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Non-metric Cranial Traits: Sex Difference and Age Dependence*

Absence of association with age and/or sex in the case of discrete traits was hypothesized by Berry & Berry (1967). The important implication that skeletal material too fragmentary for sex and age determination may also be used in discrete-trait-studies stimulated us to test this hypothesis for 49 discrete traits in 254 Amsterdam crania of known age and sex. The results were compared with those of other such studies of European skulls. No significant deviation from the hypothesis was found as far as age dependence is concerned while sex difference did occur for some traits. At the same time Corruccini's (1974) conclusion that the hypothesis fails when tested in the Terry collection was found to result largely from the fact that right and left manifestations of lateral traits were treated as being independent. The possibility of including skeletal material too fragmentary for sex and age determination in future discrete-trait-studies is still open for discussion.

1. Introduction

About 10 years ago a new wave of discrete-trait-research was initiated by Berry & Berry (1967). However, their attractive assumptions concerning many fundamental properties of these traits are partly rendered out of date, and their simple methods to treat these traits have been strongly amended (for references see Perizonius, 1979). Apart from the assumption of the existence of a genetic background for non-metric traits in general (which will not be discussed here) discrete traits were assumed to be independent of age and sex. The attractiveness of this hypothesis lays in the fact that it makes it possible to study discrete traits without first having determined sex and age. Thus fragmentary skeletal remains of mixed-up skeletons, of which age and sex cannot be determined, can also be included in discrete-trait population studies. Since the hypothesis was launched, several studies have been devoted to its testing. Three studies, based on skeletons of known age and sex, may be mentioned especially: those by Vecchi (1968), Corruccini (1974), and A. C. Berry (1975). Divergent results were found, however, while mutual comparisons were hampered by differences in method.

2. Material, Traits and Methods

Series of crania of known age and sex are scarce. In The Netherlands only one such collection is available (Laboratory of Anatomy and Embryology of the Municipal University of Amsterdam). It consists of dissection material of Amsterdam inhabitants who died between 1883 and 1909 A.D. Only skulls of adults (21 years and older) were studied. The age and sex distributions of the 254 crania are given in Table 1.

Table 1 **The distribution of 254 Amsterdam crania according to age and sex**

Age group	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	Total
Males	1	5	18	36	47	43	17	1	168
Females	2	5	8	17	21	25	6	2	86
Total	3	10	26	53	68	68	23	3	254

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Sex difference and age dependence were investigated for 49 discrete traits (see Table 2). With the exception of trait no. 28, 34 and 35 we used traits already studied by others: 27 traits by Berry & Berry (1967), nine by Ossenberg (1970), five by Czarnetzki (1971), and one by Rightmire (1972). More information on these traits, their definitions and specific difficulties in scoring, is given in a previous paper (Perizonius, 1979).

It should be stressed that the numbers for lateral traits (nos 8–49), necessarily scored on sides, were halved. This has been done in agreement with Perizonius' (1979) conclusion concerning the treatment of lateral traits. For each trait sex difference and age dependence were tested by calculating chi-squares from two-by-two tables in which the numbers of the positive observations as well as those of the negative one's were presented:

	21–50 yr/♂	71–100 yr/♀
+	*a*	*b*
−	*c*	*d*

The chi-square formula $\chi^2 = \frac{(ad-bc)^2(a+b+c+d)}{(a+b)(a+c)(c+d)(b+d)}$ was used. If any expected class value was less than five and at the same time the chi-square was significant ($>3{\cdot}84$), the correction of Yates has been applied.

Comparisons with other studies were restricted to those of European skeletons of known age and sex.

3. Results

Table 2 shows that in the Amsterdam crania *sex difference* was found to be significant at the 5% level ($\chi^2 > 3{\cdot}84$) for 7 out of 45, or 16%, of the traits used (four traits could not be included as they manifested always in the same way).

The results of other investigations on sex difference in European crania of known sex are presented in Table 3. However, important differences in method occur. These concern:

(i) the treatment of lateral traits;
(ii) the statistics used;
(iii) the traits studied.

Therefore, the chi-square values have been recalculated whenever possible according to the method proposed here.

