Effects of Smoking and Age on Gestation and Infant Mortality

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ABSTRACT: The preparation of this clinical study report is written under legal agreement of patient confidentiality with Sunnytoast Hospital, studied jointly with data provided by Physician Teng. The following analysis aims to deduce a statistical relationship between age and smoking habits of a mother in respect to mortality and gestational age of an infant. More concisely, this report focuses on the impact of a mother's age and smoking habits with regards to gestational age and infant mortality within one year of birth. Since the data provided is in the form of a contingency table reflecting categorical variables, this report will utilize the statistical test for proportions that assess whether two samples differ significantly in proportions.

INTRODUCTION: This report includes a statistical analysis on the impact of a mother's age and smoking habits with regards to gestational age and infant mortality. Specifically, how categorical classifiers such as age and smoking affect the gestational age and mortality of an infant within one year of birth. Table 1 below reflects the data that is provided for the research purposes of this report. This study will aim to answer critical questions demanded by the Sunnytoast Hospital that involve relational statistical significance between variables such as age, smoking habits and its effects on mortality and gestational age.

Table 1: Cross-classification of infants by their survival and gestational age, and their mother's age and smoking habits

Mother's Age	Smoker	Premature Infant		Full Term Infant	
		Died in 1st Year	Alive in 1st Year	Died in 1st Year	Alive in 1st Year
Younger	No	50	315	24	4012
	Yes	9	40	6	459
Older	No	41	147	14	1594
	Yes	4	11	1	124

RELATIONSHIP BETWEEN MOTHER'S AGE AND SMOKING The study is interested in possible significant relationship between a mother's age and the consequence of being a smoker or nonsmoker. Specifically, the report examines if younger or older mothers are more likely to smoke.

To examine this relationship, a 2x2 contingency table depicting relational counts between categorical variables - *Mother's Age* and *Smoker* - is constructed. The contingency table outlines two samples depicting mutually exclusive events with different proportions of successes and failures. We define the following null and alternative hypothesis:

H (Null)**.** *The proportion of smoking young mothers and older mothers are equal ($p_1 = p_2$)*

H (Alt)**.** *The proportion of smoking young mothers and older mothers are not equal ($p_1 \neq p_2$)*

Since the sample size is relatively large, assuming that the data is randomly sampled, it suffices to use the two sample Z test of proportions.

Equation (1) on the right hand side provides the formula for the two sample Z-test of proportions. The appropriate values to calculate the Z-test statistic are found in Table 2.

In this particular case, $\hat{p}_1$ is set to be proportion of young mothers who are smokers. Thus, $\hat{p}_2$ would represent the proportion of older mothers who are smokers, and $\hat{p}_0$ being the proportion of total smokers across both samples.

Table 2: 2x2 contigency table of categorical variables Age and Smoker

	Smoker		
Age	Yes	No	Total
Younger	514	4401	4915
Older	140	1796	1936
Total	654	6197	6851

Equation (1): Two sample Z test of proportions

$$Z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}_0(1-\hat{p}_0)(\frac{1}{n_1} + \frac{1}{n_2})}}$$

$\hat{p}_1$ = sample 1 proportion of successes
$\hat{p}_2$ = sample 2 proportion of successes
$\hat{p}_0$ = pooled sample successes

And finally, n_1 would be the total number of young mothers and n_2 would be the total number of older mothers.

Thus we have $\hat{p}_1 = 514/4915$,$\hat{p}_2 = 140/1936$,$\hat{p}_0 = 654/6851$,$n_1 = 4915$, and $n_2 = 1936$. Using the prop.test function in r, we obtain *outcome*1[1] and a p-value of 0.000052. Thus we reject the null hypothesis and determine that the results are statistically significant. The proportions between the two sample groups are not equal and since $\hat{p}_1$ represents a higher proportion of smokers for younger mothers, the report deduce that there is statistically sufficient evidence to support that young mothers are more likely to be smokers than older mothers.

RELATIONSHIP BETWEEN AGE, SMOKING AND GESTATIONAL AGE This study is also interested in the relationship between a mother's age and smoking status in respect to gestational age of their infant. Refer to table 3 and 4 for the contingency tables regarding this portion of the report.

