HORNIK K., 2019: exactRankTests: Exact Distributions for Rank and Permutation Tests.

JAMISON C. S., JAMISON P. L., MEIER R. J., 1994: Effect of prenatal testosterone administration on palmar dermatoglyphic intercore ridge counts of rhesus monkeys (Macaca mulatta). *American Journal of Physical Anthropology* 94: 409–419.

JANTZ R. L., 2022: Finger ridge-counts correlate with the second to fourth digit ratio (2d:4d). *American Journal of Human Biology* 34: e23625. DOI: 10.1002/ajhb.23625

JANTZ R. L., HUNT D. R., 1986: The influence of sex chromosomes on finger dermatoglyphic patterns. *Annals of Human Biology* 13: 287–295.

KELLEY C. T., 1999: *Iterative Methods for Optimization*. Society for Industrial and Applied Mathematics.

KOHL M., 2020: MKinfer: Inferential Statistics. R package.

KRÁLÍK M., HUPKOVÁ A., ZEMAN T., HLOŽEK M., HLAVÁČEK L., SLOVÁČKOVÁ M., ČUTA M., URBANOVÁ P., 2019a: Family effects on the digit ratio (2D : 4D): The role of the interbirth interval. *American Journal of Human Biology* 31: e23260. DOI: 10.1002/ajhb.23260

KRÁLÍK M., KLÍMA O., ČUTA M., MALINA R. M., KOZIEŁ S. M., POLCEROVÁ L., ŠKULTÉTYOVÁ A., ŠPANĚL M., KUKLA L., ZEMČÍK P., 2021: Estimating Growth in Height from Limited Longitudinal Growth Data Using Full-Curves Training Dataset: A Comparison of Two Procedures of Curve Optimization—Functional Principal Component Analysis and SITAR. *Children* 8: 934. DOI: 10.3390/children8100934

KRÁLÍK M., KLÍMA O., POLCEROVÁ L., 2017a: *Dermatoglyphix 1.0*. Masaryk University, Faculty of Science, Department of Anthropology, Laboratory of Morphology and Forensic Anthropology (LaMorFA), Brno.

KRÁLÍK M., KLÍMA O., POLCEROVÁ L., 2017b: *Dermatoglyphix: User Manual*. Masaryk University, Faculty of Science, Department of Anthropology, Laboratory of Morphology and Forensic Anthropology (LaMorFA), Brno.

KRÁLÍK M., POLCEROVÁ L., ČUTA M., 2019b: Sex differences in frequencies of dermatoglyphic patterns by individual fingers. *Annals of Human Biology* 46: 231–245. DOI: 10.1080/03014460.2019.1622778

LOESCH D., 1978: Topological classification and genetical studies of dermatoglyphic patterns. *Journal of Human Evolution* 7: 669–677.

LOESCH D. Z., 1983: *Quantitative dermatoglyphics classification, genetics, and pathology*. Oxford University Press, Oxford.

LUTCHMAYA S., BARON-COHEN S., RAGGATT P., KNICKMEYER R., MANNING J. T., 2004: 2nd to 4th digit ratios, fetal testosterone and estradiol. *Early Human Development* 77: 23–28.

MALINA R. M., BOUCHARD C., BEUNEN G., 1988: Human Growth: Selected Aspects of Current Research on Well-Nourished Children. *Annual Review of Anthropology* 17: 187–219.

MANNING J. T., 2002: *Digit Ratio: A Pointer to Fertility, Behavior, and Health*. Rutgers University Press, New Jersey.

MCFADDEN D., 2009: Masculinization of the mammalian cochlea. *Hearing Research* 252: 37–48. DOI: 10.1016/j.heares.2009.01.002

OKAJIMA M., 1975: Development of dermal ridges in the fetus. *Journal of Medical Genetics* 12: 243–250.

PENROSE L. S., 1967: Finger-print pattern and the sex chromosomes. *Lancet* 1: 298–300.

POLCEROVÁ L., CHOVANCOVÁ M., KRÁLÍK M., BEŇUŠ R., KLÍMA O., MEINEROVÁ T., ČUTA M., PETROVÁ M. E., 2022: Radioulnar Contrasts in Fingerprint Ridge Counts: Searching for Dermatoglyphic Markers of Early Sex Development. *American Journal of Human Biology* 34: e23695. DOI: 10.1002/ajhb.23695

QAZI Q. H., THOMPSON M. W., 1971: Dermatoglyphics in Congenital Virilizing Adrenal Hyperplasia. *American Journal of Diseases of Children* 122: 28–30.

R CORE TEAM, 2020: *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.

SAINO N., LEONI B., ROMANO M., 2006: Human digit ratios depend on birth order and sex of older siblings and predict maternal fecundity. *Behavioral Ecology and Sociobiology* 60: 34–45.

SCHWIDETZKY I., JANTZ R. L., 1977: Rassenunterschiede der Geschlechtsdifferenzierung von Hautleistenmerkmalen. *Mitteilungen der Anthropologischen Gesellschaft in Wien* 107: 182–187.

