Parasuram and Martens, Gynecol Obstet (Sunnyvale) 2017, 7:1
DOI: 10.4172/2161-0932.1000420

Gynecology & Obstetrics
ISSN: 2161-0932

Research Article Open Access

Statistical Analysis of Socioeconomic Factors Correlating to Caesarean Section Rates 2015-2016

Nethra Parasuram* and Mark Martens*

Jersey Shore University Medical Center, 1945 Route 33, Neptune, NJ 07753, USA

Abstract

Objective: Caesarean section rates have significantly increased in the past decade in the United States. To make an attempt at lowering these rates, it is important to first understand how states' rates compare with each other and which factors correlate with these rates. Then, possible ways to impact these rates can be suggested.

This investigation sought to determine whether or not there is a significant difference between the rates of caesarean sections in Utah, United States and New Jersey, United States using representative hospitals' data. Also, we sought to evaluate selected socioeconomic factors and their possible correlation with higher or lower caesarean rates in each United States' states.

Methods: Information collected from various federal and private sources were utilized to collect caesarean section rate data. These data were correlated to selected variables including average birthing age, logarithm of the percent of females in the workforce, median household income, number of hospitals, logarithm of the percent of people who have graduated with a Bachelor's degree or higher, average number of people in a household, and the standard of living. A Linear Multiple Regression Model and T-Test were utilized to determine significance of each variable.

Results: There was a statistical difference between the caesarean section rates of Utah and the caesarean section rates of New Jersey. The p-value obtained from the T-Test was $1.805*10^{-5}$. Therefore, there is a significant difference between the two states' caesarean data. The variables birthing age, logarithm of the percent of females working, and the number of hospitals significantly correlated with caesarean section rates. Median household income, logarithm of the percent of people who have graduated with a Bachelor's degree or higher and average number of people in a household did not significantly correlate with caesarean section rate data.

Conclusion: It appears that there are several economic factors that significantly correlate with caesarean section rates. Other economic factors which did not appear significant may have had several conflicting components, which under estimated any true significance. Understanding these factors may permit us to develop strategies to impact the caesarean section rate.

Introduction

It is reported that about one in every three deliveries in the United States is a caesarean section delivery. Nineteen percent has been proposed as an ideal rate of caesarean section delivery [1]. It is proposed that, as the rate increases, the rate of mortality decreases. Caesarean rates higher than 19 percent have shown that there is no significant decrease in infant mortality and no significant advantage to caesarean deliveries [1]. Caesarean sections can result in several adverse events including blood clots, embolisms, hemorrhages, infections, and injury to surrounding organs [2]. It is also estimated that 14 of every 100,000 live births end in maternal death in the United States [1]. Aside from immediate complications, there are also long term sequelae including possible infertility, placenta previa, placenta accreta, ectopic pregnancy, and uterine rupture [2].

The rate of caesarean delivery has increased tremendously, from 5 percent in 1970 and 20 percent in 1996 to about 33 percent currently [1]. A study by Keeler and Brodie [3] showed that women who have "private, fee-for-service insurance" have a higher rate of caesarean sections as opposed to women who have other types of insurances. Various socioeconomic factors have been cited as leading to higher caesarean section rates. It is important to recognize and understand these factors if there will be attempts to reduce caesarean section rates.

Caesarean section rates have increased due to many reasons. The objective of this study is to specifically investigate socioeconomic factors which correlate with caesarean section rates in the United States. International rates will also be discussed briefly in comparison.

Methodology

The current study investigated data collected by the Leapfrog Group, the Tax Foundation, the U.S. Census Database, *mentalfloss.com*, and *caesareanrates.com*. To retrieve the caesarean section rate data, the phrase, "C-Section Rates by Hospital," was utilized in Google's search engine. The average caesarean section rates from each state from 2015 were taken from the Leapfrog Group. To find the standard of living of each state, the phrase, "The Value of $100 by State in the United States," was typed into the Google search engine. The site published by the Tax Foundation provided data about the value of $100 in each American state, which reflects the standard of living. The two states chosen were

***Corresponding author:** Nethra Parasuram, Jersey Shore University Medical Center, 1945 Route 33, Neptune, NJ 07753, USA, Tel: (217) 402-4906; E-mail: rp.nethra@gmail.com

Mark Martens, Jersey Shore University Medical Center, 1945 Route 33, Neptune, NJ 07753, USA, Tel: (217) 402-4906; E-mail: Mark.Martens@hackensackmeridian.org