Smoking and Gestational Age The report is interested in whether smokers are more likely to have premature infants. Thus the null and alternative hypothesis are:

H (Null). *The proportion of smokers having premature infants is less than or equal to nonsmokers ($p_1 \leq p_2$)*

H (Alt). *The proportion of smokers having premature infants is greater than nonsmokers ($p_1 > p_2$)*

Referencing Table 3, the variables of interest in this particular experiment are $p_1 = 64/654$, $p_2 = 553/6197$, $\hat{p}_0 = 617/6851$,$n_1 = 654$,$n_2 = 6197$

With the above values in tandem with Equation (1), we conduct a one-tailed two sample Z-test of proportions to obtain a p-value of 0.7456. Thus, we failed to reject the null hypothesis and there is not sufficient evidence to support that smoking has a definitive effect on gestational age.

Table 3: 2x2 contigency table of categorical variables Smoker and Gestational Age

	Gestational Age		
Smoker	Premature	Full Term	Total
Yes	64	590	654
No	553	5644	6197
Total	617	6234	6851

Table 4: 2x2 contigency table of categorical variables Age and Gestational Age

	Gestational Age		
Age	Premature	Full Term	Total
Young	414	4501	4915
Older	203	1733	1936
Total	617	6234	6851

Mother's Age and Gestational Age The report is also interested in whether the older mothers are more likely to have premature infants. Thus the null and alternative hypothesis are:

H (Null). *The proportion of older mothers having premature infants is less than or equal to younger mothers ($p_1 \leq p_2$)*

H (Alt). *The proportion of older mothers having premature infants is greater than younger mothers ($p_1 > p_2$)*

Referencing Table 4, the variables of interest in this particular experiment are $p_1 = 203/1936$, $p_2 = 414/4915$, $\hat{p}_0 = 617/6851$,$n_1 = 1936$,$n_2 = 4915$

With the above values in tandem with Equation (1), we conduct a one-tailed two sample Z-test of proportions to obtain a p-value of 0.00417. Thus, we reject the null hypothesis and the results suggest that there is statistically sufficient evidence to support the claim that older mothers are more likely to have premature infants.

RELATIONSHIP BETWEEN AGE, SMOKING AND INFANT MORTALITY To uncover more about the relationship between the health of an infant in relation to age and smoking habits of a mother, this report will also dive into studying the relationship between age and smoking status of a mother in respect to an infant's mortality within one year of birth. Refer to table 5 and 6 for the contingency tables regarding this portion of the report.

Smoking and Infant Mortality This report is interested in whether or not smokers have a higher infant mortality rate compared to nonsmokers. Thus the null hypothesis and alternative hypothesis are:

H (Null). *The proportion of smokers suffering infant mortality within one year of birth is less than or equal to nonsmokers ($p_1 \leq p_2$)*

H (Alt). *The proportion of smokers suffering infant mortality within one year of birth is greater than nonsmokers ($p_1 > p_2$)*

Referencing Table 5, the variables of interest in this particular experiment are $p_1 = 20/654$, $p_2 = 129/6197$, $\hat{p}_0 = 149/6851$,$n_1 = 654$,$n_2 = 6197$

Performing a one-tailed two sample Z-test of proportions using Equation (1), the test statistic yields a p-value of 0.06847. Thus, the result is significant and we reject the null hypothesis. Therefore, there is enough evidence to support the alternative hypothesis that smokers are more likely to experience babies dying in the 1st year of birth compared to nonsmokers.

Table 5: 2x2 contigency table of categorical variables Smoker and Infant Mortality

	Infant Mortality		
Smoker	Died in One Year	Alive in One Year	Total
Yes	20	634	654
No	129	6068	6197
Total	149	6702	6851

Table 6: 2x2 contigency table of categorical variables Age and Infant Mortality

	Infant Mortality		
Age	Died in One Year	Alive in One Year	Total
Young	89	4826	4915
Older	60	1876	1936
Total	149	6702	6851

Age and Infant Mortality This report is interested in whether older mothers are more likely to have babies who died in the first year. Thus, we test for the following null and alternative hypothesis:

H (Null). *The proportion of older mothers suffering infant mortality within one year of birth is less than or equal to young mothers ($p_1 \leq p_2$)*

H (Alt). *The proportion of older mothers suffering infant mortality within one year of birth is greater than young mothers ($p_1 > p_2$)*

Referencing Table 6, the variables of interest in this particular experiment are $p_1 = 60/1936$, $p_2 = 89/4915$, $\hat{p}_0 = 149/6851$, $n_1 = 1936$, $n_2 = 4915$

Performing a one-tailed two sample Z-test of proportions using Equation (1), the test statistic yields a p-value of 0.0006874. Thus, the result is highly significant and we reject the null hypothesis. Therefore, there is enough evidence to support the alternative hypothesis that older mothers are more likely to experience babies dying in the 1st year of birth compared to younger mothers.

RELATIONSHIP BETWEEN AGE AND SMOKING ON INFANT MORTALITY Following from the above results, this clinical report will also study whether a significant statistical relationship exists between infant mortality if both age and smoking are taken in as factors. Therefore, the study will rely on two contingency tables with conditioned samples on smoking and nonsmoking mothers.

Conditioned on Smoking Table 7 is a contingency table reflecting frequencies of infant survival if the data is restricted only to mothers who are smokers. Thus, the null and alternative hypothesis are:

H (Null). *The proportion of smoking young mothers suffering infant mortality within one year of birth is equal to that of smoking older mothers ($p_1 = p_2$)*

H (Alt). *The proportion of smoking young mothers suffering infant mortality within one year of birth is not equal to that of smoking older mothers ($p_1 \neq p_2$)*

Before any analysis can be done, a statistically significant relationship between infant mortality among smokers and mother's age must be established. Since we are looking for equivalence of proportion, a two-tailed two sample Z-test of proportion is conducted.

Referencing Table 7, the variables of interest in this particular experiment are $p_1 = 15/514$, $p_2 = 5/140$, $\hat{p}_0 = 20/654$, $n_1 = 514$, $n_2 = 140$

From the results, we obtain a p-value of 0.9036 which fails to reject the null hypothesis. Thus, there is not sufficient evidence to support that proportion of infant mortality is different between young smoking mothers and older smoking mothers.

It is of interest to note that earlier portions of the report did outline a statistical significance between smoking and infant mortality. Thus, the categorical variable age may not play a critical role if there already exists the condition of a mother being a smoker.

Table 7: 2x2 contigency table of categorical variables Age and Infant Mortality conditioned on Smoker

	Infant Mortality Among Smokers		
Age	Died in One Year	Alive in One Year	Total
Young	15	499	514
Older	5	135	140
Total	20	634	654

Table 8: 2x2 contigency table of categorical variables Age and Infant Mortality conditioned on nonsmoking mothers

	Infant Mortality Among Nonsmokers		
Age	Died in One Year	Alive in One Year	Total
Young	74	4327	4401
Older	55	1741	1796
Total	129	6068	6197

Conditioned on Nonsmoking Table 8 is a contingency table of frequencies of infant survival if the data is restricted only to mothers who are nonsmokers.Thus, the null and alternative hypothesis are:

H (Null). *The proportion of nonsmoking young mothers suffering infant mortality within one year of birth is equal to that of nonsmoking older mothers ($p_1 = p_2$)*

H (Alt). *The proportion of nonsmoking young mothers suffering infant mortality within one year of birth is not equal to that of nonsmoking older mothers ($p_1 \neq p_2$)*

Referencing Table 8, the variables of interest in this particular experiment are $p_1 = 74/4401$, $p_2 = 55/1796$, $\hat{p}_0 = 129/6197$, $n_1 = 4401$, $n_2 = 1796$

From the results, we obtain a p-value of 0.0007898. Thus, we reject the null hypothesis and establish that there exists sufficient evidence to support that proportion of infant mortality differs between young nonsmoking mothers and older nonsmoking mothers.

To examine the exact effects on how age and smoking impact infant mortality, this report inspects the odds ratio of the contingency table. Refer to Equation (2) under Formulaes of the Appendix for calculation on odds ratio of a contingency table.