SCHWIDETZKY I., JANTZ R. L., 1979: Race differences in the sex dimorphism of dermatoglyphic traits. *Journal of Human Evolution* 8: 773–776.

SEIDENBERG-KAJABOVA H., POSPISILOVA V., VRANAKOVA V., VARGA I., 2010: An original histological method for studying the volar skin of the fetal hands and feet. *Biomedical Papers of the Medical Faculty of the University Palacky, Olomouc, Czechoslovakia* 154: 211–218.

SORVA R., TOLPPANEN E. M., LANKINEN S., PERHEENTUPA J., 1989: Growth evaluation: parent and child specific height standards. *Archives of Disease in Childhood* 64: 1483.

SYBERT V. P., MCCAULEY E., 2004: Turner's Syndrome. *The New England Journal of Medicine* 351: 1227–1238.

TANNER J. M., HEALY M. J., LOCKHARDT R. D., MACKENZIE J. D., WHITEHOUSE R. H., 1956: Aberdeen growth study. I. The prediction of adult body measurements from measurements taken each year from birth to 5 years. *Archives of Disease in Childhood* 31: 372–381.

WEI T., SIMKO V., 2017: R package "corrplot": Visualization of a Correlation Matrix.

WERTHEIM K., MACEO A., 2002: The Critical Stage of Friction Ridge and Pattern Formation. *Journal of Forensic Identification* 52: 35–85.

WISNIEWSKI A. B., ESPINOSA-VARAS B., ASTON C. E., EDMUNDSON S., CHAMPLIN C. A., PASANEN E. G., MCFADDEN D., 2014: Otoacoustic emissions, auditory evoked potentials and self-reported gender in people affected by disorders of sex development (DSD). *Hormones and Behavior* 66: 467–474. DOI: 10.1016/j.yhbeh.2014.07.004

Martin Čuta
Lenka Polcerová
Anna Škultétyová
Miroslav Králík*

Masaryk University
Faculty of Science, Department
of Anthropology
Brno, Czech Republic
E-mail: cuta@sci.muni.cz
E-mail: polcerova@muni.cz
E-mail: skultetyova@mail.muni.cz
E-mail: 18313@muni.cz

Ondřej Klíma
Pavel Zemčík
IT4Innovations Centre of Excellence,
Brno University of Technology, Brno,
Czech Republic
E-mail: iklima@fit.vutbr.cz
E-mail: zemcik@fit.vut.cz

*Corresponding author.

APPENDIX – TABLES

TABLE A1: Descriptive statistics and testing of sex differences of finger ridge counts in children (girls and boys) of the tested semilongitudinal sample; L1.RCr–R5.RCu – codes of ridge counts (L – left, R – right, 1 – first finger, 5 – fifth finger, r – radial side of the finger, u – ulnar side of the finger), N – number of valid cases, Mean – arithmetic mean, Median – median, SD – standard deviation, Med diff – difference between medians for boys and girls (boys minus girls), Mean diff – difference between means for boys and girls (boys minus girls), SMD – standardized mean difference or Cohen's d (Mean diff divided by pooled standard deviation); p-value – significance value of the sex difference tested by means of permutation test.

	BOYS				GIRLS							
ridge count	N	Mean	Median	SD	N	Mean	Median	SD	Med diff	Mean diff	SMD	p-value
L1.RCr	30	15.23	16.5	7.2	27	12.15	15	6.6	1.5	3.09	0.44	0.10
L1.RCu	30	5.07	0	7.4	27	3.89	0	8.0	0	1.18	0.15	0.57
L2.RCr	30	8.60	10.5	6.1	27	5.37	3	6.5	7.5	3.23	0.51	0.06
L2.RCu	30	5.27	0	7.6	27	3.63	0	5.9	0	1.64	0.24	0.38
L3.RCr	30	10.93	13.5	6.8	27	8.48	9	6.0	4.5	2.45	0.38	0.16
L3.RCu	30	1.80	0	4.4	27	1.04	0	4.3	0	0.76	0.17	0.56
L4.RCr	30	14.70	16.5	7.0	27	12.96	13	7.2	3.5	1.74	0.25	0.36
L4.RCu	30	4.40	0	6.3	27	2.81	0	6.6	0	1.59	0.24	0.37
L5.RCr	30	13.10	15	5.7	27	10.37	9	5.3	6	2.73	0.50	0.07
L5.RCu	30	1.87	0	3.8	27	0.74	0	2.7	0	1.13	0.35	0.23
R1.RCr	30	17.03	20	7.9	27	16.56	18	7.2	2	0.48	0.06	0.82
R1.RCu	30	7.63	5	8.1	27	6.81	0	8.6	5	0.82	0.10	0.72
R2.RCr	30	8.00	9.5	6.5	27	6.19	4	7.1	5.5	1.81	0.27	0.32
R2.RCu	30	6.37	0	8.4	27	3.22	0	6.6	0	3.14	0.42	0.13
R3.RCr	30	10.33	10.5	6.3	27	9.22	10	6.1	0.5	1.11	0.18	0.51
R3.RCu	30	1.50	0	4.1	27	0.74	0	3.7	0	0.76	0.20	0.51
R4.RCr	30	14.87	16.5	7.1	27	13.07	11	8.0	5.5	1.79	0.24	0.38
R4.RCu	30	5.30	1	6.6	27	2.96	0	6.0	1	2.34	0.37	0.17
R5.RCr	30	12.67	13.5	5.8	27	10.22	8	5.7	5.5	2.45	0.43	0.12
R5.RCu	30	1.80	0	3.6	27	1.41	0	3.7	0	0.39	0.11	0.69

