

USGS Data Exploration Unit: Lesson 1 Smoking Bias Activity (KEY)

When you are given scientific information, it is important to be able to evaluate if the information is accurate. You can investigate the accuracy of scientific information by evaluating whether the conclusions presented are justified based on the experimental design used to collect data. In today's activities you will practice identifying sources of bias introduced by different experimental designs.

In Part 1, you will be presented with six studies, all which make different claims about the rate of teenage smoking. First, carefully read each study and the results from each study. Next, report an aspect of the experimental design that might bias the results. Following this, determine if the bias you have identified is sampling bias (testing unrepresentative sample, not taking a random sample, or taking too small a sample) or measurement error. Finally, write two sentences explaining the possible affects of the bias on the results (e.g. overestimation or underestimation of teenage smoking). In Part 2, you will be asked to design your own experiment to determine the rate of teenage smoking.

PART 1: Evaluating different experimental designs

Experiment 1: Dr. Jackson is making observations at Davisville High School to investigate the rate of smoking among American teenagers. Dr. Jackson decides she will observe students having their lunch in the parking lot where smoking is permitted. Dr. Jackson observes 25 out of 30 students smoking in the parking lot. Based on her observations she records that 83.3% of American teenagers smoke.

Source of Bias: Looking only at the smoking parking lot.

Type of Bias: Sampling bias

Affects of Bias on Results: Since Dr. Jackson is only looking at the smoking parking lot, the rate of teenage smoking assessed from this sample will not be representative of the population of teenagers; and will most likely be higher than the smoking rate of all teenagers.

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Experiment 2: Dr. Cloud is conducting interviews of Davisville and Springville High School students to determine the rate of smoking among American teenagers. Dr. Cloud gets a list of all the students from each high school and randomly selects 50 students from each school. An appointment for the interview is scheduled with each student and their parents. Each student is interviewed with their parents in the room. The students are asked questions such as, “Do you smoke regularly?”, “Have you ever smoked?”, and “What percentage of your friends smoke?” After finishing the interviews Dr. Cloud concludes that only 1% of American teenagers smoke regularly and 18% of teenagers have tried smoking.

Source of Bias: Having the parents in the room

Type of Bias: Measurement bias

Affects of Bias on Results: Few students will admit in front of their parents that they smoke so there will likely be an underestimation of the teenage smoking rate.

Experiment 3: Dr. Garcia is using both observations and interviews to investigate the rate of smoking among American teenagers. She first selected three study sites: one urban, one rural, and one suburban. Dr. Garcia went to two popular teenage hangouts in each study site and made observations of the teenage students standing around the buildings. She observed a total of 117 students and of those 33 were smoking (28%). Dr. Garcia then went to one high school in each study site and interviewed 25 students from each school. The principal of each school selected the 25 students that would be interviewed for Dr. Garcia’s study. Of the 75 total students only 3 said that they smoked regularly (4%). Taking the average percentage from her observations and interviews, Dr. Garcia concluded approximately 16% of American teenagers smoke.

Source of Bias: Sampling a teenage hangout and students selected by the principal

Type of Bias: Sampling bias

Affects of Bias on Results: Although the teenage hangout results may give an overestimation of the teenage smoking rate and sampling the students selected by the principal may give an underestimation of the teenage smoking rate, there is no reason to believe that these biases will cancel each other out to give an accurate smoking rate.

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Experiment 4: Dr. Nandi is using confidential interviews to estimate the rate of smoking among American teenagers. She contacted principals at three high schools (rural, urban, and suburban) and asked for entire lists of their student body. After randomly selecting 50 students from each school she gave permission slips and confidentiality forms to each student so that the students' parents would know that their child was participating in the study and they, as parents, would not have access to the file on their own child. Roughly 35 students from each school returned the permission slips and confidentiality forms. Students were asked fifteen questions about their experiences with smoking. Dr. Nandi found that 53% of the high school students had tried smoking and 25% of high school students smoke a half pack of cigarettes or more a day.

Source of Bias: Requiring the permission slips to be returned to be able to sample

Type of Bias: Sampling bias

Affects of Bias on Results: Although this is not as blatant a bias as 1-3, by requiring the students to return the permission slip, there may be some self-selection for students who don't smoke resulting in an underestimation of the teenage smoking rate.

Experiment 5: Dr. Wellstone is using a shadowing method to study rates of smoking among American high school students. First, Dr. Wellstone hired 50 college freshmen and sophomores making certain that the hired students blended in well with the high school students being sampled. He received a list of students attending Davisville and Springville high schools and randomly selected 25 students from each school. Each college student Dr. Wellstone hired shadowed one of the randomly selected high school students from 3 pm to 5 pm and the college students attended Thursday, Friday, and Saturday night parties for two consecutive weeks. The hired college students recorded whether or not their study subject smoked and, if so, how often. Dr. Wellstone concluded that 28% of American teenagers smoke regularly and 44% will smoke at weekend parties only.

Source of Bias: Students only monitored from 3-5 pm and at parties.

Type of Bias: Measurement bias

Affects of Bias on Results: Observing students for only 2 hours of the day may result in an underestimation of the rate of teenage smoking. Students who smoke in the morning or at night (not at parties) may not be counted as smokers. By the same logic, the percentage of teenagers that smoke only at parties may be an overestimation since some of these smokers may smoke at other times but just not during 3-5 pm.

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Experiment 6: A citizen’s group, No Butts, has passed around a petition that will make it illegal to have billboard cigarette advertisements in their city. The group claims that billboard cigarette advertisements are often geared at teenagers and that these billboards cause increased smoking rates among teens. The Dancing Frog Cigarette Company claims that their advertising is not aimed at teenagers and that restricting their advertising will have no effect on the rate of teenage smoking. To demonstrate their point, Dancing Frog Cigarette Company hires Dr. Crabtree to conduct a study comparing the smoking rate at schools in towns with cigarette billboard advertising and schools in towns without cigarette billboard advertising. Dr. Crabtree goes to three freshman classrooms in areas with and without advertising. These areas are approximately 5 miles apart. Dr. Crabtree asks the students to raise their hands if they would answer “yes” to the following questions: Have you ever smoked? Do you smoke everyday? Do you smoke once a month or more? The following data was recorded from Dr. Crabtree’s data collection:

	Schools Without Advertising	Schools With Advertising
Have you smoked?	4%	3.5%
Daily Smoker?	1.3%	1.5%
Monthly Smoker?	2.1%	2%

Because there is no significant difference in the results, Dr. Crabtree concludes that the cigarette advertising has no effect on the teenage smoking rate.

Source of Bias: Areas being compared are only 5 miles apart, Student asked to raise hands in classroom.

Type of Bias: Sampling bias and measurement bias

Affects of Sampling Bias on Results: The inhabitants of the two towns have probably both seen the same advertising since the towns are only separated by 5 miles, a distance likely to be traveled regularly. This contributed to sampling bias. Asking student to raise their hands in front of their classmates will most likely affect their answers, introducing measurement bias. If smoking is considered to be hip or desirable, the smoking rate may be overestimated. If smoking is considered to be stupid or undesirable, the smoking rate may be underestimated.

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PART 2: Designing your own experiment

The studies above give examples of ways in which bias is unintentionally and intentionally introduced into scientific research. In the next activity you will break into groups of three to five students and design your own experiment to determine the rate of smoking among teenagers at your high school. Try to minimize bias in your experiment. In the space below, describe the experiment you will use to determine the rate of teenage smoking at your high school and identify possible sources of bias in your experiment.

Method to determine the number of students that smoke at your high school:

Sources of possible bias in your experiment: