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Previous cesarean section and major complications during surgical abortion: A national multicentre case–control study☆,☆☆

Natalie Drever [a,b,*], Liam Johnston [a], Zinat Mohammadpour [a], Cecelia O'Brien [c], Catriona Melville [d], Kirsten Black [e], Philip Goldstone [f], Caroline de Costa [g]

[a] Cairns Clinical School, College of Medicine and Dentistry, James Cook University, Level 2, A Block, Cairns Hospital, 165 The Esplanade, Cairns, Australia
[b] Department of Obstetrics and Gynaecology, Cairns Hospital, Cairns, Australia
[c] College of Medicine and Dentistry, James Cook University, Townsville, Australia
[d] Department of Obstetrics and Gynaecology, Logan Hospital, Logan, Queensland, Australia
[e] Reproduction and Perinatal Centre, Faculty of Medicine and Health, University of Sydney, Level 6, Block K, Westmead Hospital, Westmead, Australia
[f] Medical Director, MSI Australia, Melbourne, Australia
[g] The Cairns Institute, James Cook University, Cairns, Australia

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ABSTRACT

Objectives: To investigate the association between previous cesarean section (CS) and major complications during first- and second-trimester surgical abortion.
Study design: We conducted a national retrospective case–control study using prospectively collected data from all MSI Australia surgical abortion facilities between 2016 and 2024. Individuals undergoing surgical abortion between 5 + 0 and 23 + 6 weeks' gestation were eligible. Cases were procedures complicated by hemorrhage ≥ 500 mL, transfusion, uterine perforation, hospital transfer, laparotomy, laparoscopy, or hysterectomy. Each case was matched to four gestation-matched controls (± 3 weeks) through a blinded process. A composite severe outcome included hysterectomy, laparotomy, intensive care admission, disseminated intravascular coagulation, or massive hemorrhage (≥2000 mL). Logistic regression estimated adjusted odds ratios (aORs) with 95% confidence intervals (CIs).
Results: Among 159 major-complication cases and 636 gestation-matched controls, a history of previous CS was more common among cases than controls. After adjustment for age, gestational age, parity and body mass index, previous CS remained associated with increased likelihood of being a case (aOR 2.6, 95% CI 1.7–4.0). Odds of being a case increased with increasing numbers of previous CS (aOR 2.0 per cesarean, 95% CI 1.5–2.6). Previous CS was more common among composite severe adverse outcome cases than controls (OR 9.56, 95% CI 4.34–21.04).
Conclusion: A history of previous CS was more common among cases than controls, with the odds of being a case increasing according to the number of prior CS. These findings may assist counseling, pre-procedure assessment and perioperative planning for patients with a history of cesarean birth.
Implications: Previous cesarean section was more common among cases than controls, including cases with severe adverse outcomes. Increasing numbers of prior cesarean sections were associated with higher odds of being a case. These findings may inform counseling and perioperative planning.

1. Introduction

Abortion is among the most common reproductive health procedures globally, with an estimated 73 million induced abortions annually [1]. Surgical abortion is a routine gynecological procedure across both trimesters, with complication rates rising with advancing gestation [2]. Major complications are rare but clinically serious, including hemorrhage, uterine perforation, laparotomy, and hysterectomy [3,4]. Identifying those at increased risk is therefore essential for counseling and perioperative planning.

Global cesarean section (CS) rates continue rising, projected to reach 29% worldwide by 2030 [5]. Increasingly, patients presenting for abortion have a history of one or more CS, yet the implications for procedural safety remain poorly defined [6]. Anatomical sequelae of CS - such as scarring of the internal os and changes in uterine

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* Corresponding author.
E-mail address: Natalie.Drever@jcu.edu.au (N. Drever).

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axis—may increase difficulty of mechanical cervical dilation, increasing the risk of surgical complications [7–9]. Additionally, CS carries risks of placenta accreta spectrum and cesarean scar pregnancy, which, though uncommon, can result in catastrophic hemorrhage during abortion [10].

Most available evidence addresses medical abortion safety after CS, particularly the risk of uterine rupture with prostaglandins, estimated at 0.4–1% and rising with gestation and increasing number of prior CS [10]. By contrast, evidence on surgical abortion following previous CS remains limited and inconsistent. Retrospective cohort studies have reported conflicting findings, with some suggesting increased risk of complications [11,12], while others demonstrate no such association [6,13]. These studies are limited by low event numbers. Data on first-trimester outcomes are particularly scarce, and robust evidence regarding the impact of multiple previous CS is lacking [6,12,14].