The odds ratio in this case for older non-smoking mothers having their infants die within one year is $\frac{(55/1741)}{(74/4327)} = 1.847$ Thus, approximately per every younger nonsmoking mother suffering infant mortality within one year, around 2 older nonsmoking also suffers from infant mortality within one year.

RELATIONSHIP BETWEEN AGE AND SMOKING ON GESTATIONAL AGE The report will also conduct an analysis on if there exists a statistically significant relationship between both age and smoking in regards to gestational age. Here, similar steps are followed as above to condition samples of gestational age of age in regards to smoking and nonsmoking.

Conditioned on Smoking Table 9 is a contingency table reflecting frequencies of gestational age if the data is restricted only to mothers who are smokers. Thus, the null and alternative hypothesis are:

H (Null). *The proportion of smoking young mothers suffering premature infants is equal to that of smoking older mothers ($p_1 = p_2$)*

H (Alt). *The proportion of smoking young mothers suffering premature infants is not equal to that of smoking older mothers ($p_1 \neq p_2$)*

To deduce if a statistically significant relationship between gestational age and mother's age among smoking mothers exist, a two-tailed two sample Z-test of proportion is conducted.

Referencing Table 9, the variables of interest in this particular experiment are $p_1 = 49/514$, $p_2 = 15/140$, $\hat{p}_0 = 64/654$, $n_1 = 514$, $n_2 = 140$.

From the results, we obtain a p-value of 0.7975 which fails to reject the null hypothesis. Thus, there is not sufficient evidence to support that the proportion of premature infants are different between young smoking mothers and older smoking mothers.

Table 9: 2x2 contigency table of categorical variables Age and Gestational Age conditioned on Smoker

	Gestational Age Among Smokers		
Age	Premature	Full Term	Total
Young	49	465	514
Older	15	125	140
Total	64	590	654

Table 10: 2x2 contigency table of categorical variables Age and Gestational Age conditioned on Nonsmoker

	Gestational Age Among Nonsmokers		
Age	Premature	Full Term	Total
Young	365	4036	4401
Older	188	1608	1796
Total	553	5644	6197

Conditioned on Nonsmoking Table 10 is a contingency table of frequencies of gestational if the data is restricted only to mothers who are nonsmokers.Thus, the null and alternative hypothesis are:

H (Null)**.** *The proportion of nonsmoking young mothers suffering premature infants is equal to that of nonsmoking older mothers* ($p_1 = p_2$)

H (Alt)**.** *The proportion of smoking young mothers suffering premature infants is not equal to that of nonsmoking older mothers* ($p_1 \neq p_2$)

Referencing Table 10, the variables of interest in this particular experiment are $p_1 = 365/4401$, $p_2 = 188/1796$, $\hat{p}_0 = 553/6197$, $n_1 = 4401$, $n_2 = 1796$

From the results, we obtain a p-value of 0.007483. Thus, we reject the null hypothesis and establish that there exists sufficient evidence to support that proportion of premature infants differs between young nonsmoking mothers and older nonsmoking mothers.

The odds ratio for Table 10 can be obtained using Equation (2) under the appendix. The odds ratio in this case for older non-smoking mothers having premature infants is $\frac{(188/1608)}{(365/4036)} = 1.293$. Thus, approximately 1.3 older nonsmoking mother suffer premature infants per every young mother suffering a premature infant.

AGE AND SMOKING ON SURVIVAL OF PREMATURE INFANTS The final part of this report examines the statistical relationship between Survival of Premature Infants in respect to Age and Smoking. Similar to above, the analysis conditions the sample based on smoking mothers and nonsmoking mothers.

Conditioned on Smoking Table 11 is a contingency table reflecting frequencies of surviving premature infants among smoking young and older mothers. Thus, the null and alternative hypothesis are:

H (Null)**.** *The proportion of premature infants dying within one year is the same between young smoking mothers and older smoking mothers* ($p_1 = p_2$)

H (Alt)**.** *The proportion of premature infants dying within one year is not the same between young smoking mothers and older smoking mothers* ($p_1 = p_2$)($p_1 \neq p_2$)

To deduce if a statistically significant relationship between premature infant survival rate among younger and smoking smoking mothers exist, a two-tailed two sample Z-test of proportion is conducted.