TABLE A2: Descriptive statistics and testing of differences of finger ridge counts in mothers of children (mothers of girls and mothers of boys) of the tested semilongitudinal sample; L1.RCr–R5.RCu – codes of ridge counts (L – left, R – right, 1 – first finger, 5 – fifth finger, r – radial side of the finger, u – ulnar side of the finger), N – number of valid cases, Mean – arithmetic mean, Median – median, SD – standard deviation, Med diff – difference between medians for boys and girls (boys minus girls), Mean diff – difference between means for boys and girls (boys minus girls), SMD – standardized mean difference or Cohen's d (Mean diff divided by pooled standard deviation); p-value – significance value of the sex difference tested by means of permutation test.

	MOTHERS OF BOYS				MOTHERS OF GIRLS							
ridge count	N	Mean	Median	SD	N	Mean	Median	SD	Med diff	Mean diff	SMD	p-value
L1.RCr	22	14.91	16.5	5.5	18	16.39	18	5.9	-1.5	-1.48	-0.26	0.43
L1.RCu	22	1.82	0	5.1	18	4.89	0	7.4	0	-3.07	-0.49	0.1422
L2.RCr	22	8.91	13.5	7.1	18	10.00	12.5	7.8	1	-1.09	-0.15	0.6516
L2.RCu	22	7.59	2	8.7	18	8.61	6	8.3	-4	-1.02	-0.12	0.7072
L3.RCr	22	12.23	13.5	5.6	18	12.78	14	5.2	-0.5	-0.55	-0.10	0.7705
L3.RCu	22	0.50	0	2.3	18	2.67	0	6.4	0	-2.17	-0.50	0.2117
L4.RCr	22	15.50	16.5	5.8	18	16.06	17	5.6	-0.5	-0.56	-0.10	0.7839
L4.RCu	22	4.41	0	6.3	18	4.83	1	6.4	-1	-0.42	-0.07	0.8411
L5.RCr	22	13.14	15.5	5.6	18	13.39	15	5.2	0.5	-0.25	-0.05	0.9072
L5.RCu	22	0.00	0	0.0	18	0.94	0	2.8	0	-0.94	-0.69	0.1962
R1.RCr	22	18.18	19	6.3	18	17.78	19	5.5	0	0.40	0.07	0.8564
R1.RCu	22	3.23	0	6.4	18	6.44	0	9.1	0	-3.22	-0.41	0.2037
R2.RCr	22	7.23	6	6.9	18	8.17	9.5	7.2	-3.5	-0.94	-0.13	0.6837
R2.RCu	22	7.64	4	8.8	18	9.00	8.5	9.0	-4.5	-1.36	-0.15	0.6421
R3.RCr	22	12.00	12.5	6.9	18	13.11	13.5	5.6	-1	-1.11	-0.18	0.601
R3.RCu	22	0.95	0	2.8	18	2.17	0	5.3	0	-1.21	-0.30	0.4259
R4.RCr	22	15.86	18	5.8	18	17.17	18	5.3	0	-1.30	-0.23	0.4806
R4.RCu	22	3.77	0	5.3	18	4.50	0	6.9	0	-0.73	-0.12	0.7159
R5.RCr	22	13.09	14.5	5.6	18	13.61	16.5	6.1	-2	-0.52	-0.09	0.7852
R5.RCu	22	0.95	0	3.1	18	1.11	0	3.2	0	-0.16	-0.05	0.8711

TABLE A3: Descriptive statistics and sex differences of finger ridge count contrasts on the right hand in children (boys and girls of the tested semilongitudinal sample; R1rR1u–R5rR5u – codes of ridge count contrast (R – right, 1 – first finger, 5 – fifth finger, r – radial side of the finger, u – ulnar side of the finger), N – number of valid cases, Mean – arithmetic mean, Median – median, SD – standard deviation, Med diff – difference between medians for boys and girls (boys minus girls), Mean diff – difference between means for boys and girls (boys minus girls), SMD – standardized mean difference or Cohen's d (Mean diff divided by pooled standard deviation).

