

Increase in Cesarean Operative Time Following Institution of the 80-Hour Workweek

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ABSTRACT

Background In 2003, the Accreditation Council for Graduate Medical Education limited resident duty hours to 80 hours per week. More than a decade later, the effect of the limits on resident clinical competence is not fully understood.

Objective We sought to assess the effect of duty hour restrictions on resident performance of an uncomplicated cesarean delivery.

Methods We reviewed unlabored primary cesarean deliveries at Duke University Hospital after 34 weeks gestation, between 2003 and 2011. Descriptive statistics and linear regression were used to compare total operative time with incision to delivery time as a function of years since institution of the 80-hour workweek. Resident training level, subject body mass index, estimated blood loss, and skin closure method were controlled for in the regression model.

Results We identified 444 deliveries that met study criteria. The mean (SD) total operative time in 2003–2004 was 43.3 (14.3) minutes and 59.6 (10.7) minutes in 2010–2011 ($P < .001$). Multivariable regression demonstrated an increase in total operative time of 1.9 min/y ($P < .001$) but no change in incision to delivery time ($P = .05$). The magnitude of increased operative time was seen among junior residents (2.0 min/y, $P < .001$) compared to that of senior residents (1.2 min/y, $P = .06$).

Conclusions Since introduction of the 2003 duty hour limits, there has been an increase of nearly 20 minutes in the time required for a routine cesarean delivery. It is unclear if the findings are due to a change in residency duty hours or to another aspect of residency training.

Introduction

Obstetrics and gynecology (ob-gyn) residency training programs are charged with the responsibility to provide trainees with an adequate volume of patients to gain sufficient experience that will allow them to serve as specialists in women's health care. Obstetricians and gynecologists must achieve competency in clinical and surgical skills in order to practice the breadth of their specialty. In 2003, the Accreditation Council for Graduate Medical Education (ACGME) instituted duty hour restrictions across all accredited programs, which included limiting the workweek to no more than 80 hours per week.

There have been numerous conflicting reports in the ob-gyn and surgery literature regarding the impact of the 80-hour workweek on resident operative volume.^{1–6} While the debate over adequate surgical exposure continues, few studies have evaluated the association of duty hour restrictions on resident surgical performance and proficiency. The purpose of our study was to assess the association between

duty hour restrictions and the time to perform an uncomplicated cesarean delivery.

Methods

This study was conducted at Duke University Hospital. The Duke University ob-gyn residency program is 4 years in length and has 8 residents per year of training. Using an anesthesia electronic delivery database, we retrospectively reviewed all unlabored primary cesarean deliveries performed at Duke University Hospital after 34 weeks gestation, between 2003 and 2011. Women with multiple gestations, prior abdominal or pelvic surgery including prior cesarean, pelvic adhesive disease, or who were undergoing additional surgical procedures at the time of delivery were excluded from analysis. Cesarean deliveries performed exclusively by 1 or more attending physicians due to the lack of an available ob-gyn resident were also excluded from analysis. Operative reports were reviewed to ensure that subjects met all inclusion and exclusion criteria for the study.

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The primary outcome for the study was total operative time, defined as skin incision to completion of skin closure, and the secondary outcome was incision to delivery time. Both time points are documented in the anesthesia record as routine parts of patient care. Baseline demographic characteristics of maternal age, race, gravidity, weight, and body mass index (BMI) were also collected from the delivery database. The date of surgery, indication for surgery, estimated blood loss (EBL), skin closure method, and resident level of primary surgeon were extracted from the operative reports. Postgraduate year (PGY)-1s and PGY-2s were classified as “junior residents,” and PGY-3s and PGY-4s were classified as “senior residents.” Cesarean deliveries were grouped by academic year from July to June, starting in year 1 (2003–2004) and ending in year 8 (2010–2011).

The study was approved by the Duke University Medical Center Institutional Review Board.

To analyze the data, we constructed a linear regression model for the primary and secondary outcomes. Resident junior/senior status, academic year, patient BMI, EBL, and skin closure method were included in the final multivariate regression model as clinically relevant variables. Comparisons of outcomes were made between junior and senior residents for the first and the last study year. Surgical case volumes reported by graduating residents were obtained from ACGME resident case logs for cesarean deliveries, total abdominal hysterectomies, and operative laparoscopies. The mean number of

What was known and gap

Little is known about the effects of 2003 duty hour limits on operative time for obstetrics and gynecology residents.