Referencing Table 11, the variables of interest in this particular experiment are $p_1 = 9/49$, $p_2 = 4/15$, $\hat{p}_0 = 13/64$, $n_1 = 49$, $n_2 = 15$.

From the results, we obtain a p-value of 0.7396 which fails to reject the null hypothesis. Thus, there is not sufficient evidence to support that the proportion of surviving premature infants are different between young smoking mothers and older smoking mothers.

Conditioned on Nonsmoking Table 12 is a contingency table reflecting frequencies of surviving premature infants among nonsmoking young and older mothers. Thus, the null and alternative hypothesis are:

H (Null). *The proportion of premature infants dying within one year is the same between young nonsmoking mothers and older nonsmoking mothers ($p_1 = p_2$)*

H (Alt). *The proportion of premature infants dying within one year is not the same between young nonsmoking mothers and older nonsmoking mothers ($p_1 = p_2$)($p_1 \neq p_2$)*

Referencing Table 12, the variables of interest in this particular experiment are $p_1 = 50/365$, $p_2 = 41/147$, $\hat{p}_0 = 91/553$, $n_1 = 365$, $n_2 = 188$

Table 11: 2x2 contigency table of categorical variables Premature Surival and Age among smoking mothers

	Premature Survival Among Smoking Mothers		
Age	Died in One Year	Alive in One Year	Total
Young	9	40	49
Older	4	11	15
Total	13	51	64

Table 12: 2x2 contigency table of categorical variables Premature Surival and Age among nonsmoking mothers

	Premature Survival Among Nonsmoking Mothers		
Age	Died in One Year	Alive in One Year	Total
Young	50	315	365
Older	41	147	188
Total	91	462	553

From the results, we obtain a p-value of 0.02059 Thus, we reject the null hypothesis and establish that there exists sufficient evidence to support that proportion of surviving premature infants differs between young nonsmoking mothers and older nonsmoking mothers.

The odds ratio for Table 12 can be obtained using Equation (2) under the appendix. The odds ratio in this case for older non-smoking mothers having non-surviving premature infants is $\frac{(41/147)}{(50/315)} = 1.757$. Thus, approximately 1.8 older nonsmoking mother have non-surviving premature infants per every young mother suffering a non-surviving premature infant. Another way to perceive this odds ratio is number of surviving premature infant for young nonsmoking mothers per older nonsmoking mothers. This is represented by $\frac{(315/50))}{(147/41)} = 1.757$. Thus, per every older nonsmoking mother that has premature infant that survived, approximately 1.8 younger nonsmoking mothers has a premature infant that survived.

YOUNG AND OLDER MOTHER'S SMOKING HABITS ON SURVIVAL OF PREMATURE INFANTS Table 13 and Table 14 reflects contingency tables in which the sample groups are conditioned on age instead. The question of interest for this section of the report is how do smoking habits affect survival among premature babies with young mothers? And how do smoking habits affect survival among premature babies with older mothers?

Conditioning on Young Mothers Table 13 is a contingency table reflecting frequencies of surviving premature infants among smoking and nonsmoking young mothers. Thus, the null and alternative hypothesis are:

H (Null). *The proportion of premature infants dying within one year is the same between young smoking mothers and young nonsmoking mothers ($p_1 = p_2$)*

H (Alt). *The proportion of premature infants dying within one year is not the same between young smoking mothers and young nonsmoking mothers ($p_1 = p_2$)($p_1 \neq p_2$)*

To deduce if a statistically significant relationship between premature infant survival rate among smoking and nonsmoking younger mothers exist, a two-tailed two sample Z-test of proportion is conducted.

Referencing Table 13, the variables of interest in this particular experiment are $p_1 = 9/49$, $p_2 = 50/365$, $\hat{p}_0 = 59/414$, $n_1 = 49$, $n_2 = 365$.

From the results, we obtain a p-value of 0.5091 which fails to reject the null hypothesis. Thus, there is not sufficient evidence to support that the proportion of surviving premature infants are different.

