

Influence of Resident Involvement in Obstetrics and Gynaecology Surgery on Surgical Outcomes: Systematic Review and Meta-Analysis



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Abstract

Objective: The effect of resident involvement during obstetrics and gynaecology (OB/GYN) surgery on surgical outcomes is unclear. This study sought to review the evidence systematically for the influence of resident participation in OB/GYN surgery on (1) operative time, (2) estimated blood loss, and (3) perioperative complications.

Method: Published studies were identified via searches of PubMed, Embase, Cochrane Central Register, Web of Science, and ClinicalTrials.gov databases. The study included randomized or observational studies that compared outcomes for OB/GYN surgery performed by attending surgeons alone or with residents. Risk ratios or mean differences were extracted from the studies. A random effect model was performed for each outcome, with subgroup analysis by type of surgery and study quality.

Results: A total of 13 studies were included in the meta-analysis, comprising 40 968 patients in seven countries. Surgical procedures performed only by attending surgeons had shorter operative times (mean difference 18.20 minutes; 95% CI 13.58–22.82), whereas surgical procedures with resident involvement were associated with an increased risk of blood transfusion (risk ratio 1.23; 95% CI 1.08–1.41). There were no observable differences in risk of estimated blood loss, wound infection, urologic injury, viscus injury, or return to the operating room. Significant heterogeneity ($I^2 > 50\%$) was present in one of seven outcomes.

Key Words: Obstetrics, gynaecology, resident, complications, patient safety

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Conclusion: Resident participation in OB/GYN surgery is associated with longer operative times and increased risk of blood transfusion; however, other perioperative complications are not increased.

Résumé

Objectif : L'incidence sur les issues chirurgicales de la participation des résidents aux chirurgies gynéco-obstétricales est méconnue. Notre étude avait pour but d'analyser systématiquement les données relatives à l'effet de la participation des résidents sur : (1) le temps opératoire; (2) la perte sanguine estimée; et (3) les complications périopératoires.

Méthodologie : Nous avons effectué des recherches dans les bases de données PubMed, Embase, Cochrane Central Register, Web of Science et ClinicalTrials.gov afin de repérer des études randomisées ou observationnelles comparant les issues de chirurgies gynéco-obstétricales réalisées uniquement par des chirurgiens à celle de chirurgies du même type auxquelles participaient des résidents. Les risques relatifs (RR) et les différences moyennes ont été extraits des études retenues. Un modèle à effets aléatoires a été utilisé pour chacune des issues, et des analyses par sous-groupes ont été réalisées par type de chirurgie et par cote de qualité de l'étude.

Résultats : Au total, 13 études ont été retenues pour la méta-analyse; elles portaient sur 40 968 patientes recrutées dans sept pays. Les chirurgies réalisées uniquement par des chirurgiens avaient un temps opératoire moindre (différence moyenne : 18,20 minutes; IC à 95 % : 13,58–22,82), et les chirurgies auxquelles participaient des résidents étaient associées à un risque accru de transfusion sanguine (RR : 1,23; IC à 95 % : 1,08–1,41). Aucune différence n'a été observée quant au risque de perte sanguine estimée, d'infection de la plaie, de lésion urologique, de lésion viscérale ou de retour sur la table d'opération. Une des sept issues à l'étude présentait toutefois une hétérogénéité significative ($I^2 > 50\%$).

Conclusion : La participation des résidents aux chirurgies gynéco-obstétricales est associée à un temps opératoire prolongé et à un

risque accru de transfusion sanguine, mais pas à un risque accru d'autres complications périopératoires.

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INTRODUCTION

The training of future obstetricians and gynaecologists requires residents to perform surgeries independently and competently before entering licensed medical practice. Surgical expertise is essential in this specialty because these physicians perform some of the most common surgical procedures, including Caesarean sections (CSs) and hysterectomies.¹ Residency training programs involve trainees performing or assisting in such surgeries because these residents gain the technical skills to become independent, proficient surgeons. Although there is great value in the observation of procedures performed by experienced surgeons, trainees must hone these necessary surgical skills through hands-on involvement as the primary operator or first assistant. However, from a patient care perspective, it is important to establish whether resident involvement in surgery has a negative impact on the quality and safety of surgical care. Specifically, the presence of significantly increased complication rates associated with resident surgical involvement would necessitate redesigning surgical education programs, such as through increased use of surgical simulation among junior learners. Furthermore, an increased risk of complications with resident-performed surgeries may necessitate its discussion in the informed consent procedure.