Received November 30, 2016; **Accepted** January 05, 2017; **Published** January 10, 2017

Citation: Parasuram N, Martens M (2017) Statistical Analysis of Socioeconomic Factors Correlating to Caesarean Section Rates 2015-2016. Gynecol Obstet (Sunnyvale) 7: 420. doi: 10.4172/2161-0932.1000420

New Jersey and Utah because they had standards of living on the higher end of the spectrum and on the lower end, respectively. The caesarean section rates of these two states, whose data were provided by the Leapfrog Group, were analyzed using a T-Test. The U.S. Census Database provided data for the percent of females in the workforce, median household income, percent of people who have graduated with a Bachelor's degree or higher and average number of people in a household. Average birthing age data was found on *mentalfloss.com* by searching up "Average birthing age by state *mentalfloss.com*" in the search engine and collecting corresponding data from the site. The number of hospitals by state was given in American Hospital Directory. "Number of Hospitals by State American Hospital Directory," was typed into the search engine and corresponding data from the site was collected. To find specific data regarding hospital rates in a state, "C-section rates by state hospitals," was typed into the search engine. The website *caesareanrates.com* provided the data. This data was used to analyze New Jersey and Utah.

T-Test was utilized to compare the two populations and a p-value less than 0.05 was considered a significant difference. The rates of caesarean sections from both cities were entered into a two tailed T-Test, which analyzed samples from populations with different variances. Percentages were calculated by dividing the sum of caesarean sections and natural deliveries for the trial by the number of caesarean sections for the trial. There were two arrays of data. The two arrays were 16 randomly chosen rates from 16 different hospitals for caesarean sections in Utah, USA and 16 randomly chosen rates from 16 different hospitals for caesarean sections in New Jersey, USA. The averages, medians, standard deviations, variations, and standard errors were calculated for these arrays, as well.

A Linear Multiple Regression Model was utilized to observe the variance of one variable when others are held constant. Also, it depicts the correlation among the variables. This was used to find which of the selected variables correlated with the states' corresponding caesarean section rate. The critical value is 0.05. Data from the fifty states of the United States were used. Seven variables from each state were investigated: average birthing age, logarithm of the percent of females in the workforce, median household income, number of hospitals, logarithm of the percent of people who have graduated with a Bachelor's degree or higher, average number of people in a household, and the standard of living. These factors were considered as a group.

Results

Rates of caesarean sections in Utah, U.S. and New Jersey, U.S. is shown in (Table 1). The two arrays of 16 data points from New Jersey and Utah were analyzed for a significant difference. The p-value obtained from the T-Test was $1.805*10^{-5}$, which is less than the alpha value of 0.05. The median caesarean section rate for Utah is 18.6% with a standard of deviation of 3.4. This caesarean section is near the aforementioned ideal rate of 19%. Similarly, the median caesarean section rate in New Jersey is 29.75% with a standard deviation of 7.7. This caesarean section rate is near the national average caesarean section rate of 32.2% [4].

Variables studied that possibly correlate with caesarean section rates in the United States are shown in (Table 2). Of the seven factors explored (average birthing age, percent of females in the workforce, median household income, number of hospitals, percent of people who have graduated with a Bachelor's degree or higher, average number of people in a household, and the standard of living), birthing age, percent of females working, and the number of hospitals were significantly correlated with caesarean section rates with p-values of $1.79*10^{-2}$, $7.63*10^{-3}$ and $4.96*10^{-2}$, respectively. Three factors, median household income, logarithm of the percent of people who have graduated with a Bachelor's degree or higher, and average number of people in a household produced p-values of $1.292*10^{-1}$, $6.535*10^{-1}$, and $7.616*10^{-1}$, respectively, which demonstrate an insignificant correlation. Standard of living produced a p-value of $8.949*10^{-2}$, which is considered to show a statistical trend. The Linear Multiple Regression Model requires the logarithm of the variables that are expressed as percentages, to be utilized for statistical evaluation. In Table 2, the closer the logarithmic value is to zero, the greater the frequency of the variable.

All variables had a positive coefficient except for the logarithm of the percent of females in the workforce and the logarithm of the percent of people who have graduated with a Bachelor's degree or higher. A positive coefficient suggests that as the value of the variable increases, the rate of caesarean section increases. Conversely, a negative coefficient suggests that as the value of the variable decreases, the rate of caesarean section increases. The intercept of the linear regression model has a p-value of $5.16*10^{-4}$ indicating that the model is statistically significant. In conjunction to the p-value's significance, the intercept is a number other than 0. This implies that there are factors that have not been considered in this model (Tables 1 and 2).

