Dermatoglyphic patterns, very low birth weight, and blood pressure in adolescence

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Abstract

***Aims*—To test the null hypotheses that finger and palm prints have no relation with fetal growth or adolescent blood pressure.**

***Methods*—All 128 singleton, unimpaired, very low birth weight (VLBW; ≤1500 g) infants born to mothers resident in the county of Merseyside in 1980 and 1981 were studied retospectively. The comparison group consisted of 128 age, sex, and school matched children. Main outcome measures were blood pressure at age 15 years, birth weight ratio, fingerprint patterns, and palmar AtD angles.**

***Results*—The VLBW index population had a significantly higher systolic blood pressure than the comparison group (mean difference 3.2 mm Hg). The difference in diastolic blood pressure between the VLBW index and the matched comparison group was not significant. No significant differences were found in the palmar AtD angles or in the fingerprint proportions of arches, loops, and whorls and no correlation was found between fingerprint patterns and blood pressure. Among the VLBW index population, both height and right palmar AtD angle were independently and significantly correlated with and explained 12.1% of the variance in the systolic blood pressure. Birth weight ratio, as a measure of fetal growth restriction, had no significant correlation with systolic blood pressure.**

***Conclusions*—The higher systolic blood pressure of adolescents who were of very low birth weight compared with the matched comparison group is not associated with fingerprint patterns or birth weight ratio as markers for fetal growth restriction.**

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Keywords: dermatoglyphic pattern; finger print; palm print; growth; blood pressure; adolescent

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Dermatoglyphic patterns in the hand are usually laid down between the tenth and eighteenth weeks of gestation. Once laid down, they remain unchanged except for an increase in size in parallel with general growth.[1 2] In clinical medicine, chromosomal anomalies such as the trisomies 13–15 (Patau's syndrome), 18 (Edwards' syndrome), 21 (Down's syndrome), and the sex chromosomes (Turner's syndrome X0 and Kleinfelter's syndrome 47,XXY) and deletion of the short arm of chromosome 5 (Cri du Chat syndrome) are recognised as having abnormal dermatoglyphic patterns.[3] Differences in fingerprint pattern frequencies from normal controls have also been found in leukaemia,[4] early onset diabetes mellitus,[5–8] alopecia areata,[9] atopic dermatitis,[10] rubella embryopathy,[11 12] and chronic intestinal pseudoobstruction.[13] These observations suggested that hereditary or environmental factors, acting in early gestation, may have played a role in the genesis of the disease.

More recently, an examination of dermatoglyphic patterns and blood pressure in an adult population concluded that fingertip whorls and a narrow palmar angle are indelible markers of impaired fetal development at different stages of pregnancy and that both were associated with raised blood pressure in adult life.[14] This was used as evidence supporting the hypothesis that raised adult blood pressure had its origin in environmental factors acting during early fetal development. The hypothesis is controversial; the interpretation of the study data has been criticised,[15 16] and other work has not confirmed the initial observation.[17]

The objective of this study is to test the null hypothesis that there is no association of fingerprint patterns and hand palmar angles with birth weight or blood pressure in adolescence.

Methods

A cohort study of a population of very low birth weight (VLBW) infants and a matched comparison group was carried out.

The VLBW index population was obtained from birth notifications and comprised all infants of birth weight 1500 g or less born in 1980 and 1981, to mothers whose place of residence at the time of the birth was the county of Merseyside. The obstetric and neonatal records were abstracted for demographic and clinical details of mother and birth weight of the child. The children were examined at age 3 years[18] and again at age 8 years[19] to determine the prevalence of clinical disability. At the 8 year follow up of the index population, for those children attending normal school, an age and sex matched comparison from the same school was also assessed.

The children were reassessed when aged 15 years with the same comparison group as at the 8 year follow up. The children now have moved from primary to secondary schools and in some instances the index children and their matched comparison children were at different secondary schools. If the original comparison child from primary school was not available, a new comparison child of the same sex, in the same

class at secondary school, and nearest in birth date to the index child was selected.