Several studies combining different surgical specialties have examined this question, with conflicting results.^{2–4} Recently, a meta-analysis performed by D'Souza et al.⁵ examined whether surgical outcomes differed depending on whether the surgery was performed by the resident or the attending surgeon, across all surgical specialties. These investigators found that surgeries performed by residents took longer to complete and resulted in an increase in minor complications.⁵ Although D'Souza et al.⁵ conducted a subgroup analysis

looking at obstetrics and gynaecology surgeries, several important studies within this surgical specialty were published after this review. As such, it would be of value to review the evidence systematically and meta-analyze a summary effect measure, specifically in the field of OB/GYN.

The objective of this systematic review and meta-analysis was to examine the impact of residents' participation in OB/GYN surgery on the following outcomes: (1) operative time, (2) estimated blood loss, and (3) intraoperative or postoperative complications, compared with surgery performed by attending staff only.

METHODS

Protocol and Registration

The study was developed in compliance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guideline.⁶ This meta-analysis was registered with the PROSPERO International Prospective Register of Systematic Reviews (ref. CRD42016050428 at <http://www.crd.york.ac.uk/PROSPERO>) on October 31, 2016.

Sources

The search strategy was developed by the authors, with input from a research librarian. PubMed, Embase, the Cochrane Central Register of Controlled Clinical Trials, Web of Science, and [ClinicalTrials.gov](http://www.clinicaltrials.gov) databases were searched from date of the database inception to October 10, 2016. In addition, abstracts from the following conferences were hand searched for the preceding 5 years: Association of Academic Professionals in Obstetrics and Gynaecology (APOG), Council on Resident Education in Obstetrics and Gynecology/Association of Professors in Gynecology and Obstetrics (CREOG/APGO), International Conference on Resident Education (ICRE), and International Association for Medical Education (AMEE). These abstracts were selected on the basis of recommendations from content experts. The search strategy included key words and MeSH (medical subject headings) terms including residency, training, obstetrics, gynaecology, surgery, CS, hysterectomy, long-term adverse effects, complications (intraoperative and postoperative), and adverse events. For details of the search performed, see [online Appendix S1](#). Endnote was used as the reference manager software to export and organize all the abstracts found through our search strategy and subsequently remove duplicate publications.

Study Selection

We included studies that reported on the associations between resident participation in surgery and surgical outcomes,

ABBREVIATIONS

NOS	Newcastle-Ottawa risk of bias scale
OB/GYN	obstetrics and gynaecology
RR	relative risk

including length of surgery, estimated blood loss, and perioperative complications. Studies were included in our meta-analysis if they met the following criteria: (1) studies involved OB/GYN surgery; (2) studies were RCTs, cohort studies, or case-control studies; (3) length of surgery, estimated blood loss, and intraoperative or postoperative complications were reported; (4) English full-text article were available; (5) A minimum of 10 patients were involved; and (6) patients were >18 years of age. There were no restrictions in length of follow-up because many of the outcomes that we were interested in do not require observation beyond the initial surgery. Authors of the abstracts were contacted to obtain the full-text articles or additional information if inclusion criteria were met on the basis of the information provided in the abstract. The study abstracts were divided in half, and each half was screened by two authors (N.S, S.Z, J.H, and M.S.), with disagreements reviewed and settled by an arbitrator (O.B.). Following the abstract review, potentially eligible studies underwent a full-text review, using the same division of labour as previously described.

Data Extraction

Data extraction and assessment of study quality were performed by two independent reviewers (O.B. and N.S.). Standardized data collection forms were used for data extraction. Data were collected regarding study characteristics, including the following: design and setting; baseline participant data, including age, parity, and eligibility criteria; nature of surgery performed; and description of the level of resident involvement in the surgery. Any discrepancy between reviewers in the extraction of data or assessment of study quality was resolved by discussion and consensus, as well as by input from a third reviewer (J.H.).