Conclusion

Caesarean section rates have increased dramatically in the past decade, and attempts to lower them have not been effective. It is therefore vital to understand that various factors that impact this rate.

In this investigation, increases in maternal age at birth demonstrated a significant correlation with increasing caesarean section rate. Advanced maternal age patients have been shown to have more complications, such as hypertension or diabetes. To avoid serious complications, a caesarean section may be required for the mother.

Infertility is also common in older patients resulting in the need for in-vitro procedures, which are shown to have a higher caesarean section rate [5]. Also, older gravidas have a higher incidence of leiomyomata and other anatomic alterations, therefore a risk for premature or breech deliveries. Placenta previa is also more likely to occur in older gravidas as is the likelihood of a previous delivery by caesarean section.

The first caesarean delivery often leads to a repeat caesarean section because of the risk of uterine rupture in patients. In a study done of potential Vaginal Birth after Caesarean (VBAC) patients in

Hospital	Utah	New Jersey
1	18.7	22.9
2	18.7	30
3	25.6	33.3
4	18.5	14.1
5	15.9	35
6	19.3	33.5
7	22	27.1
8	12.2	32.9
9	13.6	29.4
10	18.6	27.5
11	14	25.8
12	19.8	41.8
13	18.2	29.8
14	18.6	42.8
15	13.7	16.1
16	18.3	29.7

Table 1: Rates of cesarean sections in Utah, U.S. and New Jersey, U.S.

	Avg. birthing Age	Log of % females 16+ working	Median household income	Number of hospitals	Log of % females holding grad. bachelors or higher	Avg. number of people in a household	Standard of living (value of $100)	Log of cesarean section rate
Lousiana	24.3	-0.24872	44991	109	-0.65561	2.6	109.65	-0.4023
New Jersey	28.3	-0.21681	72062	73	-0.4389	2.72	87.34	-0.41567
Florida	26.2	-0.25964	47212	215	-0.57187	2.62	101.21	-0.42251
Mississippi	23.6	-0.26761	39464	69	-0.69037	2.64	115.21	-0.4318
West Virginia	24.1	-0.30627	41576	35	-0.72816	2.43	112.87	-0.4437
Kentucky	24.4	-0.25885	43342	75	-0.66154	2.5	112.23	-0.451
Alabama	24.5	-0.27246	43511	92	-0.63639	2.55	114.03	-0.45223
Connecticut	27.4	-0.20135	69899	34	-0.4318	2.56	92.17	-0.45469
Texas	25	-0.23732	52576	381	-0.56703	2.83	103.41	-0.45469
South Carolina	24.7	-0.24795	45033	64	-0.59688	2.56	110.5	-0.45593
Arkansas	23.8	-0.26761	41264	49	-0.68613	2.53	114.16	-0.45842
Nevada	25.7	-0.22257	52205	27	-0.64782	2.71	101.83	-0.45842
Oklahoma	24.2	-0.25259	46235	101	-0.62342	2.56	111.23	-0.45967
New York	27.5	-0.23136	58687	198	-0.47237	2.62	86.66	-0.46218
Maryland	27.1	-0.18977	74149	52	-0.42829	2.67	89.85	-0.46218
Virginia	26.8	-0.21538	64792	94	-0.44612	2.61	96.9	-0.46471
Tennessee	24	-0.24872	22621	112	-0.61261	2.53	110.25	-0.46597
Delaware	26	-0.22257	60231	8	-0.53165	2.63	97.75	-0.4698
Georgia	25	-0.23582	49342	116	-0.54821	2.72	108.7	-0.47108
Rhode Island	27	-0.20971	56423	12	-0.50307	2.47	101.32	-0.48149
California	26.9	-0.24109	61489	349	-0.50864	2.95	88.57	-0.48149
Massachusetts	28.7	-0.1986	67846	80	-0.39794	2.53	93.28	-0.48149
Michigan	25.5	-0.24033	49087	107	-0.5784	2.52	105.93	-0.48678
Missouri	25.1	-0.22475	47764	86	-0.57349	2.48	113.51	-0.49621
Pennsylvania	26.1	-0.23433	53115	180	-0.55129	2.49	101.32	-0.50446
Illinois	26.5	-0.21467	57166	140	-0.49621	2.63	99.4	-0.50724
Nebraska	25.5	-0.1831	52400	30	-0.5376	2.47	110.99	-0.50724
North Carolina	25.6	-0.23657	46.693	108	-0.55596	2.54	109.17	-0.51145
Ohio	27.6	-0.22841	48.849	147	-0.59176	2.46	112.11	-0.51286
Kansas	25	-0.20691	51872	59	-0.51286	25.2	111.23	-0.5157
New Hampshire	27.2	-0.19314	65986	14	-0.46344	2.46	94.16	-0.51713
Iowa	25.5	-0.19723	52716	41	-0.5784	2.42	111.73	-0.51856
Indiana	24.7	-0.22768	48737	98	-0.62709	2.55	109.77	-0.51856
Montana	25.3	-0.22257	46766	16	-0.53611	2.4	106.16	-0.51856
Maine	26.3	-0.21968	48804	21	-0.54668	2.34	101.73	-0.52578
Washington	27	-0.22988	60294	63	-0.4908	2.55	96.9	-0.53018
Oregon	26.7	-0.23732	50521	38	-0.52143	2.5	101.21	-0.53165
Wyoming	27.1	-0.20273	58252	14	-0.60033	2.49	103.73	-0.5544
North Dakota	25.5	-0.18442	55579	10	-0.56384	2.32	110.62	-0.55752
Vermont	26.7	-0.1945	54447	7	-0.45346	2.34	99.11	-0.56067
Hawaii	26.7	-0.22768	68201	14	-0.5157	3	85.32	-0.56543
Minnesota	27	-0.17849	60828	56	-0.47886	2.48	102.56	-0.56703
Arizona	25.5	-0.26043	49928	76	-0.56703	2.69	101.94	-0.56864
South Dakota	25	-0.18842	50338	26	-0.57349	2.45	113.38	-0.57512
Wisconsin	26.1	-0.19518	52738	76	-0.56225	2.43	107.64	-0.58503
Colorado	26.8	-0.20135	59448	53	-0.42597	2.54	98.43	-0.5867
Idaho	24.6	-0.24336	47334	18	-0.59517	2.68	106.84	-0.60555
Utah	25	-0.22403	59846	36	-0.51428	3.14	103.31	-0.63639
New Mexico	23.9	-0.25727	44968	37	-0.58336	2.66	105.49	-0.64207
Alaska	25.5	-0.18642	71829	12	-0.55752	2.79	93.37	-0.66756