	BOYS				GIRLS						
Contrasts	**N**	**Mean**	**Median**	**SD**	**N**	**Mean**	**Median**	**SD**	**Med diff**	**Mean diff**	**SMD**
R1rR1u	27	9.74	9	9.5	30	9.40	9.5	6.4	-0.5	0.34	0.04
R1rR2r	27	10.37	9	8.3	30	9.03	8	7.1	1	1.34	0.17
R1rR2u	27	13.33	17	9.7	30	10.67	9.5	9.2	7.5	2.67	0.28
R1rR3r	27	7.33	8	6.8	30	6.70	6	5.6	2	0.63	0.10
R1rR3u	27	15.82	18	7.7	30	15.53	17	8.4	1	0.28	0.04
R1rR4r	27	3.48	1	8.4	30	2.17	2.5	6.2	-1.5	1.31	0.18
R1rR4u	27	13.59	15	8.3	30	11.73	11.5	7.5	3.5	1.86	0.24
R1rR5r	27	6.33	8	7.0	30	4.37	4	5.9	4	1.97	0.30
R1rR5u	27	15.15	18	8.2	30	15.23	15.5	7.8	2.5	-0.09	-0.01
R1uR2r	27	0.63	0	10.8	30	-0.37	0	8.9	0	1.00	0.10
R1uR2u	27	3.59	0	9.7	30	1.27	0	9.2	0	2.33	0.25
R1uR3r	27	-2.41	-3	8.7	30	-2.70	-1	7.8	-2	0.29	0.04
R1uR3u	27	6.07	0	7.9	30	6.13	0	8.4	0	-0.06	-0.01
R1uR4r	27	-6.26	-9	8.5	30	-7.23	-7	7.1	-2	0.97	0.12
R1uR4u	27	3.85	0	7.5	30	2.33	0	9.2	0	1.52	0.18
R1uR5r	27	-3.41	-7	6.2	30	-5.03	-4.5	6.9	-2.5	1.63	0.25
R1uR5u	27	5.41	0	8.5	30	5.83	0	8.2	0	-0.43	-0.05
R2rR2u	27	2.96	2	8.0	30	1.63	1.5	9.9	0.5	1.33	0.15
R2rR3r	27	-3.04	-3	6.4	30	-2.33	-1	4.8	-2	-0.70	-0.13
R2rR3u	27	5.44	2	7.2	30	6.50	7.5	7.0	-5.5	-1.06	-0.15
R2rR4r	27	-6.89	-6	8.6	30	-6.87	-7.5	7.9	1.5	-0.02	0.00
R2rR4u	27	3.22	2	9.0	30	2.70	0.5	6.5	1.5	0.52	0.07
R2rR5r	27	-4.04	-4	7.1	30	-4.67	-4	6.2	0	0.63	0.09
R2rR5u	27	4.78	3	8.2	30	6.20	5	5.5	-2	-1.42	-0.21
R2uR3r	27	-6.00	-5	6.4	30	-3.97	-2.5	9.2	-2.5	-2.03	-0.26
R2uR3u	27	2.48	0	5.5	30	4.87	0	7.7	0	-2.39	-0.36
R2uR4r	27	-9.85	-9	8.6	30	-8.50	-5	8.8	-4	-1.35	-0.16
R2uR4u	27	0.26	0	6.4	30	1.07	0	8.5	0	-0.81	-0.11
R2uR5r	27	-7.00	-7	7.5	30	-6.30	-5	7.1	-2	-0.70	-0.10
R2uR5u	27	1.81	0	4.5	30	4.57	0	8.6	0	-2.75	-0.42
R3rR3u	27	8.48	8	5.7	30	8.83	9.5	7.3	-1.5	-0.35	-0.05
R3rR4r	27	-3.85	-4	5.8	30	-4.53	-5	6.1	1	0.68	0.11
R3rR4u	27	6.26	5	5.2	30	5.03	5.5	6.3	-0.5	1.23	0.21
R3rR5r	27	-1.00	-1	5.4	30	-2.33	-3	4.5	2	1.33	0.27
R3rR5u	27	7.81	7	5.9	30	8.53	8	6.2	-1	-0.72	-0.12
R3uR4r	27	-12.33	-10	7.9	30	-13.37	-15	7.6	5	1.03	0.13
R3uR4u	27	-2.22	0	5.5	30	-3.80	0	6.3	0	1.58	0.27
R3uR5r	27	-9.48	-8	5.6	30	-11.17	-12	6.0	4	1.69	0.29
R3uR5u	27	-0.67	0	3.4	30	-0.30	0	3.4	0	-0.37	-0.11
R4rR4u	27	10.11	9	7.0	30	9.57	9	7.2	0	0.54	0.08
R4rR5r	27	2.85	4	5.8	30	2.20	2	3.9	2	0.65	0.13
R4rR5u	27	11.67	10	8.4	30	13.07	13.5	7.1	-3.5	-1.40	-0.18
R4uR5r	27	-7.26	-7	5.8	30	-7.37	-8	5.6	1	0.11	0.02
R4uR5u	27	1.56	0	4.6	30	3.50	0	5.0	0	-1.94	-0.41
R5rR5u	27	8.81	8	6.4	30	10.87	9	5.8	-1	-2.05	-0.34

TABLE A4: Descriptive statistics and sex differences of finger ridge count contrasts on the left hand in children (boys and girls of the tested semilongitudinal sample; L1rL1u–L5rL5u – codes of ridge count contrast (L –left, 1 – first finger, 5 – fifth finger, r – radial side of the finger, u – ulnar side of the finger), N – number of valid cases, Mean – arithmetic mean, Median – median, SD – standard deviation, Med diff – difference between medians for boys and girls (boys minus girls), Mean diff – difference between means for boys and girls (boys minus girls), SMD – standardized mean difference or Cohen's d (Mean diff divided by pooled standard deviation).

