

Worksheet 13 — Hypothesis testing

1. In the US in 1990, there were 2.1 million deaths from all causes, compared to 1.7 million in 1960: nearly a 25% increase. Does this data show that the public's health got worse over the period 1960–1990?
2. The Public Health Service studied the effects of smoking on health, in a large sample of representative households. For men and women in each age group, those who had never smoked were on average somewhat healthier than the current smokers, but the current smokers were on average much healthier than those who had recently stopped smoking.
 - (a) Was this a controlled experiment or an observational study?
 - (b) Why did they study men and women and the different age groups separately?
 - (c) The conclusion seems to be that you shouldn't start smoking, but once you've started, you shouldn't stop. Comment.
3. According to a study done by Kaiser Permanente in California, users of oral contraceptives have a higher rate of cervical cancer than non-users, even after adjusting for age, education, and marital status.
 - (a) Was this a controlled experiment or an observational study?
 - (b) Why did the investigators adjust for age, education, and marital status?
 - (c) The investigators concluded that the pill causes cervical cancer. Was this justified?
4. An experiment was carried out to determine the effect of providing free milk to school children in a certain district in Scotland. Some children in each school were chosen for the treatment group and got free milk; others were chosen as controls and got no milk. Assignment to the treatment or control groups was done at random, to make the two groups comparable in terms of family background and health.

After randomization, teachers were allowed to use their judgement in switching children between treatment and control, to equalize the two groups. Was it wise to let teachers use their judgement in this way?
5. Studies of death certificates in the 1990s showed the average age of death was smaller for left-handed people than for right-handers.

During the 20th century, there were big changes in child-rearing practices. In the early part of the century, parents insisted that their children be right-handed. By mid-century, parents were a lot more tolerant of left-handedness. Could this explain the observed discrepancy in average age at death of left- and right-handed people in the 1990s?
6. In 10,000 tossings, a coin came up heads 5,400 times. Should we conclude that the coin is biased?
 - (a) Formulate the null hypothesis and alternative hypothesis.
 - (b) Compute the z statistic and the p -value.

- (c) What do you conclude?
7. A die is rolled 100 times. The total number of spots is 368 instead of the expected 350. Can this be explained as chance variation, or is the die loaded?
8. Other things being equal, which is better for the null hypothesis: a higher p -value or a lower p -value?
9. The National Household Survey on Drug Abuse was conducted in 1985 and 1992. In each year, a simple random sample of 700 people was used.
- (a) Among persons age 18 to 25, the percentage of marijuana users dropped from 21.9% to 11.0%. Is this difference real, or a chance variation?
- (b) Among persons age 18 to 25, the percentage of cigarette smokers dropped from 36.9% to 31.9%. Is this difference real, or a chance variation?
10. A random sample of 1000 freshmen at public universities were asked how many hours they worked each week (for pay). The average number of hours turned out to be 12.2, with a standard deviation of 10.5. A similar survey at private universities had an average of 9.2 hours, with a standard deviation of 9.9. Is the difference between these two averages due to chance?
11. John claims that he has extrasensory powers and can tell which of two symbols is on a card turned face down. To test his ability, he is asked to do a sequence of trials. The null hypothesis is that he is just guessing, so that the probability of being right on any trial is $1/2$, whereas the alternative hypothesis is that he can name the symbol correctly more than half the time. Devise a test with the following properties:
- If the null hypothesis is correct, then it is accepted at least 95% of the time.
 - If John can guess symbols correctly with probability $\geq 3/4$, then the alternative hypothesis is accepted at least 95% of the time.
12. A survey was conducted to determine the distribution of marital status by sex for persons age 25-29 in Wyoming. A random sample of 103 people was chosen, of whom 48 were men and 55 were women. The following results were obtained:

	Men	Women
Never married	43.8%	16.4%
Married	41.7%	70.9%
Widowed, divorced, separated	14.6%	12.7%

Are the distributions really different for men and women?