

# DMJ

Dalhousie Medical Journal

Volume 49 | No. 2



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Dalhousie Medical Journal  
Box 201, Sir Charles Tupper Medical Building, Dalhousie University  
Halifax, Nova Scotia, B3H 4R2  
dmj@dal.ca  
www.dal.ca/dmj

DMJ is supported in part by the Dalhousie Medical Students' Society.

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ISSN 1488-9994  
Publication Agreement number 4006-9552

# EDITOR'S MESSAGE

## Carving a new path: empowering women in surgery

Sareen Singh, MSc<sup>1</sup>

*1. Faculty of Medicine, Dalhousie University*

For more than two decades, females have represented over half of Canadian medical school graduates<sup>1</sup>. Females also accounted for 52% of post-MD trainees in Canada in 2020-2021, with a slightly lower proportion of females (45%) among surgery and surgery subspecialty trainees<sup>1</sup>. This gap widens as we ascend the professional ladder. In 2019, females comprised only 30% of surgical specialists across Canada, compared to 43% of all physicians, ranging from a low of 9% in cardiac surgery to a high of 62% in obstetrics and gynecology among the Canadian Resident Matching Service (CaRMS) direct entry programs<sup>2</sup>.

The existing underrepresentation of women in surgery, compounded by the lack of women surgeons in positions of leadership, may dissuade some female medical students from embarking on a surgical career path. In 2021, across the 17 Canadian faculties of medicine, 21% of academic surgeons and 10% of surgical program division heads were female<sup>3</sup>. Furthermore, among the 40 highest-ranked surgical journals by impact factor in 2022, females made up only 20% of editorial team members and 13% of editors-in-chief<sup>4</sup>. The presence of this glass ceiling might inadvertently prevent female medical students from envisioning a successful career in surgery.

In addition, women who pursue surgical specialties encounter a host of challenges ranging from subtle biases to overt discrimination, including inflexible training options and parental leave policies, being unfairly perceived as less competent or less suitable for surgical careers than their male counterparts, receiving differential treatment from colleagues and patients, and experiencing sexual harassment<sup>5,6</sup>.

In this issue of the DMJ, we spotlight potential solutions to some of the barriers faced by women in surgery today. The papers and perspectives presented here emerge from a student-led hackathon event with Dalhousie medical students aimed at addressing the question: "How can we better support more women in surgery?" Among the proposed solutions are the provision of on-site childcare services, creating virtual platforms to facilitate networking opportunities between female trainees and surgeons, and implementing job sharing for female surgeons.

This event showcases the potential for transformative change within the surgical sphere and demonstrates

a collective will to address ongoing gender disparities head-on. While considerable work remains to be done to eliminate barriers for women in surgery, it is encouraging to see aspiring female surgeons confronting these issues early in their medical training and moving us forward in a positive direction.

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# ORIGINAL RESEARCH

## The association between gestational age at delivery and neonatal abstinence syndrome: A systematic review and meta-analysis

Sarah Brothers MD<sup>1</sup>, Victoria M Allen MD MSc<sup>1</sup>, Christy G Woolcott PhD<sup>1,2</sup>

1. Department of Obstetrics and Gynaecology, Dalhousie University

2. Department of Pediatrics, Dalhousie University

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### Abstract

**Objectives:** Some evidence suggests that infants born at later gestational age (GA) are at higher risk of developing neonatal abstinence syndrome (NAS). This systematic review estimated the association between GA at delivery and development of NAS in infants born to women on opioid agonist therapy (OAT). **Methods:** MEDLINE/PubMed, Scopus, Embase, CINAHL, and the Cochrane Central Register of Controlled Trials were searched from January 2000 to April 2023. Studies reporting data on the association between GA and NAS among pregnant women being treated with OAT were eligible for inclusion. Random effects meta-analysis was used to estimate the mean difference in GA between infants affected by NAS and unaffected infants; odds ratio (OR) for the association between preterm birth and NAS; and OR for the association between gestational week and NAS. **Results:** Of 966 records identified, 38 studies were eligible for this review. The pooled mean difference in GA between infants affected by NAS and unaffected infants was 0.62 weeks (95% CI: 0.08–1.16,  $I^2=90.7\%$ ). The odds of developing NAS were estimated to increase by 3% per gestational week (OR 1.03, 95% CI: 0.997–1.06,  $I^2=84.2\%$ ). The OR for the association between preterm birth and developing NAS was estimated to be 0.87 (95% CI: 0.63–1.21,  $I^2=85.7\%$ ). **Conclusions:** The data included in this review demonstrate that higher GA is unlikely to be associated with an increased risk of NAS, although poor study quality and significant study heterogeneity were observed.

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### Introduction

Opioid use disorder is an important public health issue, and its prevalence in pregnant women is rising<sup>1,2</sup>. Opioid agonist therapy (OAT) with agents such as methadone or buprenorphine is the treatment of choice for opioid use disorder during pregnancy<sup>3–5</sup>, reducing fetal exposure to repeated cycles of withdrawal, increasing adherence to prenatal care, and improving neonatal outcomes<sup>6,7</sup>. However, prenatal exposure to OAT can cause neonatal abstinence syndrome (NAS), which is characterized by central nervous system hyperirritability, autonomic dysregulation and gastrointestinal tract disturbance, as well as increased length of hospital stay and admission to the neonatal intensive care unit<sup>8–10</sup>. The incidence of NAS in Canada tripled between 2003 and 2014<sup>11</sup>. Similarly, in the United States the incidence of NAS increased from 3.4 to 5.8 cases per 1,000 live births between 2009 and 2012<sup>12</sup>.