What is new

Since 2003, there has been an increase in time of nearly 20 minutes for a routine cesarean delivery.

Limitations

Single site study, and retrospective data make it difficult to eliminate confounding variables.

Bottom line

Duty hour limits and the shift from open laparotomy to laparoscopy for many procedures may both contribute to increased operative time for cesarean sections.

cases was determined for each year, and the linear trend for each period was calculated using 1-way analysis of variance with a posttest for linear trend analysis. There was no formal correction for multiple comparisons. The type 1 error was adjusted to 0.01 to reduce the chance of a spurious significant finding. All statistical analyses were performed using SAS version 9.3 (SAS Institute Inc) and Prism version 6.0 (Graph-Pad) software for Macintosh (Apple Inc). A *P* value of < .01 was considered significant.

Results

From July 2003 to June 2011, 8694 cesarean deliveries were performed and recorded in the Duke University obstetric anesthesia database. The primary and overall cesarean delivery rates at our institution increased from 19% and 30%, respectively, in 2003 to 25% and 41% in 2011. The mean primary cesarean delivery rate during the entire study time period was 22% (*n* = 5359), with 4724 (88%) of the primary cesarean deliveries being performed in labor. A total of 635 unlabored primary cesarean deliveries were identified. Of these, 444 unlabored primary cesarean deliveries met study criteria during the study period. Malpresentation was the most common indication for cesarean delivery, comprising 63% of cases, followed by placenta previa (8%), elective upon maternal request (8%), and macrosomia (7%).

Demographic data for our subject population can be found in the TABLE. The median EBL at cesarean over the entire time period was 750 mL (interquartile range, 600–900 mL). Maternal BMI and EBL during cesarean delivery did not change over the study time period. The proportion of patients receiving subcuticular suture for skin closure changed during the study period from 65% at the beginning to 89% at the end. The distribution of unlabored primary

TABLE
Baseline Maternal Demographic and Obstetric Characteristics

Characteristic	All Subjects (N = 444)
Age, y ^a	29.4 ± 6.2
Parity ^b	0 (0, 7)
Gestational age, weeks ^a	38.4 ± 2.3
Race/ethnicity, n (%)	
White	196 (44.1)
African American	108 (24.3)
Hispanic	93 (20.9)
Other	47 (10.6)
Maternal BMI, kg/m ^{2c}	30.4 (27.5, 34.7)
Skin closure method, n (%)	
Suture	264 (59.5)
Staples	180 (40.5)

Abbreviation: BMI, body mass index.

^a Mean ± standard deviation.

^b Median (range).

^c Median (interquartile range).

cesarean deliveries among junior and senior residents remained stable during the study period. Over the entire study period, junior residents performed 337 (76%) and senior residents performed 107 (24%) of the cesarean deliveries. Junior residents performed 85% (34 of 40) of the procedures in the first year of the study and 81% (30 of 37) of the procedures in the last year of the study ($P = .65$).

FIGURE 1 illustrates the distribution of time to complete a cesarean delivery total operative time (FIGURE 1A) and incision to delivery time (FIGURE 1B). Simple linear regression demonstrated a significant linear increase in the total operative time by year since introduction of the 80-hour workweek ($P < .001$; FIGURE 1A). In contrast, the incision to delivery time did not change over the study time period ($P = .20$; FIGURE 1B).

Overall, the mean (SD) total operative time increased during the study period from 43.3 (14.2) minutes in 2003–2004 to 59.6 (10.7) minutes in 2010–2011 ($P < .001$; FIGURE 2A). The mean (SD) total operative time by resident level increased significantly for junior residents, from 44.7 (14.6) to 62.7 (8.7) minutes, respectively, in 2003–2004 and then in 2010–2011 ($P < .001$). There were no significant differences in total operative time for senior residents over the time period (35.0 [± 8.5] to 46.7 [± 8.9] minutes, respectively, in 2003–2004 and then in 2010–2011 [$P = .10$]; FIGURE 2A). Incision to delivery time among all residents did not significantly change over the study period from 9.9 (4.1) in 2003–2004 to 11.0 (2.9) minutes in 2010–2011 ($P = .17$; FIGURE 2B).

