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# Evaluating the Impact of ACGME Resident Duty Hour Restrictions on Patient Outcomes for Bilateral Breast Reductions

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**Background:** The Accreditation Council for Graduate Medical Education (ACGME) implemented duty-hour restrictions limiting residents to 80 hours per week in 2003 and further extended restrictions in 2011 to improve resident and patient well-being. Numerous studies have examined the effects of these restrictions on patient outcomes with inconclusive results. Few efforts have been made to examine the impact of this reform on the safety of common plastic surgery procedures. This study seeks to assess the influence of ACGME duty-hour restrictions on patient outcomes, using bilateral breast reduction mammoplasty as a marker for resident involvement and operative autonomy.

**Methods:** Bilateral breast reductions performed in the 3 years before and after each reform were collected from the National Inpatient Sample database: pre-duty hours (2000–2002), duty hours (2006–2008), and extended duty hours (2012–2014). Multivariable logistic regression models were constructed to investigate the association between ACGME duty hour restrictions on medical and surgical complications.

**Results:** Overall, 19,423 bilateral breast reductions were identified. Medical and surgical complication rates in these patients increased with each successive iteration of duty hour restrictions ($P < 0.001$). The 2003 duty-hour restriction independently associated with increased surgical (OR = 1.51, $P < 0.001$) and medical complications (OR = 1.85, $P < 0.001$). The 2011 extended duty-hour restriction was independently associated with increased surgical complications (OR = 1.39, $P < 0.001$).

**Conclusions:** ACGME duty-hour restrictions do not seem associated with better patient outcomes for bilateral breast reduction although there are multiple factors involved. These considerations and consequences should be considered in decisions that affect resident quality of life, education, and patient safety. *(Plast Reconstr Surg Glob Open 2023; 11:e4820; doi: 10.1097/GOX.0000000000004820; Published online 7 February 2023.)*

## INTRODUCTION

Resident duty hour restrictions have been intensely discussed for the last several decades with many competing and complex perspectives involved. Excessive resident fatigue and sleep deprivation are well documented to be associated with diminished decision-making ability, impaired cognitive functioning, and poor surgical performance, which may increase the risk of motor vehicle accidents and patient harm.[1–4] Following concerns regarding patient safety and resident wellness, the Accreditation Council for Graduate Medical Education (ACGME) implemented sweeping restrictions limiting residents to 80 duty hours per week in 2003.[5,6] Continued concerns over resident health and patient care led to further extension of resident duty hour restrictions in 2011 with reductions in

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maximal daily duty length with duty periods of interns not exceeding 16 hours, and 8 duty-free hours between scheduled duty hours with 14 duty-free hours after 24 hours of in-house duty.[7,8]

However, duty hour restrictions impact various specialties differently, and there may not be a "one size fits all" approach to hours spent training a pathology resident versus a surgical resident. Although resident quality of life appears somewhat improved, the effect on patient outcomes and resident education remains mixed. Surveyed residents from medical and surgical specialties felt that while fatigue-related errors decreased, continuity of care-related errors increased with no overall patient benefit.[9–11] In particular, an increased rate of surgical complications leading to patient morbidity has been documented across a wide range of surgical specialties, including plastic surgery.[12–14] Furthermore, a reduction in duty hours and shift length was perceived to result in reduced learning opportunities and fewer operations performed by surgical residents, particularly in the more autonomous roles of primary surgeon and first assist.[15–17]

Surgical training involves increasing operative experience and autonomy, and plastic surgery residents gradually increase their mastery of the reconstructive and aesthetic components of surgery. Clearly, surgical residents are spending less time in the hospital during their training. Studies assessing the possible effects of ACGME duty hour restrictions on plastic surgery may not accurately capture resident-centered effects, given varying levels of attending surgeon oversight and involvement of other collaborating surgical services.[18,19] As one of the most commonly performed procedures in plastic surgery, reduction mammoplasty can be considered a marker for resident skill, operative autonomy, and surgical decision-making with residents often operating on the contralateral side to the attending surgeon's side.[20,21] In contrast, other procedures with high resident involvement such as microsurgery or severe hand trauma cases were not deemed suitable, given these cases' wide range of complexity and difficulty in modeling resident autonomy and decision-making. This study seeks to examine a national database for reduction mammoplasty outcomes before and after each ACGME duty hours intervention to assess for their resident-mediated effect on patient outcomes.