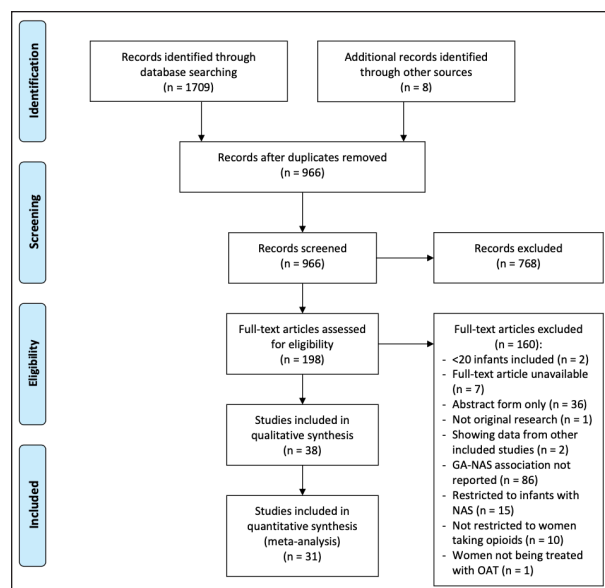
The relationship between gestational age (GA) at delivery and NAS is unclear, and may be influenced by maternal and fetal physiology, as well as by duration of opioid agonist treatment, the type of assessment tool, and concurrent prescribed and illicit substance use and other confounding factors. Cohort and randomized

studies have found that later GA at delivery is associated with an increased risk of developing NAS, increased severity of NAS, or both<sup>13–16</sup>, while other studies found no relationship<sup>17–19</sup>. Given the increasing prevalence of opioid use disorder and NAS, characterization of risk factors for NAS, such as GA at delivery, is important in the clinical management of the newborn. Information regarding the role of GA in the development of NAS may help guide obstetrical and neonatal management, such as ensuring adequate pregnancy dating and normal neonatal adaptation to extrauterine life, although clinical decision making is challenged by conflicting data.

The objective of this systematic review and meta-analysis was to estimate the association between GA at delivery and development of NAS in women receiving OAT, and explore potential sources of bias and heterogeneity in the published literature. We hypothesized that infants born to mothers using OAT in pregnancy delivering at earlier GA would be less likely to develop NAS.

### Methods

The protocol for this systematic review was registered



**Figure 1.** Systematic review of the literature evaluating the relationship between gestational age at delivery and risk of neonatal abstinence syndrome.

in PROSPERO (CRD42019118562). The systematic review and meta-analysis were reported following the PRISMA guidelines<sup>20</sup>.

### Search strategy and selection criteria

A search strategy was developed in consultation with a medical librarian. Peer-reviewed literature was searched to identify articles reporting the relationship between GA and NAS using MEDLINE/PubMed, Scopus, Embase, CINAHL, and the Cochrane Central Register of Controlled Trials from January 2000 to April 2023, with publications limited to the English language. Our search strategy included one string of terms related to the exposure of interest (GA at delivery) and a second string related to the outcome of interest (NAS). The MEDLINE and Embase search strategies are included in Appendix S1. The reference lists of studies included in the review were hand searched to identify additional papers for inclusion.

Studies were eligible for inclusion if the population was women who had used opioids in pregnancy and data on the association between GA and NAS were reported (even if not designed specifically to evaluate this association). Studies using any method of assessing NAS were included, and were excluded if they: contained fewer than 20 women (to differentiate case series from true cohort studies); were a review or commentary; were not published in English; were not a full-text article; were not published in a peer-reviewed journal; or included only infants who had been diagnosed with NAS. At least two reviewers (SB and either VMA or CGW) independently screened and reviewed

all titles and abstracts and performed a full-text review of identified articles for eligibility. Conflicts in the title and abstract or full-text review were resolved by consensus among the three authors.

### Data extraction and assessment of risk of bias

For each eligible study, population characteristics were extracted by the first author and confirmed by a second reviewer (VMA). Characteristics included: author and year published, geographic setting, years of birth included in the study, study design, sample size, type and rates of OAT used, maternal characteristics (age, rates of illicit opioid and other substance use, and infectious disease status), whether the study excluded infants below a certain GA, NAS assessment method, NAS outcome definition (e.g., pharmacologically treated NAS or NAS diagnosis), Caesarean delivery rate, and breastfeeding rate. The quantitative data on the association between GA and NAS (frequencies of GA by NAS, mean (SD) GA by NAS status, and effect estimates) were extracted by two reviewers (CGW and SB) with conflicts resolved by consensus.

Risk of bias was independently assessed using a modified Newcastle-Ottawa Quality Assessment Scale for Cohort Studies<sup>21</sup> by two reviewers (SB and either VMA or CGW) and all conflicts were resolved by consensus among the group of three reviewers. Risk of bias was assessed across four domains: sample selection, ascertainment of exposure, comparability, and outcome measurement. Three potential stars could be allotted for sample selection, one for exposure, two for comparability, and two for outcome. The modified risk of bias scale is attached in Appendix S2.

### Data synthesis and statistical analyses

Three effect measures for the association between GA and NAS were extracted or derived from data presented in the publications: mean difference in GA between infants affected by NAS and unaffected infants; odds ratio (OR) for the association between gestational week and NAS; and OR for the association between preterm birth (<37 weeks) and NAS. For studies that presented ORs for multiple categories of GA in relation to NAS, the OR per week of GA was estimated using weighted least squares regression<sup>22</sup>. One paper included in the meta-analysis reported an OR for GA but not its scale; based on other information provided in the report, we determined that the OR referred to GA per week<sup>23</sup>. Overall pooled effect estimates were derived using a random effects model<sup>24</sup>. Statistical heterogeneity was quantified with the  $I^2$  statistic, the percentage of variation among studies that is due to heterogeneity rather than chance<sup>25</sup>. Pre-specified subgroup analyses were

undertaken by the GA range included (infants born <34 weeks vs not), NAS definition (pharmacologically treated only vs all NAS), proportion of mothers taking methadone (100% using methadone, 33%–88% using methadone, and 0% using methadone), and rate of Caesarean delivery (<30% vs ≥30%). Analyses were performed using the *meta* package of Stata 16 (StataCorp LLC 2019). Recommended guidelines for reporting systematic reviews (PRISMA)<sup>20</sup> and meta-analyses of observational studies (MOOSE)<sup>26</sup> were followed.