Assessment of Risk of Bias

Quality assessment was performed using the Newcastle-Ottawa risk of bias scale.⁷ This scale examines study quality on the basis of three perspectives: (1) the selection of the study groups (maximum four points); (2) the comparability of the groups (maximum two points); and (3) the ascertainment of either the exposure or outcome of interest for case-control or cohort studies, respectively (maximum four points). We considered studies of high quality if the NOS score was equal to or greater than 5.

Data Synthesis

For the primary outcome, operative time, mean operative times (SD) were extracted for attending and resident surgeons from each study. Two studies, by Slopnick et al.⁸ and Leonard et al.,⁹ were included in the systematic review but not in the meta-analysis because they reported on out-

comes of interest, but not in a format compatible for data synthesis in the meta-analysis.

Two studies did not report on the proportion of surgeries with resident participation. For the primary analysis, we assumed a 50% resident participation rate. To test this assumption, a sensitivity analysis was performed with a 25% resident participation rate, 75% resident participation rate, and exclusion of these studies.

Continuous outcomes, including operative time and estimated blood loss, were compared using mean difference. For dichotomous outcomes, a relative risk was calculated. A random effect model using the method of DerSimonian and Laird¹⁰ was performed for each outcome. Pre-specified subgroup analysis stratified by type of surgery (CS, hysterectomy, or prolapse repair) and study quality (NOS score ≤ 5 vs. >5) was performed to explore heterogeneity using the same methods.

A test for small study and publication bias effect was performed using a funnel plot. A formal test for funnel plot asymmetry was performed with an Egger test.

RESULTS

Study Selection and Description

[Online Figure S1](#) summarizes the study selection process. An initial query yielded 1675 studies, which was subsequently narrowed to 15 studies in the qualitative review.^{8,9,11–23} An overview of the included studies' characteristics and primary outcome is summarized in the [online Table S1](#). Of the included studies, 10 were retrospective cohorts, four were prospective cohorts, and one was an RCT. Of the 15 included studies in the qualitative review, the studies by Slopnick et al.⁸ and by Leonard et al.⁹ could not be included in the meta-analysis because of the way their data were presented. However, both studies were included in the qualitative systematic review.

Risk of Bias

The median score using the Ottawa-Newcastle risk of bias score was 7 (range: 4–9) and 11 scores were considered to be of high quality (NOS >5). Median score for assessment of selection was 4 (range: 2–4), for comparability 0 (range: 0–2), and for study outcome 3 (range: 1–3).

Synthesis of Results

A summary of study results is provided in the [Table 1](#). Two studies could not be included in the meta-analysis. Slopnick et al.⁸ queried the National Surgical Quality Improvement Program (NSQIP) database to determine notable trends in outcomes in patients undergoing midurethral sling place-

Table 1. Summary of outcomes of the studies included in the meta-analysis

Outcome	Summary effect (95% CI) (surgeries with resident involvement vs. surgeries without resident involvement)
Operating time (min)	MD: -18.20 (-22.82, -13.58)
Estimated blood loss (mL)	MD: -15.01 (-30.29, 0.27)
Blood transfusion	RR: 1.23 (1.08, 1.41)
Surgical wound infection	RR: 1.03 (0.90, 1.17)
Urologic injury	RR: 1.27 (0.95, 1.71)
Return to the operating room	RR: 1.10 (0.97, 1.26)
Viscus injury	RR: 1.14 (0.75, 1.74)