	BOYS				GIRLS						
Contrasts	N	Mean	Median	SD	N	Mean	Median	SD	Med diff	Mean diff	SMD
L1rL1u	27	8.26	9	9.2	30	10.17	12	9.0	-3	-1.91	-0.21
L1rL2r	27	6.78	6	7.4	30	6.63	6	6.6	0	0.14	0.02
L1rL2u	27	8.52	9	7.7	30	9.97	12.5	9.0	-3.5	-1.45	-0.17
L1rL3r	27	3.67	3	5.7	30	4.30	4.5	5.2	-1.5	-0.63	-0.12
L1rL3u	27	11.11	13	7.1	30	13.43	15	7.2	-2	-2.32	-0.32
L1rL4r	27	-0.81	-2	7.4	30	0.53	0	5.7	-2	-1.35	-0.21
L1rL4u	27	9.33	11	8.2	30	10.83	11	7.0	0	-1.50	-0.20
L1rL5r	27	1.78	1	6.0	30	2.13	3	4.6	-2	-0.36	-0.07
L1rL5u	27	11.41	13	6.8	30	13.37	14.5	7.0	-1.5	-1.96	-0.28
L1uL2r	27	-1.48	0	10.0	30	-3.53	-3	6.9	3	2.05	0.24
L1uL2u	27	0.26	0	8.9	30	-0.20	0	7.1	0	0.46	0.06
L1uL3r	27	-4.59	-5	8.5	30	-5.87	-5.5	8.4	0.5	1.27	0.15
L1uL3u	27	2.85	0	9.6	30	3.27	0	7.7	0	-0.41	-0.05
L1uL4r	27	-9.07	-8	9.5	30	-9.63	-9.5	8.0	1.5	0.56	0.06
L1uL4u	27	1.07	0	9.7	30	0.67	0	7.8	0	0.41	0.05
L1uL5r	27	-6.48	-7	6.7	30	-8.03	-8.5	7.7	1.5	1.55	0.22
L1uL5u	27	3.15	0	7.1	30	3.20	0	9.4	0	-0.05	-0.01
L2rL2u	27	1.74	1	7.9	30	3.33	1.5	7.3	-0.5	-1.59	-0.21
L2rL3r	27	-3.11	-2	6.8	30	-2.33	-3	6.0	1	-0.78	-0.12
L2rL3u	27	4.33	2	5.8	30	6.80	7	6.4	-5	-2.47	-0.40
L2rL4r	27	-7.59	-7	5.9	30	-6.10	-5	7.1	-2	-1.49	-0.23
L2rL4u	27	2.56	0	5.5	30	4.20	2.5	6.9	-2.5	-1.64	-0.27
L2rL5r	27	-5.00	-5	6.0	30	-4.50	-4	5.5	-1	-0.50	-0.09
L2rL5u	27	4.63	2	7.0	30	6.73	6	7.1	-4	-2.10	-0.30
L2uL3r	27	-4.85	-5	5.9	30	-5.67	-3.5	8.0	-1.5	0.81	0.12
L2uL3u	27	2.59	0	6.0	30	3.47	0	7.1	0	-0.87	-0.13
L2uL4r	27	-9.33	-8	7.3	30	-9.43	-9.5	7.7	1.5	0.10	0.01
L2uL4u	27	0.81	0	7.1	30	0.87	0	7.3	0	-0.05	-0.01
L2uL5r	27	-6.74	-7	6.6	30	-7.83	-11	7.5	4	1.09	0.15
L2uL5u	27	2.89	0	5.7	30	3.40	0	9.0	0	-0.51	-0.07
L3rL3u	27	7.44	8	6.0	30	9.13	12	8.0	-4	-1.69	-0.24
L3rL4r	27	-4.48	-5	4.6	30	-3.77	-2.5	5.0	-2.5	-0.71	-0.15
L3rL4u	27	5.67	7	6.3	30	6.53	6.5	7.0	0.5	-0.87	-0.13
L3rL5r	27	-1.89	-1	4.4	30	-2.17	-2	4.5	1	0.28	0.06
L3rL5u	27	7.74	8	6.2	30	9.07	11	7.0	-3	-1.33	-0.20
L3uL4r	27	-11.93	-12	7.5	30	-12.90	-15	7.8	3	0.97	0.13
L3uL4u	27	-1.78	0	6.6	30	-2.60	0	5.8	0	0.82	0.13
L3uL5r	27	-9.33	-8	5.9	30	-11.30	-14	6.5	6	1.97	0.32
L3uL5u	27	0.30	0	5.2	30	-0.07	0	5.3	0	0.36	0.07
L4rL4u	27	10.15	8	6.1	30	10.30	10.5	7.9	-2.5	-0.15	-0.02
L4rL5r	27	2.59	2	5.3	30	1.60	2	4.3	0	0.99	0.21
L4rL5u	27	12.22	12	7.6	30	12.83	14	7.9	-2	-0.61	-0.08
L4uL5r	27	-7.56	-8	6.1	30	-8.70	-7	6.1	-1	1.14	0.19
L4uL5u	27	2.07	0	6.5	30	2.53	0	6.6	0	-0.46	-0.07
L5rL5u	27	9.63	8	5.6	30	11.23	12.5	5.9	-4.5	-1.60	-0.28