## Results

### Study characteristics and quality

In total, 966 titles and abstracts were screened and 198 were deemed eligible for full-text review (Figure 1). One hundred and sixty papers were excluded following full-text review; therefore 38 articles were included in the systematic review<sup>13–19,23,27–56</sup>. The reasons for exclusion were as follows: the association between GA and NAS was not reported ( $n = 86$ ); full-text article unavailable ( $n = 7$ ), majority in abstract form only ( $n = 36$ ); restricted to infants with NAS ( $n = 15$ ); population not restricted to women taking opioids ( $n = 10$ ); less than 20 infants included ( $n = 2$ ); not original research ( $n = 1$ ); or women not being treated with OAT ( $n = 1$ ). Two articles<sup>57,58</sup> reported data that were reported in other included articles; results from the articles presenting more complete data that could be used in the meta-analysis from each study were included<sup>13,15</sup>.

Table 1 shows the characteristics of the 38 included studies. Six studies considered populations from Europe, 26 studies from the United States, five from Australia, and one from New Zealand. One study represented secondary cohort analyses of the MOTHER trial, a randomized controlled trial comparing the efficacy of methadone and buprenorphine in the United States, Canada and Europe<sup>15</sup>. Thirty-six studies were cohort studies and two were case-control studies. The assessment tool used to evaluate NAS varied among studies, with most using a modified Finnegan Neonatal Abstinence Score. The NAS outcome was usually defined as requiring pharmacologic treatment, but in some studies was based on criteria with the Finnegan scale (e.g., at least two successive scores ≥8) or on administrative codes (e.g., International Statistical Classification of Diseases, ICD). The incidence of pharmacologically treated NAS was reported in 34 papers including 6946 infants, and varied from 13% to 95%.

The risk of bias assessment indicated that most studies performed well for sample selection and exposure measurement but poorly for comparability, while quality of outcome measurement was variable. Comparability was poor because only three studies controlled

for potential confounders of the relationship between GA and NAS<sup>15,27,28</sup>; most studies were not specifically designed to evaluate this relationship. Additionally, six studies controlled for OAT dose, a potential mediator of the relationship between GA and NAS, biasing the estimate of the association<sup>27</sup>. Eleven studies scored the maximum of two scores in the outcome measurement category, but the remaining 27 studies did not comment on the method of assessing NAS and/or for how many days infants were evaluated.

### Association between GA and NAS

Of the 38 studies included in this review, four included only qualitative results (i.e., whether a statistically significant association was observed, but neither an effect measure nor the numbers from which an effect estimate could be calculated); all reported no significant relationship between GA at delivery and initiation of treatment for NAS<sup>29–32</sup>. Three additional studies reported data on the relationship between GA and NAS that could not be converted to the effect estimates considered for the meta-analyses. The first study found no difference in the median GA between infants treated for NAS and infants not treated<sup>52</sup>; the second found no significant association between GA and measures of NAS severity<sup>53</sup>; and the third found that the percentage of newborns treated for NAS was not significantly different between early term and full/late term cohorts<sup>54</sup>.

Results from the meta-analysis are shown in Table 2 and the forest plots in Figure 2. Pooled across 15 studies, the mean GA in infants with NAS was 0.62 weeks higher than in infants without (95% CI: 0.08 – 1.16). The odds of developing NAS were estimated to increase by 3% per gestational week at delivery using data from nine studies (OR 1.03, 95% CI: 0.997 – 1.06). The pooled OR for the association between preterm birth and NAS from 17 studies was estimated to be 0.87 (95% CI: 0.63 – 1.21). Because the effect estimates varied markedly among the studies, as can be seen in the forest plots and quantified with  $I^2$  ranging from 84.2% to 90.7%, the pooled estimates should be interpreted with caution.

Pre-specified subgroup analyses examined the impact of excluding infants with GA<34 weeks, NAS outcome definition, rates of maternal methadone use, and Caesarean birth rates (Table 2). Some between-group differences were significant; for example, results in the subgroup of studies that used an outcome definition of NAS requiring treatment tended to suggest that NAS increases with GA, but studies that used an outcome definition not specifically stating that pharmacologic treatment was used showed pooled effect estimates that were null or estimated an inverse association be-

