Smoking During Pregnancy Associated With Lower Birth Weight

By Alana R. McGraw

Abstract

Health professional have warned for decades that smoking during pregnancy can impact the outcome of the baby. In this report, we investigated the effects of maternal smoking on their children's birth weights. Using Mathematica, we described data collected from 1236 families in the Child Health and Development Study. Several numerical summary statistics and graphical summaries were used to compare the birth weights of children from smoking and nonsmoking mothers. We found that the mean and median birth weights from the smoking mothers were lower and overlapping smooth histograms of both groups indicate that the birth weights from the smoking mothers tend to be lower than nonsmoking mothers. We concluded that smoking during pregnancy is associated with lower birth weights. As lower birth rates are associated with decreased survival rates of infants, we can corroborate the warning of health officials against smoking during pregnancy.

Introduction

Environmental stimuli affecting pregnant mothers can influence their baby's health. Before the 1940s, children were considered safe from any diseases or chemicals that impacted their mothers during pregnancy. By 1941, evidence showed that rubella in pregnant mothers led to higher incidences of heart, eye, and ear defects in their infants, indicating that babies were not protected in the uterus as many previously believed. Consequently, smoking during pregnancy became a concern for pregnant women, with the US Surgeon General's printing warnings that smoking during pregnancy can lead to fetal injury, premature birth, and low birth weight on the sides of cigarette cartons. In 1996, 15% of women who gave birth smoked during pregnancy despite the warnings from health officials (1). Given the prevalence of smoking during pregnancy, it is important to understand the consequences.

Chemicals in cigarettes including carbon monoxide, can impact vital resources that the fetuses needs to develop properly. Carbon monoxide in cigarettes binds to hemoglobin in the place of oxygen, reducing the amount of oxygen carried in the mother's blood. The mother supplies the fetus with oxygen from her blood through gas exchanges mediated by the placenta. When there is less oxygen in the mother's blood, the fetus's oxygen supply also decreases. To compensate, the placenta increases in surface area to increase the amount of space for oxygen exchange, and the fetus prioritizes blood flow to vital areas. On its own, the decreased oxygen supply can lead to problems with the fetus's vital tissues, but the changes to the placenta can also lead to preterm delivery and fetal death if the placenta separates from the uterine wall (1).

Birth weight is one measure of a baby's maturity. Smaller babies and babies born before 37 weeks tend to have lower survival rates than large babies born within the normal gestational period (37-42 weeks). Epidemiological studies have shown that smoking leads to reduced birth weights and that smoking mothers are twice as likely to have low birth weight babies compared to nonsmoking mothers (1). We will be investigating the effect of maternal smoking on birth weights because of the impact of birth weight on infant survival. In this report we will confirm whether smoking during pregnancy leads to lower birth weight.

Methods

The data used in this study was found at the UC Berkeley Stats Lab website. The birth weight data is a subset of 1236 families from a larger data set collected as part of the Child Health and Development Studies (CHDS). Birth weights were collected from women in the Kaiser Foundation Health Plan in the East Bay area of San Francisco between 1960 and 1967. The data set entitled "Birth weight I" was downloaded and imported into Mathematica, the program used for this data analysis. After removing the first and last entries which did not contain any data, the dataset was separated into subsets of smoking and nonsmoking mothers. The mean was calculated for the smoking and nonsmoking subsets to numerically describe the center of the data distribution. The standard deviation of both groups was calculated to measure the dispersion of the data from the center. A 5-number summary (the median, upper and lower quartiles, maximum, and minimum) was calculated for each subset in order to describe the data center and spread. Skewness and Kurtosis were calculated for both subset in order to assess the normality of the data. Skewness also describes the symmetry of the distribution, and the kurtosis describes how pronounced the peaks are. Histograms for smoking and nonsmoking mothers were created as a graphical representation of the birth weight distribution (Figure 1 and Figure 2). Smooth histograms of both subsets were created and displayed together on one plot in order to visually compare the differences in birth weight distributions between smoking and nonsmoking groups (Figure 3). A side by side box and whisker plot was constructed for both data sets to graphically represent data spread, dispersion, and outliers (Figure 4). Quantile plots were generated for both data sets to graphically compare the data distribution to the normal distribution (Figure 5 and Figure 6).

Results

The center of the data, described by both the mean and the median, is lower in smoking mothers than the birth weights from nonsmoking (Table 1). The smooth histograms visually show that most infants from nonsmoking mothers have birth weights above the both the mean and median of the smoking subset (Figure 3). Histograms and a side-by-side box and whisker plot for both data subsets visually describe the distribution of the data (Figure 1, Figure 2, and Figure 4). The maximum, minimum, median, upper quartile, and lower quartile numerically summarize the data distribution (Table 1). The skewness of both data sets is negative. The kurtosis of the smoking group is close to 3 at 2.99, while the kurtosis of the nonsmoking group is 4.04 (Table 1). The quantile plot of the nonsmoking group curves downward on the left side and upward on the right side but maintains a linear relationship with the theoretical quantiles in the middle of the plot (Figure 5). The quantile plot of the smoking group maintains a mostly linear relationship with the theoretical quantiles for all of the data (Figure 6).