Table 2: Variables Studied that Possibly Correlate with Cesarean Section Rates in the United States.

2012, 98% of mothers who planned to deliver via caesarean section did so. However, only 43% of mothers who planned to deliver vaginally actually delivered vaginally [6].

The percent of females working during pregnancy also demonstrated to have a significant correlation. As the percent of working women increased, the caesarean section rate decreased. Women working are presumably more active possibly resulting in a lower caesarean section rate. Also, maternity leave is limited, so women needing to return to their jobs earlier may have a faster recovery for

vaginal deliveries. Lastly, employed women more often have medical insurance coverage, which should provide better healthcare options, including earlier antepartum exams, testing, and greater choice in their obstetrician selection.

The number of hospitals in each state also significantly correlated with the caesarean section rate of each state. As the number of hospitals increased, the caesarean section rates also increased.

Hospitals are now being publicly rated on factors including patient mortality and safety. Presumably, a state with more hospitals is also more likely to have more malpractice attorneys. Obstetricians and gynecologists have one of the highest malpractices insurance rates of all the specialties as demonstrated by an 85% increased likelihood of being sued by patients than any other type of physician [7]. Because of this, obstetricians may be more likely to opt for caesarean sections to prevent as many complications as possible.

Median household income was shown to be insignificant in correlation with caesarean section rates in our review. We hypothesize that the income variability is less in America than it is in densely populated areas, such as Asian countries. Therefore, we hypothesize the disparity in income has a more apparent correlation with caesarean section rates. In our international review, there is a strong correlation between caesarean section rates and median household income. In India (personal communication - Parasuram), two cities were analyzed: Chennai and Madurai, which are urban and rural, respectively. Chennai is a more developed urban city with the cost of living in local areas reported to be 29% greater in Chennai (₹83,000 in Chennai versus ₹64,528 in Madurai) [8]. The caesarean section rate in a hospital in Chennai was 76.8%, while it was 33.2% in the less developed rural town of Madurai. One study done in China between 1988 and 2008," said that the average increase in caesarean rates went from 3.4% in 1988 to 39.3% in 2008. The biggest increases were seen in urban cities, with 64.1% of women giving birth through caesarean section in 2008. In the least developed rural area, the rate went from less than 1% in 1988 to 11.3% in 2008. There are stark differences in the caesarean section rate even within the urban population and the rural population in China. Household income can be divided into four quartiles with the fourth quartile being the poorest. In 2008, Quartile I had 90.5% of births delivered via caesarean section, whereas Quartile IV, the poorest of the population, had 48.6% of births delivered through caesarean section. Similarly, in the rural areas, Quartile I, the wealthiest of the rural, had a caesarean section rate of 97.6%, while Quartile IV had 32.6% of births delivered via caesarean section [9]. These data show that household income does have a significant effect on caesarean section rates in highly populated Asian countries and as household income increases, so do caesarean section rates.