Table 1. Characteristics of included studies

First Author, Year	Number of Infants	Location	Study Period	OAT Type (%)	Other Opioids (%)	NAS Assessment; NAS Outcome Definition	Gestational Age (Weeks)	Confounding*
O'Brien, 2002	21	Sydney, Australia Single hospital	1999-2000	Methadone: 85.7	47.6	Finnegan scale; NAS requiring treatment	38 (mean) 36-41 (range)	Not controlled
Kuschel, 2004	25	Auckland, NZ Single hospital	1999-2001	Methadone: 100	5	Modified Finnegan scale; NAS requiring treatment	38 (median) 35-41 (range)	Not controlled
O'Brien, 2004	40	Sydney, Australia Single hospital	2000-2002	Methadone: 87.5	52.5	Modified Finnegan scale; NAS requiring treatment	38.4 (mean) 35-42 (range)	Not controlled
Scully, 2004	114	Dublin, Ireland Single hospital	1999-2000	Methadone: 75	Not reported	NAS assessment tool not reported; NAS diagnosis	38.5 (mean) 17-43 (range)	Not controlled
Burns, 2007	2941	New South Wales Australia state data	1992-2002	Methadone: 100	Not reported	Assessment scale not reported; NAS diagnosis	Not reported	Not controlled
Ebner, 2007	53	Vienna, Austria Single hospital	Not reported	Methadone: 41.5 Buprenorphine: 26.4 Slow-release oral morphine: 32.1	None	Modified Finnegan scale; NAS requiring treatment	38.6 (mean) 34-42 (range)	Not controlled
Jansson, 2007	50	Baltimore, US Single hospital	2002-2004	Methadone: 100	Not reported	Modified Finnegan scale; NAS requiring treatment	39.6 (mean) 1.3 (SD) 37 (minimum)	Not controlled
Dryden, 2009	444	Glasgow, UK Single hospital	2004-2006	Methadone: 100	Heroin: 51.1	Modified Lipitz Tool; NAS requiring treatment	38 (median), 37-40 (IQR)	Not controlled
Velez, 2009	77	Baltimore, US Single hospital	2002-2007	Methadone: 100	Not reported	Modified Finnegan scale; NAS requiring treatment	39.6 (mean) 1.2 (SD) 36.6-41.1 (range)	Not controlled
Holbrook, 2010	308	Philadelphia, US Single hospital	2005-2009	Methadone: 100	15	Modified Finnegan scale; NAS requiring treatment	37.7 (mean) 2.8 (SD)	Not controlled
Jansson, 2010	64	Baltimore, US Single hospital	2006-2008	Methadone: 100	Not reported	Modified Finnegan scale; NAS requiring treatment	39.2 (mean) 1.2 (SD) 37 (minimum)	Not controlled
Liu, 2010	232	Sydney, Australia Two hospitals	2000-2006	Methadone: 100	Not reported	Finnegan scale; NAS requiring treatment	37.9 (mean)	MD not controlled; OR adjusted for mode of delivery, maternal methadone dose
Seligman, 2010	388	Philadelphia, US Single hospital	1996-2006	Methadone: 100	23	Finnegan scale; NAS requiring treatment	37.7 (mean) 2.2 (SD)	Adjusted for tobacco, opiate abuse, cocaine use, benzodiazepine use at delivery
Cleary, 2011	618	Dublin, Ireland Single hospital	2000-2007	Methadone: 100	31.1	Modified Finnegan scale; NAS diagnosis	Not reported	Adjusted for methadone dose at delivery

First Author, Year	Number of Infants	Location	Study Period	OAT Type (%)	Other Opioids (%)	NAS Assessment; NAS Outcome Definition	Gestational Age (Weeks)	Confounding*
Kaltenbach, 2012/ Unger, 2011**	129	US, Canada, Europe Multiple clinics	2005-2008	Methadone: 55.7 Buprenorphine: 44.3	8	Modified Finnegan scale; NAS requiring treatment	38.4 (mean)	Adjusted for birthweight, tobacco use, anxiolytics, SSRIs, mode of delivery, maternal weight, OAT dose and duration
Cleary, 2012	114	Dublin, Ireland Two hospitals	2009-2010	Methadone: 100	36.4	Modified Finnegan scale; NAS requiring treatment	39.2 (median) 32.9-41.9 (range)	Adjusted for methadone dose, opiates, benzodiazepines, cocaine
Wachman, 2013	86	Massachusetts and Maine, US Four hospitals	2011-2012	Methadone: 55.7 Buprenorphine: 44.3	Not reported	Modified Finnegan scale; NAS requiring treatment	Not reported	Not controlled
Parlier, 2014	96	North Carolina, US Single hospital	2010-2012	Methadone: 61.5 Buprenorphine: 9.4 Buprenorphine/ Naloxone: 3.1	26	NAS assessment tool not reported; NAS diagnosis	Not reported	Not controlled
Liu, 2015	120	Florida, US Two hospitals	2003-2010	Methadone: 100	Not reported	Modified Finnegan scale; NAS requiring treatment	37.5 (mean) 2.5 (SD)	MD not controlled; OR per week GA adjusted for methadone dose; OR for preterm not controlled
McCarthy, 2015	62	California, US Eight hospitals	2008-2013	Methadone: 100	Not reported	Finnegan scale; NAS requiring treatment	38.2 (mean) 4.9 (SD) 23-42 (range)	Not controlled
Ruwanpathirana, 2015	909	New South Wales, Australia Multiple hospitals	2004, 2007	Methadone: 42.5 Buprenorphine: 3.6	17.5	Modified Finnegan scale; NAS requiring treatment	37.7 (mean)	Adjusted for amphetamine-type stimulant, cannabis, breastfeeding, polydrug use
Allocco, 2016	94	Boston, US Single hospital	2006-2010	Methadone: 100	41.5	Modified Finnegan scale; NAS requiring treatment	Preterm: 35 (median), 33-36 (IQR) Term: 39 (median), 38-40 (IQR)	Not controlled
Gibson, 2017	403	Cleveland, US Single hospital	2000-2014	Methadone: 57 Buprenorphine: 9	34	Modified Finnegan scale; NAS requiring treatment	38 (median) 34-41 (range)	Not controlled
Isemann, 2017	143	Cincinnati, US Single hospital	2013-2015	Methadone: 32.9 Buprenorphine: 21.7	31	Modified Finnegan scale; NAS requiring treatment	38 (median) 37.39 (IQR) 34 (minimum)	Not controlled
Lemon, 2018**	716	Pittsburgh, US Single hospital	2013-2015	Methadone: 55.7 Buprenorphine: 43	Not reported	Finnegan scale; NAS requiring treatment	38 (mean) 2.8 (SD)	