## Takeaways

**Question:** Is there an effect on plastic surgery patient outcomes after the ACGME resident duty hour restrictions passed since 2000?

**Findings:** Examining the varying patient cohorts before and after duty hour restrictions and using reduction mammoplasty as a marker of resident involvement, ACGME duty hour restrictions seem to be associated with increased surgical complications. However, patient comorbidities were also significantly associated.

**Meaning:** Alterations to resident training parameters should be carefully evaluated to optimize resident training, resident wellness, and patient outcomes.

## METHODS

This study was approved for exempt status from the institutional review board at our institution on the basis of deidentified information. The National Inpatient Sample (NIS) database, which was developed for the Healthcare Cost and Utilization and sponsored by the Agency for Healthcare Research and Quality, was queried for this study.[22] The NIS gathers information from a broad base of patients that receive care through Medicare, Medicare Advantage, Medicaid, and private insurance, as well as the uninsured. Study hospitals comprise a 20% stratified sample of all US hospitals, public and private, and teaching hospitals. As the largest publicly available national inpatient database comprising more than 35 million hospitalizations per year, the NIS has routine quality control measures to maintain the validity of the data, and weighting of these various factors allows for the comparison of outcomes data.[23]

To assess the varying effects of the 2003 and 2011 ACGME duty hour restrictions, three data collection periods were defined for this study. Because the 2003 ACGME duty hour restrictions were implemented on July 1, 2003, the pre-duty hour study period covered the three years extending from January 1, 2000 to December 31, 2002.[5] To allow for downstream policy response and observable changes in between the 2003 and 2011 ACGME restrictions, the duty hour study period comprised the 3 years extending from January 1, 2006 to December 31, 2008. Once the extended ACGME duty hour restrictions were enacted on July 1, 2011, the extended duty hour study period covered the 3 years extending from January 1, 2012 to December 31, 2014.[8] To select only for teaching hospitals, two NIS variables were assessed: HOSP_LOCTEACH and HOSP_TEACH. Only hospitals that were designated as "urban teaching" and "teaching," under those variables, respectively, were included in this study. There was no "rural teaching" designation.

All patients who underwent breast reduction mammoplasty as defined using the International Classification of Diseases, Ninth Revision system code 85.32 were studied. **(See table, Supplemental Digital Content 1,** which displays International Classification of Diseases, Ninth Revision (ICD-9) codes. **http://links.lww.com/PRSGO/C405**.)

Other reduction mammoplasty codes in the grouping 85.3 were not selected, and patients matching these codes were excluded because they incorporated placement of implants and/or unilateral reduction mammoplasty, where residents are less likely to have autonomy. Patients with concomitant abdominoplasty procedures were also excluded. Patients were separated into the three groups (pre-duty hours, duty hours, and extended duty hours) based on time period as defined above.

Outcomes of postoperative complications were defined as surgical or medical complications using International Classification of Diseases, Ninth Revision codes (**Supplemental Digital Content 1**, **http://links.lww.com/PRSGO/C405**). Surgical complications were

composed of wound infection, wound dehiscence, seroma, hematoma, and bleeding, whereas medical complications were comprised of pneumonia, acute respiratory failure, sepsis, urinary tract infection, acute kidney failure, myocardial infarction, and deep venous thrombosis. Patient demographics included age, gender, ethnicity, All Patient Defined-Diagnosis Related Group (APD-DRG) risk of mortality, and APD-DRG severity of illness. APD-DRG severity of illness and APD-DRG risk of mortality scores were utilized to characterize patients' preoperative likelihood of medical and surgical complications using patient comorbidity factors such as BMI, diabetes, and chronic kidney disease. Hospital characteristics included region, bed size, and teaching status, as it pertains to breast reconstruction. Using the group average all-payer inpatient cost-to-charge ratio in the cost-to-charge data files, hospital cost was calculated from NIS charge data.[24] Costs were adjusted for inflation using the consumer price index in relation to the year 2020 and for area wage index, a measure of hospital wage level based on geographic location compared with the national average.[25,26] This adjusted cost (cost = charge × group average all-payer inpatient cost-to-charge ratio × consumer price index × area wage index) was utilized for hospital cost analysis.

