EXAMPLES ON STUDIES

QUESTION 1 Men who engaged in regular, vigorous exercise as teens and young adults drastically cut their risk of developing Parkinson's disease later in life, a study reports. As many as 1 million people in the USA, including actor Michael J. Fox, have this progressive neurological disease, which commonly strikes after age 50.

In addition to suggesting that exercise could ward off the disease, the findings also raise the hope that physical activity might help the line on brain cell destruction in people who already have it. Robin Elliott, executive director of the Parkinson's Disease Foundation in New York, said the study is promising because there is no cure for Parkinson's. Doctors today have no way to stop or delay the progression of the disease, which affects the brain region that controls movement. Common symptoms of Parkinson's are tremors and a shuffling gait.

Researcher Alberto Ascherio of the Harvard School of Public Health and his colleagues studied 48,000 men and 77,000 women who were relatively healthy and middle-aged or older at the study's start. Over the course of the study, 387 people developed the disease. The team did a statistical analysis to look for a link between physical activity and the risk of Parkinson's.

a) What is the explanatory variable? The response?
b) Is this an observation study or an experiment. Explain, providing relevant details.
c) Based on the study, what conclusions <u>can</u> and <u>cannot</u> be drawn?
d) Suggest a suitable pair of Hypotheses for the study.
e) Based on the information in the study – no math required! – suggest <u>any</u> plausible P-value and interpret it in context.
f) Can the results of this study be generalized to all men and women? Why or why not? To whom *could* it be generalized to?

Solution.

a) Explanatory variable: (Regularity of) Exercise as teens and young adults,
Response variable: Incidence of Parkinson's disease
b) This is an observation study since the researchers passively observed and recorded information about (Regularity or Incidence of) Exercise as teenagers and Incidence of Parkinson's disease, without seeking to influence their response. They did not randomly assign the the individuals to the "treatment" groups.
c) This was an observation study and not a well-designed randomized controlled

comparative experiment, so we only conclude that there is an association between (Regularity or Incidence of) Exercise as teens and Incidence of Parkinson's disease. We cannot conclude that Exercise *caused* or was responsible for the lower risk of Parkinson's disease.
d) Ho: there is no significant difference in the proportion of individuals suffering from Parkinson's between those that exercised as teens and those that didn't
H1: the proportion of individuals suffering from Parkinson's is significantly lower for those that exercised as teens than for those that didn't
e) Our P-value of ≈0% indicates that ***if*** there is no significant difference in the proportion of individuals suffering from Parkinson's between those that exercised as teens and those that didn't, we'd get a result as extreme as that observed almost never.
f) No, the conclusions are not generalizable to all men and women since it was not a random sample from the entire population. It is relevant only to men and women who were relatively healthy and middle-aged or older.

QUESTION 2 The article "Television's Value to Kids: It's All in How They Use It" (*Seattle Times*, July 6, 2005) described a study in which researchers analyzed standardized test results and television viewing habits of 1700 children. They found that the proportion of children scoring poorly on reading ability tests and short-term memory tests was higher for those that averaged more than 2 hours of television viewing per day when they were younger than 3 than for those that didn't.
a) Is this an experiment or an observation study? Explain.
b) What was the explanatory variable(s)? Response variable(s)?
c) State a pair of Hypotheses that was likely to have been used. Define the Parameter of Interest. **Tip!** Is this a Mean or Proportion scenario?
d) Name the test of hypotheses that would have been used, based on c).
e)
(I) Is it reasonable to conclude that watching two or more hours of television caused lower reading scores? Explain based on the nature of the study.
(II) What conclusions *can* be drawn, based on the study? **Read the entire Q again and answer BOTH components.**
f) Do you think it is reasonable to generalize the results of this study to all children? Explain. **Tip!** Under what circumstances can you generalize the results?

Solution.

a) This is an observation study since the researchers passively collected / recorded information about TV habits of children and their test scores subsequently, and did not seek to influence their response [test scores]. The researchers did not randomly assign the subjects to different "treatment groups" – more than 2 hours or TV / day,

or not – or carefully control the conditions of the study.
b) Explanatory Variable: Viewing 2 hours of television per day [Y / N]; Response Variables: Proportion of children scoring poorly on reading ability tests and short-term memory tests.
c) Proportion situation: Ho: P1 – P2 = 0, there is no significant difference in the **Proportion** of children scoring poorly on reading ability tests and short-term memory tests between those that averaged more than 2 hours of television viewing per day when they were younger than 3 (1) and those that didn't (2)
H1: P1 – P2 > 0, the **Proportion** of children scoring poorly on reading ability tests and short-term memory tests and averaged more than 2 hours of television viewing per day when they were younger than 3 was significantly higher than those that didn't.

Parameter of Interest: P1 – P2, difference in the **Proportion** of children scoring poorly on reading ability tests and short-term memory tests between those that averaged more than 2 hours of television viewing per day when they were younger than 3 (1) and those that didn't (2)

d) 2-Prop Z-Test for Difference in Proportions
e) Since this is an observation study, we cannot conclude that TV habits caused the lower scores. We can only infer that there is a negative relationship / association between TV habits and test scores.
f) It would be reasonable to generalize the results to all children ***only if*** these 1700 were representative of the population.