SURVEY MEASURES

All the assessments were carried out by one examiner (CJS) either at school or in the home. Blood pressure was measured in the left arm after being seated for approximately 15 minutes. Three blood pressure readings were made at one minute intervals using a Dinamap 1846SX automated oscillometric monitor and using a small adult size cuff. The last of the three readings of systolic and the diastolic blood pressure was used in the analysis. The Dinamap was calibrated and serviced at six monthly intervals. Height was measured using a portable stadiometer (the Leicester Height Measure), to the nearest 0.5 cm, with the child standing on a firm level surface. Weight was measured to the nearest 0.5 kg, with the child lightly clothed, using SECA Patient Scales.

The researcher received training from the Merseyside Police Department to take fingerprints using standard methods. Printer's ink and a good quality printing paper were used. A small quantity of ink was placed on an inking slab and spread with a roller into a thin, even film. Each fingertip was pressed against the ink slab, and the palms coated with a thin film of ink. Prints were then taken of the palms and of the individual digits on each hand.

The classification of the fingerprints is based on the recognition of the triradii. A triradius is defined as the meeting place of three dermal lines that make angles of approximately 120° with one another. Galton's original classification recognised three basic patterns of fingerprint: the whorl has two triradii, the loop has one lateral triradius, and the arch has no triradii.[20] Each of these basic patterns may be subclassified into: simple; central pocket; double loop and accidental whorls; ulnar or a radial loop; and simple or tented arches. However, for this analysis, only the three basic fingerprint patterns of arches, loops, and whorls have been used.

Triradii are also present on the palm of the hand. Typically there are four distal triradii over the metacarpal region at the base of the index, middle, ring, and little fingers labelled as A, B, C, and D respectively. There are also usually one or more axial triradii on the palm. The axial triradius proximal to the palmar margin is labelled t. The more distal axial triradii, if present, are labelled progressively t' and t".

The finger and palm prints were scanned into a computer and the dermatoglyphic analysis was made using the computer program Dermaglyph 2.1.[21] This computed the measurement of the palmar axial triradii AtD, At'D, and At"D angles.

EXCLUSIONS FROM THE COHORT

All children with disabilities were excluded because cerebral palsy and chromosomal anomalies were the most common diagnoses among the disabled children and these impairments are known to be associated with abnormal dermatoglyphic patterns. All twins and their matched controls were also excluded because of the possible bias that could be introduced as a result of concordance of dermatoglyphic patterns among twin pairs. The results therefore include all non-disabled singletons of birth weight ⩽1500 g, born to mothers resident in the county of Merseyside in 1980 and 1981 and their age, sex, and school matched comparison children.

STATISTICAL METHODS

A matched pairs or unmatched pairs *t* test was used as appropriate. A χ^2 test with 2 degrees of freedom was applied to the comparison of fingerprint patterns between index and comparison groups. To examine the association of systolic and diastolic blood pressure and the proportions of arches, loops, and whorls in both hands, the non-parametric Spearman's correlation coefficient was determined. The association of systolic blood pressure as the dependent variable and height, AtD angle, birth weight ratio, and gestational age was examined using computer software (SPSS 9.0).

Results

There were 40 321 live births in Merseyside in 1980–81; 399 were of birth weight ⩽1500 g of whom 219 survived to age 15 years. Of the 219 survivors, 10 of the index cases refused assessment, were abroad, or could not be traced. Forty seven children from twin pregnancies and 34 children with clinical disability were excluded, leaving 128 children that comprised the index cohort, each with an age, sex, and school matched comparison child.

The mean birth weight of the 128 index children was 1249 g (range 630–1500 g) and for the comparison children was 3338 g (range 2098–4550 g). The gestational age of the index children ranged from 26 to 37 weeks with a mean of 30.7 weeks. Data on the gestational age of the controls were not obtained but the mean and range of birth weight indicate that the great majority must have been term infants.