In the case of the modern Romans, recalculation did not change Vecchi's (1968) final results. For the Europeans of the Terry collection recalculation resulted in sex difference for 8% of the traits used, instead of the 31% found by Corruccini (1974). This is a consequence of the fact that Corruccini's chi-square values for lateral traits were twice as high as they should be since his numbers for lateral traits, scored on sides, were not halved. For the St. Bride's Church material (1800–1859 A.D.) recalculation was impossible because absolute numbers were not given.

Of the three populations (the method used in the case of the St. Bride's Church collection not being clear) whose results finally are comparable, the mean percentage of non-metric traits demonstrating sex difference is 9%. This need not lead to the conclusion that in future discrete-trait-studies, sexes should be separated, as felt by Corruccini (1974).

Table 2 **Sex difference in the Amsterdam series. In the last column the sex with the highest incidence is indicated**

		Males		Females				
		+	−	+	−	χ^2	♂	♀
1.	Metopism	20	147	9	77	0·13	×	
2.	Bregmatic bone	4	154	1	78	0·38*	×	
3.	Sagittal ossicle	5	92	2	63	0·41*	×	
4.	Ossicle at lambda	12	125	6	64	0·00		
5.	Palatine torus	7	158	5	80	0·33*		×
6.	Inca bone	—	163	—	84			
7.	Tuberculum pharyngeum	—	166	—	83			
8.	Frontal grooves	41	121	39·5	41·5	13·41		×
9.	Coronal ossicle	4·5	146·5	5	71	1·63*		×
10.	Parietal foramen	105·5	56·5	55·5	26·5	0·16		×
11.	Lambdoid ossicle	56·5	71·5	25	36·5	0·21	×	
12.	Highest nuchal line	40	126	30·5	53·5	4·11		×
13.	Accessory lesser palatine foramen	114	51	48	35	3·09	×	
14.	Pterygo-spinous bridge	12	155	2·5	82·5	1·87*	×	
15.	Foramen ovale incomplete	3	163·5	3·5	81·5	1·20*		×
16.	Foramen spinosum open	14·5	151	10·5	74·5	0·81		×
17.	Precondylar tubercle	6	159·5	0·5	83	2·00*	×	
18.	Hypoglossal canal bridging	24	143	16·5	68	1·10	×	
19.	Condylar facet double	10	155·5	3	80·5	0·67*	×	
20.	Paracondylar process	6·5	154	6	78·5	1·06*		×
21.	Posterior condylar canal patent	96	68	52	30	0·54		×
22.	Mastoid foramen absent	6	160·5	6·5	78·5	1·95*		×
23.	Mastoid foramen exsutural	137·5	22·5	59·5	22·5	6·41	×	
24.	Occipito-mastoid wormians	3	133	4	64·5	1·82*		×
25.	Foramen supraorbitale	48·5	118·5	28·5	56·5	0·53		×
26.	Sulcus supraorbitalis	108	57·5	64·5	20·5	2·96		×
27.	Foramen supraorbitale and sulcus supraorbitalis	23	144	10·5	74·5	0·10	×	
28.	Foramen nasale	153·5	9·5	72	7	0·77	×	
29.	Trochlear spur	26·5	137·5	8·5	76	1·71	×	
30.	Posterior ethmoid foramen absent	6·5	158	2	83	0·44*	×	
31.	Anterior ethmoid foramen exsutural	11·5	40·5	4·5	25	0·56	×	
32.	Foramen zygomatico-faciale double	94·5	72	41·5	43	1·32	×	
33.	Foramen zygomatico-faciale absent	17	149·5	8	77	0·04	×	
34.	Foramen zygomatico-temporale	138	28·5	79	5	6·01		×
35.	Foramen zygomatico-orbitale	149·5	16	78	6·5	0·27		×
36.	Processus marginalis	61	105·5	25·5	59·5	1·10	×	
37.	Os Japonicum trace	7	157·5	3	80	0·06*	×	
38.	Infraorbital suture	29	137	48·5	36	41·78		×
39.	Accessory infraorbital foramen	22	142·5	8·5	73	0·44	×	
40.	Epipteric bone	18·5	122·5	17	49·5	4·93		×
41.	Fronto-temporal articulation	—	161·5	3·5	79	4·27†		×
42.	Parietal notch bone	26	139·5	17·5	65	1·15		×
43.	Ossicle at asterion	12·5	152	6	72	0·00		
44.	Foramen of Huschke	34·5	127·5	16	63	0·03	×	
45.	Maxillary torus	—	166·5	—	85			
46.	Maxillary third molar	137·5	1·5	68	—	0·74*		×
47.	Pterygo-basal bridge	1	166	—	85	0·51*	×	
48.	Supratrochlear foramen	—	165·5	—	84·5			
49.	Auditory exostosis	0·5	164·5	—	84·5	0·26*	×	

* One of the expected values was less than five.