QUESTION 3 Is brain volume associated with schizophrenia? A study conducted by researchers was designed "to determine the genetic and nongenetic factors to structural brain abnormalities on schizophrenia." The researchers determined the brain volumes of 29 twins who were patients diagnosed with schizophrenia and compared them to the brain volumes of 29 healthy twins. Based upon a high-resolution MRI, it was determined the whole-brain volumes were smaller in the schizophrenic patients. The researchers concluded that an increased genetic risk to develop schizophrenia is related to reduced brain growth early in life.
a. What is the Explanatory variable? [**Tip!** Which variable or factor *affected* the response? It's a categorical variable...] What was the Response variable? [**Tip!** What was measured at the end of the study?]
b. Is this an observation study or an experiment? Justify ***in detail*** based on their definitions.

c. Based on ***b,*** what could we conclude? Why can we not conclude that schizophrenia *causes* brain volumes to shrink?

d. HELPING YOU THINK Is this a Mean or Proportion situation? [Read the Q...] State a pair of Hypotheses that may have been used, and define the Parameter of Interest.
e. State the Procedure used to Test the Hypotheses in ***d*.**

Solution.

a) The explanatory variable is: [Presence of] Schizophrenia; the Response is: Whole-brain volume
b) Objective: Determine the genetic and nongenetic factors to structural brain abnormalities to schizophrenia; specifically, is brain volume associated with Schizophrenia. The sample was the 29 schizophrenic and 29 healthy twins.
b) This is an observation study since the researchers passively collected / recorded information about presence of schizophrenia and brain volumes for the sets of twins and did not seek to influence the response being measured [brain volume]. The researchers did not randomly assign the subjects to different "treatment groups", or control the conditions of the study.
c) We can only infer association – or a relationship between – between the explanatory [schizophrenia / not] and response variable [brain volumes] since this is an observation study. Since this is not an randomized controlled experiment, we cannot conclude that it was indeed schizophrenia that *caused* the brain volumes to shrink.
d) Mean situation: Ho: $\mu 1 - \mu 2 = 0$, there is no significant difference in the **Mean** brain volume between the Schizophrenic (1) and Healthy (2) twins

H1: $\mu 1 - \mu 2 < 0$, the **Mean** brain volume between the Schizophrenic (1) twin was significantly lower than for the Healthy (2) twin

Parameter of Interest: $\mu 1 - \mu 2 \sim$ Difference in true Mean brain volume between the Schizophrenic (1) and Healthy (2) twins

e) T-test for Difference in Means [independent samples]

QUESTION 4 Merck Pharmaceutical Company manufactures Propecia, a drug that claims to treat male pattern hair loss on the vertex (top of the head) and anterior midscalp area in men. For 12 months, doctors studied over 1800 men aged 18 to 41 with mild to moderate amounts of ongoing hair loss. All men, whether receiving Propecia or placebo (a pill containing no medication), were given a medicated shampoo. In general, men who took Propecia maintained or increased the number of visible scalp hairs and noticed improvement in their hair in the first year, with the effect maintained in the second year. Hair counts in men who did not take Propecia continued to decrease. Merck concluded that Propecia is effective in

maintaining or increasing the amount of hair on the vertex and anterior midscalp area.
a. Is this an observation study or an experiment? Justify ***in detail*** based on the definitions + the evidence.
b. What could be concluded from the study? Write an answer based on ***a***.
c. What was the explanatory variable? [**Tip!** Which variable or factor *affected* the response? It's a categorical variable...] What was the Response variable? [**Tip!** What was measured at the end of the study?]
d. Who were the subjects of this study?
e. Is this a Mean or Proportion situation? [Read the Q...] State a pair of Hypotheses – in symbols and words – that may have been used, and define the Parameter of Interest.
f. State the Procedure used to Test the Hypotheses in ***e*.**
g. Suppose the P-value for the study was 1.3%. Interpret the P-value in context, and write a detailed conclusion.

Solution.

a) The study is an Experiment since the researchers [likely] randomly assigned **[Randomization]** the subjects: 1800 men **[Replication]**, 18-41 years old, with mild to moderate hair-loss **[Direct Control of extraneous factors to make the treatment groups comparable]** to one of the 2 treatment groups, Propecia vs. Placebo [**Comparison Group**], and controlled the conditions across the treatment groups to make the circumstances as alike as possible [also **Direct Control]** to observe the ***differences*** in the response.

b) Since this is likely a well-designed randomized placebo-controlled comparative experiment, we can infer causation between the treatment Propecia and the response, Hair Count i.e. Propecia is indeed effective in maintaining or increasing the amount of hair on the vertex and anterior midscalp area.
c) Explanatory variable: Propecia; Response variable: Hair Count ~ Number of Visible Scalp Hair
d) Sample: 1800 men, 18-41 years old, with mild to moderate hair-loss

e) Mean situation:

Ho: $\mu 1 - \mu 2 = 0$, there is no significant difference in the **Mean** hair count between the Propecia (1) and Placebo (or Control) (2) groups

H1: $\mu 1 - \mu 2 > 0$, the **Mean** hair count for the Propecia (1) group was significantly higher than for the Placebo (or Control) (2) group

Parameter of Interest: $\mu 1 - \mu 2$ ~ Difference in true Mean hair Count for Propecia and Control / Placebo group

f) T-test for Difference in Means [independent samples]

g) Our P-value of 1.3% indicates that if indeed there is no significant difference in the **Mean** hair count between the Propecia (1) and Placebo (or Control) (2) groups, we would get a result as extreme as that observed in only 1.3% of similar experiments or studies. Since the P-value = 1.3% < 5%, we find the results to be statistically significant and not attributable to natural sampling variations. We reject Ho at the 5% significance level and conclude that we did find evidence that

the **Mean** hair count for the Propecia (1) group was significantly higher than for the Placebo (or Control) (2) group.