An Investigation into the Effect of Maternal Smoking on Birth Weight

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Abstract

The purpose of this investigation is to determine how smoking effects the health of newborn children whose mothers smoked during their pregnancy, specifically, how their birth weight differs. It was hypothesized that smoking during pregnancy increases the likelihood of a baby having a low birth weight. In order to determine the credibility of this hypothesis, three forms of statistical analysis were completed on data from the Child Health and Development Studies database. Using R programming software, the following three analyses were conducted: descriptive analysis (mean, median, maximum, minimum, quartiles, standard deviation); graphical analyses (histograms); incidence of low birthweight comparisons. The results of the investigation show a clear difference in the data of birthweight of babies with smoking and non-smoking mothers. This suggests that a greater amount of the babies born to smoker mothers classify as low birth weight in every threshold in comparison to babies born to non-smoker mothers. Overall, it can be said that the data analysis conducted in this investigation supports the original hypothesis that smoking during pregnancy leads to an increase in frequency o flow birth weights in comparison to babies whose mothers did not smoke.

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Introduction

Over the past few decades, it has been widely discussed in the scientific community the effects of smoking on health. Recreational smoking of cigarettes has been presented as a health issue with the health risks including increased risk of lung cancer as well as coronary heart disease as examples (CDC, 2018). In addition to these risks, there are multiple added complications which can occur if the smoker is pregnant while engaging in smoking such as increased tissue damage of the lung and brain in the baby (US Department of Health and Human Services, 2010). One particular complication which has been studied at length is the relationship between birth weight and smoking during pregnancy. This investigation seeks to determine additional support for the hypothesis that smoking during pregnancy increases the likelihood of a baby having a low birth weight.

Methods

Data Collection. In order to determine the relationship between smoking during pregnancy and low birth weight occurrences, data from the Child Health and Development Studies database was used. This database contains information on pregnancies which occurred between 1960 and 1967, specifically on women who were enrolled in a particular health care program delivered in the East Bay Area of San Francisco (Nolan, Speed , 2000, p.2). More specifically, the data which was obtained for this particular study is a subset of the total data and solely included birth weights and the smoking status of the mother from 1236 baby boys who were single births and lived longer than 28 days (Nolan, Speed, 2000, p.3).

Variable Determination. In order to analyze the data based on the hypothesis, it is first critical to determine the variables which will be examined. The first variable which was defined was the smoking status of the mother. This was determined as being either “Smoker Mother” or “Non-Smoking Mother”. Within the raw dataset, the Smoker Mothers were represented by a 1 and Non-Smokers were represented with a 0.

Building on this, the second variable which was defined was the birth weight of the babies. This weight is defined as being the initial measurement of weight in ounces at the time of birth (Nolan, Speed, 2000,p. 3).

Analytic Methods. In terms of statistical analyses, a variety of statistical methods were performed on the data set. Firstly, the numerical comparison between the birth weights of babies with smoking or non-smoking mothers was determined. For this comparison, the minimum, first quartile, median, mean, third quartile, maximum and standard deviation of each subset (either smoking or non-smoking mother) was calculated using R statistical software. These values allow for the distribution of the data to be compared in a numerical fashion.

The second form of analysis conducted was using graphical methods, specifically histograms of the frequency of each birth weight based on the smoking status of the mother. Firstly, individual histograms for each subset of the data were created using R statistical software. Secondly, a single histogram with overlapping bars was created in order to visually compare the frequency distribution. In order to differentiate between the sets of data, various colors were used (green for non-smoker mother, purple for smoker mother and blue for overlap).

The final form of analysis which was conducted was determining the incidence of low birth weight. This was completed by setting an initial threshold for low birthweight (80oz.) and

then determining the amount of babies in each subset whose birthweight was less than or equal to this threshold (frequency). Building on this, the relative frequency was calculated by dividing the previously determined frequency by the total number of babies which fit into the subset. Following this, the threshold of low birthweight was increased in 20 ounce increments until the threshold reached 160 ounces. For each of these increments, the process of determining frequency and then relative frequency was repeated.