### Statistical Analyses

Patient demographics, hospital characteristics, and outcomes were compared between the pre-duty hour, duty hour, and extended duty hour study cohorts using Pearson $\chi^2$ test/Fisher exact test for patient characteristics, hospital characteristics, medical complications, and surgical complications, and the median test for k samples for age, cost, and length of stay. To assess whether ACGME duty hour restrictions were independently associated with patient outcomes, a multivariate logistic regression model is used to adjust for all other patient and hospital characteristics. Statistical analysis was performed using SPSS, version 22 (IBM, Armonk, N.Y.). For all analyses, a value of $P$ less than 0.05 was considered significant.

## RESULTS

Over the 2000–2002, 2006–2008, and 2012–2014 study periods, a total of 19,423 patients who underwent bilateral breast reduction mammoplasty were extracted with overall baseline patient and hospital data found in Table 1. Average patient age undergoing surgery was 40.3 years. The majority of the patients were White (61.1%), 26% of the patients were African-American, and 12.8% of patients were identified as other. Most of the patients were healthy with only 363 (1.9%) presenting with moderate, major, or extreme risk of mortality and 1761 (9.1%) with moderate, major, or extreme patient illness severity, as defined by APD-DRG. Large teaching hospitals were the most represented with 10,776 (55.5%) patients, followed by medium size with 5705 (29.4%) patients and small hospitals with 2942 (15.1%) patients. Geographically, the sampled hospitals were roughly distributed with a predominance of the Northeast region representing 7754 (39.9%) patients, then the West region representing 5026 (25.9%) patients, closely followed by the South region with 4417 (22.7%) patients, and then the Midwest with 2,226 (11.5%) patients. The mean hospital cost for each procedure was $21345.34. There were 625 patients who developed medical complications (3.2%) and 758 patients who developed surgical complications (3.9%) in our sample.

**Table 1. Breast Reduction Mammoplasty Patient Demographics**

| Variables | | |
|---|---|---|
| Age (mean, SD) | 40.3 | 11.4 |
| Ethnicity, N (%) | | |
| White | 11,877 | (61.1) |
| African American | 5055 | (26.0) |
| Other | 2491 | (12.8) |
| Risk of mortality, N (%)* | 363 | (1.9) |
| Patient illness severity, N (%)* | 1761 | (9.1) |
| Hospital bed size, N (%) | | |
| Small | 2942 | (15.1) |
| Medium | 5705 | (29.4) |
| Large | 10,776 | (55.5) |
| Hospital region, N (%) | | |
| Northeast | 7754 | (39.9) |
| Midwest | 2226 | (11.5) |
| South | 4417 | (22.7) |
| West | 5026 | (25.9) |
| Charges (mean, SD) | 21345.45 | 23471.23 |
| Medical complications, N (%) | 625 | (3.2) |
| Surgical complications, N (%) | 758 | (3.9) |

*Moderate, major, or extreme.

Patient demographics, hospital characteristics, hospital costs, and outcomes grouped by duty hour cohort can be found in Table 2. Significant patient demographic differences were present between the duty hour cohorts as patient age increased from 37.4 years in the pre-duty and 42.8 years in the duty hour cohorts to 45.5 years in the extended duty cohorts ($P < 0.001$). Preponderance of White ethnicity also diminished over time from 64.1% in the pre-duty and 61% in the duty hour cohorts to 51.6% in the extended duty cohort with corresponding increases in African-American (25.2% and 25.8% to 29.0%) and other (10.7% and 13.1% to 19.3%) representation across the three cohorts, respectively ($P < 0.001$). Patient comorbidities were also found to increase over time with APD-DRG risk of mortality and patient illness severity trending upward from 0.3% to 1.8% and 7.2% and 2.5%, 11.2%, and 27.2%, respectively ($P < 0.001$). Significant differences in hospital size ($P < 0.001$) and hospital region ($P < 0.001$) between the cohorts were also detected. Teaching hospitals also experienced significantly higher costs ($P < 0.001$) after passage of duty hour restrictions from $13,280.41 to $24,950.42 and further increased to $41,721.01 after extended duty hours were implemented. Significantly more medical complications ($P < 0.001$) were reported in the extended duty hour cohort (8.0%) in comparison to the duty hour cohort (4.0%) and pre-duty hour (1.4%) cohorts. Significantly more surgical complications ($P < 0.001$) were reported in the extended duty