DIFFERENCES IN BLOOD PRESSURE BETWEEN INDEX AND COMPARISON GROUPS

The mean systolic blood pressure of the index group was 114.7 (SD 12.8) and of the comparison group was 111.5 (SD 10.6) mm Hg. The mean of the differences between index and comparison groups was 3.2 (95% confidence interval (CI) 0.4 to 6.0; $p < 0.05$).

The mean diastolic blood pressure of the index group was 59.4 (SD 8.2) and of the comparison group was 58.3 (SD 7.5) mm Hg. The mean of the differences between index and comparison groups was 1.1 (95% CI –0.7 to +2.9). This difference is not statistically significant.

AtD ANGLES IN INDEX AND COMPARISON GROUPS

The AtD and the At'D angles were not significantly different between or within index and comparison groups for either the right or the left hand (table 1). For this cohort, it has been shown previously that the comparison group was 4.0 cm taller than the index children.[22]

Table 1 Comparison of AtD angles in index and comparison children

	AtD angle		Difference between means in index and comparison group (95% CI)
	Index children	Comparison children	
Right hand			
AtD	40.9 (7.1); n = 128	39.8 (5.1); n = 128	1.2 (−0.3 to 2.6); NS
At'D	54.5 (10.4); n = 13	56.4 (8.1); n = 20	−1.9 (−8.5 to 4.7); NS
At"D	49.9 (4.2); n = 3	54.3 (11.3); n = 2	Not appropriate
Left hand			
AtD	40.8 (6.9); n = 126*	40.4 (5.3); n = 128	0.4 (−1.2 to 2.0); NS
At'D	51.4 (8.1); n = 11	53.3 (9.1); n = 14	−2.0 (−9.2 to 5.3); NS
At"D	49.1 (–); n=1	Not applicable; n = 0	Not appropriate

Results expressed as mean (SD); n = number of observations.
*In two cases, a satisfactory palm print was not obtained.
NS, not significant.

Therefore, the possibility that height may be a confounding variable in the comparison of AtD angles was considered. As an examination of the association between height and AtD angle showed no statistically significant correlation, adjustment of the AtD angle for height was not carried out.

FINGERPRINT PATTERNS IN INDEX AND COMPARISON GROUPS

The analysis of the combined fingerprint patterns of all ten digits showed no statistically significant difference between index and comparison groups for any of the digits or for the combined total of all ten digits (table 2). For both index and control groups, there was a notable degree of concordance in the proportions of arches, loops, and whorls when the digits of the right and left hands were compared.

To examine the representativeness of the index and comparison populations, comparison was made with the fingerprint patterns reported nationally[23 24] and from Preston, Lancashire.[14] No statistically significant differences were found for any of the comparisons.

CORRELATION OF FINGERPRINT PATTERNS WITH BLOOD PRESSURE

No statistically significant correlations were observed among either the index or comparison populations (table 3).

CORRELATION OF PALMAR ANGLES WITH BLOOD PRESSURE

We have shown previously, in this cohort of index VLBW children and the comparison group, that height correlated with systolic but not diastolic blood pressure and that the index children had a significantly higher systolic blood pressure than the comparison group.[22] The association of systolic blood pressure as the dependent variable was examined with height and right and left AtD angles as independent variables in a linear regression (table 4). Among the VLBW index children, height and right AtD angle were independently significantly associated with and explained 12.1% of the variance in systolic blood pressure. Height and left AtD angle explained 10.9% of the variance in systolic blood pressure but the left AtD did not attain statistical significance ($p = 0.13$). Among the comparison group, neither right nor left AtD angle was significantly associated with systolic blood pressure and even height did not quite attain the conventional level of statistical significance. Also, among the comparison group, considerably less of the variance in systolic blood pressure was explained by height and AtD angle.