Conditioning on Older Mothers Table 14 is a contingency table reflecting frequencies of surviving premature infants among older smoking and nonsmoking mothers. Thus, the null and alternative hypothesis are:

H (Null). *The proportion of premature infants dying within one year is the same between older smoking mothers and older nonsmoking mothers ($p_1 = p_2$)*

H (Alt). *The proportion of premature infants dying within one year is not the same between older smoking mothers and older nonsmoking mothers ($p_1 = p_2$)($p_1 \neq p_2$)*

Referencing Table 14, the variables of interest in this particular experiment are $p_1 = 4/15$, $p_2 = 41/188$, $\hat{p}_0 = 45/203$, $n_1 = 15$, $n_2 = 188$

From the results, we obtain a p-value of 0.9101 which fails to reject the null hypothesis. Thus, there is not sufficient evidence to support that the proportion of surviving premature infants are different between older smoking mothers and older nonsmoking mothers.

Table 13: 2x2 contigency table of categorical variables Premature Surival and Age among smoking mothers

	Premature Survival Among Young Mothers		
Smoker	Died in One Year	Alive in One Year	Total
Yes	9	40	49
No	50	315	365
Total	59	355	414

Table 14: 2x2 contigency table of categorical variables Premature Surival and Age among nonsmoking mothers

	Premature Survival Among Older Mothers		
Smoker	Died in One Year	Alive in One Year	Total
Yes	4	11	15
No	41	147	188
Total	45	158	203

CONCLUSION From the above results, there are heavy indicators that suggest infant survival is tied more closely to gestation age more so than the smoking habits of the mother. Anytime samples from the contingency table suggest a significant difference in gestational age, there also exists a correlative significant difference in survival of the infant. Young mothers are more likely to smoke but that factor has no relation to the likelihood of having premature babies. In general, older mothers are more likely to have premature babies and more likely to suffer infant mortality.

Although smokers are more likely to have infant mortality compared to nonsmokers, this report does not have substantive evidence for why. However, the report does suggest that there is not any significant difference between the mortality of premature infants among smokers and non smokers in either age groups. Thus, being a smoker and non-smoker does not affect the chances of survival for a premature infant regardless of a mother's age.

The report suggests an increase monitorization and advisory caution for older mothers looking into child birth.

The report concludes by suggesting that further research is to be conducted on smoking mothers. A more in depth analysis into both the babies health and habits of smoking mothers might offer more conclusive evidence behind the statistical correlation behind smoking mothers and child mortality. Furthermore, more quantitative analysis is suggested to be collected to find if there is a more defined scalar relationship between age of a mother and infant gestation and mortality.

APPENDIX

Formulaes

Equation (1): Two sample Z test of proportions

$$Z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}_0(1-\hat{p}_0)(\frac{1}{n_1}+\frac{1}{n_2})}}$$

$\hat{p}_1$ = sample 1 proportion of successes

$\hat{p}_2$ = sample 2 proportion of successes

$\hat{p}_0$ = pooled proportion of success combined sample 1 and sample 2

n_1 = total count of sample 1

n_2 = total count of sample 2

Equation (2): Odds Ratio

Given the following contigency table below:

		Event	
		Yes	No
Exposure	Yes	a	b
	No	c	d

Odds Ratio = $\frac{\text{Odds of the event in the exposed group}}{\text{Odds of the event in non-exposed group}}$

Odds Ratio = $\frac{a/b}{c/d} = \frac{ad}{bc}$

Test 1:

H (Null). *Young mothers and older mothers are equally likely to smoke ($p_1 = p_2$)*

H (Alt). *Young mothers and older mothers are not equally likely to smoke ($p_1 \neq p_2$)*

$\hat{p}_1 = 514/4915$,$\hat{p}_2 = 140/1936$,$\hat{p}_0 = 654/6851$,$n_1 = 4915$, and $n_2 = 1936$.