† One of the expected values was less than five and the Yates' correction has been applied.

Table 3 **Number of discrete traits showing sex difference ($P < 0.05$) in four European samples of known sex**

Publication	Collection	Traits with sex difference ($P < 0.05$) / Total number of traits	%	According to our methods	%
Vecchi (1968)	Modern Romans	1/30	3	1/30	3
Corruccini (1974)	Terry collection (Europeans)	19/61	31	5/61	8
A. C. Berry (1975)	St. Bride's Church	7/29	24		
Present study	Amsterdam inhabitants	7/45	16	7/45	16

Hence, it does not seem to be incorrect or inconvenient *to exclude* the few traits demonstrating sex difference from non-metric-trait population studies (as already done by Jantz, 1970). In that case material of unknown sex can also be used. The interesting question of whether the same traits demonstrate sex difference in the present intrapopulational comparison of four European samples cannot be answered satisfactorily because the actual traits studied per population differ. The four traits that did show sex difference in more than one of the samples are listed in Table 4. Note that in case of "highest nuchal line" (no. 12) the sex difference found is caused once by preference for males, and once by preference for females.

Table 4 **Discrete traits showing sex difference ($P < 0.05$) in more than one European sample of known sex**

	Modern Romans [Vecchi (1968)]	Terry collection (Europeans) [Corruccini (1974)]	St. Bride's Church [A. C. Berry (1975)]	Amsterdam inhabitants [Present study]
5. Palatine torus	×	♀	♀	×
12. Highest nuchal line	×	—	♂	♀
40. Epipteric bone	×	×	♀	♀
43. Ossicle at asterion	♂	×	♂	×

×, No significant sex difference; —, not scored; ♂ or ♀, sex sample with the highest incidence in case of significant sex difference.

Age dependence was studied in the Amsterdam crania by comparing two age groups: one comprising 39 crania aged between 21 and 50 years and one comprising 94 crania aged between 71 and 100 years. Only two of 44 traits showed age dependence ($P < 0.05$). This amounts to 5%, i.e. exactly the percentage to be expected on the basis of chance alone (see Table 5). These two traits ("epipteric bone", no. 40, and "foramen zygomaticotemporale", no. 34) also showed sex difference in the present sample. This cannot be caused by a different sex distribution in the age group samples or by a different age distribution in the sex samples: the percentages of females in the two age groups are 38% and 35%, and the mean age of the male and female samples is 64·3 years and 63·5 years respectively.

Age dependence of discrete traits in European samples of known age has also been studied by Corruccini (1974) and A. C. Berry (1975). Differences in method however

Table 5 **Age dependence in the Amsterdam series. In the last column the age group with the highest incidence is indicated**