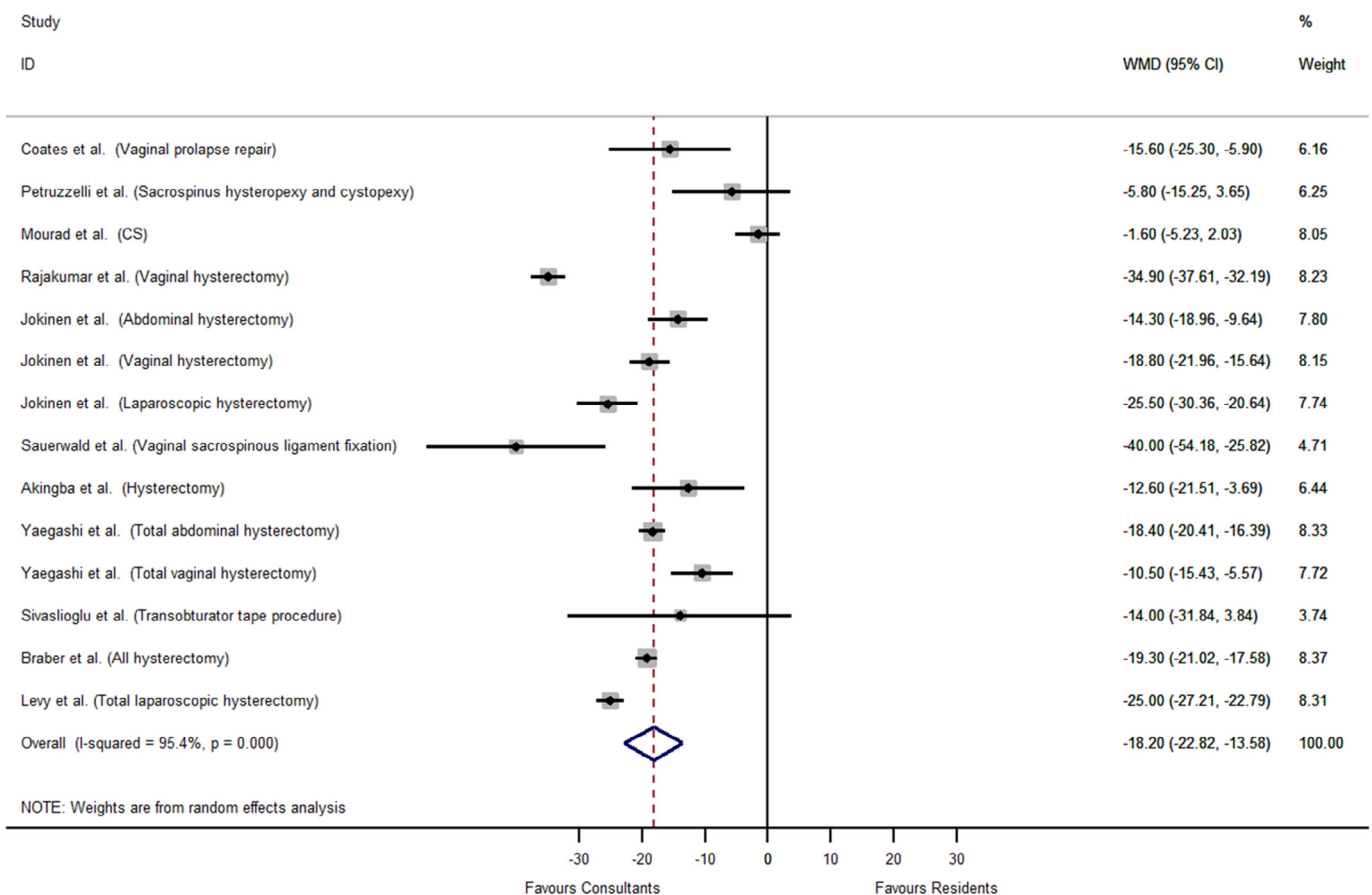
MD: mean difference; RR: relative risk.

ment. A total of 7767 women were studied, and after multivariable logistic regression, resident participation was associated with significantly increased odds of 30-day complications (5.1% vs. 3.7%; OR 1.32; 95% CI 1.01–1.73, $P = 0.04$) but not with hospital readmission. These investigators reported that despite increased complications among

resident cases, the overall complication rate was very low. They recommended that programs develop sustainable teaching plans with appropriate supervision in both urology and gynaecology. Leonard et al.⁹ reviewed the morbidity associated with 1333 gynaecologic laparoscopic procedures and found 31 complications (3%). Although surgeons' experience was not found to be associated with total complications (2.7% for beginner vs. 3.4% for experts, $P = 0.60$), there was a slight trend towards an increased rate of hemorrhage among beginners (1.2% beginners vs. 0.5% for experts, $P = 0.30$); however, this did not achieve statistical significance.

