

ALBINISM: A SAMPLE HARDY-WEINBERG PROBLEM

Albinism is a rare genetically inherited trait that is only expressed in the phenotype of homozygous recessive individuals (aa). The most characteristic symptom is a marked deficiency in the skin and hair pigment melanin. This condition can occur among any human group as well as among other animal species. The average human frequency of albinism in North America is only about 1 in 20,000.

Referring back to the Hardy-Weinberg equation ($p^2 + 2pq + q^2 = 1$), the frequency of homozygous recessive individuals (aa) in a population is q^2 . Therefore, in North America the following must be true for albinism:

$$q^2 = 1/20,000 = .00005$$

By taking the square root of both sides of this equation, we get: (Note: the numbers in this example are rounded off for simplification.)

$$q = .007$$

In other words, the frequency of the recessive albinism allele (a) is .00707 or about 1 in 140. Knowing one of the two variables (q) in the Hardy-Weinberg equation, it is easy to solve for the other (p).

$$p = 1 - q$$

$$p = 1 - .007$$

$$p = .993$$

The frequency of the dominant, normal allele (A) is, therefore, .99293 or about 99 in 100.

The next step is to plug the frequencies of p and q into the Hardy-Weinberg equation:

$$\begin{aligned} p^2 + 2pq + q^2 &= 1 \\ (.993)^2 + 2(.993)(.007) + (.007)^2 &= 1 \\ .986 + .014 + .00005 &= 1 \end{aligned}$$

This gives us the frequencies for each of the three genotypes for this trait in the population:

$$p^2 = \text{predicted frequency} = .986 = 98.6\% \\ \text{of homozygous} \\ \text{dominant individuals}$$

$$2pq = \text{predicted frequency} = .014 = 1.4\% \\ \text{of heterozygous} \\ \text{individuals}$$

$$q^2 = \text{predicted frequency} = .00005 = .005\%$$

of homozygous
recessive individuals
(the albinos)

With a frequency of .005% (about 1 in 20,000), albinos are extremely rare. However, heterozygous carriers for this trait, with a predicted frequency of 1.4% (about 1 in 72), are far more common than most people imagine. There are roughly 278 times more carriers than albinos. Clearly, though, the vast majority of humans (98.6%) probably are homozygous dominant and do not have the albinism allele.