A possible association between previous CS and hysterectomy following surgical abortion has been reported, but this is based on extremely few reported cases across large datasets, underscoring the difficulty of studying rare outcomes using retrospective cohort studies [15]. No prior study has used a case-control design to examine severe complications following surgical abortion in individuals with previous cesarean birth. A case–control approach permits detailed medical record review of rare outcomes without requiring chart extraction across the entire source population.

Because major complications are uncommon, cohort studies require very large populations yet often include relatively small numbers of participants with multiple prior CS, limiting statistical precision. In addition, detailed clinical and procedural variables relevant to complications often require manual medical-record review, which is not feasible across cohorts exceeding 100,000 procedures. A case-control design is an efficient approach for studying rare outcomes in this context, enabling detailed evaluation of obstetric history and examination of associations according to the number of previous CS.

The objective of this study was to conduct a national, multicentre case-control investigation into the association between previous CS and major complications during first- and second-trimester surgical abortion.

2. Methods

This retrospective case–control study was conducted across all ten MSI Australia surgical abortion facilities. MSI is the largest private provider of surgical abortion nationally, with services operating across Victoria, New South Wales (NSW), the Australian Capital Territory (ACT), Queensland, and Western Australia (WA).

Cases comprised all patients between 5 + 0 and 23 + 6 weeks' gestation who experienced a major surgical abortion complication at an MSI clinic between January 2016 to December 2024. Major surgical complications were defined as: uterine perforation, hemorrhage ≥ 500 mL, blood transfusion, transfer to hospital for a procedure-related reason, emergency laparoscopy, laparotomy, or hysterectomy. Procedures involving failed abortion, retained products, cervical laceration, or same-day return to theater were not classified as major unless accompanied by one of these criteria. Non-surgical complications—including equipment issues, anesthetic complications (seizures, laryngospasm, hypoxia), behavioral or psychiatric events—were excluded. Delayed or community presentations for infection or pelvic inflammatory disease were excluded because the study focused on acute procedural complications. Cases were identified through Riskman, MSI Australia's organization-wide risk management and incident reporting database. Riskman is used routinely across all MSI sites to record clinical adverse events, hospital transfers and other reportable incidents as part of governance processes. To identify eligible cases, all clinical adverse events recorded during the study period were reviewed, and events relating to surgical abortion were assessed against the predefined case criteria. Additional database searches using relevant terms (e.g. "hemorrhage", "perforation", "transfer", "transfusion", "laparoscopy", "laparotomy" and "hysterectomy") were undertaken to ensure case completeness.

Four cases could not be retrieved and were excluded, with no controls matched for these patients.

Controls were patients undergoing surgical abortion during the study period who did not experience a major complication. Controls were matched to cases in a 1:4 ratio, selected sequentially from procedures performed on the same date within a gestational window of ± 3 weeks until four matches were identified. This approach was selected to ensure adequate control selection across the full gestational range while maintaining close similarity in gestational duration between cases and controls. Investigators were blinded to demographics and obstetric history during matching; gestational age and procedure date were the only matching variables. Patients undergoing procedures for miscarriage, fetal demise, or retained products were excluded.

Data were extracted from medical records of cases and controls into a standardized de-identified database.

Collected variables included patient factors (age, country of birth, Indigenous status, gravidity, parity, prior CS, BMI, previous surgical abortion, cervical surgery), pregnancy factors (gestational age, plurality, indication), and procedural factors (cervical preparation, procedure duration, estimated blood loss (EBL), complications). EBL was clinically estimated by the operating clinician at the time of procedure. EBL < 100 mL was commonly recorded using a standard field in the clinical record, while EBL exceeding this threshold was documented as a clinician-estimated value.

Procedures were performed as day-surgery cases under sedation by doctors holding fellowship with RANZCOG or RACGP, using standard clinical protocols across sites. These factors were consistent across all cases and controls.