First Author, Year	Number of Infants	Location	Study Period	OAT Type (%)	Other Opioids (%)	NAS Assessment; NAS Outcome Definition	Gestational Age (Weeks)	Confounding*
Nguyen, 2018	26	West Virginia, US Single hospital	2016-2017	Buprenorphine/ Naloxone: 100	12	NAS assessment scale not reported; NAS requiring treatment	37.4 (mean) 3.1 (SD)	Not controlled
Bakhireva, 2019	42	Albuquerque, US Multiple prenatal clinics	2013-2013	Methadone: 40.5 Buprenorphine: 54.5 Methadone + buprenorphine: 4.2	54.8	Assessment scale not reported; NAS requiring treatment	38.7 (mean)	Not controlled
Oji-Mmuo, 2019	202	Pennsylvania, US Single hospital	2011-2016	Methadone: 47 Buprenorphine: 16	35	Modified Finnegan scale; NAS requiring treatment	39 (median) 38.0-39.6 (IQR) 37-42 (range)	Not controlled
Parikh, 2019	651	Baltimore, US Single hospital	2008-2017	Methadone: 53	Not reported	Modified Finnegan scale; NAS requiring treatment	38.1 (mean) 35-42 (range)	Race, methadone use, benzodiazepine use
Mullins, 2020	193	North Carolina, US Single centre	2014-2018	Buprenorphine: 56 Buprenorphine/ naloxone: 44	Not reported	Modified Finnegan scale; NAS requiring treatment	25 (minimum)	OAT type, prescriber, dose; year; hepatitis C
Rodriguez, 2020	25	Massachusetts, US Single institution	2015-2018	Methadone: 20 Buprenorphine: 56	Not reported	Modified Finnegan scale; NAS requiring treatment	Not reported	Not controlled
Scott, 2020	204	US Midwest Single institution	2011-2017	Methadone: 24 Buprenorphine: 21	48	Modified Finnegan scale; NAS requiring treatment	37.2 (mean) 28-41 (range)	Not controlled
Towers, 2020	230	Knoxville, US Single clinic	2017-2018	Methadone or buprenorphine: 47 (Naltrexone: 53)	Not reported	Finnegan scale; NAS requiring treatment	38.0 (mean) 27.6-41.2 (range)	Not controlled
Leyenaar, 2021	7207	Texas, US Medicaid insured	2010-2014	Methadone: 13.2	Not reported	ICD-9-CM code 779.5 (drug withdrawal syndrome in newborn)	37.5 (mean) 22-43 (range)	Not controlled
Pourcyrour, 2021	150	Memphis, US Single hospital	2013-2017	Methadone: 24 Buprenorphine: 21	74	Modified Finnegan scale; NAS requiring treatment	39 (mean) 1 (SD) 37 (minimum)	Not controlled
Townsel, 2021	49	Connecticut, US Single institution	2007-2017	Not reported	Not reported	Finnegan scale; "severe NOWS"	37.0 (mean) 2.6 (SD) 34 (minimum)	Not controlled
Amiri, 2022	166	Buffalo, US Single hospital	2014-2020	Not reported	Not reported	Modified Finnegan scale; NAS requiring treatment	37.8 (mean) 1.1 (SD) 32 (minimum)	Not controlled
Rana, 2022	30	Memphis, US Single centre	2017-2019	Methadone: 17 Buprenorphine: 30	Not reported	Modified Finnegan scale; NAS requiring treatment	38.3 (mean) 1 (SD) 36 (minimum)	Not controlled

IQR, inter-quartile range; MD, mean difference; NAS, neonatal abstinence syndrome; OAT, opioid agonist therapy; OR, odds ratio.

\*With respect to the data available to estimate the gestational age – NAS associations included in this systematic review.

\*\*The two papers were based on the same population. Data from only the more complete report were included.

**Table 2:** Pooled estimates for the association between gestational age at delivery and neonatal abstinence syndrome from the meta-analyses.

