SHORT REPORT

Metacarpophalangeal pattern profile analysis of a sample drawn from a North Wales population

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Summary. Sexual dimorphism and population differences were investigated using metacarpophalangeal pattern profile (MCPP) analysis. Although it is an anthropometric technique, MCPP analysis is more frequently used in genetic syndrome analysis and has been under-used in the study of human groups. The present analysis used a series of hand radiographs from Gwynedd, North Wales, to make comparisons, first, between the sexes within the sample and then with previously reported data from Japan. The Welsh sexes showed MCPP analyses that indicated size and shape differences but certain similarities in shape were also evident. Differences with the Japanese data were more marked. MCPP analysis is a potentially useful anthropometric technique but requires further statistical development.

1. Introduction

Metacarpophalangeal pattern profile (MCPP) analysis is a method whereby the lengths of each of the 19 long bones of the hand (metacarpals and phalanges) may be used to form a numerical and graphical representation of the hands of individuals or groups. It is an anthropometric technique that has tended to find greater application in clinical genetics than in human biology since numerous genetic syndromes also manifest themselves through an alteration in the relative lengths of the hand's long bones (Butler *et al*. 1986, Poznanski, Garn, Nagy *et al*. 1972). MCPP analysis, as developed by Garn, Hertzog, Poznanski *et al*. (1972) and Poznanski *et al*. (1972), compares measured bone lengths with a series standardized for age and sex. This standard is derived from a population of white Americans of Northern European ancestry.

The aim of the present study is to report a MCPP analysis of a sample drawn from North Wales and to go on to compare the males and females within that sample for sexual dimorphism. Secondarily, the present data were also compared with that previously reported for a racially different (Japanese) group, being a rare example of the use of MCPP to investigate population characteristics (Matsuura and Kajii 1989).

2. Materials and methods

Dorsi-palmar projection hand radiographs of mature male and female patients were obtained from Ysbyty Gwynedd, Bangor, North Wales (Lewis 1996,

1999). Using patient surname (Ashley and Davies 1966) and domicile, those uncharacteristic of or non-resident in Gwynedd were excluded from this study. The sample consisted of a total of 163 males and 90 females, for each of which measurements of all 19 metacarpal and phalangeal bones of the hand were made according to the method set out by Parish (1966). Measurements were made using electronic calipers (Mitutoyo (UK) Ltd. Model 500-133U) and recorded to the nearest 0.1 mm.

A *Z* score for each bone was calculated by subtracting from the measured length the relevant standard length given by Garn *et al*. (1972) and Poznanski (1984, 1991) and then dividing that difference by the standard deviation also prescribed by those authors. The mean of the *Z* scores for each bone was then calculated and plotted. Although they represent discrete entities, conventionally all 19 points are joined in a prescribed sequence (Garn *et al*. 1972, Poznanski 1984, 1991). As this can prove misleading, in the present report, only points pertaining to relevant anatomical rows of bones are joined.

In order to assess similarities between pattern profiles, Pearson's product moment correlation coefficient (*r*) using the 19 *Z* scores is the suggested statistical method (Garn 1955, Poznanski 1984). This was used to, in effect, compare the male and female patterns in the present sample. Furthermore, this method was used to compare each sex in the present sample with the oldest group (17 years of age) of 50 males and 53 females from Saga, Japan, reported by Matsuura and Kajii (1989).

3. Results

The mean lengths, standard deviations and *Z* scores for the North Wales population are given in table 1 and the MCPP in figure 1. Both sexes show profiles that are generally below the zero line of the profile chart. This indicates that for all but the male third metacarpal, the bone lengths in the present sample are shorter than the North American derived standard. The MCPPs were not straight lines, indicating that the bone-to-bone proportions and thus the overall shape of the Welsh and North American hands was not identical. However, Welsh male and female hands did show certain similarities. The correlation coefficient between the sexes ($r = 0.834$) suggested a similarity between their overall pattern profiles. However, upon closer inspection of figure 1, it can be seen that the MCPP falls into different sub-patterns with different shapes: one for the middle and proximal phalanges that is flatter and has a greater separation between the sexes, and one for the metacarpals and distal phalanges that was more undulating and less separated. This latter pair may be further divided. The sub-pattern for the distal phalanx seems to behave similarly to the other phalanges and falls further below the zero line than the metacarpal pattern, which, in turn, seems to have its own sub-pattern. The same statistical and graphical techniques suggested that the Welsh and Japanese samples differed more markedly in MCPP (Males: $r = -0.347$; Females: $r = -0.09$).

4. Conclusion

As originally envisaged, pattern analysis (Garn 1955) is a technique that can be applied to any set of measurements. The present study has sought to use this technique to investigate sexual and racial differences rather than genetic conditions and, in so doing, demonstrate its potential use as an anthropometric tool.