The multivariable linear regression model for total operative time over the time period since introduction of the 80-hour workweek controlled for patient BMI, EBL, skin closure method, and PGY status, resulting in the ability to isolate the impact of these individual factors while controlling for the others. While controlling for these variables, linear regression demonstrated a 1.9-minute per year increase in total operative time for each year since the beginning of the 80-hour workweek ($P < .001$). The magnitude of increased total operative time was seen among junior residents (2.0 minutes per year, $P < .001$) rather than among senior residents (1.2 minutes per year; $P = .06$; FIGURE 3A).

Multivariate linear regression demonstrated that the incision to delivery time did not change over the studied time period ($P = .05$; FIGURE 3B). Incision to delivery time was driven primarily by the effect of patient BMI ($P < .001$) and PGY status ($P < .001$), rather than an effect of years since introduction of the 80-hour workweek ($P = .04$).

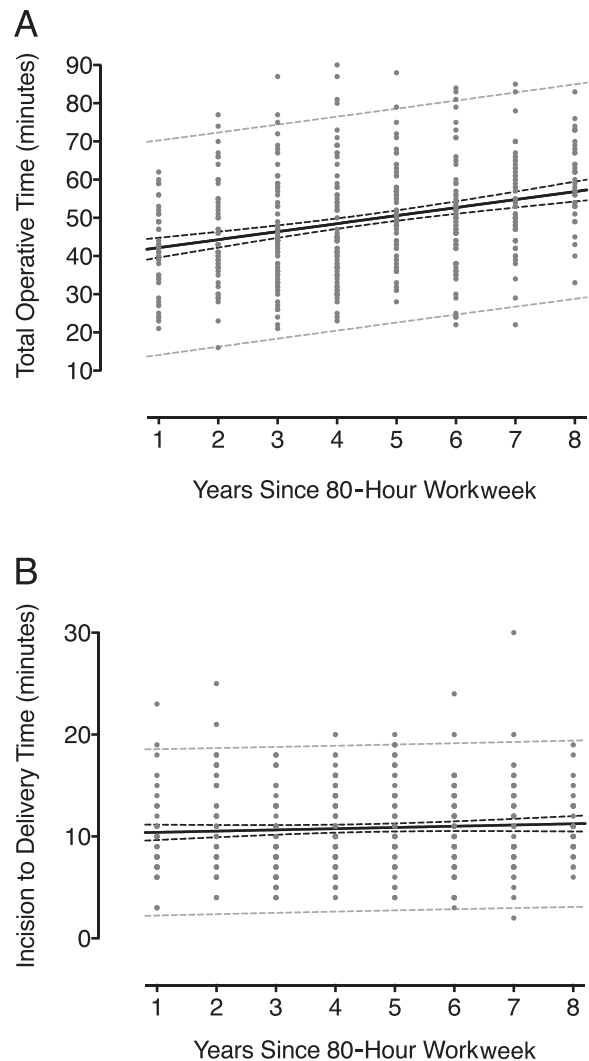


FIGURE 1
Distribution of Time to Complete a Cesarean Delivery

(A) Total operative time and (B) incision to delivery time.

A. Distribution of total operative times is shown by year since institution of the 80-hour workweek, modeled by the equation total operative time = $2.097 * X + 40.09$.

B. Distribution of incision to delivery times is presented by year since the institution of the 80-hour workweek. For each curve, the solid black line represents the simple linear regression line, the dotted black line is the 95% CI for the mean regression line, and the dotted gray line is the 95% boundary line within which 95% of the expected data points should fall.