		21–50 yr		71–100 yr		χ^2	21–50 yr	71–100 yr
		+	−	+	−			
1.	Metopism	5	34	12	82	0·00*		
2.	Bregmatic bone	—	35	3	89	1·17*		×
3.	Sagittal ossicle	2	23	2	61	0·96*	×	
4.	Ossicle at lambda	4	29	5	71	0·93*	×	
5.	Palatine torus	3	35	2	89	2·34*	×	
6.	Inca bone	—	37	—	93			
7.	Tuberculum pharyngeum	—	37	—	91			
8.	Frontal grooves	13·5	23·5	33·5	60	0·00		
9.	Coronal ossicle	2·5	32	1·5	83·5	2·28*	×	
10.	Parietal foramen	24	13	63·5	30·5	0·09		×
11.	Lambdoid ossicle	13·5	18·5	24·5	42·5	0·29	×	
12.	Highest nuchal line	15	23	24·5	68·5	2·21	×	
13.	Accessory lesser palatine foramen	22	16	64·5	26	2·18		×
14.	Pterygo-spinous bridge	3	35	5·5	87·5	0·17*	×	
15.	Foramen ovale incomplete	—	37·5	1·5	91·5	0·61*		×
16.	Foramen spinosum open	3	34	9·5	83·5	0·14*		×
17.	Precondylar tubercle	0·5	35·5	1	92	0·02*	×	
18.	Hypoglossal canal bridging	8·5	29·5	15·5	77	0·57	×	
19.	Condylar facet double	2	34	3	89	0·36*	×	
20.	Paracondylar process	2·5	34·5	4·5	84·5	0·14*	×	
21.	Posterior condylar canal patent	23	14	59·5	29·5	0·25		×
22.	Mastoid foramen absent	1·5	36	6	87	0·30*		×
23.	Mastoid foramen exsutural	28·5	8	72	20	0·00		
24.	Occipito-mastoid wormians	0·5	31·5	0·5	76·5	0·21*	×	
25.	Foramen supraorbitale	10·5	27·5	30	63	0·27		×
26.	Sulcus supraorbitalis	21·5	16·5	65	28	2·13		×
27.	Foramen supraorbitale and sulcus supraorbitalis	3·5	34·5	10·5	82·5	0·12*		×
28.	Foramen nasale	33·5	4	86	4	1·74*		×
29.	Trochlear spur	5·5	31	14	78	0·00*		
30.	Posterior ethmoid foramen absent	1·5	36	3	89·5	0·05*	×	
31.	Anterior ethmoid foramen exsutural	4	13	4	20	0·30*	×	
32.	Foramen zygomatico-faciale double	20·5	17	50	42·5	0·00		
33.	Foramen zygomatico-faciale absent	4	34	8·5	84	0·06*	×	
34.	Foramen zygomatico-temporale	35	3	68·5	24	5·35	×	
35.	Foramen zygomatico-orbitale	35	33	85	7·5	0·00*		
36.	Processus marginalis	14	24	31·5	61	0·09	×	
37.	Os Japonicum trace	3	34	3·5	87	0·98*	×	
38.	Infraorbital suture	14	23·5	28·5	64	0·52	×	
39.	Accessory infraorbital foramen	3·5	32	13	77·5	0·45*		×
40.	Epipteric bone	11·5	20·5	8·5	63	8·20	×	
41.	Fronto-temporal articulation	—	36·5	1·5	86·5	0·63*		×
42.	Parietal notch bone	5	31·5	16	76	0·26		×
43.	Ossicle at asterion	1·5	34·5	7·5	84	0·64*		×
44.	Foramen of Huschke	6	30·5	18·5	70·5	0·31		×
45.	Maxillary torus	—	38	—	92·5			
46.	Maxillary third molar	36·5	—	68	0·5	0·27*	×	
47.	Pterygo-basal bridge	—	38	0·5	92·5	0·21*		×
48.	Supratrochlear foramen	—	38	—	92			
49.	Auditory exostosis	—	38	—	92			

* One of the expected values was less than five.

are even greater here than in the studies on sex differences. Corruccini (1974), comparing adults younger and older than 40 years, found age dependencies for twice as many traits as could be explained by random error (more than 10%). He concluded that the hypothesis of age independence fails when tested on the Terry collection. However, we have indicated already that Corruccini's numbers for lateral traits were not halved. In the case of age dependence it was not possible to recalculate his data because absolute numbers were not given. One may predict, however, that an appreciable reduction of the amount of traits showing age dependence would result.

A. C. Berry (1975) calculated for each trait the mean ages of two groups of crania, one distinguished by the presence and one by the absence of that specific trait. In only one out of 29, i.e. 3% of the traits, was this difference in mean age significant ($P < 0{\cdot}05$). Also in this case recalculation according to the method used on the Amsterdam sample was not possible.

It may be safely concluded that, despite differences in method, these three investigations of age dependence all seem to confirm the hypothesis that non-metric traits are independent of age.

4. Conclusion

Skeletal material too fragmentary for sex and age determination may be used in discrete-trait population studies as far as the age problem is concerned. As far as influence of sex on discrete trait frequencies is concerned, more knowledge is desirable especially about the question of whether the same traits show sex differences in various populations. If indeed only a few specific traits do show sex differences, e.g. in European samples, than these traits may be excluded. In that case fragmentary skeletal material may be used without sex and age determinations in discrete-trait-studies of European samples.

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