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MA-304
Due 5/11/2021

Smoking Cigarettes During Pregnancy Decreases Birthweight, Effects of Alcohol Unclear

Abstract

An investigation into the effects of cigarettes and alcohol on birthweight was approved by the North Carolina State Center for Health and Environmental Statistics following the collection of 1000 pieces of data. The investigation will examine whether smoking cigarettes or drinking alcohol while pregnant corresponds to a lower birthweight. The investigation concluded that while birthweight tended to be lower for children of mothers who drank alcohol or smoked cigarettes during pregnancy, only cigarettes correlated with a significantly lower birthweight of the child when all other factors were accounted for.

Introduction

Infant birthweight has often been associated with the development of important characteristics such as intelligence, coordination, and strength. Finding factors that decrease birthweight will allow Health and Environment professionals to create more accurate guidelines for pregnant mothers to ensure the safety and health of their newborn child. It is common knowledge that a pregnant woman should not drink alcohol or smoke cigarettes, but this investigation will determine whether those two substances significantly decrease birthweight, and thus contribute to weaker development of the child. This will be accomplished by performing a pair of hypothesis tests, listed below.

Let μ represent the average birthweight among children born under similar circumstances.

H_{01}: $\mu_{smoker} = \mu_{non-smoke}$
H_{a1}: $\mu_{smoker} < \mu_{non-smoker}$

H_{02}: $\mu_{drinker} = \mu_{non-drinke}$
H_{a2}: $\mu_{drinker} < \mu_{non-drinker}$

Summary statistics of the variables included with the dataset are shown below.

Table 1 : variable distributions

Variable	*N*	*Mean*	*St. Dev.*
Mothage	1000	26.015	6.015
Mothed	1000	12.722	2.608
Gest	1000	38.938	2.511
Plural	1000	1.022	0.153
Totounc	1000	116.826	21.383

Table 2 variable distributions

Variable	**Outcome 1**	**Outcome 2**
Sex	511 female	489 male
Marital	668 married	331 not married
Cigs	827 no smoking	173 smoking
Drinks	984 no drinking	16 drinking
Fas	999 no fas	1 fas
btotounc	920 not underweight	80 underweight

Table 3 variable distributions

	Race	*Kessner*
Outcome 1	700 White	790 adequate
Outcome 2	266 Black	159 intermediate
Outcome 3	17 American Indian	50 inadequate
Outcome 4	1 Chinese	1 unknown
Outcome 5	0 Japanese	N/A
Outcome 6	0 Hawaiian	N/A
Outcome 7	0 Filipino	N/A
Outcome 8	16 Other	N/A

Methods

Permutation tests were used in this investigation. Non-parametrized tests are used when underlying assumptions about the data may not be met. In this case, the normality of our response variable (Birthweight in ounces) has irregularities in its normal probability plot[1], so we cannot perform statistical tests like Z-tests or t-tests. The tests in this study were conducted by randomly assigning all subjects to either the treatment or control and measuring the difference in means many times – in this case, 10,000 repetitions are performed. The result, a one-sided p-value, represents the proportion of times the calculated difference in means was equal to or greater than our observed difference in means. This p-value is an estimate of the probability of having a difference in means so high given the null hypothesis is true – a small value (< 0.05) indicates strong evidence in favor of rejecting the null hypothesis.

Results

The first question addressed by the investigation is whether there is a difference in birthweight for those with non-smoking mothers and those with smoking mothers. The boxplots below show the difference in distributions of birthweight separated by whether the mother smoked, and by whether the mother drank alcohol. From the distributions, it is clear that smoking cigarettes and drinking alcohol correlates to a lower birthweight. Next, permutation tests will be run to examine whether these differences are statistically significant.

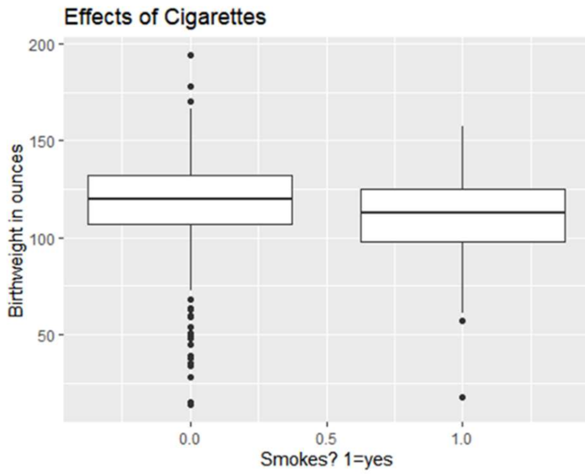


Figure 1 Birthweight by smoking

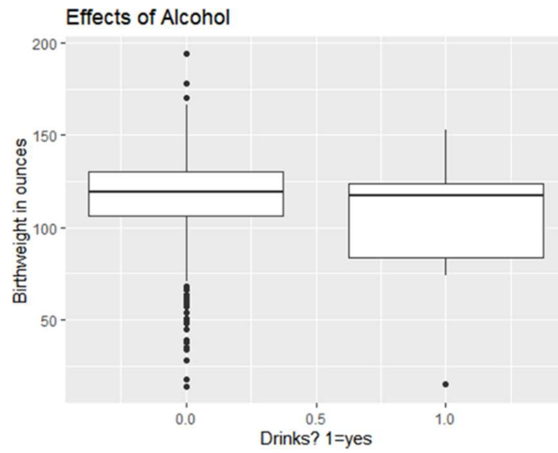


Figure 2 Birthweight by drinking

The measured difference in mean birthweight between those whose mothers smoke and those whose mothers do not smoke is 7.48 ounces, which corresponds to a p-value of 0. This means that, assuming cigarettes have no effect on birthweight, there is a 0% chance of such a high difference in means occurring by random chance alone. The measured difference in mean birthweight between those whose mothers drink and those whose mothers do not drink is 13.03 ounces, which corresponds to a p-value of 0.0126. This means that, assuming alcohol has no effect on birthweight, there is a 1.26% chance of observing such a high difference in means occurring by random chance alone. Based on the results of these permutation tests, a mother smoking cigarettes and drinking alcohol correspond to lower birthweights.