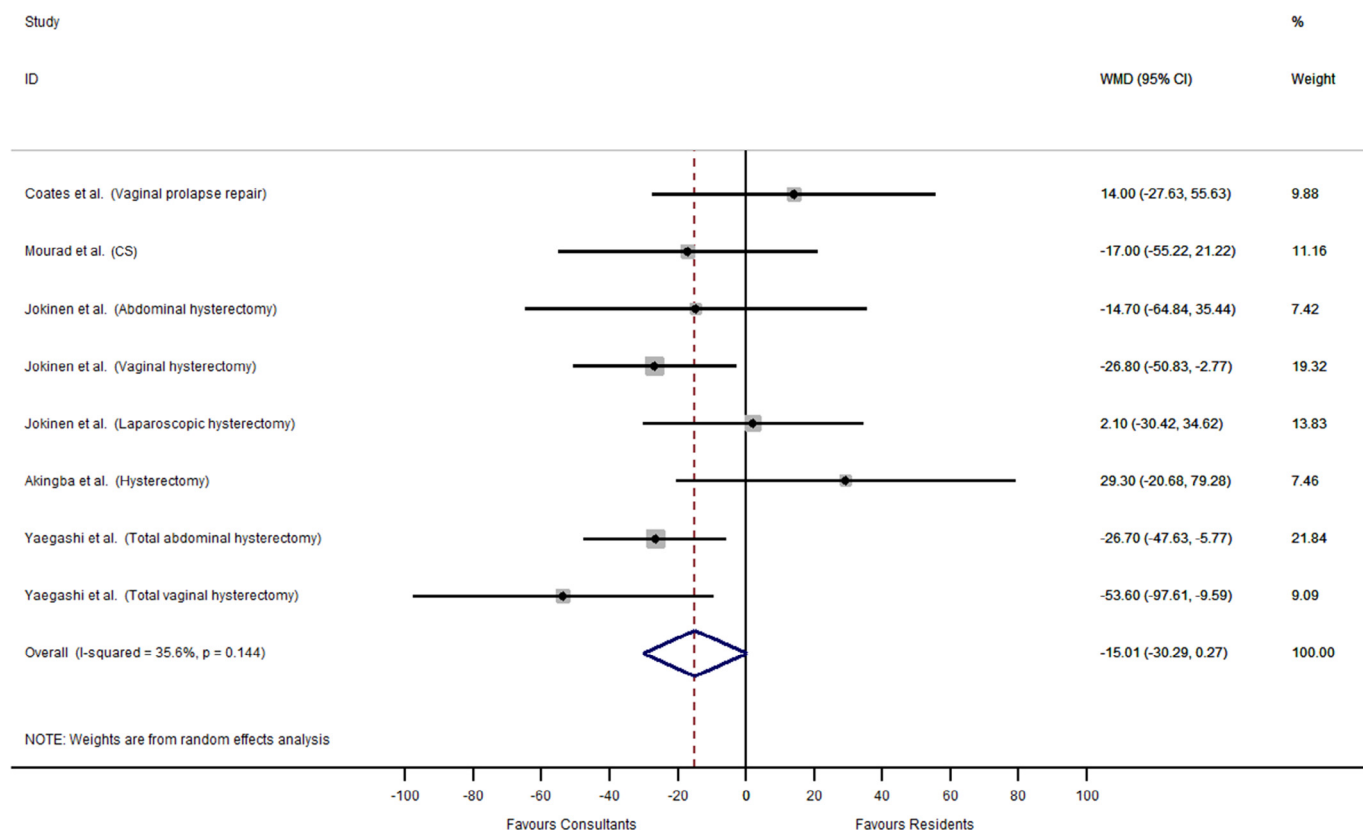
Operative Time

In the primary outcome of operative time, 11 studies were analyzed. A meta-analysis of all studies combined (Figure 1) and stratification by type of surgery (online Figure S2) was conducted. Two studies could not be included because they did not report on variance estimation.^{16,20} Igwe et al.²⁰ found that resident involvement in total laparoscopic hysterectomy resulted in longer operative times, compared with when the procedure was performed by attending surgeons (179.29 minutes vs. 135.46 minutes, $P < 0.0001$). Vandendriessche

Figure 1. Forest plot of mean difference in operative time (minutes).