Systolic blood pressure was higher in the VLBW index population than in the matched comparison population, and height and AtD angles were independently associated with systolic blood pressure. Therefore, the hypothesis that these differences could be explained by intrauterine growth restriction was tested. As a measure of intrauterine growth restriction, the birth weight ratio of the observed to the expected birth weight for a given gestational age was used. This analysis could be applied to only the VLBW index children as gestational age was not available for the comparison children. Adding birth weight ratio or gestational age to the multiple regression model showed no significant effect of either variable. The conclusion is that neither intrauterine growth restriction as measured by the birth weight ratio nor the degree of prematurity as determined by the gestational age of the VLBW cohort, is of primary importance in the difference in systolic blood pressure between the index and comparison children.

Table 2 Fingerprint comparison of VLBW cases and matched comparison children: number (%) of arches, loops, and whorls

	Arches		Loops		Whorls		Total		
Digit	Index group (%)	Comparison group (%)	Index group (%)	Comparison group (%)	Index group (%)	Comparison group (%)	Index group (%)	Comparison group (%)	χ^2 (DF); p value
Right hand									
Thumb	1 (1%)	2 (2%)	87 (68%)	77 (60%)	40 (31%)	49 (38%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 1.85; p = 0.40
Fore	15 (12%)	14 (11%)	74 (58%)	73 (57%)	39 (30%)	41 (32%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 0.09; p = 0.96
Middle	8 (6%)	6 (5%)	96 (75%)	98 (77%)	24 (19%)	24 (19%)	128 (100%)	128 (100%)	χ^2 (1 DF) = 0.31; p = 0.86
Ring	1 (1%)	2 (2%)	66 (52%)	63 (49%)	61 (48%)	63 (49%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 0.66; p = 0.80
Little	0 (0%)	4 (3%)	113 (88%)	107 (84%)	15 (12%)	17 (13%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 4.29; p = 0.12
All digits	25 (4%)	28 (4%)	436 (68%)	418 (65%)	179 (28%)	194 (30%)	640 (100%)	640 (100%)	χ^2 (2 DF) = 1.15; p = 0.56
Left hand									
Thumb	3 (2%)	2 (2%)	93 (73%)	81 (63%)	32 (25%)	45 (35%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 3.22; p = 0.20
Fore	18 (14%)	16 (13%)	69 (54%)	77 (60%)	41 (32%)	35 (27%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 1.02; p = 0.60
Middle	15 (12%)	16 (13%)	84 (66%)	85 (66%)	29 (23%)	27 (21%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 0.11; p = 0.95
Ring	3 (2%)	4 (3%)	79 (62%)	80 (63%)	46 (36%)	44 (34%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 0.44; p = 0.91
Little	2 (2%)	4 (3%)	112 (88%)	107 (84%)	14 (11%)	17 (13%)	128 (100%)	128 (100%)	χ^2 (2 DF) = 1.07; p = 0.59
All digits	41 (6%)	42 (6%)	437 (68%)	430 (67%)	162 (25%)	168 (26%)	640 (100%)	640 (100%)	χ^2 (2 DF) = 0.12; p = 0.92
All digits, both hands	66 (5%)	70 (5%)	873 (68%)	848 (66%)	341 (27%)	362 (28%)	1280 (100%)	1280 (100%)	χ^2 (2 DF) = 1.11; p = 0.57

Table 3 Correlation of fingerprint patterns with blood pressure

	Index children (n = 128)		*Comparison children (n = 128)*	
	Systolic BP correlation coefficient (p value)	*Diastolic BP correlation coefficient (p value)*	*Systolic BP correlation coefficient (p value)*	*Diastolic BP correlation coefficient (p value)*
Proportion of arches	−0.02 (p = 0.82)	0.11 (p = 0.21)	−0.02 (p = 0.79)	−0.05 (p = 0.59)
Proportion of loops	−0.16 (p = 0.07)	−0.10 (p = 0.28)	0.01 (p = 0.93)	0.09 (p = 0.31)
Proportion of whorls	0.16 (p = 0.07)	0.04 (p = 0.69)	−0.01 (p = 0.89)	−0.07 (p = 0.43)