The primary exposure was history of previous CS. Secondary exposures included age, BMI, indigenous status, gestational age, parity, and cervical preparation. The primary outcome was the occurrence of a major surgical complication. A prespecified composite severe adverse outcome was defined to capture the most clinically consequential complications and resource-intensive events. The composite included any of the following: hysterectomy, emergency laparotomy, intensive care unit (ICU) admission, disseminated intravascular coagulation (DIC), or massive hemorrhage (EBL≥2000 mL). Hemorrhage ≥ 500 mL was used to define major complications for case identification, consistent with prior studies [15], whereas the higher threshold of ≥ 2000 mL was selected for the severe composite to capture life-threatening hemorrhage in accordance with FIGO definitions [16].

Comparisons between cases and controls used *t*-tests or Mann–Whitney U for continuous variables and χ^2 tests for categorical variables. Logistic regression estimated odds ratios (ORs) with 95% confidence intervals (CIs).

Core covariates (age, gestational age, parity, and BMI) were selected a priori as potential confounders of the association between previous cesarean section and major-complication case status and were retained regardless of statistical significance. Because gestational age is a strong independent predictor of surgical complications and matching was performed within a ± 3-week range rather than exactly, adjustment for gestational age was retained to minimize residual confounding. Cervical preparation method was examined in sensitivity models but was not retained because it is closely linked to gestational age and did not materially change the estimated association between prior cesarean section and major-complication case status.

For the composite severe outcome ($n = 29$), cases were compared with the full gestation-matched control sample. Owing to the

Table 1
Baseline characteristics of women undergoing surgical termination of pregnancy, by case–control status

Characteristic	Cases (n = 159)	Controls (n = 636)	Missing, n (%)	p-value
Demographics				
Age, mean (SD)	29.7 (6.5)	27.6 (6.5)	0 (0%)	< 0.001
Place of birth			0 (0%)	0.303
Australia, *n* (%)	105 (66.0%)	446 (70.1%)		
Oceania (excl. Australia), *n* (%)	13 (8.2%)	51 (8.0%)		
Asia, *n* (%)	32 (20.1%)	87 (13.7%)		
Europe, *n* (%)	3 (1.9%)	9 (1.4%)		
Americas, *n* (%)	3 (1.9%)	9 (1.4%)		
Africa, *n* (%)	3 (1.9%)	17 (2.7%)		
Indigenous status, *n* (%)	14 (8.8%)	70 (8.8%)	0 (0%)	1.000
Obstetric history				
Gestation at abortion (weeks), median (IQR)	11.0 (9–15)	11.0 (8–15)	0 (0%)	0.156
Pregnancy type			0 (0%)	0.112
Singleton, *n* (%)	155 (97.5%)	628 (98.7%)		
Twin, *n* (%)	3 (1.9%)	8 (1.3%)		
Triplet, *n* (%)	1 (0.6%)	0 (0%)		
Reason for abortion			0 (0%)	0.666
Unplanned pregnancy	151 (95.0%)	609 (95.8%)		
Fetal anomaly	8 (5.0%)	27 (4.2%)		
Gravidity, median (IQR)	4.0 (2.0–5.0)	2.0 (1.0–4.0)	0 (0%)	< 0.001
Parity, median (IQR)	2.0 (1.0–3.0)	1.0 (0.0–2.0)	0 (0%)	< 0.001
Nulliparous, *n* (%)	39 (24.5%)	296 (46.5%)	0 (0%)	< 0.001
Previous cesarean section, *n* (%)			0 (0%)	
LSCS	57 (35.8%)	89 (14.0%)		< 0.001
Classical cesarean	0 (0.0%)	0 (0.0%)		
Number of previous CS, mean (SD)			0 (0%)	
None	102 (64.2%)	549 (86.3%)		
1	24 (15.1%)	61 (9.6%)		
2	21 (13.2%)	21 (3.3%)		
≥ 3	12 (7.5%)	5 (0.8%)		
Previous vaginal birth, *n* (%)	78 (49.1%)	284 (44.7%)	0 (0%)	0.319
Previous SToP, *n* (%)	63 (39.9%)	212 (33.3%)	0 (0%)	0.122
Previous LLETZ/cone, *n* (%)	4 (2.5%)	6 (0.9%)	0 (0%)	0.112
BMI, mean (SD)	25.9 (5.4)	24.8 (5.3)	20 (2.5%)	0.017

SD, standard deviation; IQR, interquartile range; LSCS, lower segment cesarean section; "classical cesarean", any upper segment cesarean technique including inverted T or J incision to uterus; SToP, surgical termination of pregnancy; LLETZ, large loop excision of the transformation zone; BMI, body mass index
Data are presented as mean (SD), median (IQR), or *n* (%). p-values calculated using *t*-test, Mann–Whitney *U* test, or Chi-square test, as appropriate.
[a]p-value is for overall test (Australia vs overseas-born)

limited number of events, results are presented as unadjusted odds ratios.