WMD: weighted mean difference.

Figure 2. Mean difference in estimated blood loss (cc).



WMD: weighted mean difference.

et al.¹⁶ also found that surgery (laparoscopic sacrocolpopexy) was faster when performed by attending surgeons alone, and this result was statistically significant. Including all studies in our primary outcome, a statistically significant trend towards decreased operative time for non-resident cases was seen (mean difference: 18.20 minutes, 95% CI 13.58–22.82 minutes). One study, by Levy et al.,²³ was a potential outlier. However, the results did not change when this study was excluded (mean difference: -17.59 minutes, 95% CI 12.48–22.70 minutes) (online Figure S3).

Difference in operative time changed when stratified by type of surgery (online Figure S2). For prolapse repair, attending surgeons were found to perform faster without resident participation (mean difference: 18.37 minutes; 95% CI 4.53, 32.22 minutes). There was only one study examining CS, and no difference was observed between residents and attending physicians (mean difference: 1.60 minute; 95% CI -2.03, 5.23 minutes). For hysterectomies, six studies were included, divided into nine entities on the basis of surgical approach. Overall, surgeries performed by the attending surgeon alone were faster than with resident participation (mean difference: 20.29 minutes; 95% CI 15.90–24.68 minutes). Surgeries were faster when performed by attending surgeons than with resident participation when stratified

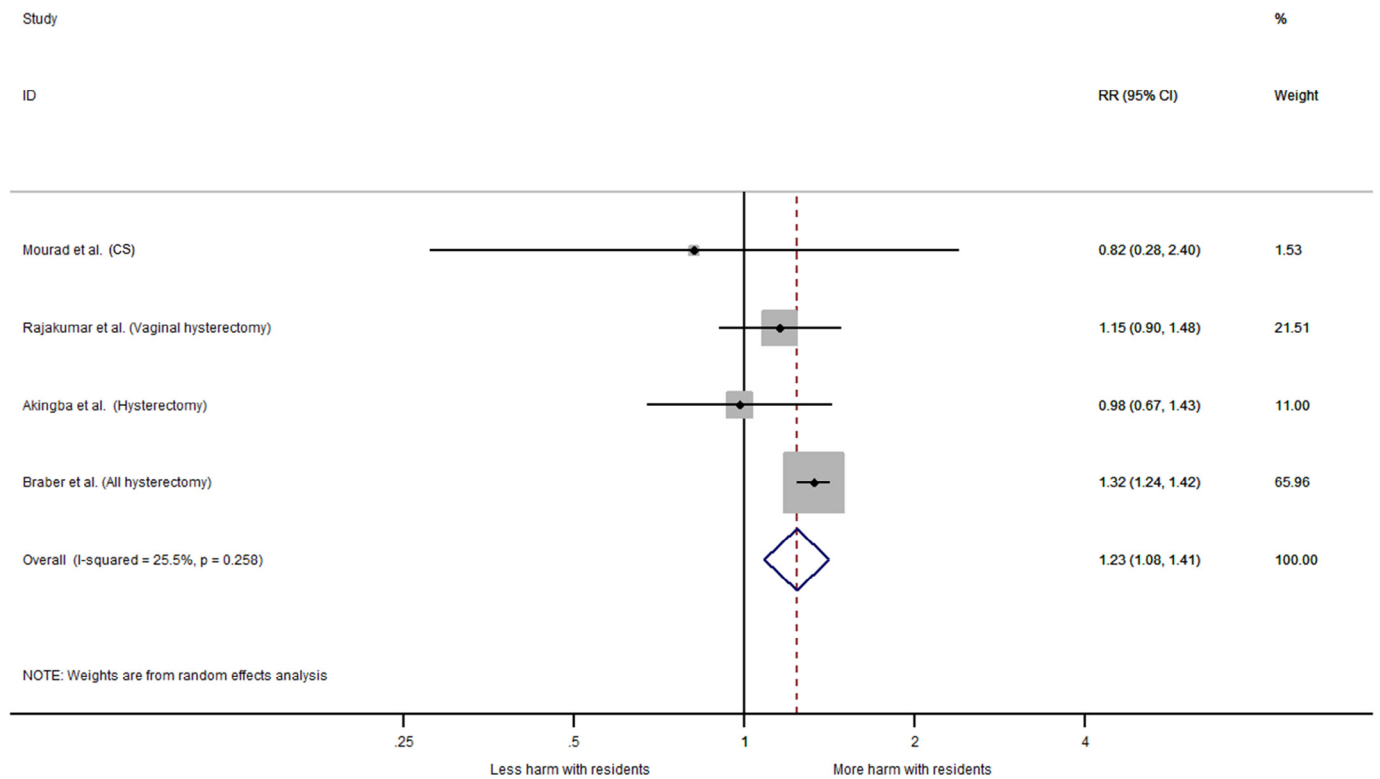
by study quality, although the difference was smaller in high-quality studies. Although we did attempt to examine the level of resident involvement in surgical cases, the studies did not report sufficient information for an accurate assessment of this variable.