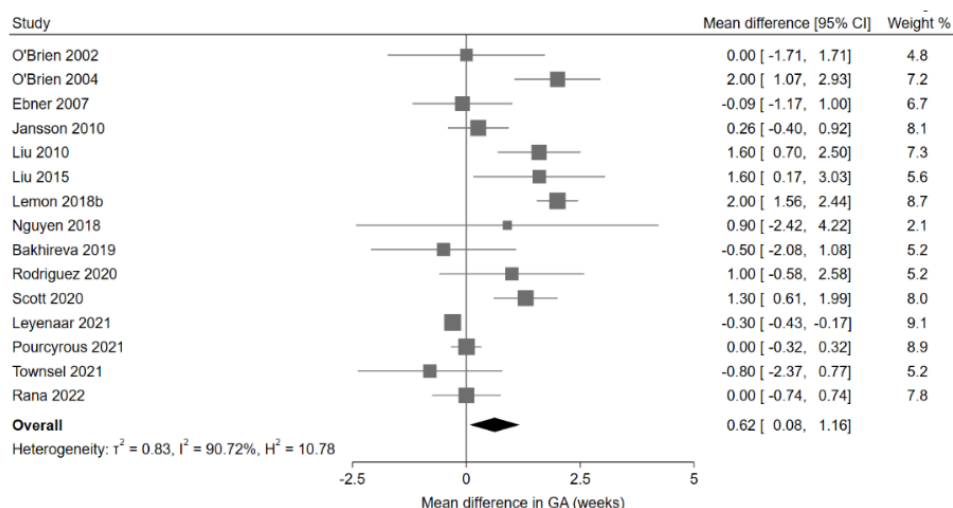
Subgroup	No. studies	Mean difference (CI), GA, weeks, treated vs untreated	I <sup>2</sup>	p-value*	No. studies	OR, per week GA (CI)	I <sup>2</sup>	p-value*	No. studies	OR, preterm birth-NAS (CI)	I <sup>2</sup>	p-value*
Overall	15	0.62 (0.08 – 1.16)	90.7	-	9	1.03 (1.00 – 1.06)	84.2	-	17	0.87 (0.63 – 1.21)	85.7	-
Exclusion based on gestational age				0.300				0.312				0.320
No	7	0.97 (-0.16 – 2.09)	95.4		6	1.05 (0.99 – 1.11)	83.7		14	0.83 (0.57 – 1.20)	88.3	
Yes	8	0.31 (-0.20 – 0.83)	63.1		3	1.15 (0.97 – 1.38)	88.3		3	1.09 (0.73 – 1.63)	0.0	
NAS definition				<0.001				0.016				0.019
All NAS	2	-0.30 (-0.43 – -0.17)	0.00		2	1.00 (0.97 – 1.03)	78.6		6	1.37 (1.08 – 1.74)	55.2	
Treated NAS	13	0.81 (0.22 – 1.39)	84.4		7	1.15 (1.03 – 1.27)	85.3		11	0.70 (0.42 – 1.16)	81.6	
Proportion treated with methadone				0.852				0.081				0.021
0%	1	0.90 (-2.42 – 4.22)	**		0	-			2	0.33 (0.19 – 0.59)	0.0	
20-88%	9	0.70 (-0.05 – 1.44)	88.6		5	1.04 (0.98 – 1.10)	82.1		5	0.80 (0.56 – 1.13)	18.5	
100%	3	1.06 (0.05 – 2.07)	70.8		3	1.27 (1.02 – 1.59)	85.9		8	0.95 (0.49 – 1.84)	89.5	
Proportion delivered by Caesarean				0.059				0.222				0.601
<30%	3	0.90 (-0.05 – 1.85)	64.8		4	1.01 (0.98 – 1.05)	61.2		6	1.04 (0.70 – 1.54)	72.3	
≥30%	5	-0.08 (-0.44 – 0.29)	60.5		5	1.13 (0.96 – 1.33)	86.4		8	0.87 (0.51 – 1.48)	60.2	

CI, 95% confidence interval; GA, gestational age; NAS, neonatal abstinence syndrome; OR, odds ratio

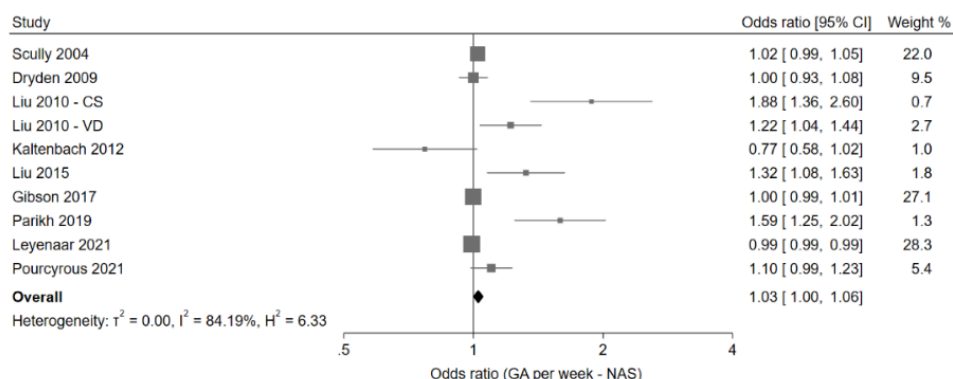
\*P-value for differences between subgroups.

\*\*Only one study within subgroup so heterogeneity not relevant.

## A. Mean difference in gestational age between infants affected by NAS and infants unaffected by NAS



## B. Odds ratio for the association between gestational age (per week) and NAS



## C. Odds ratio for the association between preterm delivery and NAS

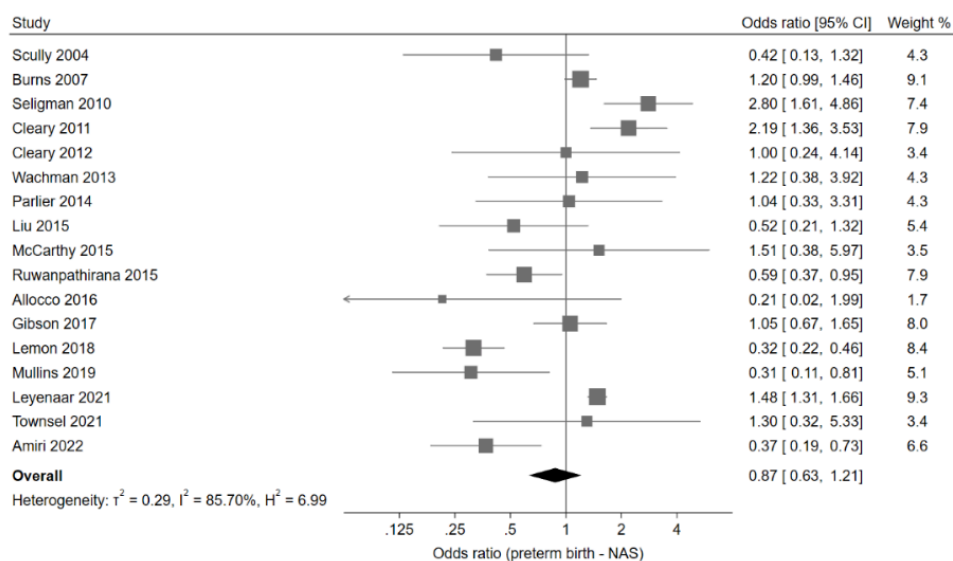


Figure 2. Forest plots for the association between gestational age and the development of NAS. CI, confidence interval; GA, gestational age; NAS, neonatal abstinence syndrome.

tween GA and NAS. In general, a high amount of heterogeneity persisted among the studies within each of the subgroups.