The overall cesarean delivery case volume per resident was unchanged during the study period, with graduating residents reporting a mean (SD) of 213 (66) cesarean deliveries in 2003–2004 and 227 (40) cesarean deliveries in 2010–2011 ($P = .97$, test for linear trend; FIGURE 4A). The mean (SD) number of total abdominal hysterectomies per resident decreased from 114 (31) to 52 (26) during the same time period ($P < .001$, test for linear trend; FIGURE 4B). The mean (SD) number of operative laparoscopy cases increased

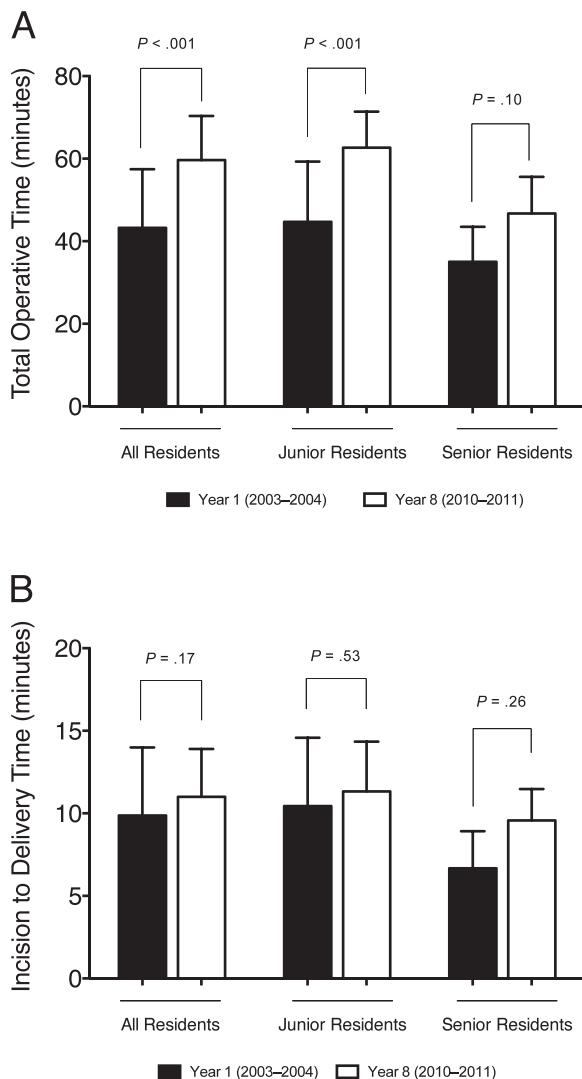


FIGURE 2
Distribution by Resident Level to Complete a Cesarean Delivery

(A) Total operative time and (B) incision to delivery time.

A. Total operative time to perform an uncomplicated primary cesarean delivery among all residents and by junior and senior residents during the first year of the study period (black bars) compared to the last year of the study (white bars). Values are mean operative times (minutes), and error bars are SD.

B. Incision to delivery time among all residents and then by junior and senior residents during the first year of the study period (black bars) compared to the last year of the study period (white bars). Values represent mean operative times (minutes), and error bars are SD.

during the study time period from 47 (23) in 2003 to 259 (57) in 2010 ($P < .001$, test for linear trend; FIGURE 4C).

Discussion

We demonstrated with multivariate linear regression that there has been a linear increase in the time for