Table 4 Relation between systolic blood pressure and height and right and left AtD angles in index and comparison groups

	Index children		*Comparison children*	
	Variance (R^2)	*Regression coefficient (95% CI); p value*	*Variance (R^2)*	*Regression coefficient (95% CI); p value*
Height	12.1%	0.52 (0.34 to 0.79); p < 0.001	2.8%	0.22 (−0.02 to +0.46); p = 0.07
Right AtD angle		0.32 (0.02 to 0.62); p < 0.05		0.11 (−0.26 to +0.48); p = 0.56
Height	10.9%	0.51 (0.23 to 0.79); p < 0.001	3.0%	0.23 (−0.02 to +0.47); p = 0.06
Left AtD angle		0.25 (−0.07 to +0.56); p = 0.13		0.15 (−0.22 to +0.51); p = 0.42

Discussion

It has been hypothesised that factors acting during fetal life have an important bearing on the subsequent risk of adult disease, particularly adult cardiovascular disease. There have been several studies advanced in support of this hypothesis, the "Barker" hypothesis.[25] The proposed mechanism is that maternal nutritional factors "programme" the fetus with important repercussions for subsequent development. Such programming of the fetus has enormous public health implications for the prevention of disease. However, the validity of the hypothesis has been questioned[26 27] and, in particular, doubt has been cast on the role of maternal nutritional factors acting at critical periods of pregnancy.[28–31]

Support for the hypothesis came from the observation that fingerprint patterns and palmar AtD angles were associated with raised blood pressure in adult life. The dermal ridges of the fingers and palms were promulgated as markers of fetal growth and the conclusion drawn that impaired fetal development was a component factor in raised blood pressure in adults.[14] We have shown previously that low birth weight children have a significantly higher systolic blood pressure than a matched comparison group,[22] thus confirming observations from other studies.[29 32] We found no significant difference between VLBW index children and the comparison group in palmar AtD angles (table 1) or in fingerprint patterns (table 2). We were also unable to confirm a correlation between the proportion of whorls on all ten digits with systolic blood pressure (table 3). If these dermatoglyphic patterns are, indeed, markers of maternal nutrition acting on fetal growth, then maternal nutritional factors were not able to account for the case control difference in systolic blood pressure that was found.

The report by Godfrey and colleagues[14] specifically concerned dermatoglyphic patterns in individuals who were small at birth whereas the data we report here relate to very low birth weight infants, the majority of whom were of low birth weight because of prematurity rather than fetal growth retardation. However, because birth weight was used as a cut off point, a disproportionate number in our cohort were growth retarded, and adjusting for fetal growth retardation in the analysis was an attempt to address the same hypothesis.

Systolic blood pressure was highly significantly correlated with height at age 15 years in the VLBW children but in the controls, the correlation was on the margin of statistical significance. However, independently of height, the palmar right AtD angle was significantly correlated with systolic blood pressure (table 4), whereas birth weight ratio, as a marker of fetal growth, showed no association. This association was much stronger in index cases than in the comparison controls. Caution must be exercised in placing clinical significance on the correlation between the right AtD angle and systolic blood pressure because there was no correction for multiple statistical testing. If the observation is replicated in other studies, then a confounding factor such as a genetic or fetoplacental unit component could account for both the birth weight and systolic blood pressure index and comparison group differences. Such a confounding factor may also account for the stronger association of systolic blood pressure with height and AtD angle in index cases than in the comparison controls. It could be postulated that this factor could both predispose to premature delivery and affect the subsequent level of blood pressure.

In conclusion, we could find no evidence that the higher systolic blood pressure associated with VLBW could be attributed to, or that dermatoglyphic patterns could be markers of, fetal growth.

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