Adjusted ORs (aORs) with 95% CIs were reported; $p \leq 0.05$ was considered significant.

All analyses were conducted using IBM SPSS Statistics version 29.

All patients provide consent for use of clinical data in research and quality improvement; individual re-consent was not required. Ethics approval for this study was obtained from the James Cook University Human Research Ethics Committee (H9201).

3. Results

A total of 116,996 clients underwent surgical abortion at MSI Australia clinics between January 2016 and December 2024. During this period, 159 major-complication cases were identified, corresponding to an overall major complication rate of 0.14%.

In total, 159 major-complication cases and 636 gestation-matched controls were included in the analysis. Table 1 outlines the baseline demographic and clinical characteristics of cases and controls. Compared with controls, cases were older, had higher BMI, gravidity and parity, and were less likely to be nulliparous. Previous cesarean section was more common among cases, while place of birth, Indigenous status, previous vaginal birth, previous surgical abortion and prior cervical surgery were similar between groups. Median gestational age at procedure was 11 weeks in both groups.

Complications among the 159 cases are summarized in Table 2. Hemorrhage ≥ 500 mL and uterine perforation were the most frequent complications. Transfer to hospital occurred in 110 cases (69.2%); however, only six individuals were transferred without

Table 2
Major surgical complications among cases (*n* = 159)

Major complication	n (%) of cases
Hemorrhage	
Estimated blood loss ≥ 500 mL	105 (66.0%)
Massive hemorrhage ≥ 2000 mL	19 (11.9%)
Need for blood transfusion	29 (18.2%)
Foley catheter / balloon tamponade	29 (18.2)
DIC	4 (2.5%)
Surgical injuries	
Uterine perforation	55 (34.6%)
Cervical laceration[a]	12 (7.5%)
Visceral injury (eg. bladder, bowel)	3 (1.9%)
Emergency procedures/Further surgery	
Return to MSI operating theater (same day)[b]	23 (14.5%)
Emergency laparoscopy	35 (22.0%)
Emergency laparotomy	15 (9.4%)
Hysterectomy	10 (6.3%)
Other outcomes	
Transfer to hospital	110 (69.2%)[c]
ICU admission	7 (4.4%)
Composite severe adverse outcome[d]	29 (18.2%)

mL, milliliters; DIC, disseminated intravascular coagulation; ICU, intensive care unit
Note: As some women experienced multiple complications, categories are not mutually exclusive and totals do not sum to 100%.
[a] Cervical lacerations only included as cases if procedure was also complicated by hemorrhage > 500 mL or other major complication
[b] Refers to procedures performed within the original day surgery admission, not following hospital transfer
[c] 153/159 cases (96.2%) that were transferred also met other major complication criterion; 6 cases were transferred for severe postoperative pain only.
[d] Defined as hysterectomy, laparotomy, visceral injury, ICU admission, DIC, or massive hemorrhage ≥ 2000 mL

Table 3
Perioperative characteristics of cases and controls

Characteristic	Cases (n = 159)	Controls (n = 636)	p-value
Gestational age at procedure (weeks), median (IQR)	11.0 (9–15)	11.0 (8–15)	0.156
Type of cervical ripening[a,b]			0.047[c]
None	75 (47.2%)	310 (49.3%)	
Misoprostol only	54 (34.0%)	191 (30.4%)	
2 day procedure: laminaria + misoprostol	25 (15.7%)	72 (11.4%)	
2 day procedure: laminaria + mifepristone + misoprostol	5 (3.1%)	56 (8.9%)	
Total cumulative misoprostol dose (mcg), median (IQR)[d]	600 (400–800)	600 (400–1000)	0.890
Duration of cervical preparation, (hours), median (IQR)[e]	3.25 (2.0–4.25)	3.0 (2.0–4.0)	0.723
Operative time (minutes), median (IQR)	15 (8.0–25.0)	7 (5.0–10.0)	< 0.001
Estimated blood loss (mL), median (IQR)	500 (100–1000)	100 (100–100)	< 0.001