Results

The results of the first set of descriptive analyses conducted on the subsets of Non-smoking mothers and Smoker mothers yielded results such that the minimum weight of the smoker mother data set (58oz) was greater than that of the non-smoking mother data set (55oz). However, in each of the other descriptive categories aside from standard deviation, the non-smoking mother subset provided birthrights which were greater than those of the smoker mother. For example, the median of the non-smoking mother subset was 123oz whereas the median of the smoking mother subset was 115oz. Building on this, the mean of the non-smoking mother subset was 123oz whereas the smoker mother subset mean was 114.1oz. Similarly, the maximum birth weight of the non-smoking mother subset was 176oz whereas the smoker mother subset maximum was 163oz. Finally, the standard deviation of the non-smoking mother was 17.4oz whereas the standard deviation of the smoker mother was 18.1oz. These results, along with the results of the first and third quartiles are depicted in Figure 1.

Figure 1: Numerical Summary Comparison of Birth Weight of Infants with Smoking or Non Smoking Mothers

	Non-Smoking Mother	Smoker Mother
Minimum (oz)	55.0	58.0
1st Quartile (oz)	113.0	102.0
Median (oz)	123.0	115.0
Mean (oz)	123.0	114.1
3rd Quartile (oz)	134.0	126.0
Maximum (oz)	176.0	163.0
Standard Deviation (oz)	17.40	18.10

Building on this, in order to visually depict the differences between these two subsets of the data, individual and combined histograms were created. The histogram for the non-smoking mothers data is depicted in Figure 2. The frequency exhibits a clear normal distribution in that the frequency greatly increases towards the mean of 123oz but decreases towards the extremes. Similarly, the individual histogram for the smoking mothers frequency data is depicted in Figure 3. This histogram also exhibits a normal distribution in that the frequency greatly increases towards the mean of 114.1oz but decreases dramatically towards each extreme. When comparing these two histograms through creating a single combined histogram of both frequency data sets, it is clear that the non-smoking mother data set (green) has considerably more occurrences of birthweight towards the right hand side of the graph signifying that there are a greater amount of babies with higher birthweight in this subset in comparison to the smoking mother subset.

Building on this, the smoking mother subset of the data (purple) had a greater frequency of lower birthweight babies. Each of these comparisons are depicted in Figure 4.

Figure 2: Histogram of the Distribution of Birth Weight Data of Infants with Non Smoking Mothers (mean: 123oz , stdev.: 17.4oz)

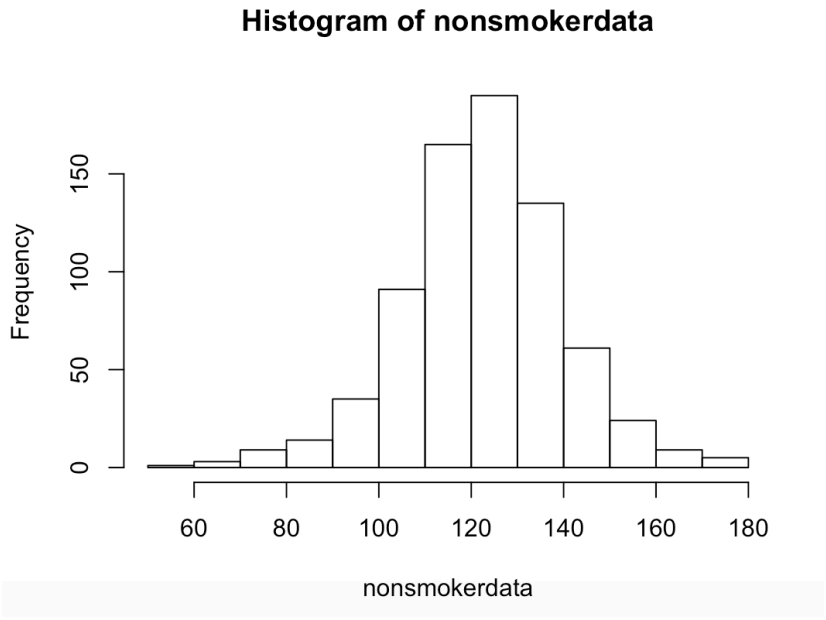


Figure 3: Histogram of the Distribution of Birth Weight Data of Infants with Smoker Mothers (mean: 114.1oz, stdev.: 18.1oz)