**Table 2. Breast Reduction Mammoplasty Patient Demographics by ACGME Duty Hour Cohort**

| Study Periods | Pre-duty Hours (2000–2002) | | Duty Hours (2006–2008) | | Extended Duty Hours (2012–2014) | | |
|---|---|---|---|---|---|---|---|
| **Variables** | | | | | | | |
| Age (mean, SD) | 37.4 | 13.8 | 42.8 | 14.1 | 45.5 | 15.1 | <0.001 |
| Ethnicity, N (%) | | | | | | | <0.001 |
| White | 6777 | (64.1) | 3455 | (61.0) | 1645 | (51.6) | |
| African American | 2667 | (25.2) | 1463 | (25.8) | 925 | (29.0) | |
| Other | 1133 | (10.7) | 743 | (13.1) | 615 | (19.3) | |
| Risk of mortality, N (%)* | 33 | (0.3) | 100 | (1.8) | 230 | (7.2) | <0.001 |
| Patient illness severity, N (%)* | 262 | (2.5) | 634 | (11.2) | 865 | (27.2) | <0.001 |
| Hospital bed size, N (%) | | | | | | | <0.001 |
| Small | 1083 | (10.2) | 1369 | (24.2) | 490 | (15.4) | |
| Medium | 3129 | (29.6) | 1761 | (31.1) | 815 | (25.6) | |
| Large | 6365 | (60.2) | 2531 | (44.7) | 1880 | (59.0) | |
| Hospital region, N (%) | | | | | | | <0.001 |
| Northeast | 4525 | (42.8) | 2114 | (37.3) | 1115 | (35.0) | |
| Midwest | 1305 | (12.3) | 566 | (10.0) | 355 | (21.2) | |
| South | 2264 | (21.4) | 1198 | (21.2) | 955 | (30.0) | |
| West | 2483 | (23.5) | 1783 | (31.5) | 760 | (23.9) | |
| Charges (mean, SD) | 13280.41 | 10595.06 | 24950.42 | 13959.62 | 41721.01 | 88726.27 | <0.001 |
| Medical complications, N (%) | 145 | (1.4) | 225 | (4.0) | 255 | (8.0) | <0.001 |
| Surgical complications, N (%) | 259 | (2.4) | 234 | (4.1) | 265 | (8.3) | <0.001 |

*Moderate, major, or extreme.

**Table 3. Medical Complications Regression Pre-duty Hours (2000–2002) versus Duty Hours (2006–2008)**

| Variables | Exp[β] | 95% CI | *P* |
|---|---|---|---|
| Age | 1.023 | 1.015–1.031 | **<0.001** |
| Race | | | |
| White | Reference | | |
| African American | 1.119 | 0.860–1.456 | 0.403 |
| Other | 0.680 | 0.448–1.033 | 0.070 |
| Risk of mortality* | 2.958 | 1.877–4.661 | **<0.001** |
| Patient severity of illness* | 6.755 | 5.227–8.731 | **<0.001** |
| Hospital bed size | | | |
| Small | Reference | | |
| Medium | 1.761 | 1.238–2.503 | **0.002** |
| Large | 1.278 | 0.906–1.803 | 0.162 |
| Hospital region | | | |
| Northeast | Reference | | |
| Midwest | 1.380 | 0.972–1.961 | 0.072 |
| South | 1.236 | 0.922–1.657 | 0.156 |
| West | 0.877 | 0.652–1.180 | 0.387 |
| ACGME duty hours | 1.849 | 1.460–2.343 | **<0.001** |

Bold values indicate statistical significance at $P < 0.05$.
*Moderate, major, or extreme.

hour cohort (8.3%) in comparison to the duty hour cohort (4.1%) and pre-duty hour (2.4%) cohorts consisting primarily of excessive bleeding complications like hematoma and transfusion.