## Discussion

The results of this systematic review and meta-analysis do not demonstrate a strong and consistent relationship between GA at delivery and development of NAS. While infants with NAS were born, on average, 0.67 weeks later than infants without NAS, the odds of developing NAS were only estimated to increase 3% per week GA. In addition, the OR for the association between preterm birth and NAS failed to show an association (OR 0.87, 95% CI: 0.63-1.21); however, dichotomizing GA into preterm versus term increases the probability of a type II error (missing a true association)<sup>59</sup>. All meta-analyses demonstrated significant heterogeneity among studies, which should be taken into account when interpreting these pooled estimates. Heterogeneity remained high in subgroup analyses suggesting that these factors do not explain the high heterogeneity observed in the overall association.

Two potential biological and clinical explanations could explain an apparent relationship between GA and an increased risk of NAS. The first is that as pregnancy progresses, increasing doses of OAT are often required to prevent withdrawal symptoms<sup>3</sup>. Pregnancy alters methadone pharmacokinetics, with higher observed clearance later in gestation<sup>60-62</sup>. However, a systematic review and meta-analysis found no clear relationship between maternal methadone dose and the incidence and duration of NAS<sup>63</sup>; increased dose requirements likely do not explain the relationship between GA and NAS. A second explanation relates to changes in placental physiology that occur throughout pregnancy. The syncytiotrophoblast (in direct contact with maternal blood) thins throughout gestation, while its surface area increases<sup>64</sup> and diffusion distance decreases<sup>65</sup>; these changes to placental physiology impact the transport of methadone across the placenta. One study found that both the amount of methadone in fetal circulation and the fetal transfer rate of methadone was significantly lower in preterm compared to term placentas<sup>66</sup>.

## Strengths and limitations

This review included a large body of evidence spanning two decades and we were able to combine evidence across multiple studies to generate overall effect estimates. Furthermore, this study followed the recommended guidelines for reporting systematic reviews (PRISMA)<sup>20</sup> and meta-analyses of observational studies (MOOSE)<sup>26</sup>.

However, this study had some limitations. We restricted studies to those published in English and, to increase the quality of the data included, reported in full-text and published in a peer-reviewed journal; these restrictions may have resulted in some data being excluded. The Newcastle-Ottawa Scale used to assess risk of bias of included studies has some limitations, such as potential over-emphasis on the community representativeness of the exposed cohort and lack of definition regarding important confounders<sup>67</sup>. We modified the Newcastle-Ottawa Scale to better evaluate the studies included in our review and to exclude items where no variability would be possible in this context (e.g., demonstration that NAS was not present at the start of the study), but these changes may have decreased the validity of the tool.

The most significant limitation affecting the validity of the pooled estimates derived in the meta-analysis is the high risk of bias in most of the studies included. Our risk of bias assessment showed that most of the included studies did not account for important confounders. Most studies were not specifically designed to evaluate the relationship between GA at delivery and NAS. Although these studies presented enough data to extract or derive effect estimates, only nine studies adjusted for covariates, of which six presented results adjusted for OAT dose that was a potential mediator. Additionally, a majority of studies either did not provide specific details on the NAS assessment tool used or for how long infants were monitored. In some of the included studies, it was noted that there was a policy of admitting all infants to a neonatal intensive care unit for monitoring or that observation by trained health care providers was conducted on the postnatal wards. While it can be assumed that a validated assessment instrument was used at an acceptable frequency in these settings, it would not be applied in a blinded fashion (i.e., GA would be known). Finally, the sensitivity of the Finnegan and modified Finnegan instruments may be inversely correlated with GA, which could induce a positive bias in the GA-NAS association.

## Conclusion

A clear understanding of the relationship between GA and NAS is needed to help guide obstetrical management of women receiving OAT. While the data included in this review do not demonstrate a strong and consistent relationship between GA and NAS, this conclusion is weakened by poor study quality and significant study heterogeneity. Further high-quality research designed to specifically address this question is needed to guide recommendations for optimal management.

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## Appendix S1

*Embase and Medline search strategies for the systematic search of the literature related to gestational age at delivery and neonatal abstinence syndrome*

### *Embase Search Strategy*

['neonatal abstinence syndrome'/exp OR 'neonatal abstinence syndrome':ti,ab OR nas:ti,ab OR 'neonatal opioid withdrawal':ti,ab OR 'neonatal withdrawal':ti,ab OR 'neonatal opiate withdrawal':ti,ab] AND ['gestational age'/exp OR 'gestational age':ti,ab OR 'prematurity'/exp OR 'postmaturity'/exp OR 'prolonged pregnancy'/exp OR 'term birth'/exp OR ((birth OR pregnancy OR gestational OR infant OR baby) NEAR/2 term):ti,ab] OR ((prematu\* OR preterm OR postmatu\* OR postterm OR 'post-term') NEAR/2 (birth OR pregnancy OR infant OR baby):ti,ab) OR 'prolonged pregnancy':ti,ab]