TABLE A5: Descriptive statistics and sex differences of finger ridge count contrasts on the right hand in mothers of children (mothers of boys and mothers of girls) of the tested semilongitudinal sample; R1rR1u–R5rR5u – codes of ridge count contrast (R –right, 1 – first finger, 5 – fifth finger, r – radial side of the finger, u – ulnar side of the finger), N – number of valid cases, Mean – arithmetic mean, Median – median, SD – standard deviation, Med diff – difference between medians for boys and girls (boys minus girls), Mean diff – difference between means for boys and girls (boys minus girls), SMD – standardized mean difference or Cohen's d (Mean diff divided by pooled standard deviation).

	MOTHERS OF BOYS				MOTHERS OF GIRLS						
Contrasts	**N**	**Mean**	**Median**	**SD**	**N**	**Mean**	**Median**	**SD**	**Med diff**	**Mean diff**	**SMD**
R1rR1u	22	14.95	17	8.6	18	11.33	15.5	9.5	1.5	3.62	0.40
R1rR2r	22	10.95	8	8.5	18	9.61	8	7.8	0	1.34	0.16
R1rR2u	22	10.55	14	9.3	18	8.78	7	7.9	7	1.77	0.21
R1rR3r	22	6.18	5	6.6	18	4.67	4	4.0	1	1.52	0.29
R1rR3u	22	17.23	18.5	6.4	18	15.61	17.5	5.9	1	1.62	0.26
R1rR4r	22	2.32	3	5.8	18	0.61	1	4.0	2	1.71	0.35
R1rR4u	22	14.41	15	7.7	18	13.28	16	7.9	-1	1.13	0.15
R1rR5r	22	5.09	6	4.5	18	4.17	3	4.5	3	0.92	0.20
R1rR5u	22	17.23	19	6.4	18	16.67	18.5	6.2	0.5	0.56	0.09
R1uR2r	22	-4.00	-3.5	9.7	18	-1.72	-1	11.9	-2.5	-2.28	-0.21
R1uR2u	22	-4.41	0	6.9	18	-2.56	0	9.3	0	-1.85	-0.23
R1uR3r	22	-8.77	-10.5	9.8	18	-6.67	-9	9.3	-1.5	-2.11	-0.22
R1uR3u	22	2.27	0	6.9	18	4.28	0	9.9	0	-2.01	-0.24
R1uR4r	22	-12.64	-16.5	8.6	18	-10.72	-15	9.1	-1.5	-1.91	-0.22
R1uR4u	22	-0.55	0	4.4	18	1.94	0	9.9	0	-2.49	-0.35
R1uR5r	22	-9.86	-13.5	7.4	18	-7.17	-3.5	8.8	-10	-2.70	-0.33
R1uR5u	22	2.27	0	5.3	18	5.33	0	9.1	0	-3.06	-0.42
R2rR2u	22	-0.41	0.5	11.5	18	-0.83	-1.5	11.7	2	0.42	0.04
R2rR3r	22	-4.77	-1.5	8.7	18	-4.94	-2	7.1	0.5	0.17	0.02
R2rR3u	22	6.27	6	6.4	18	6.00	4	6.7	2	0.27	0.04
R2rR4r	22	-8.64	-8	7.8	18	-9.00	-9	8.1	1	0.36	0.05
R2rR4u	22	3.45	3.5	7.3	18	3.67	0	6.0	3.5	-0.21	-0.03
R2rR5r	22	-5.86	-4.5	8.0	18	-5.44	-5.5	9.1	1	-0.42	-0.05
R2rR5u	22	6.27	6	8.5	18	7.06	5.5	7.1	0.5	-0.78	-0.10
R2uR3r	22	-4.36	-5.5	9.7	18	-4.11	0	8.6	-5.5	-0.25	-0.03
R2uR3u	22	6.68	4	7.7	18	6.83	4.5	7.8	-0.5	-0.15	-0.02
R2uR4r	22	-8.23	-10	8.8	18	-8.17	-6	7.9	-4	-0.06	-0.01
R2uR4u	22	3.86	0.5	7.1	18	4.50	1.5	9.0	-1	-0.64	-0.08
R2uR5r	22	-5.45	-5	8.2	18	-4.61	-3.5	8.1	-1.5	-0.84	-0.10
R2uR5u	22	6.68	3.5	8.0	18	7.89	8.5	9.5	-5	-1.21	-0.14
R3rR3u	22	11.05	10.5	7.2	18	10.94	13	6.5	-2.5	0.10	0.01
R3rR4r	22	-3.86	-3	4.1	18	-4.06	-3.5	3.9	0.5	0.19	0.05
R3rR4u	22	8.23	9	8.3	18	8.61	10.5	6.7	-1.5	-0.38	-0.05
R3rR5r	22	-1.09	0.5	6.1	18	-0.50	-1.5	5.6	2	-0.59	-0.10
R3rR5u	22	11.05	11.5	7.9	18	12.00	13	6.1	-1.5	-0.95	-0.14
R3uR4r	22	-14.91	-17.5	6.2	18	-15.00	-15.5	6.2	-2	0.09	0.01
R3uR4u	22	-2.82	0	5.4	18	-2.33	0	5.8	0	-0.48	-0.09
R3uR5r	22	-12.14	-14	5.6	18	-11.44	-13.5	6.5	-0.5	-0.69	-0.11
R3uR5u	22	0.00	0	4.2	18	1.06	0	5.5	0	-1.06	-0.22
R4rR4u	22	12.09	12.5	7.7	18	12.67	15	6.7	-2.5	-0.58	-0.08
R4rR5r	22	2.77	3.5	4.3	18	3.56	3	4.0	0.5	-0.78	-0.19
R4rR5u	22	14.91	17.5	7.0	18	16.06	16.5	6.1	1	-1.15	-0.17
R4uR5r	22	-9.32	-8	6.9	18	-9.11	-10	7.7	2	-0.21	-0.03
R4uR5u	22	2.82	0	4.5	18	3.39	0	6.8	0	-0.57	-0.10
R5rR5u	22	12.14	14	6.1	18	12.50	15.5	6.3	-1.5	-0.36	-0.06

