Math 247: Test 2 Take Home **Name:** KEY

_____/30 points **Class day and time:** _____

Due at the beginning of class on Thursday, 10/10/19.

I encourage you to work with other students in the class but the final work you hand in must be your own. You may consult with tutors for general guidance but please do not ask them to solve the problems for you!

For full credit, your work must be clear, legible and well organized.

this should be "preventing" not "treating"

Vitamin C A study (double-blind) was done investigating the therapeutic value of vitamin C (ascorbic acid) for treating common colds. The study (done in 1971 by Linus Pauling) was conducted during a 2-week period on a sample of 279 school children in a skiing camp in the Swiss Alps. The participants were split into two groups (assume random assignment), one taking 1 gram of vitamin C per day and the other taking a placebo. At the end of two weeks the researchers assessed who had gotten a cold and who hadn't.

What is the research question? Does Vitamin C reduce the incidence of colds in school age children?

What is the Independent Variable? Vitamin C (1 gram)

What is the Dependent Variable? Incidence of Colds

Will this study be able to establish cause and effect? Explain how you can tell.

Short answer: Yes, because this is a controlled, double-blind experiment (with random assignment into groups), the results will establish cause-and-effect if there is a significant association between Vitamin C and the incidence of colds.

Results from the study:

	Cold	No Cold	Total
Placebo	31	109	140
Vitamin C	17	122	139
Total	48	231	279

$P(\text{colds} \mid \text{no Vit C}) = \frac{31}{140} = .221 = 22.1\%$

$P(\text{colds} \mid \text{Vit C}) = \frac{17}{139} = .122 = 12.2\%$

$P(\text{colds}) = \frac{48}{279} = .172 = 17.2\%$

Does this data suggest that there may be a link between taking Vitamin C is linked to fewer colds? Explain youir thinking, using the numbers in the table and relevant percentages.

Yes, there does seem to be a link due to the fact that substantially fewer kids got colds in the Vitamin C group (17 kids, 12.2%) as compared to the kids in the placebo group (31 kids, 22.1%). (Of course this difference may just be due to chance, which is why we need to see if the difference in the groups is statistically significant!)

Conduct a Chi-Square Hypothesis Test (all 4 steps) to see whether there is an association between taking Vitamin C and getting colds. You may write or type your work on the 4 steps. (Space is provided on the next page if you choose to write your work by hand.

For the "Compute" step, do the work for finding the Chi Square value and the degrees of freedom by hand, then use StatCrunch to confirm your results and to find the P-value.

Include the StatCrunch results with your exam. Be sure to include the "Expected Counts" and the "Contribution to Chi square" values in the StatCrunch work.

Step 1: Hypothesize

H_0: There is not an association between taking Vitamin C and getting a cold. They are independent.

H_a: There IS an association between taking Vitamin C and getting a cold.

Note: Cause-and-affect language is also okay here, since the study was a controlled experiment.

Step 2: Prepare

Choose test: χ^2 Test for Association

Level of Significance: $\alpha = .05$ (default)

Check conditions:

1. Random sample from population? No! This is definitely not a random sample from the population of all school-age children. This was a sample of convenience (the kids were already at the camp.) Independent observations? We don't know, so assume *

2. Expected counts all at least 5?

~ see next page ~

Yes, all expected counts are at least 5.

* The kids were undoubtedly not kept separate from one another so the assumption of independent observations is a bit sketchy...

Step 3: Compute

	Cold	No Cold	Total
Placebo	O = 31 E = 24.1	O = 109 E = 115.9	140
Vitamin C	O = 17 E = 23.9	O = 122 E = 115.1	139
Total	48	231	279

Expected (Placebo, Cold)

$$E = \frac{140 \times 48}{279} = 24.1$$

Expected (Placebo, No Cold)

$$E = \frac{140 \times 231}{279} = 115.9$$

Expected (Vit. C, Cold)

$$E = \frac{139 \times 48}{279} = 23.9$$

Expected (Vit. C, No Cold)

$$E = \frac{139 \times 231}{279} = 115.1$$

O	E	$\frac{(O-E)^2}{E}$
31	24.1	$\frac{(31-24.1)^2}{24.1} = 1.976$
109	115.9	$\frac{(109-115.9)^2}{115.9} = .411$
17	23.9	$\frac{(17-23.9)^2}{23.9} = 1.992$
122	115.1	$\frac{(122-115.1)^2}{115.1} = .414$

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$$= 1.976 + .411 + 1.992 + .414$$

$$= 4.793$$

degrees of freedom:

$$df = (2-1)(2-1) = 1 \cdot 1 = 1$$

P-value = .0283

This comes from StatCrunch

Step 4: Interpret

P-value = .0283 < .05 = α

Reject H_0, accept H_a

There is only a 2.83% we would see the differences we observed in the data if there actually wasn't a link between Vitamin C and colds. This means the evidence is against the null, so we can conclude that Vitamin C had a significant effect* in reducing* the incidence of colds. (The study isn't perfect and since the sample isn't random, we can't extend the results to the general population, but, nevertheless, an interesting result!)

* note that the words "reducing" and "effect" imply a cause-and-effect relationship.

Contingency table results:

Cell format

Count
(Expected count)
(Contributions to Chi-Square)

	Cold	No Cold	Total
Placebo	31 (24.09) (1.98)	109 (115.91) (0.41)	140
Vitamin C	17 (23.91) (2)	122 (115.09) (0.42)	139
Total	48	231	279

Chi-Square test:

Statistic	DF	Value	P-value
Chi-square	1	4.8114126	0.0283