A sensitivity analysis was performed to test the assumption that resident and attending surgeons performed the same number of surgeries in the two studies that did not specify the number of cases for each group.^{12,23} The meta-analysis for the primary outcome was repeated assuming a 25% resident participation rate, a 75% resident participation rate, and exclusion of these studies. The overall results did not change.

Blood Loss

By using the definition of estimated blood loss, no difference was observed with resident participation (mean difference: -15.01 mL; 95% CI -30.29, 0.27 mL) (Figure 2). When stratified by type of procedure, there was a significant decrease noted blood loss in hysterectomies performed by attending surgeons alone (mean difference: -18.18 mL; 95% CI -35.98, -0.38) (online Figure S4).

When blood loss was defined by requirement for blood transfusion, surgical cases with resident participation did

Figure 3. Relative risk (RR) for requiring blood transfusion.

demonstrate an increased risk of requiring a blood transfusion (RR 1.23; 95% CI 1.08–1.41) (Figure 3). When risk of transfusion was stratified by type of surgery, the increased risk of requiring a transfusion was confined to hysterectomies (RR 1.23; 95% CI 1.06–1.43) (online Figure S5), although only one CS study and no prolapse repair studies were included in the analysis.

Other Complications

There was no difference in the risk of developing a surgical wound infection with resident participation (RR 1.03; 95% CI 0.90, 1.17) (online Figure S6). In the study examining CS, there was a trend towards an increased risk for wound infection with resident participation, although this did not reach statistical significance (RR 1.31; 95% CI 0.98–1.75) (online Figure S7).

For urologic injury, resident involvement was associated with a non-significant increased risk (RR 1.27; 95% CI 0.95–1.71) (online Figure S8). When results were stratified by surgery type, residents were found to have higher urologic injury rates when performing prolapse repairs (RR 1.63; 95% CI 1.08–2.47), but not CSs or hysterectomies (online Figure S9).

For the outcome of return to the operating room, no difference was seen in the combined analysis (RR 1.10; 95%

CI 0.97–1.26) (online Figure S10) or when results were stratified by surgery type (online Figure S11).

For complications of viscus injury, no differences were seen in the combined analysis of three studies, divided into five entities (RR 1.14; 95%CI 0.75, 1.74) (online Figure S12). The trend was consistent when CS and hysterectomy were examined separately (online Figure S13).

When assessing heterogeneity, one of the seven outcomes featured in our analysis, operative time, demonstrated evidence of moderate to high heterogeneity ($I^2 > 50\%$). This heterogeneity was not reduced when stratified by surgery type or study quality.

To assess small study effect, a funnel plot was performed (online Figure S14). Visual inspection showed asymmetry, suggesting the presence of small study bias. An Egger test result was negative ($P = 0.062$).