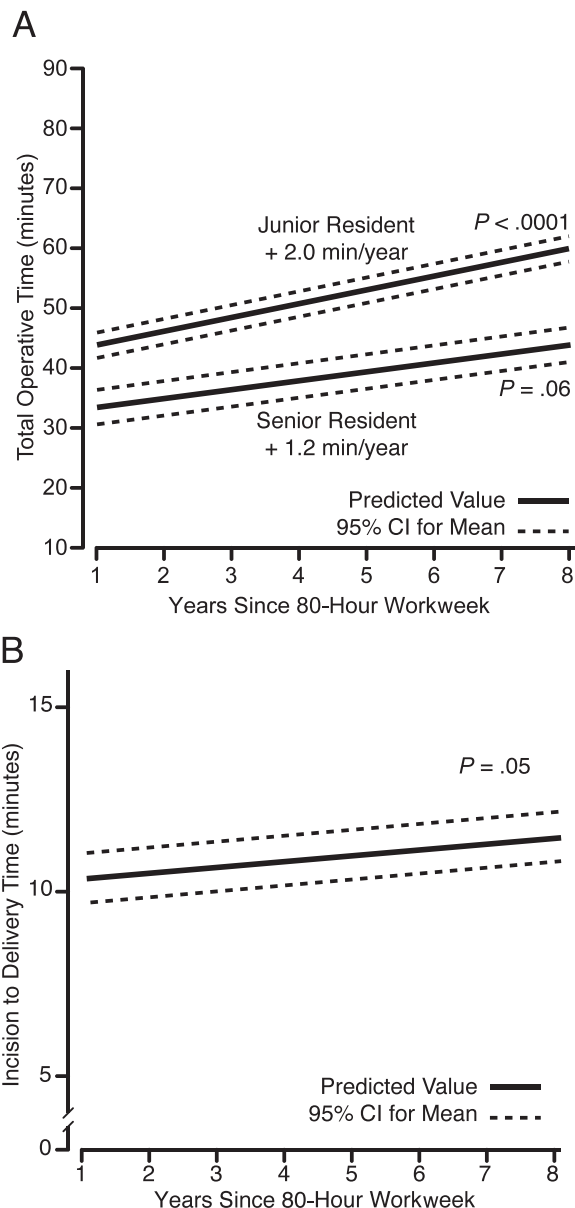
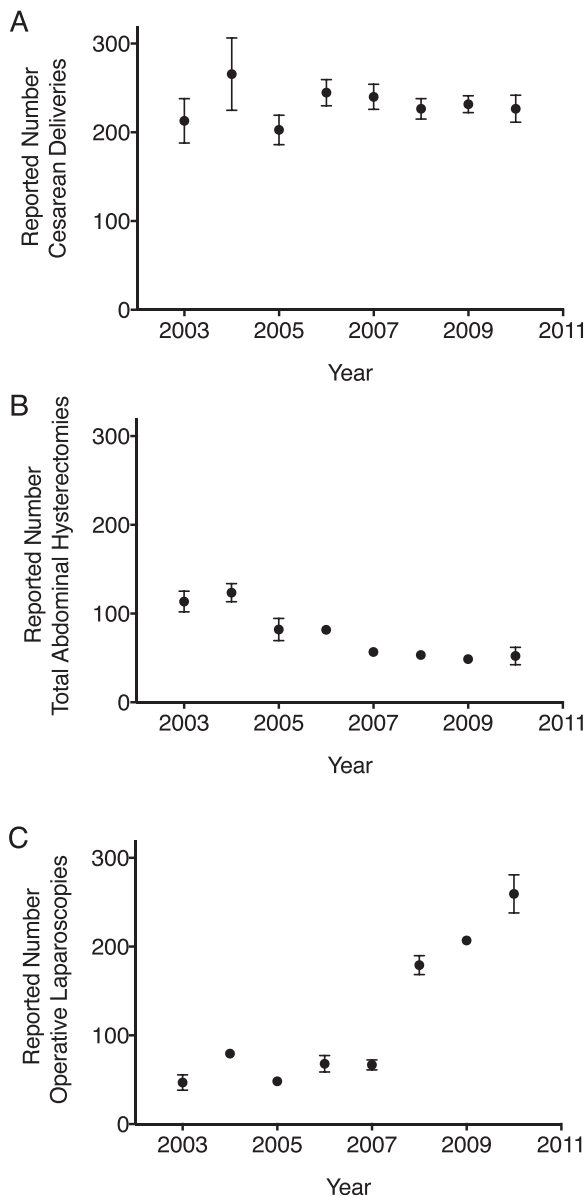


FIGURE 3
Multivariate Linear Regression Model for Total Operative Time Over The Entire Study Period by Resident Status, Controlling for Patient BMI, EBL, and Skin Closure Method

A. Solid lines represent predicted mean operative time, and dotted lines are 95% CI. The linear regression line is modeled by the equations: (1) total operative time for junior residents = $18.16 + (7.24 * \text{suture closure}) + (0.41 * \text{BMI}) + (0.0095 * \text{EBL}) + (2.04 * \text{year since the institution of the 80-hour workweek})$; and (2) total operative time for senior residents = $11.85 + (6.84 * \text{suture closure}) + (0.45 * \text{BMI}) + (0.0069 * \text{EBL}) + (1.20 * \text{year since institution of the 80-hour workweek})$. Suture closure = 1 for suture closure of the skin and 0 for staple closure of the skin. Year since institution of the 80-hour workweek is 1 for the years 2003–2004, 2 for 2004–2005, 3 for 2005–2006, 4 for 2006–2007, 5 for 2007–2008, 6 for 2008–2009, 7 for 2009–2010, and 8 for 2010–2011.