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(514, 140) out of c(514 + 4401, 140 + 1796)
## X-squared = 16.372, df = 1, p-value = 5.204e-05
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  0.01754066 0.04698689
## sample estimates:
##     prop 1     prop 2
## 0.10457782 0.07231405
```

Test 2:

H (Null). *Smokers are less or equally likely to have premature infants than nonsmokers ($p_1 \leq p_2$)*

H (Alt). *Smokers are more likely to have premature infants than nonsmokers ($p_1 > p_2$)*

$p_1 = 64/654$, $p_2 = 553/6197$, $\hat{p}_0 = 617/6851$,$n_1 = 654$,$n_2 = 6197$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(64, 553) out of c(654, 6197)
## X-squared = 0.43665, df = 1, p-value = 0.2544
## alternative hypothesis: greater
## 95 percent confidence interval:
##  -0.01224015  1.00000000
## sample estimates:
##     prop 1     prop 2
## 0.09785933 0.08923673
```

Test 3

H (Null). *Older mothers are less or equally likely to have premature infants than younger mothers ($p_1 \leq p_2$)*

H (Alt). *Older mothers are more liokely to have premature infants than younger mothers ($p_1 > p_2$)*

$\hat{p}_1 = 203/1936$, $\hat{p}_2 = 414/4915$, $\hat{p}_0 = 617/6851$,$n_1 = 1936$,$n_2 = 4915$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(203, 414) out of c(1936, 4915)
## X-squared = 6.9592, df = 1, p-value = 0.00417
## alternative hypothesis: greater
## 95 percent confidence interval:
##  0.007086529 1.000000000
## sample estimates:
##     prop 1     prop 2
## 0.10485537 0.08423194
```

Test 4

H (Null). *Mothers who are smokers are less or equally likely to suffer first year infant mortality compared to nonsmoking mothers ($p_1 \leq p_2$)*

H (Alt). *Mothers who are smokers are more likely to suffer first year infant mortality compared to nonsmoking mothers ($p_1 > p_2$)*

$p_1 = 20/654$, $p_2 = 129/6197$, $\hat{p}_0 = 149/6851$,$n_1 = 654$,$n_2 = 6197$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(20, 129) out of c(654, 6197)
## X-squared = 2.212, df = 1, p-value = 0.06847
## alternative hypothesis: greater
## 95 percent confidence interval:
##  -0.002549847  1.000000000
## sample estimates:
##     prop 1     prop 2
## 0.03058104 0.02081652
```

Test 5

H (Null). *Older mothers are less or equally likely to suffer first year infant mortality compared to young mothers ($p_1 \leq p_2$)*

H (Alt). *Older mothers are more likely to suffer first year infant mortality compared to young mothers ($p_1 > p_2$)*

$p_1 = 60/1936$, $p_2 = 89/4915$, $\hat{p}_0 = 149/6851$, $n_1 = 1936$, $n_2 = 4915$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(60, 89) out of c(1936, 4915)
## X-squared = 10.239, df = 1, p-value = 0.0006874
## alternative hypothesis: greater
## 95 percent confidence interval:
##  0.005329767 1.000000000
## sample estimates:
##     prop 1     prop 2
## 0.03099174 0.01810783
```

Test 6

H (Null). *Young smoking mothers are equally likely to suffering infant mortality within one year of birth as older smoking mothers ($p_1 = p_2$)*

H (Alt). *Young smoking mothers are not equally likely to suffering infant mortality within one year of birth as older smoking mothers ($p_1 \neq p_2$)*

$p_1 = 15/514$, $p_2 = 5/140$, $\hat{p}_0 = 20/654$, $n_1 = 514$, $n_2 = 140$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(15, 5) out of c(514, 140)
## X-squared = 0.014657, df = 1, p-value = 0.9036
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.04508594  0.03202312
```

```
## sample estimates:
##     prop 1     prop 2
## 0.02918288 0.03571429
```

Test 7

H (Null). *Young nonsmoking mothers are equally likely to suffer first year infant mortality as older non-smoking mothers ($p_1 = p_2$)*

H (Alt). *Young nonsmoking mothers are not equally likely to suffer first year infant mortality as older nonsmoking mothers ($p_1 \neq p_2$)*