IQR, interquartile range; mcg, micrograms
[a] Some women underwent feticide at the time of laminaria insertion; these data were not included in the present analysis
[b] Women with missing ripening data ($n = 7$, 0.9%) were excluded from the analysis (final $n = 788$)
[c] A significant difference in ripening practices was observed between cases and controls ($p = 0.047$). This difference primarily reflected variation in the use of mifepristone.
[d] Cumulative misoprostol dose and duration calculated among women receiving misoprostol only

another major complication, all for severe postoperative pain requiring further assessment and management. The composite severe adverse outcome occurred in 29 (18.2%) cases. Individual patients could contribute to more than one component of the composite outcome; therefore, component events were not mutually exclusive. In two cases, uterine artery embolization was successfully used to control hemorrhage and avoid hysterectomy.

Perioperative characteristics are shown in Table 3. Cervical preparation practices differed modestly between groups, while total misoprostol dose and duration of cervical preparation were similar. Operative times were longer among cases. Cervical preparation method was not associated with increased likelihood of being a case on univariable logistic regression analysis ($p = 0.68$).

In multivariable analysis, previous CS was independently associated with increased likelihood of being a case (aOR 2.58, 95% CI 1.65–4.01, $p < 0.001$) (Table 4).

In a secondary model examining the number of previous cesarean sections, increasing numbers of prior cesareans were associated with progressively higher odds of being a case (Table 5). This model included the same adjustment variables as the primary analysis.

Previous cesarean was more common among composite severe adverse outcome cases than controls (Table 6).

4. Discussion

In this national multicentre case–control study, previous cesarean section was more common among major-complication cases than gestation-matched controls. Increasing numbers of previous CS were associated with progressively higher odds of being a case, although estimates for those with three or more previous CS were less precise because of small numbers. Prior CS was also more common among composite severe adverse outcome cases than among controls.

Table 4
Association between previous cesarean section and major-complication case status: multivariable logistic regression analysis

Predictor	aOR (95% CI)	p-value
Previous CS (≥1 vs none)	**2.58 (1.65–4.06)**	**< 0.001**
Age (per year)	1.00 (0.98–1.05)	0.80
Gestational age (per week)	1.02 (0.97–1.07)	0.41
Parity	1.25 (1.10–1.43)	0.001
BMI (per unit increase)	1.01 (0.97–1.04)	0.72

aOR, adjusted odd ratio; CI, confidence interval; CS, cesarean section; BMI, body mass index
Multivariable logistic regression adjusted for age, gestational age, parity and BMI. Reference group = women with no previous cesarean section. Women with missing BMI ($n = 20$, 2.5%) were excluded from the analysis (final $n = 775$)

Table 5
Adjusted odds ratios for major-complication case status by number of previous cesarean sections

Number of previous CS	aOR (95% CI)[a]	p-value
Categorical analysis		
0 (reference)	1.00	–
1 CS	1.71 (0.98–2.96)	0.058
2 CS	4.35 (2.18–8.67)	< 0.001
≥ 3 CS	8.34 (2.49–27.95)	< 0.001
Trend analysis		
Per additional CS	2.01(1.54–2.62)	< 0.001

OR, odds ratio; CI, confidence interval; CS, cesarean section
Women with missing BMI ($n = 20$, 2.5%) were excluded from the analysis (final $n = 775$)
[a] Adjusted for age, BMI, gestation, and parity.

Evidence on surgical abortion safety after CS has been inconsistent. Several cohort studies have reported higher rates of complications among individuals with prior CS, whereas others have not observed such differences. A large series of second trimester surgical abortion found ≥ 2 previous CS as the strongest predictor of major complications (aOR ~7), but included only 38 events among more than 2500 procedures, limiting precision [11]. Patel et al. reported 10 major events among approximately 2200 procedures, only two of which occurred in individuals with previous CS, illustrating how most cohorts are underpowered for rare complications [17]. Guahi et al. found an association between prior CS and adverse outcomes in nearly 2000 first-trimester procedures, but most events were minor. Our findings add to a body of literature examining surgical abortion outcomes among individuals with previous CS. In this case-control study, increasing numbers of previous CS were associated with progressively higher odds of being a case, while also capturing severe complications that are rarely examined in detail. Although direct comparison of effect estimates across study designs should be interpreted cautiously, the direction of our findings is broadly consistent with the existing literature.