B. Linear regression model for incision to delivery time is shown over the entire study period. Solid line represents the predicted mean incision to delivery time, and the dotted line represents the 95% CI.

Abbreviations: BMI, body mass index; EBL, estimated blood loss.

**FIGURE 4**

Mean Number of Cases for DUMC Graduating Chief Residents (2003–2004 to 2010–2011) for (A) Cesarean Deliveries, (B) Total Abdominal Hysterectomies, and (C) Major Operative Laparoscopies

A. There was no change in the mean number of reported cesarean deliveries performed by year among graduating chief residents ($P = .97$ for test of linear trend).

B. Over the 8-year period, there was a significant decrease in the mean ($\pm$ SD) number of total abdominal hysterectomies performed by graduating chief residents ($P < .001$ for a test of linear trend) from 114 ($\pm$ 31) in 2003–2004 to 52 ($\pm$ 26) in 2010–2011.

C. During the same time period, there was a significant increase in the mean ($\pm$ SD) number of major operative laparoscopies performed by graduating chief residents ($P < .001$ for a test of linear trend) from 47 ($\pm$ 23) in 2003–2004 to 259 ($\pm$ 57) in 2010–2011.

Abbreviation: DUMC, Duke University Medical Center.

residents to perform an uncomplicated cesarean delivery at our center since the institution of the 80-hour workweek. Although the incremental increase of 1.9 minutes per year added to a routine cesarean delivery may seem trivial in any given year, the overall trend of an additional 15 to 16 minutes to perform the procedure during the study period raises concern. Prolonged operative times have been associated with increased blood loss, infectious morbidity, and surgical complications.^{7–9} Our study does not demonstrate causation but highlights an association of longer cesarean operative times in the first 8 years after implementation of the 80-hour workweek. Interpreting the causes and implications of these trends is challenging, given the multitude of factors that may potentially impact surgical time.

There have been reports that ob-gyn resident surgical case volumes have not been significantly affected by the duty hour limits.^{4,6} Similarly, our data show no change in the total number of cesarean deliveries performed by graduating residents. However, there was a significant decrease in the number of total abdominal hysterectomies and a simultaneous increase in the total number of major laparoscopic procedures performed by graduating residents during the study period. It is possible that the combination of duty hour limits and the changing pattern of fewer open laparotomy cases collectively may reduce residents' efficiency with open surgical procedures. With the shift in major gynecological operative cases from open laparotomy to laparoscopy, cesarean delivery has become the primary open abdominal procedure for ob-gyn residents. This trend may be driving, or contributing to, the association found in our study with longer operative times. Finally, as medical students have increasingly less autonomy during medical school, new interns may have less operative experience as they begin their training.

We are unaware of other studies attempting to determine the effect of resident duty hour restrictions on the time to complete a specific surgical procedure. Others have demonstrated that inclusion of residents in surgical cases increased operative time compared to attending physicians performing the procedure alone.^{10–13} The effect of the duty hour restrictions on patient outcomes in the surgical literature is conflicting.^{14–16} Studies in general surgery and ob-gyn suggest that laboratory-based training leads to more rapid improvement in technical skills and that residents who participate in laboratory-based/simulation training achieve greater competency during patient procedures.^{17–21} Future studies should explore whether simulation training in cesarean delivery will affect the time required to complete the procedure.

Our study has limitations. It was conducted at a single academic medical center, and it is not known whether the findings are representative of other ob-gyn residency training programs. The data were collected retrospectively, and we were limited to the variables available from the medical record, although a prospective study attempting to answer this question would be hindered by the fact that surgeons are aware that they are being timed and may adjust their practice accordingly. Beyond the variables studied, other confounding factors, such as innate ability, skill of assistants, or urgency for case completion due to other responsibilities, may have influenced the outcomes.

Conclusion

We found that total operative times to perform an uncomplicated primary cesarean delivery increased at a rate of almost 2 minutes per year, which, if the trend continues, translates into almost an additional 20 minutes to complete a similar procedure only a decade after the implementation of duty hour restrictions. It is unclear if changes in duty hour restrictions are driving this association, or if other aspects of residency training, such as a shift from less open gynecological procedures to more operative laparoscopies, account for these findings.

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