$p_1 = 74/4401$, $p_2 = 55/1796$, $\hat{p}_0 = 129/6197$, $n_1 = 4401$, $n_2 = 1796$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(74, 55) out of c(4401, 1796)
## X-squared = 11.265, df = 1, p-value = 0.0007898
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.023028751 -0.004589745
## sample estimates:
##     prop 1     prop 2
## 0.01681436 0.03062361
```

Test 8

H (Null). *Young smoking mothers are equally likely to suffer premature infants as older smoking mothers ($p_1 = p_2$)*

H (Alt). *Young smoking mothers are not equally likely to suffer premature infants as older smoking mothers ($p_1 \neq p_2$)*

$p_1 = 74/4401$, $p_2 = 55/1796$, $\hat{p}_0 = 129/6197$, $n_1 = 4401$, $n_2 = 1796$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(49, 15) out of c(514, 140)
## X-squared = 0.065835, df = 1, p-value = 0.7975
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.07353543  0.04991120
## sample estimates:
##     prop 1     prop 2
## 0.09533074 0.10714286
```

Test 9

H (Null). *Young nonsmoking mothers are equally likely to suffer premature infants as older nonsmoking mothers ($p_1 = p_2$)*

H (Alt). *Young nonsmoking mothers are not equally likely to suffer premature infants as older nonsmoking mothers ($p_1 \neq p_2$)*

$p_1 = 365/4401$, $p_2 = 188/1796$, $\hat{p}_0 = 553/6197$, $n_1 = 4401$, $n_2 = 1796$

```
##
##  2-sample test for equality of proportions with continuity correction
##
```

```
## data:  c(365, 188) out of c(4401, 1796)
## X-squared = 7.1531, df = 1, p-value = 0.007483
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.038468743 -0.005013984
## sample estimates:
##    prop 1    prop 2
## 0.0829357 0.1046771
```

Test 10

H (Null). *Young smoking mothers are equally likely to suffer premature infant fatality compared to older smoking mothers ($p_1 = p_2$)*

H (Alt). *Young smoking mothers are not equally likely to suffer premature infant fatality compared to older smoking mothers($p_1 \neq p_2$)*

$p_1 = 9/49$, $p_2 = 4/15$, $\hat{p}_0 = 13/64$, $n_1 = 49$, $n_2 = 15$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(9, 4) out of c(49, 15)
## X-squared = 0.11045, df = 1, p-value = 0.7396
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.3751989  0.2092125
## sample estimates:
##    prop 1    prop 2
## 0.1836735 0.2666667
```

Test 11

H (Null). *Young nonsmoking mothers are equally likely to suffer premature infant fatality compared to older nonsmoking mothers ($p_1 = p_2$)*

H (Alt). *Young nonsmoking mothers are not equally likely to suffer premature infant fatality compared to older nonsmoking mothers($p_1 \neq p_2$)*

$p_1 = 50/365$, $p_2 = 41/147$, $\hat{p}_0 = 91/553$, $n_1 = 365$, $n_2 = 188$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(50, 41) out of c(365, 188)
## X-squared = 5.3611, df = 1, p-value = 0.02059
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.153892981 -0.008304629
## sample estimates:
##    prop 1    prop 2
## 0.1369863 0.2180851
```

Test 12

H (Null). *Young smoking mothers and young nonsmoking mothers are equally likely to suffer premature infant fatality ($p_1 = p_2$)*

H (Alt). *Young smoking mothers and young nonsmoking mothers are not equally likely to suffer premature infant fatality ($p_1 \neq p_2$)*

$p_1 = 9/49$, $p_2 = 50/365$, $\hat{p}_0 = 59/414$, $n_1 = 49$, $n_2 = 365$.

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(9, 50) out of c(49, 365)
## X-squared = 0.43586, df = 1, p-value = 0.5091
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.07889946  0.17227380
## sample estimates:
##    prop 1    prop 2
## 0.1836735 0.1369863
```

Test 13

H (Null). *Older smoking mothers and older nonsmoking mothers are equally likely to suffer premature infant fatality ($p_1 = p_2$)*

H (Alt). *Older smoking mothers and older nonsmoking mothers are not equally likely to suffer premature infant fatality ($p_1 \neq p_2$)*

$p_1 = 4/15$, $p_2 = 41/188$, $\hat{p}_0 = 45/203$, $n_1 = 15$, $n_2 = 188$

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(4, 41) out of c(15, 188)
## X-squared = 0.01276, df = 1, p-value = 0.9101
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.2188538  0.3160169
## sample estimates:
##    prop 1    prop 2
## 0.2666667 0.2180851
```