Cigarettes and alcohol are not necessarily the only explanatory variables contributing to this difference in birthweights. Other factors that should be accounted for are the mother's age, the number of completed weeks in gestation, and how many children were carried simultaneously. These are all possible confounders and should be held constant during these permutation tests. The graphs below examine the relationships between cigarettes and alcohol and birthweight while holding these confounding variables constant.

A sample of mothers will be taken who were in gestation for at least 37 weeks and no more than 42 weeks (control for premature and post-term births), who are under the age of 35 (control for age complications), and who only had one child (to account for twins being smaller at birth). The distributions of birthweights are shown below.

Table 4 'normal' births

Variable	***n***	***Avg. Birthweight (oz)***	***St. Dev. birthweight***
Cigarettes	127	114.71	18.07
No cigarettes	647	121.39	17.02
Alcohol	11	116.73	22.80
No Alcohol	763	120.35	17.28

Identical permutation tests were run on this new sample of "normal" births. In this new sample, the measured difference in mean birthweight between those whose mothers smoke and those whose mothers do not smoke is 6.68 ounces, which corresponds to a p-value of 0.0002. This means that, assuming cigarettes have no effect on birthweight, there is a 0.0002% chance of such a high difference in means occurring by random chance alone. The measured difference in mean birthweight between those whose mothers drink and those whose mothers do not drink is 3.62 ounces, which corresponds to a p-value of 0.2478. This means that, assuming alcohol has no effect on birthweight, there is a 24.78% chance of observing such a high difference in means occurring by random chance alone. Based on the results of these tests, for mothers who gave birth under similar circumstances, there is enough evidence to conclude that mothers who smoke have children with a lower average birthweight than those who do not smoke. However, there is not enough evidence to conclude that drinking has a significant effect on birthweight.

We reject H_{01} and adopt H_{a1}. We fail to reject H_{02}.

Discussion

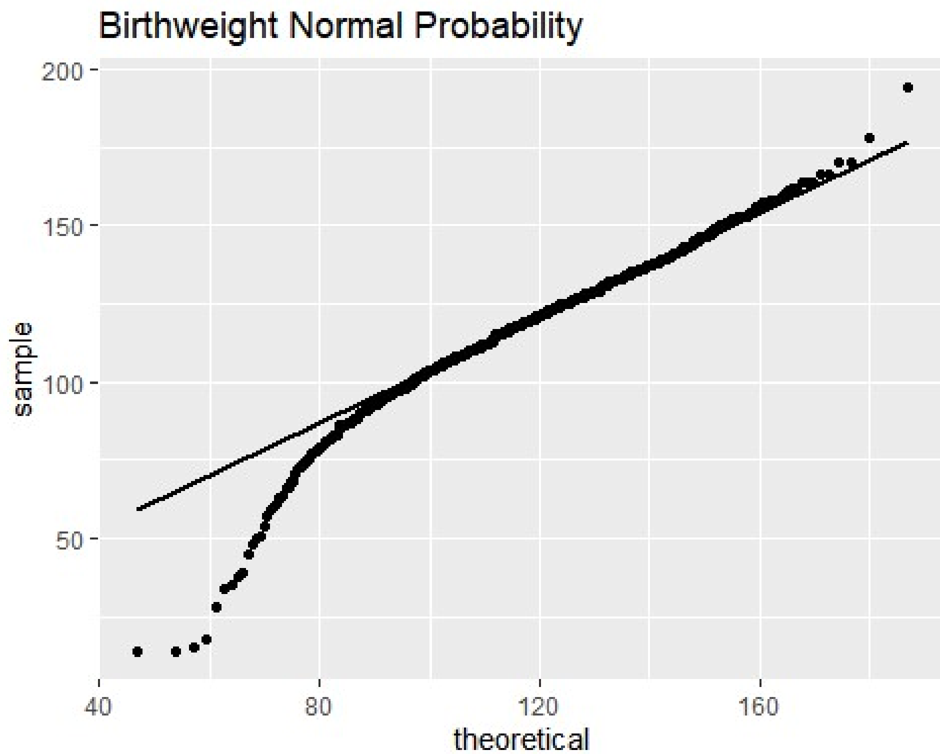
There were observed differences in the birthweights of children whose mothers smoked and those whose did not. There were also observed differences in the birthweights of children whose mothers drank alcohol and those whose did not. The results of the permutation tests confirm that there is strong evidence to conclude that the average birthweight of a child whose mother smoked is lower than the average birthweight of a child whose mother did not smoke. However, there was no evidence to conclude that the birthweights of children whose mothers drank are lower than those whose mothers did not drink *when other explanatory variables are accounted for*. While those who drank tended to have lighter children, the bodyweight is likely explained by a different explanatory variable.

Conclusion

The investigation performed with a nonparametric permutation test concluded that with other explanatory variables accounted for, the average birthweight of a child whose mother smoked during pregnancy is significantly lower than that of a child whose mother did not smoke. More research should be done into the effects of alcohol on birthweight – possibly, ingesting alcohol during pregnancy contributes to a different explanatory variable (such as number of weeks in gestation) that has a higher correlation with birthweight.

Appendix:

1.



Birthweight Normal Probability
200
150
100
50
sample
40
80
120
160
theoretical