Cervical factors may mediate some of the observed association between previous cesarean birth and case status. Ben-Ami et al. identified prior CS as a major risk factor for difficult dilation [8], supporting impaired cervical compliance as a plausible mechanism. Cervical preparation may be an important contributor to procedural safety in individuals with previous cesarean birth. Randomized and observational studies show that preoperative mifepristone followed by misoprostol, or combined with osmotic dilators, shortens operative time and reduces procedural difficulty compared with misoprostol alone [18,19], and systematic reviews recommend tailored use of osmotic dilators and pharmacologic agents by gestation [7,20]. In our study, the inclusion of mifepristone in two-day procedures above 16 weeks was less frequent among cases than controls (3 % vs 9 %), while total misoprostol dose and duration of preparation were similar between groups.

Table 6
Association between previous cesarean section and composite severe adverse outcome case status

Previous cesarean section	Composite severe adverse outcome (n = 29)*	No severe composite adverse outcome (n = 766)	Crude OR (95% CI)	p-value
No prior CS	10 (34.5%)	639 (83.4%)	Reference	
≥ 1 prior CS	19 (65.5%)	127 (16.6%)	9.56 (4.34–21.04)	< 0.001

CS, cesarean section
*Values are *n* (%).

The study's strengths include its national scope and case-control design, which allowed detailed analysis of rare, clinically verified outcomes. Inclusion of a substantial number of patients with ≥ 2 previous CS enabled examination of associations according to the number of prior CS. Limitations include the single-provider network, which may limit generalizability to other service models, and exclusion of patients referred directly to hospital for complex cases such as suspected placenta accreta or multiple prior CS, potentially limiting applicability of the findings to the highest-complexity patients. Not all sites provide procedures beyond 16 weeks, and the most complex late-gestation abortions were concentrated among a small number of clinicians, potentially contributing to variation by operator experience. Case ascertainment relied on an incident-reporting database and some under-reporting is possible; however, the major complications included in the case definition routinely trigger clinical governance review, making substantial under-ascertainment unlikely. Nearly half of controls were nulliparous (46.5%), which likely contributed to the relatively low prevalence of previous CS observed in this abortion population. Differences in cervical preparation protocols may also have influenced outcomes, and as a retrospective study, unmeasured factors such as surgical technique or anesthetic management could not be fully controlled. As an outcome-based case–control study, results may be affected by selection bias if the sampled controls do not accurately represent the exposure distribution in the underlying source population. To mitigate this, controls were selected sequentially from procedures performed on the same date as the index case within a narrow gestational window, with investigators blinded to obstetric history and demographics during matching; however, residual selection bias cannot be excluded. Furthermore, some severe complication cases may have been attributable to previously unrecognized placenta accreta spectrum or cesarean scar pregnancy. As both conditions are associated with previous cesarean birth, it is possible that some of the observed association with case status reflects these underlying pathologies rather than cesarean birth itself.

Our findings should be interpreted in the context of several remaining evidence gaps. National guidance recognizes that although limited and low-quality evidence has suggested higher complication rates after previous cesarean birth, robust data to guide management are lacking [16]. Evidence for individuals with a prior classical cesarean is virtually absent [10,21], and none were included in our study. The comparative safety of medical versus surgical abortion in individuals with ≥ 2 CS also remains unclear. Further research is needed to determine the optimal cervical preparation regimen and whether universal use of prophylactic hemostatic agents is warranted.

In summary, prior CS was associated with a higher likelihood of being a case, with progressively higher odds observed among individuals with increasing numbers of previous CS. Prior CS was also more common among severe adverse outcome cases than controls. These findings provide additional evidence to inform counseling and perioperative planning for patients with a history of cesarean birth.

Ethics approval

Ethical approval was granted by the James Cook University Human Research Ethics Committee (H9201).

Author contributions

P.G.: Writing – review and editing, Investigation. Cde.C.: Writing – review and editing, Supervision, Conceptualization. C.M.: Writing – review and editing, Supervision, Investigation, Conceptualization. K.B.: Writing – review and editing, Supervision. O.C.: Writing – review and editing, Supervision, Methodology. L.J.: Writing – review and editing, Data curation. Z.M.: Writing – review and editing, Methodology, Formal analysis. N.D.: Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

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Data availability statement

Deidentified data supporting the findings of this study are available from the corresponding author on reasonable request and with permission from MSI Australia.

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