To control for confounders, multivariate regression analysis to compare medical and surgical complications between the pre-duty hour (2000–2002) and duty hour (2006–2008) cohorts were performed (Tables 3 and 4). ACGME duty hour restrictions (Exp[β], 1.849; 95% CI, 1.460–2.343; $P < 0.001$), patient APD-DRG severity of illness (Exp[β], 6.755; 95% CI, 5.227–8.731; $P < 0.001$), and APD-DRG risk of mortality (Exp[β], 2.958; 95% CI, 1.877–4.661; $P < 0.001$) scores were most strongly independently associated with increased medical complications. Increased surgical complications were independently associated with ACGME duty hour restrictions (Exp[β], 1.508; 95% CI, 1.224–1.859; $P < 0.001$) and APD-DRG severity of illness score (Exp[β], 2.892; 95% CI, 2.186–3.827; $P < 0.001$) (Table 4).

Similar multivariate regression analysis was performed to compare medical and surgical complications between the duty hour (2006–2008) and extended duty hour (2012–2014) cohorts (Tables 5 and 6). Patient APD-DRG risk of mortality (Exp[β], 6.206; 95% CI, 4.649–8.283; $P < 0.001$) and APD-DRG severity of illness (Exp[β], 3.261; 95% CI, 2.628–4.048; $P < 0.001$) scores were most strongly independently associated with increased medical complications. Extended ACGME duty hour restrictions were not associated with medical complications between the duty hour and extended duty hour cohorts. However, increased surgical complications between these cohorts were independently associated with ACGME duty hour restrictions (Exp[β], 1.394; 95% CI, 1.144–1.700; $P = 0.001$), APD-DRG risk of mortality (Exp[β], 1.703; 95% CI, 1.219–2.380; $P = 0.002$), and APD-DRG severity of illness score (Exp[β], 4.272; 95% CI, 3.486–5.235; $P < 0.001$) (Table 6).

## DISCUSSION

The ACGME-mandated duty hour restrictions first implemented in 2003 and then extended in 2011 were intended to protect the safety of residents and patients. Paradoxically, these restrictions have elicited a mixed response from attendings and residents due to concerns over increased patient handoffs and decreased operative time and exposure for resident training.[15,27,28] In plastic

**Table 4. Surgical Complications Regression Pre-duty Hours (2000–2002) versus Duty Hours (2006–2008)**

| Variables | Exp[β] | 95% CI | *P* |
|---|---|---|---|
| Age | 1.001 | 0.994–1.008 | 0.819 |
| Race | | | |
| White | Reference | | |
| African American | 0.918 | 0.726–1.161 | 0.473 |
| Other | 0.867 | 0.629–1.195 | 0.382 |
| Risk of mortality* | 0.524 | 0.268–1.024 | 0.059 |
| Patient severity of illness* | 2.892 | 2.186–3.827 | **<0.001** |
| Hospital bed size | | | |
| Small | Reference | | |
| Medium | 0.985 | 0.728–1.333 | 0.922 |
| Large | 1.013 | 0.767–1.338 | 0.926 |
| Hospital region | | | |
| Northeast | Reference | | |
| Midwest | 1.249 | 0.929–1.678 | 0.141 |
| South | 0.964 | 0.742–1.252 | 0.782 |
| West | 0.776 | 0.595–1.010 | 0.059 |
| ACGME duty hours | 1.508 | 1.224–1.859 | **<0.001** |

Bold values indicate statistical significance at $P < 0.05$.
*Moderate, major, or extreme.