TABLE A6: Descriptive statistics and sex differences of finger ridge count contrasts on the left hand in mothers of children (mothers of boys and mothers of girls) of the tested semilongitudinal sample; L1rL1u–L5rL5u – codes of ridge count contrast (L – left, 1 – first finger, 5 – fifth finger, r – radial side of the finger, u – ulnar side of the finger), N – number of valid cases, Mean – arithmetic mean, Median – median, SD – standard deviation, Med diff – difference between medians for boys and girls (boys minus girls), Mean diff – difference between means for boys and girls (boys minus girls), SMD – standardized mean difference or Cohen's d (Mean diff divided by pooled standard deviation).

	MOTHERS OF BOYS				MOTHERS OF GIRLS						
Contrasts	**N**	**Mean**	**Median**	**SD**	**N**	**Mean**	**Median**	**SD**	**Med diff**	**Mean diff**	**SMD**
L1rL1u	22	13.09	15.5	6.9	18	11.50	12	6.9	3.5	1.59	0.23
L1rL2r	22	6.00	4	6.7	18	6.39	4	7.2	0	-0.39	-0.06
L1rL2u	22	7.32	9	7.5	18	7.78	9	8.3	0	-0.46	-0.06
L1rL3r	22	2.68	1.5	5.0	18	3.61	4.5	4.0	-3	-0.93	-0.21
L1rL3u	22	14.41	15.5	5.7	18	13.72	16.5	7.6	-1	0.69	0.10
L1rL4r	22	-0.59	-1.5	4.9	18	0.33	1.5	4.8	-3	-0.92	-0.19
L1rL4u	22	10.50	12	6.5	18	11.56	14.5	8.1	-2.5	-1.06	-0.14
L1rL5r	22	1.77	0	4.7	18	3.00	4	5.7	-4	-1.23	-0.24
L1rL5u	22	14.91	16.5	5.5	18	15.44	18	6.8	-1.5	-0.54	-0.09
L1uL2r	22	-7.09	-8	8.0	18	-5.11	-3	10.2	-5	-1.98	-0.22
L1uL2u	22	-5.77	-0.5	8.0	18	-3.72	-2	7.8	1.5	-2.05	-0.26
L1uL3r	22	-10.41	-11	6.4	18	-7.89	-7	6.9	-4	-2.52	-0.38
L1uL3u	22	1.32	0	3.5	18	2.22	0	7.9	0	-0.90	-0.16
L1uL4r	22	-13.68	-16	6.5	18	-11.17	-12.5	7.3	-3.5	-2.52	-0.37
L1uL4u	22	-2.59	0	6.8	18	0.06	0	7.9	0	-2.65	-0.36
L1uL5r	22	-11.32	-13	7.0	18	-8.50	-6.5	7.1	-6.5	-2.82	-0.40
L1uL5u	22	1.82	0	5.1	18	3.94	0	7.4	0	-2.13	-0.34
L2rL2u	22	1.32	-0.5	9.3	18	1.39	0	11.8	-0.5	-0.07	-0.01
L2rL3r	22	-3.32	-3.5	4.2	18	-2.78	-1.5	6.0	-2	-0.54	-0.11
L2rL3u	22	8.41	12.5	7.0	18	7.33	8	8.4	4.5	1.08	0.14
L2rL4r	22	-6.59	-7	5.6	18	-6.06	-5.5	6.9	-1.5	-0.54	-0.09
L2rL4u	22	4.50	2	9.0	18	5.17	5	9.2	-3	-0.67	-0.07
L2rL5r	22	-4.23	-4	4.5	18	-3.39	-3.5	8.5	-0.5	-0.84	-0.13
L2rL5u	22	8.91	13.5	7.1	18	9.06	12	8.0	1.5	-0.15	-0.02
L2uL3r	22	-4.64	-4	9.2	18	-4.17	-1.5	8.4	-2.5	-0.47	-0.05
L2uL3u	22	7.09	2	8.1	18	5.94	3	7.4	-1	1.15	0.15
L2uL4r	22	-7.91	-6	8.9	18	-7.44	-6	7.6	0	-0.46	-0.06
L2uL4u	22	3.18	2	6.8	18	3.78	0.5	7.1	1.5	-0.60	-0.09
L2uL5r	22	-5.55	-2	8.9	18	-4.78	-3	7.7	1	-0.77	-0.09
L2uL5u	22	7.59	2	8.7	18	7.67	4	8.2	-2	-0.08	-0.01
L3rL3u	22	11.73	12	5.3	18	10.11	11	5.8	1	1.62	0.29
L3rL4r	22	-3.27	-3	4.0	18	-3.28	-3	3.3	0	0.01	0.00
L3rL4u	22	7.82	6	7.5	18	7.94	8.5	6.5	-2.5	-0.13	-0.02
L3rL5r	22	-0.91	-1	3.6	18	-0.61	-1	4.6	0	-0.30	-0.07
L3rL5u	22	12.23	13.5	5.6	18	11.83	12.5	5.4	1	0.39	0.07
L3uL4r	22	-15.00	-16	5.2	18	-13.39	-16.5	6.8	0.5	-1.61	-0.27
L3uL4u	22	-3.91	0	5.7	18	-2.17	0	4.2	0	-1.74	-0.35
L3uL5r	22	-12.64	-14	5.6	18	-10.72	-12.5	6.4	-1.5	-1.91	-0.32
L3uL5u	22	0.50	0	2.3	18	1.72	0	6.0	0	-1.22	-0.29
L4rL4u	22	11.09	11.5	6.8	18	11.22	12	6.4	-0.5	-0.13	-0.02
L4rL5r	22	2.36	2	3.8	18	2.67	1.5	4.3	0.5	-0.30	-0.07
L4rL5u	22	15.50	16.5	5.8	18	15.11	17	6.2	-0.5	0.39	0.06
L4uL5r	22	-8.73	-5.5	7.4	18	-8.56	-8	7.4	2.5	-0.17	-0.02
L4uL5u	22	4.41	0	6.3	18	3.89	0	6.2	0	0.52	0.08
L5rL5u	22	13.14	15.5	5.6	18	12.44	13	5.4	2.5	0.69	0.13

