

Exercises for Health Studies 541

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These are exercises which you can use to test your understanding of some of the quantitative concepts and methods that arise in reading and using the medical literature critically. More questions, and partial answers and notes to these items will be posted separately.

1 Diagnostic Tests

In a population of urology clinic patients, the digital rectal examination (DRE) is 86% sensitive and 44% specific for detecting previously undiagnosed prostate cancer.

1. What is the likelihood ratio for a positive DRE?
2. It is estimated that among men 85 years of age or older, 75% have prostate cancer (most of it asymptomatic and undetected). An 85-year old seen in the urology clinic has a positive DRE. What is the probability that he has prostate cancer?
3. What are the prior odds of prostate cancer in the previous question?
4. What is the pretest probability of prostate cancer in the previous question?
5. Among 60 year olds in the urology clinic, 3 men have prostate cancer for every 4 who do not. What is the pretest probability of prostate cancer for a 60 year old? What are the pretest odds?
6. What are the post-test odds of prostate cancer for a 60-year old after a positive DRE?
7. What are the post-test odds of prostate cancer for a 60-year old after a negative DRE?
8. In the general population of asymptomatic men over 40, the prevalence of prostate cancer is 1/100. If the sensitivity and specificity of DRE were as above for this population, what fraction of positive DREs done as part of routine physical examinations would you expect to be false positives?

A test has a false positive rate of 2% and a sensitivity of 98%.

9. What is the likelihood ratio of a positive test?
10. If the prevalence of the condition being tested for is 1/1000, what is the positive predictive value?
11. If the prevalence of the condition being tested for is 1/10, what is the positive predictive value?

Consider the following statement: "This diagnostic test produces false positives only rarely. However, most positive test results turn out to be false positives."

12. Explain to a lay listener (a friend, your parents, etc) how the statement can be true.
13. What circumstances are required for the statement above to be true?
14. Explain why it may be very useful to use the test widely, even when the circumstances of the previous question hold.

2 Probability

Cystic fibrosis (CF) is an autosomal recessive monogenic disorder. The frequency with which the allele for CF is found is 1 in 45 for Caucasians. A *carrier* of the allele is someone who has one or more CF alleles, that is, is either monozygous recessive or heterozygous for the trait. Assume that carriers of this allele are neither more nor less likely to marry another carrier than are noncarriers.

1. What is the probability that a randomly selected individual is *not* a carrier?
2. What is the probability that an individual is an unaffected carrier?
3. What is the probability of the CF phenotype?
4. What condition must the three probabilities above satisfy, and why?
5. Two parents each carry the CF allele, but neither has CF. What is the probability that their first child will have CF (the disease)?
6. This same couple plans to have three children. What is the probability that at least one of the three will have CF?
7. Why did we have to assume that carriers are no more likely to marry one another than noncarriers?

Your patient, Mr Brown, takes his blood pressure every day at home, and he notes that over the course of several years his systolic pressure has an average value of 136 mm with a standard deviation of 4 mm. You see Mr Brown annually for a regular checkup.

8. What is the probability that Mr Brown's systolic BP will exceed 140 mm when you take it in your office?
9. What is the probability that Mr Brown's SBP will exceed 140 mm at least once over the course of five visits to you?

3 Parameter estimation

Tierney, et al, report that of 98 patients who were not demented at evaluation, four had MMSE scores of 24 or below two years earlier.

1. The fraction $4/98$ is an estimate for what quantity?
2. What is the standard error for this estimate?
3. What is the 95% confidence interval for the quantity that is being estimated?

The Atherosclerosis Risk in Communities Study (Brancati, et al, *JAMA*. 2000; 283:2253–2259) reported risk factors for nondiabetic African-American and white men and women in a population-based sample. All of the questions refer specifically to the non-diabetic adult population aged 45–64 years.

4. There were 976 African-American men in the data set, with a mean body mass index of 27.5 (SD=4.6). What is the standard error of the estimated mean BMI in this group?
5. Give a 95% confidence interval for the average BMI among African-American men.
6. Assume that the mean BMI for white men is 27.2. Is there evidence from these data that African-American men have larger BMI on average? Explain.
7. Approximately what percentage of African-American men are obese (that is, have $\text{BMI} \geq 30$)?
8. Of 1670 African-American women in the study, 433 had a family history of diabetes. Give a 95% confidence interval for the proportion of African-American women in the community with a family history of diabetes.