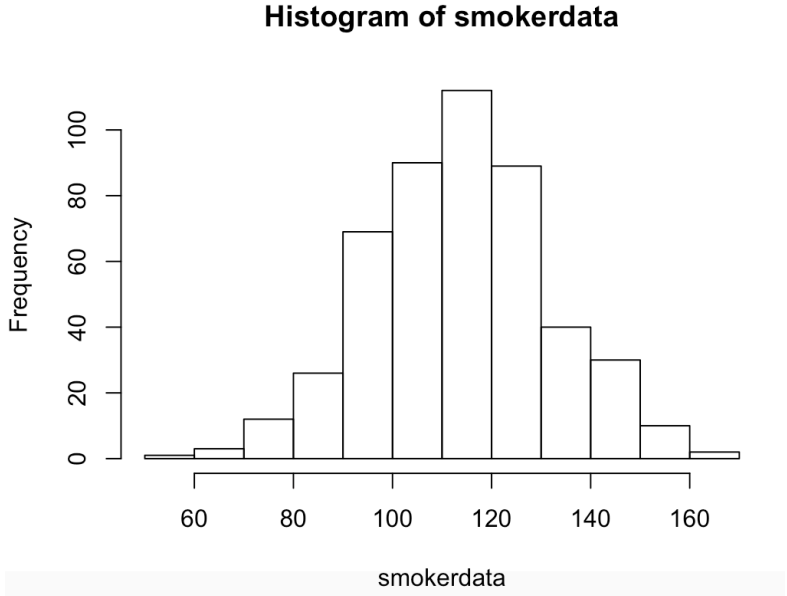
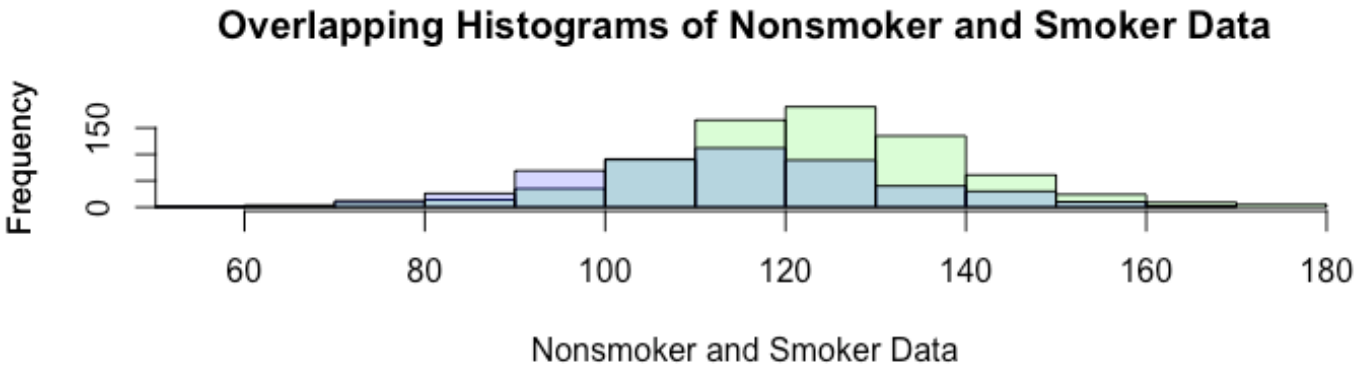


Figure 4: Overlapping Histograms of Birth Weights of Infants with Nonsmoker and Smoker Mothers where green represents Nonsmoker data, purple represents Smoker data and blue presents overlapping data.