Table 1. Description of birth weight data from children of smoking and nonsmoking mothers including mean, standard deviation, skewness, kurtosis and a five-point summary

	No Smoke	Smoke
Mean (oz)	123	114
Standard Deviation (oz)	17.4	18.1
Skewness	−0.187	−0.0336
Kurtosis	4.04	2.99
Five−Point Summary		
Minimum (oz)	55	58
Lower Quartile (oz)	113	102
Median (oz)	123	115
Upper Quartile (oz)	134	126
Maximum (oz)	176	163

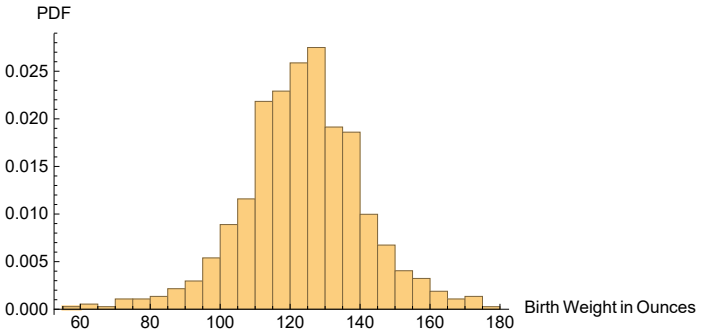


Figure 1. Birth weight data for infants of nonsmoking mothers

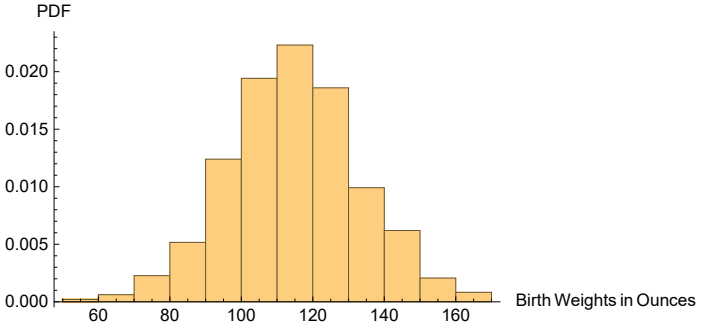
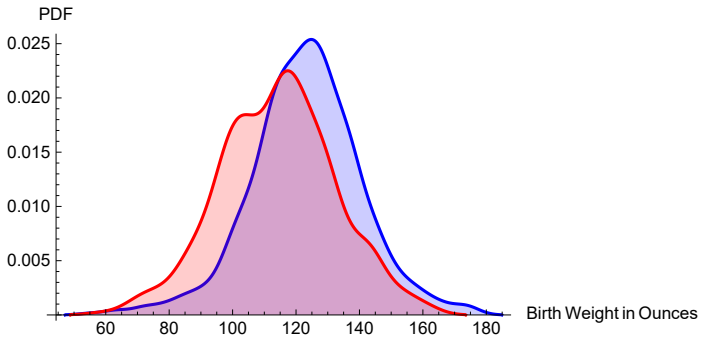


Figure 2. Birth weight data for infants of smoking mothers



"Blue = Nonsmoking Mothers"
"Red = Smoking Mothers"

