One explanation for the sickle-cell trait is that is that the trait provides some protection against malarial infection. The following data shows the conditions of 543 African children.

	Malaria		
	Heavy Infection	Noninfected or lightly infected	
Sickle-cell trait present	36	100	136
Sickle-cell trait absent	152	255	407
Total	188	355	543

(a) Find the proportion of children with a heavy malarial infection for each sample of children (those with and without the sicle-cell trait). For this sampled data, which group has a lower incidence of heavy malarial infection, and by how much? Do you think a difference of this size is of practical (not statistical) importance?

Solution: In the group with sickle-cell trait present, the proportion is $36/136 = 0.265$. In the group with sickle-cell trait absent, the proportion is $152/407 = 0.373$. The group with the trait present has a lower incidence of heavy malarial infection. The difference is 0.109 which is of practical importance.

(b) Find the numerical value of the χ^2 test statistic.

Solution: The expected counts are:

47.1	88.9
140.9	266.1

The test statistic is 5.33.

(c) Consider a directional test of association between the sickle-cell trait and malaria with the alternative hypothesis that the trait provides protection. State hypotheses, find a range for the p-value from a χ^2 table, and interpret the result in the context of the problem. (Recall that the p-value from the χ^2 table is nondirectional, as it accounts for deviation from the null hypothesis in either direction.)

Solution:

H_0: The incidence of heavy malarial infection is independent of the sickle-cell trait.
H_A: The incidence of heavy malarial infection is lower in children with the sickle-cell trait.

There is one degree of freedom. The p-value is between 0.01 and 0.025.

There is evidence that the sickle-cell trait provides protection against heavy malarial infection for this population of African children ($p < 0.025$, χ^2 test of independence).

(d) Fisher's exact test for this test gives a p-value of 0.0129. Fill in the blanks.

> If I had a bucket with <u>136</u> black balls and <u>407</u> white balls and took a sample without replacement of 188 balls, the probability of sampling <u>36</u> or fewer black balls would be 0.0129.