Thus, the controversy of attempting to correlate household income data with caesarean section rates appears to result in less variability in industrialized economies. When we attempt to add more economic variables to the median household income comparison in the United States, replacing it with a more comprehensive and inclusive category defined as "standard of living, there is a statistical trend between standard of living and caesarean section rates. Standard of living is comprised of various socioeconomic features such as, "Income, gross domestic product, national economic growth, economic and political stability, political and religious freedom, environmental quality, climate, and safety" [10]. Because of these additional variables, biases associated from a single number (median household income) may be controlled.

The percent of people who have graduated with a Bachelor's degree or higher was not shown to have a significant correlation to caesarean section rates. This may be due again to the mixture of competing variables. The educated are more likely to have better jobs with more comprehensive health insurance, which has shown to decrease caesarean section rates [11]. However, in conjunction, states with a higher concentration of universities are likely to have more hospitals because of university hospitals. As shown, a higher number of hospitals in a state are more likely to increase the number of caesarean sections. Even though there are multiple factors involved, many are not reflected by education level alone. The statistical trend shown by standard of living may be more accurate because it considers more factors.

Our review also did not find that the average number of people in a household correlated significantly with caesarean section rates because there is a wide variability within subgroups of populations. For example, some cultures or religions may promote the idea of having smaller or larger families. Also, similarly, some faiths may not allow the use of birth control. Therefore, means of preventing pregnancy may not be a viable option.

In summary, there appear to be multiple factors impacting caesarean section rates. Understanding the factors and their interactions is the first step towards addressing the serious dramatic increase in caesarean section rates not just in the United States, but around the world.

In the past, solutions have narrowly focused on the hospital environment, such as availability of anesthesia, or practice patterns of the obstetric providers. Factors that were previously believed to be unrelated, such as employment and standard of living, are now shown to correlate with caesarean section rates. Interventions taking advantage of this new information will hopefully lead to governments, organizations, and societal initiatives to promote the employment of women who want to or need to work. Also, sufficient medical leave can encourage women to avoid delaying pregnancy and childbirth until they attain financial security. Having babies at an earlier age will then prevent health complications that arise in older gravidas. Lastly, consolidating the number of hospitals providing obstetrical services may lead to increased consistency in implementing strategies to reduce caesarean section rate. All in all, the rise in caesarean section rates is multifaceted and complicated, but efforts taken as a society may be able reduce these rates.

References

1. Thielking M (2016) Why the C-section Rate Is Much Higher than It Should Be in US. Statnews.
2. Udy P (2016) The Physical Impact of Cesareans. Midwifery Today.
3. Emmett KB, Brodie M (1993) Economic Incentives in the Choice between Vaginal Delivery and Cesarean Section. The Milbank Quarterly.
4. Centers for Disease Control and Prevention (2016) Births-Method of Delivery.
5. Sullivan EA, Chapman MG, Wang YA, Adamson GD (2016) Population-based Study of Cesarean Section after in Vitro Fertilization in Australia. Birth (Berkeley, Calif.). U.S. National Library of Medicine.
6. Nierenberg C (2012) Repeat C-Section May Be Safer Option for Moms, Babies. LiveScience. TechMedia Network.
7. Baker R (2016) 2015 Malpractice Report Reveals Data about Ob/Gyn Lawsuits. Cleveland Personal Injury Law Blog Atom. The Skolnick Weiser Law Firm, LLC.
8. Cost of Living. Comparison Between Chennai, India And Madurai, India. Numbeo.
9. Lin FX, Xu L, Guo Y, Ronsmans C (2016) Factors Influencing Rising Caesarean Section Rates in China between 1988 and 2008. WHO. World Health Organization.
10. Root. Standard of Living. Investopedia.
11. Rosenberg T (2016) Reducing Unnecessary C-Section Births. The New York Times.