**Table 5. Medical Complications Regression Duty Hours (2006–2008) versus Extended Duty Hours (2012–2014)**

| Variables | Exp[β] | 95% CI | *P* |
|---|---|---|---|
| Age | 1.020 | 1.012–1.028 | **<0.001** |
| Race | | | |
| White | Reference | | |
| African American | 1.193 | 0.943–1.508 | 0.141 |
| Other | 0.551 | 0.382–0.794 | **0.001** |
| Risk of mortality* | 6.206 | 4.649–8.283 | **<0.001** |
| Patient severity of illness* | 3.261 | 2.628–4.048 | **<0.001** |
| Hospital bed size | | | |
| Small | Reference | | |
| Medium | 2.193 | 1.555–3.094 | **<0.001** |
| Large | 1.894 | 1.367–2.625 | **<0.001** |
| Hospital region | | | |
| Northeast | Reference | | |
| Midwest | 1.444 | 1.027–2.031 | **0.035** |
| South | 1.489 | 1.144–1.940 | **0.003** |
| West | 0.881 | 0.658–1.178 | 0.392 |
| ACGME duty hours | 1.167 | 0.945–1.441 | 0.152 |

Bold values indicate statistical significance at $P < 0.05$.
*Moderate, major, or extreme.

surgery, the influence of the ACGME duty hour restrictions on plastic surgery resident training and patient outcomes has not been extensively investigated. This study accounts for the two rounds of ACGME duty hour restrictions enacted in 2003 and 2011 by investigating three separate patient cohorts from the 2000–2002, 2006–2008, and 2012–2014 time periods utilizing bilateral reduction mammoplasty as a reliable marker for the role of resident operative autonomy on patient outcomes.[20,21] Surgical and medical complications in patients undergoing bilateral reduction mammoplasty increased at teaching hospitals after the ACGME implemented the 2003 duty hour restrictions and 2011 duty hour restrictions. Following multivariate logistic regression, ACGME duty hour restrictions, in addition to patient APD-DRG comorbidity measures, were an independent factor significantly associated with increased surgical complications in the duty hour and extended duty hour cohorts.

**Table 6. Surgical Complications Regression Duty Hours (2006–2008) versus Extended Duty Hours (2012–2014)**

| Variables | Exp[β] | 95% CI | *P* |
|---|---|---|---|
| Age | 1.000 | 0.993–1.007 | 0.979 |
| Race | | | |
| White | Reference | | |
| African American | 1.025 | 0.818–1.285 | 0.828 |
| Other | 0.905 | 0.682–1.200 | 0.487 |
| Risk of mortality* | 1.703 | 1.219–2.380 | **0.002** |
| Patient severity of illness* | 4.272 | 3.486–5.235 | **<0.001** |
| Hospital bed size | | | |
| Small | Reference | | |
| Medium | 0.994 | 0.748–1.321 | 0.966 |
| Large | 1.093 | 0.846–1.413 | 0.495 |
| Hospital region | | | |
| Northeast | Reference | | |
| Midwest | 0.895 | 0.645–1.241 | 0.504 |
| South | 0.960 | 0.750–1.228 | 0.744 |
| West | 0.863 | 0.670–1.111 | 0.252 |
| ACGME duty hours | 1.394 | 1.144–1.700 | **0.001** |

Bold values indicate statistical significance at $P < 0.05$.
*Moderate, major, or extreme.

Across the spectrum of medical and surgical specialties, the effect of resident duty hour restrictions continues to be unclear. Large-scale studies and systematic reviews of teaching hospitals were unable to identify any patient benefits or reduced medical errors that the duty hour restrictions were purported to bring.[29–31] Overall, patient mortality is essentially unchanged with several studies demonstrating a lower complication rate, while other studies corroborate the findings presented in this study of slightly higher complication rates.[12–14,32–34] Notably, the data from larger specialties like general surgery consistently demonstrate no change in postoperative complication rates.[35–38] On the other hand, surgical subspecialties such as otolaryngology, orthopedics, and neurosurgery have been more likely to see an increase in complication rates with the passage of duty hour restrictions.[12,39–41]

