Counterexample to a kinship conjecture of Krawczak[1]

Abstract: A counterexample shows that a criterion proposed by Krawczak for a marker to be informative for a kinship case is not a necessary condition.

To the Editor:

Michael Krawczak proposes [2] a simple and appealing mathematical criterion for a marker to be informative for a given kinship case, namely that at least one of the probabilities $r_i(k, \phi)$ – essentially the Cotterman k-coefficients [3] – that two individuals ϕ share k alleles identically by descent, should differ between the hypothetical pedigrees (indexed by i) being compared. Unfortunately this elegant characterization doesn't work.

The paper states that the condition is "probably necessary because it is hard to imagine a kinship case that can be solved by means of genetic testing, but in which none of the pairwise degrees of relatedness is disputed." With this hint, a counterexample is not hard to come by. It is well-known that (under Mendelian genetics – i.e., mutation aside) kinship testing between two persons ϕ cannot distinguish an aunt-niece relationship (i=1) from half-sister (i=2). The coefficients $r_i(k, \phi)$, k=0, 1, 2, are the same in each case. However, suppose instead of one niece we have two full sisters S, T, and a third person A who is the maternal aunt under one hypothesis and the maternal half-sister under the other hypothesis.
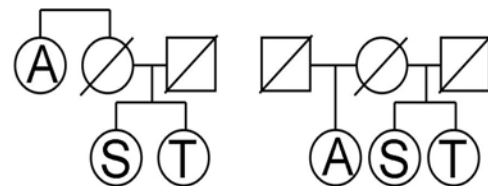
Counterexample showing that genetic evidence can be informative in distinguishing between two hypotheses that are not distinguishable by Cotterman coefficients.

The r remain independent of hypothesis: The S-T relationship is fixed, so the corresponding r are trivially unchanging, and for either the A-S or the A-T relationships the r don't change as just noted. Genetic testing, while feeble for distinguishing between these hypotheses, is not completely uninformative [2]. The reason is that occasionally (1/8 of the time) the two different alleles of an aunt will occur identically by descent (IBD) in the sisters (one in each sister), whereas the two different alleles of a half-sister cannot both occur IBD in the full sisters. This counterexample proves that the proposed criterion is not necessary. A marker can be informative even if the r rule doesn't reveal that it is.

[1]   C.H. Brenner, Symbolic Kinship Program, *Genetics* **145** (1997) 535-542

[2]   M. Krawczak, Kinship testing with X-chromosomal markers: Mathematical and statistical issues, For Sci Int: Gen **1** (2007) 111-114

[3]   E.A. Thompson, The estimation of pairwise relationships, *Ann. Hum Genet., Lond.* **39** (1975) 173–187

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