TABLE A7: Results of nonparametric tests of position ("equality") and direction ("parallelism") of nonlinear relationships (dermatoglyphic variables vs. APV) between curves for boys and girls. Tested relationships correspond to those visualized in the Figure 4. The nonparametric test of the nonlinear models of these relationships rejected the identity of the curves for girls and boys, but in none of these cases did it reject the identity of the direction (parallelism test) of the two curves. Significance codes: '****' 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

Continuous variable	**Mot.R4rR4u**	Continuous variable	**Mot.R2uR5r**	Continuous variable	**Mot.R1rR5r**
Response	**APV**	Response	**APV**	Response	**APV**
	p-value		**p-value**		**p-value**
Test of equality	0.0077 **	Test of equality	0.0070 **	Test of equality	0.0078 **
Test of paralellism	0.17	Test of paralellism	0.65	Test of paralellism	0.77

Continuous variable	**Mot.L4rL4u**	Continuous variable	**Mot.L2uL5r**	Continuous variable	**L2rL5r**
Response	**APV**	Response	**APV**	Response	**APV**
	p-value		**p-value**		**p-value**
Test of equality	0.0078 **	Test of equality	0.0082 **	Test of equality	0.0018 **
Test of paralellism	0.13	Test of paralellism	0.26	Test of paralellism	0.30

TABLE A8: Results of nonparametric tests of position ("equality") and direction ("parallelism") of nonlinear relationships (L4uL5r vs. all growth milestones) between curves for boys and girls. Tested relationships correspond to those visualized in the Figure 5. Not only the nonparametric test of the nonlinear models of these relationships rejected the identity of the curves for girls and boys, but for the age and velocity parameters (APV, ATO, VPV, and VTO) nonlinear trends for boy and girls significantly differed, but not for the height parameters. Significance codes: '****' 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

Continuous variable	**L4uL5r**	Continuous variable	**L4uL5r**	Continuous variable	**L4uL5r**
Response	**APV**	Response	**VPV**	Response	**HPV**
	p-value		**p-value**		**p-value**
Test of equality	0.0022 **	Test of equality	0.0022 **	Test of equality	0.0023 **
Test of paralellism	0.0077 **	Test of paralellism	0.0077 **	Test of paralellism	0.17

Continuous variable	**L4uL5r**	Continuous variable	**L4uL5r**	Continuous variable	**L4uL5r**
Response	**ATO**	Response	**VTO**	Response	**HTO**
	p-value		**p-value**		**p-value**
Test of equality	0.0022 **	Test of equality	0.0022 **	Test of equality	0.0027 **
Test of paralellism	0.0095 **	Test of paralellism	0.0095 **	Test of paralellism	0.11