It was found that in the North Wales sample, males and females demonstrated a similarity in MCPPs which, upon closer inspection, was shown to consist of a number of different sub-patterns. When compared with the Japanese data, both Welsh sexes differed from their counterparts more markedly. This suggests that, within populations, underlying factors may influence both sexes, leading to a similarity in their MCPPs but that these may, in turn, differ between populations. Most marked was the sexual dimorphism in the Welsh sample for middle and proximal phalanges. Males had middle and proximal phalanges that were smaller than the standard to a greater extent than was shown by females. The distal phalanges, while behaving similarly to the other phalanges, did not differ from the standard so markedly. The metacarpals behaved in a separate fashion. This was in keeping with the findings of Takai (1978) who found that normal bone length in each of the four rows is influenced by separate (presumed genetic) factors (as is the case of syndromes such as brachydactyly). The present study has shown that such factors may work differently in each sex.

Because its most common use has been as a visual diagnostic aid for clinical use, statistical analysis of MCPP has tended to go undeveloped. Pearson's *r* is not used in its true statistical sense, as Poznanski (1983) has acknowledged, but more as a measure of similarity. MCPP analysis does, however, provide a method whereby all the long bones of the hand may be compared simultaneously as an anatomical unit. However, for more thorough anthropometric studies, alternative statistical techniques are yet to be developed. For example, scope exists for ‘goodness of fit’ techniques or a ‘fit index’ (Johnson and Bhattacharyya 1996) to be applied to each of the four rows of bones in the hand.

Acknowledgements

I thank Mrs K. D. Eaton, Superintendent Radiographer and Dr J. G. Williams, Consultant Radiologist at Ysbyty Gwynedd for allowing me access to radiographs and Mrs A. Lewis for her help with the preparation of the manuscript. This work was supported by a University of Liverpool research development grant.

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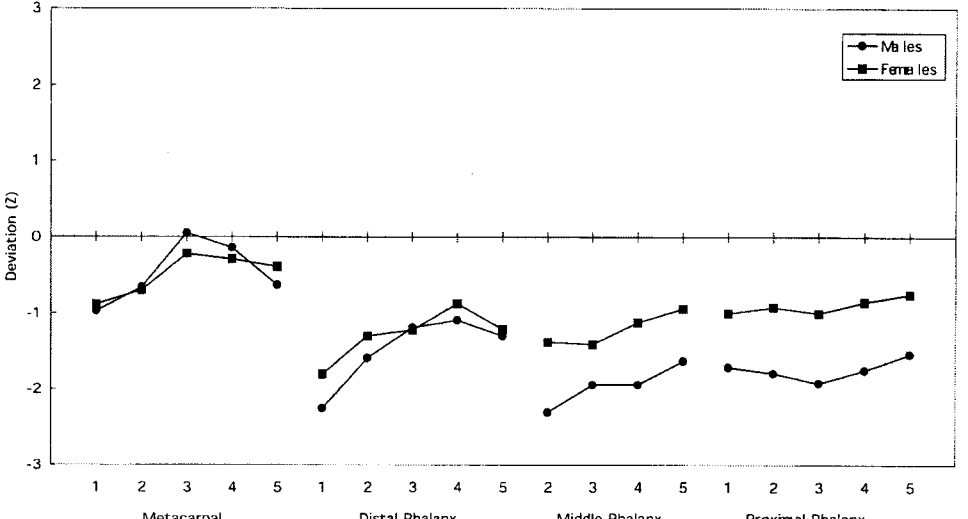
Males
Females
Deviation (Z)
3
2
1
0
-1
-2
-3
1 2 3 4 5
Metacarpal
1 2 3 4 5
Distal Phalanx
2 3 4 5
Middle Phalanx
1 2 3 4 5
Proximal Phalanx

Table 1 – Hand long bone measurements: mean lengths, standard deviations (SD) and *Z* scores

	Males (*n* = 163)			Females (*n* = 90)		
	Mean (mm)	SD	*Z*	Mean (mm)	SD	*Z*
Distal phalanx						
First	22.8	1.6	-1.7	20.5	1.3	-1.0
Second	16.3	1.9	-1.8	15.4	1.6	-0.9
Third	17.8	1.6	-1.9	16.4	1.4	-1.0
Fourth	18.4	1.7	-1.8	16.9	1.4	-0.9
Fifth	16.7	1.5	-1.5	15.3	1.3	-0.8
Middle phalanx						
Second	22.4	2.0	-2.3	21.0	1.9	-1.4
Third	27.6	2.1	-1.9	25.5	2.1	-1.4
Fourth	26.5	2.1	-1.9	24.5	1.9	-1.1
Fifth	19.0	1.9	-1.6	17.1	1.8	-0.9
Proximal phalanx						
First	30.7	2.1	-2.3	27.8	2.0	-1.8
Second	40.2	2.4	-1.6	37.0	2.2	-1.3
Third	45.4	2.6	-1.2	41.2	2.4	-1.2
Fourth	43.0	2.5	-1.1	38.7	2.4	-0.9
Fifth	33.7	2.1	-1.3	30.2	1.9	-1.2
Metacarpal						
First	46.8	2.6	-1.0	41.9	2.5	-0.9
Second	71.2	3.9	-0.7	63.9	3.7	-0.7
Third	69.2	3.7	0.1	61.7	3.5	-0.2
Fourth	61.6	3.6	-0.1	55.0	3.3	-0.3
Fifth	56.1	3.2	-0.6	50.5	2.9	-0.4