Blood groups in twin studies
Calculation of the probability of monozygosis

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In the issue of this journal of July 1960, I published a paper: " Blood groups in twin studies. Calculation of the probability of monozygosis " (Vol. IX, page 301-308). Now a few months later, working with these formulas I recognized that the calculation method is not correct.

The formulas 1a and 1b, and 2a and 2b are not usable in the calculation for two reasons:

1) The a prior probability of monozygosis is not longer the same as in the random population (i. e. 30%),

2) also if they are corrected for these over-all probability, they do not give the ratio of probability " dizygosis ": " monozygosis ", but the combination " dizygosis with a special blood type ": " monozygosis with that same blood type ".

So it must be concluded that the principle, refered to in the 2nd and 3rd edition of the book of Race and Sanger: " Blood groups in Man " is right, and the variation presented in our paper is incorrect.

Therefore instead of the formulas 1a, 1b, 2a and 2b in our preceding paper the following formulas must be used:

$$P(XY2Z) = \frac{\Sigma\ \overline{X}_i\ \overline{Y}_i\ fr\ (i,\ i)^2}{\Sigma\ \overline{X}_i\ \overline{Y}_i} \qquad (1^a)$$

$$P(XY1Z) = \frac{\Sigma\ \overline{X}_i\ \overline{Y}_i\ fr\ (i,\ i)}{\Sigma\ \overline{X}_i\ \overline{Y}_i} \qquad (1^b)$$

$$P(XYaZ) = \frac{\Sigma\ \overline{X}_i\ \overline{Y}_i\ fr\ (i,\ i)^a}{\Sigma\ \overline{X}_i\ \overline{Y}_i} \qquad (2^a)$$

$$P(XY(a-1)Z) = \frac{\Sigma\ \overline{X}_i\ \overline{Y}_i\ fr\ (i,\ i)^{a-1}}{\Sigma\ \overline{X}_i\ \overline{Y}_i} \qquad (2^b)$$

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A complication can be met, if the genotype of one of the parents is known and that of the other is not, and other children have a genotype different from the twins, due to different genes originating form the parent with the known genotype.

e.g. Parents $B \times A_1$, twins A_1, other children A_1 and A_1B. The genotype of the parent with group B must be BO; the genotype of the parent with A_1 may be A_1A_1, A_1A_2 or A_1O.

The formulas 2a and 2b must be now:

$$P \{XY (aZ_1 + bZ_2)\} = \frac{\Sigma \overline{X} \overline{Y}_i \text{ fr } (i)^{a+b}}{\Sigma \overline{X} \overline{Y}_i} = \frac{\Sigma \overline{Y}_i \text{ fr } (i)^{a+b}}{\Sigma \overline{Y}_i} \quad (2a^1)$$

$$P [XY \{(a-1) Z_1 + bZ_2\}] = \frac{\Sigma \overline{X} \overline{Y}_i \text{ fr } (i)^{a+b-1}}{\Sigma \overline{X} \overline{Y}_i} = \frac{\Sigma \overline{Y}_i \text{ fr } (i)^{a+b-1}}{\Sigma \overline{Y}_i} \quad (2b^1)$$

where Z_1 = genotype of the twins
Z_2 = the other genotype in the other children.

Furthermore it should be noted that it is also possible to use the calculation method and the formulas in cases where the blood groups of the parents are not known.

e.g. A case of twins, both with group M:

$X_1 = MM$ $Y_1 = MM$
$X_2 = MN$ $Y_2 = MN$

fr (1, 1) = 1,00 fr (2, 1) = 0,5
fr (1, 2) = 0,5 fr (2, 2) = 0,25

These fr values can be substituted with the frequencies of the genotypes MM and MN in the formulas 1a and 1b.

Another example, twins both P+:

$X_1 = PP$ $Y_1 = PP$
$X_2 = Pp$ $Y_2 = Pp$
$X_3 = pp$ $Y_3 = pp$

fr 1,1 = 1,00	fr 2,1 = 1,00	fr 3,1 = 1,00
fr 1,2 = 1,00	fr 2,2 = 0,75	fr 3,2 = 0,50
fr 1,3 = 1,00	fr 2,3 = 0,50	fr 3,3 = 0,00

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