

Derivation of the Random Grandparents Not Excluded (RGPNE) Statistic

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Genetic testing for paternity typically involves calculation of the Random Man Not Excluded (RMNE) statistic to help determine the power of the test battery to exclude men falsely accused of paternity. In cases where the alleged father is unavailable, testing of his parents can often resolve the case. However, a reliable method to determine the power of a genetic test to exclude a pair of individuals as grandparents, the Random Grandparents Not Excluded statistic, or RGPNE, has not been presented. Using two independent approaches, we derived two equations to calculate the RGPNE: when the obligate paternal allele (OPA) is defined, $RGPNE = a(4-6a+4a^2-a^3)$ and when the OPA is ambiguous, $RGPNE = 2[(a+b)(2-a-b)] \times [1-(a+b)(2-a-b)] + [(a+b)(2-a-b)]^2$. In either case, single locus RGPNE values are higher than RMNE values illustrating the fact that it is more difficult to exclude pairs of individuals from grandparentage than to exclude single individuals from parentage. Using weighted averages of CODIS short tandem repeat allele frequencies in the RGPNE equations, we determined that 11-12 markers are typically required to yield cumulative RGPNE values <0.01 (indicating that $>99\%$ of random pairs of individuals are excluded from grandparentage) in cases where the mother is tested and ~ 25 are required when she is not. These results are supported by an examination of grandparentage cases previously performed in our laboratory and highlight the importance of including the mother, when available, in all civil paternity examinations involving the parents of the alleged father. In summary, we report the derivation of the Random Grandparents Not Excluded statistic for use in paternity casework where the parents of the alleged father are tested instead of the alleged father himself. This measure will help parentage testing laboratories determine when sufficient exclusionary power has been achieved in grandparentage casework and will minimize the occurrence of false inclusions.