Figure 3. Birth weights for infants of smoking and nonsmoking mothers

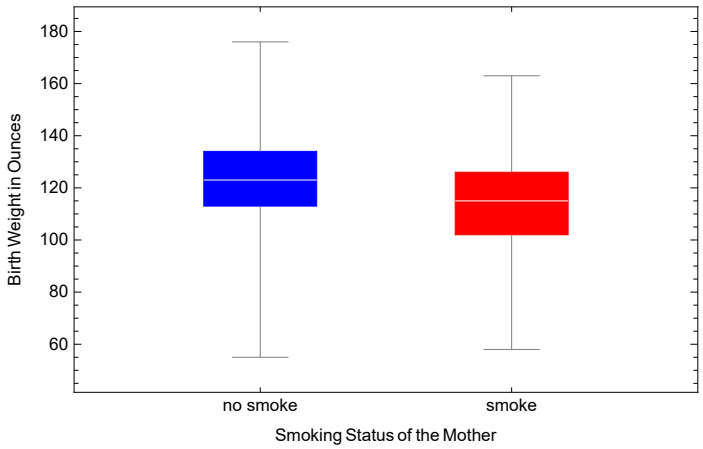


Figure 4. Birth weights for infants of smoking and nonsmoking mothers

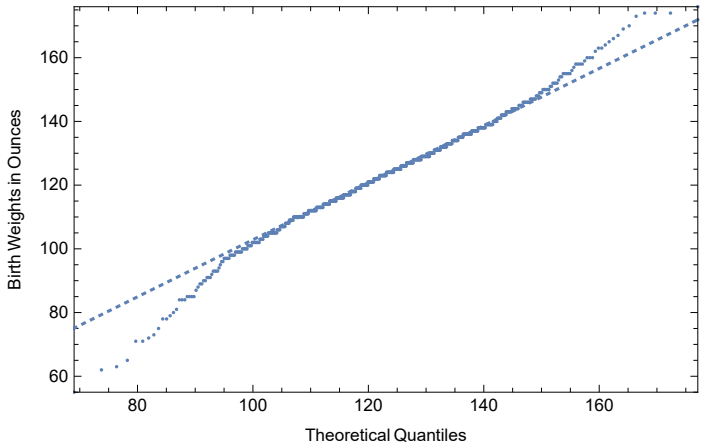


Figure 5. Quantile plot for birth weights of infants from nonsmoking mothers

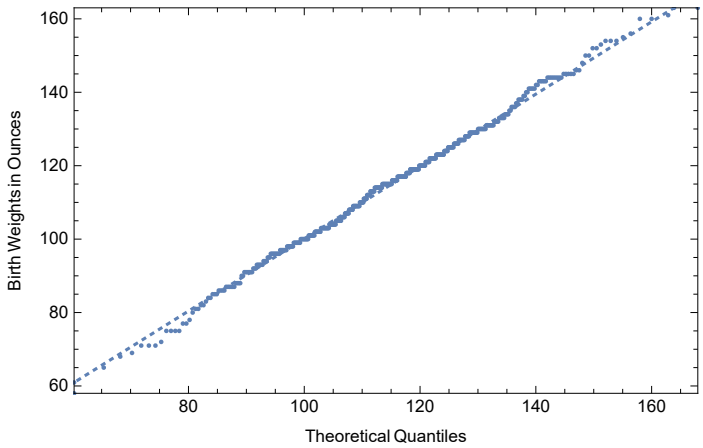


Figure 6. Quantile plot for birth weights of infants from smoking mothers

Discussion

The objective of this report was to corroborate the US Surgeon General's warning that smoking during pregnancy is associated with lower birth weight. We found that mean birth weight of the smoking mothers was 114 oz. and the median was 115 oz. which was less than the mean and median of 123 oz. from the nonsmoking group. This comparison of the center of distributions for the smoking and nonsmoking groups indicates that smoking may be correlated with lower birth weight. The overlain smooth histograms also indicates that the birth weights of infants from smoking mothers tend to be lower than the birth weights of infants from nonsmoking mothers. The side-by-side box and whisker plot shows the same general pattern with a lower quartile, median, upper quartile, and maximum higher in the smoking group than the nonsmoking group. The negative skewness of both groups indicates that the data for both groups is skewed slightly to the left, towards the lower birth weights. The kurtosis of the smoking group is very close to 3 at 2.99 and the quantile plot is linear, indicating that the data follows the normal distribution. The 4.04 kurtosis of the nonsmoking group and nonlinear quantile plot indicates that the data is peakier than it would be if it followed the normal distribution. Based on the findings in this report, we can conclude that smoking during pregnancy tends to be associated with lower birth weights in infants.

Our finding that infants have lower birth weights supports previous findings that indicate smoking during pregnancy leads to lower birth weights for their infants. The low birth weights of babies from smoking mothers has implications for their survival rate. One study found that smokers have higher rates of premature deliveries, which resulted in a higher rate of early fetal death (1). The original CHDS experiment also found that 150 per 1000 babies under 2500 grams and only 5 per 1000 babies over 2500 grams died in the first 28 days after birth (1). Considering the survival implications of birth rate, our data supports that pregnant women should avoid smoking in order to decrease the chance of low birth weights and increase the chance of the baby's survival.

Results from study is only representative of populations like this sample, and because this data was collected from 1960-1967, a number of factors have changed including the racial makeup of the US and the general health and wellness of the population. Therefore, it is unclear whether this sample remains valid for the US population. This is also an observational study so it can only tell us that smoking is

associated with low birth weight, indicating correlation and not necessarily causation. Confounding factors may be the true cause of low birth weights, as smoking mothers may be more likely to participate in other behaviors that lead to low birth weights for their infants. Additionally, descriptive statistics can elucidate patterns in the data, but it can not tell us whether those patterns are significant. Hypothesis testing is needed to determine whether the differences are significant.

Future studies to confirm the lower birth weights of smoking mothers should incorporate random sampling that is representative of the current US population. While experimental studies would be unethical, future observational studies should include hypothesis testing to confirm the significance of differences between the birth weights of infants from smoking and nonsmoking mothers.

In this report, we were able to determine that birth weights tend to be lower when mothers smoke during pregnancy. As lower birth rates lead to decreased survival rates for infants, we can confirm that women should not smoke during pregnancy.

References

1. Casella, George, et al., editors. “Maternal Smoking and Infant Health.” Stat Labs: Mathematical Statistics Through Application, by Deborah Nolan and Terry Speed, Springer, 2000, pp. 1-18.

Appendix