The results of the final method of analyzing incidence produced the following results, depicted in Figure 5. Upon setting the low birth weight threshold to 80oz, the frequency and relative frequency in the non-smoker subset were 13 and 0.018 respectively. Building on this, the frequency and the relative frequency of the smoker subset was 16 and 0.033 respectively. When the low birth weight threshold was increased by one increment to 100 oz, the non-smoker and smoker frequencies both increased to 62 and 111 respectively. Building on this, the relative frequencies of the non-smoker and smoker subsets also increased to 0.084 and 0.229 respectively. Additionally, when the low birth weight threshold increased by the next increment to 120oz, the non-smoker frequency and relative frequency increased to 318 and 0.429 respectively. Similarly, the smoker frequency and relative frequency increased to 313 and 0.647 respectively. Furthermore, when the low birthweight threshold was increased to 140oz, the non-smoker frequency and relative frequency increased to 643 and 0.867 respectively. Similarly, the

smoker frequency and relative frequency increased to 442 and 0.913 respectively. Upon the final increase in threshold to 160oz, most of the babies were included as being low birthweight in both subsets. This can be seen through the non-smoker mother frequency and relative frequency being 728 and 0.981 and the smoker mother frequency and relative frequency being 482 and 0.995.

Figure 5: Comparison of Frequencies of Low Birth Weights of Infants with Nonsmoker and Smoker Mothers with Variable Low Birth Weight Thresholds

Low Birth Weight Threshold (oz)	Non Smoker Frequency	Non Smoker Relative Frequency (freq/total)	Smoker Frequency	Smoker Relative Frequency (freq/ total)
80	13	0.018	16	0.033
100	62	0.084	111	0.229
120	318	0.429	313	0.647
140	643	0.867	442	0.913
160	728	0.981	482	0.996

Discussion and Conclusions

The purpose of this investigation was to determine the impact which mothers smoking during pregnancy has on the birthweight of the newborn. The results of the investigation show a clear difference in the data of birthweight of babies with smoking and non-smoking mothers. Firstly, the mean birthweight of the non-smoking group was 123oz (stdev. 17.4oz) whereas the mean for the smoker group was only 114.1oz (stdev. 18.1oz). Building on this, the maximum birthweight of the non-smoking mother group (176oz) was considerably greater than that of the smoking mothers group (163oz). This hypothesis is further supported in the comparison of the

frequency distributions of both of the data sets. Although both of the datasets exhibited a normal distribution, it was clear that the smoker mother dataset had a more rightly skewed graph in that more of the infants had lower weights than those of the non-smoking mothers group as seen in Figure 4. Finally, in terms of incidence, the results of this analysis show that in each threshold of low birth weight, the smoker relative frequency was considerably larger than that of the nonsmoker relative frequency. This suggests that a greater amount of the babies born to smoker mothers classify as low birth weight in every threshold in comparison to babies born to non-smoker mothers. An example of where this difference is adequately depicted is when the low birthweight was 80z. The non smoker relative frequency at this threshold was 0.018 whereas the smoker relative frequency was almost double, at 0.033. Therefore, it can be determined that the data from this investigation support the initial hypothesis that low birthweight is more frequent in babies whose mothers smoked during the pregnancy.

These results have also been mirrored by additional, more recent studies which have been conducted on the subject. For example, the *Journal of Pediatrics* article titled "Prenatal Tobacco Exposure, Biomarkers for Tobacco in Meconium, and Neonatal Growth Outcomes" by Himes et al. found that when tobacco was detected in the meconium (ie. the mother smoked either throughout or at some point during her pregnancy), there was significant correlation in low birth weights, as well as reduced head circumference and length with the cigarette consumption of the mothers (Himes et al., 2013, p. 970).

In the future, it will be important to continue to test the correlation between low birth weight and prenatal smoking. One way which this can be done is by looking at data for specifically girls. This investigation solely took data from newborn boys into consideration and

in order to gain a more accurate scope on the true effects of smoking on birth weight, it will be vital to study both sexes. Building on this, another potential area for investigation is the rate at which the fetus grows based on the smoking status of the mother. This may provide insight into potentially why many of the birth weights are reduced when the mother uses tobacco during pregnancy.

Overall, the results of this investigation were in support of the hypothesis that low birth weights are more frequent in babies whose mothers smoked during their pregnancies in comparison to mothers who did not smoke. These findings can be used to continue to educate mothers on the harmful effects of tobacco on both their own health but also the health of their child.

Works Cited

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