In plastic surgery, breast reduction mammoplasty is a keystone procedure with reconstructive and aesthetic goals that must be mastered by all plastic surgery residents.[42] Prior literature has demonstrated that resident involvement in reduction mammoplasty is associated with a small but significant increase in surgical complications from 4.5% to 6.2% when comparing breast reduction patients without and with resident participation from 2005 to 2011.[20] When cases with residents were compared with cases with physician assistants, reductions took over half an hour longer.[43] Another study examining body contouring procedures inclusive of reduction mammoplasty found an increase in surgical complication rates from 3.3% to 5.5% with resident involvement from 2006 to 2012.[44] On the other hand, studies of breast reconstruction inclusive of breast cancer free-flap reconstruction, pedicle flap, and implant reconstruction found no

increase in complications with resident involvement, but it is difficult to isolate the effect of attending versus resident involvement with likely decreased resident autonomy in these more complex surgeries.[18,19] However, the patient population data used in all of these studies were derived entirely between 2005 and 2012, corresponding almost entirely with the duty hour cohort presented here and unable to be used in isolation to ascertain any effects of duty hour restrictions on resident-mediated patient outcomes. Fortunately, increased resident experience and ability captured by higher postgraduate year were significantly associated with fewer complications, demonstrating greater resident proficiency over time and the utility of reduction mammoplasty to model resident ability.[20] When patients undergo reduction mammoplasties at chief resident-run aesthetic clinics, complication rates are similar to those performed by attendings.[45]

The training of surgical residents is a core mission of academic medical centers and accomplishes the important goal of training the future surgeons and leaders of tomorrow while performing important patient care responsibilities. National surveys of program directors and plastic surgery residents indicate that most believe that resident duty hour restrictions negatively impact resident operative experience and training.[46,47] Canadian plastic surgery residents and program directors also echo these sentiments with concern that impaired training from limited hours will ill-prepare residents for life as an attending surgeon.[48] In general surgery, operative autonomy has decreased with residents reporting fewer first assistant cases due to less time in the operating room.[17] Furthermore, compliance with the duty hour restrictions has led to the utilization of a home call or night-float system where surgical instruction tends to be more intermittent and variable.[49] A laudable goal of the duty hour effort is to improve resident wellness by reducing work hours, but many residents derive an aspect of wellness and fulfillment from increased operative exposure, and thus these duty hour restrictions may paradoxically have negative effects on resident wellness.[27,50] Besides duty hours, other extrinsic factors such as the content of those duty hours and intrinsic factors such as grit and individual social support systems likely contribute as much to resident wellness as the simple numerical total of work hours dictated by the duty hour restrictions.[51]

Limitations to this study are inherent to using the NIS database to perform this retrospective cross-sectional analysis and thus prevents the identification of any causal relationship. Use of the teaching hospital designators as provided by the NIS is an approximate measure to capture the effects of resident duty hour restrictions, and one unlikely possibility is that NIS teaching hospitals may not necessarily have plastic surgery residents. One drawback of using the NIS database for investigating bilateral reduction mammoplasty is the inability to capture mammoplasties performed as an outpatient procedure.[52] However, the majority of the study period draws patient data from a time where many reduction mammoplasties were performed in-patient, ensuring the capture of sufficient data and also records complications attributed to patient care, which is typically the residents' responsibility. Given the necessity to explore the national scope of the duty hour restrictions, use of different databases such as the American College of Surgeons – National Surgical Quality Improvement Program (ACS-NSQIP) was not feasible. Unfortunately, American College of Surgeons – National Surgical Quality Improvement Program did not enroll private hospitals until the mid-2000s and did not collect data prior to 2003 before the implementation of any duty hour restrictions. The program also discontinued resident involvement variables after 2012, precluding the capture of any outcomes following the 2011 extended duty hour restrictions.

## CONCLUSIONS

This study explores the role of the 2003 and 2011 ACGME duty hour restrictions on complications in breast reduction mammoplasty as an associated marker of patient outcomes. Both the 2003 and 2011 duty hour restrictions were found to be an independently associated factor with increased surgical complications. A one-size-fits-all approach may be inadequate across all the ACGME specialties, and plastic surgery programs should share best practices to optimize resident education. Further changes to resident duty hours and clinical responsibilities must be carefully considered by the ACGME to ensure that residents maintain sufficient operative volume to improve patient outcomes.

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