DISCUSSION

Main Findings

Resident involvement in OB/GYN surgeries is associated with longer operative time and an increased risk of blood transfusion, but not estimated blood loss or risk of other perioperative complications (urologic injury, wound infec-

tion, viscus injury, or return to the operating room). The reason for the discrepancy between estimated blood loss and requirement for blood transfusion could not be explored in this study; however, we postulate the following possible explanations: underestimation of blood loss by residents, involvement of residents in more difficult cases, or lower threshold for transfusion when residents are involved.

It is also important to consider the absolute increase in the risk of blood transfusion that may be attributable to residents' participation in surgery. It is estimated that the chance of requiring a blood transfusion during gynaecologic surgery is approximately 2%,²⁴ which may be increased to approximately 2.5% if we use the RR of 1.23, as was found in our study.

Although we did not see an increase in perioperative complications overall, the suggestion was that some specific procedures may be associated with increased risk when residents are involved. Namely, we saw an increased risk of estimated blood loss in hysterectomies and increased urologic injuries during prolapse surgeries. If the risk of urologic injuries during surgery is estimated at 1% to 3%,²⁵ we can estimate that there would be an additional injury in every 50 to 150 patients when residents are involved in surgery. These findings may highlight the need for closer attending supervision during these specific procedures.

We noted high or moderate heterogeneity in one of the seven outcomes that were assessed: operative time. This heterogeneity remained in the subgroup analysis by surgery type and study quality. Thus, our meta-analysis should be interpreted with this in mind. Potential explanations for residual heterogeneity may include differences in study type and design and in populations assessed, unclear specification of resident involvement in the surgeries, and variable outcome ascertainment. The studies included in our review spanned seven countries, where training programs in OB/GYN may vary in their educational platform and years of training.

Strengths and Limitations

Our systematic review and meta-analysis have several limitations, including concerns with regard to comparability among groups, as seen in the quality assessment analysis, and lack of adjustment for confounding, especially for the primary outcome of operative time. As such, only unadjusted operative time values were available and used in our analysis. As previously described, there was high heterogeneity noted in several of our outcomes, and this was not reduced by stratifications performed, thereby suggesting the presence of residual heterogeneity.

It would be of interest to examine the level of resident involvement in the surgical cases where residents were present;

however, the studies included in our review did not consistently report on this variable. Several of the included studies used data collected from large national databases where resident involvement in surgery was characterized as a dichotomous variable only. It is likely that the extent to which a resident was involved in a given procedure, as well as the training level, would influence our outcomes of interest.

A number of strengths in our meta-analysis should also be mentioned. This was the first review and meta-analysis examining the impact of resident involvement in OB/GYN surgery. We performed a broad search, including abstracts from grey (unpublished) literature. We also included a number of OB/GYN procedures and included a large study cohort consisting of 40 968 surgeries.

Interpretation

It is important to consider that resident involvement in surgery and longer operative time comprise an association, and other explanations besides a causative mechanism should be considered. Residents are typically present in teaching institutions, where trainees in other perioperative aspects of care are present as well. This may include nursing students, anaesthesia students or residents, and surgical medical students. Collectively, training of these individuals may lead to increased operative time.

Our study results are consistent with those of D'Souza et al.,⁵ who examined the impact of residents performing surgeries in all subspecialties. Namely, there is a consistent finding that resident-performed surgeries require more time. It appears that in appropriately selected surgeries, resident involvement does not increase the risk of perioperative complications. Residency training programs should continue to strive towards improving surgical safety while maintaining an outstanding surgical training curriculum. Namely, the implementation of surgical simulation may allow for repetitive practice of pertinent surgical tasks, thereby allowing residents to improve their time and skill level before and in conjunction with the surgical training they receive in the operating room.

CONCLUSION

Resident participation in OB/GYN surgeries is associated with longer operative times and increased risk of blood transfusion; however, other perioperative complications are not increased.

Further research is encouraged to explore the effect of surgeons' characteristics, such as the level of resident training

and the extent to which residents are involved in the surgical procedures, on operative time and surgical complications.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jogc.2017.10.035>.

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