### *Medline Search Strategy*

((((((((((("gestational age"[MeSH Terms]) OR "gestational age"[Title/Abstract]) OR "premature birth"[MeSH Terms]) OR "infant, premature"[MeSH Terms]) OR "term birth"[MeSH Terms]) OR "infant, postmature"[MeSH Terms]) OR "pregnancy, prolonged"[MeSH Terms]) OR (prematu\* [Title/Abstract] AND (birth[Title/Abstract] OR infant[Title/Abstract] OR baby) AND Title/Abstract)) OR (preterm[Title/Abstract] AND (birth[Title/Abstract] OR infant[Title/Abstract] OR baby) AND Title/Abstract)) OR (term[Title/Abstract] AND (birth[Title/Abstract] OR pregnancy[Title/Abstract] OR infant[Title/Abstract] OR baby) AND Title/Abstract)) OR "gestational term"[Title/Abstract]) OR (postmatur\*[Title/Abstract] AND (birth[Title/Abstract] OR pregnancy[Title/Abstract] OR infant[Title/Abstract] OR baby) AND Title/Abstract)) OR (postterm[Title/Abstract] AND (birth[Title/Abstract] OR pregnancy[Title/Abstract] OR infant[Title/Abstract] OR baby) AND Title/Abstract)) OR ("post-term"[Title/Abstract] AND (birth[Title/Abstract] OR pregnancy[Title/Abstract] OR infant[Title/Abstract] OR baby) AND Title/Abstract)) OR "prolonged pregnancy"[Title/Abstract])) AND (((((((("neonatal abstinence syndrome"[MeSH Terms]) OR "neonatal abstinence syndrome"[Title/Abstract]) OR NAS[Title/Abstract]) OR "neonatal opioid withdrawal" [Title/Abstract]) OR "neonatal withdrawal"[Title/Abstract]) OR "neonatal opiate withdrawal" [Title/Abstract]))))

## Appendix S2

### Modified Newcastle-Ottawa Quality Assessment Scale for Cohort Studies used to assess risk of bias

Selection
<b>S1) Representativeness of the exposed cohort</b> A - truly representative* B - somewhat representative* C - selected group of users D - no description of derivation of cohort
<b>S2) Selection of non-exposed cohort</b> A - drawn from same community as exposed* B - drawn from a different sources C - no description
<b>S3) Bias due to missing data</b> A - no or only small # participants with missing data* B - adjustment techniques used that likely correct for the presence of selection biases* C - due to missing data, <90% of participants included in final analysis D - no statement
<b>Total Selection Stars</b>
Exposure
<b>E1) Ascertainment of exposure</b> A - secure record* B - structured interview* C - written self-report D - no description
<b>Total Exposure Stars</b>
Comparability
<b>C1) Comparability of cohorts on basis of design/analysis</b> A - study controls for tobacco, SSRIs, benzodiazepine, cannabis* B - study controls for OAT dose and/or duration, birthweight, maternal weight, mode of delivery, breast feeding, Hepatitis C infection, other substances (such as opiates, cocaine)*
<b>C2) Study does not inappropriately control for potential mediators</b> A - no inappropriate control for mediators* B - inappropriate control for mediators
<b>Total Comparability Stars</b>
Outcome
<b>O1) Assessment of outcome (validated instrument used at an acceptable frequency)</b> A - yes* B - no
<b>O2) Was follow-up long enough?</b> A - yes* B - no
<b>Total Outcome Stars</b>

Modified from: Wells G, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2013. Available at: [https://www.ohri.ca/programs/clinical\\_epidemiology/oxford.asp](https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp)

The following modifications were performed:

- Item S3 (original NOS): “Ascertainment of exposure” was separated out to be included under “Exposure” because it has nothing to do with selection.
- Item S3 (modified NOS): “Bias due to missing data” was listed in the original NOS as item O3 “Adequacy of follow-up of cohorts”. It has been included here under “Selection” because loss to follow-up bias is a form of selection bias.

- Item S4 (original NOS): “Demonstration that outcome of interest was not present at start of study” was omitted because it would have yielded a “yes” for all eligible studies based on the nature of the topic only, not by design.
- Item C1: Factors that were controlled for in eligible articles were considered because of their effect on risk of NAS.
- Item O1: Using a validated instrument at an acceptable frequency was most relevant for assessing validity of the outcome assessment.



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## Hackathons within medical education: Promoting cutting-edge innovation in surgery

Abigale MacLellan BSc<sup>1</sup>, Madeline Tweel MHA<sup>1</sup>

*1. Faculty of Medicine, Dalhousie University*

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### Abstract

Medical students need to begin to learn how to innovate earlier in their training. Hackathons offer opportunities to foster innovation in healthcare. We launched a hackathon for medical students to generate solutions to a real-world surgical problem. We focused on generating solutions to better support more women in surgery, an area of medicine where women remain underrepresented. The goal of our event was to not only generate solutions at a systemic level but within our own medical school, break down barriers for female medical students by allowing them to network with Dalhousie surgeons and better explore potential career goals by attending the event. Attendees reported the event provided an opportunity to build problem solving skills, communication skills and the opportunity to network with like-minded peers. Our hackathon supported idea generation however further emphasis on translation of solutions from idea generation to implementation within our healthcare system is needed.

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Our healthcare system's longevity relies in part on creative change. Innovative solutions are needed to address challenges within our healthcare system. These innovative solutions will be required by the next generation of physicians, yet few opportunities exist within the medical curriculum to practice and foster skills in innovation. Hackathons are one of the most reliable methods to foster innovation within healthcare starting from idea generation, idea acceptance and idea implementation<sup>1</sup>. With this in mind, we created an organized hackathon opportunity for medical students to begin building these necessary innovation skills earlier in their training.

Our Cutting-Edge Hackathon Event invited Dalhousie medical students from all four years of training in both Nova Scotia and New Brunswick campuses to work in teams to tackle a real-world surgical problem. The event was mentored by surgery and health systems experts and offered medical students the chance to build teamwork, problem solving, adaptability, communication, critical thinking, and creativity skills relevant to future practice.

The surgical problem being addressed by students at this event was: "How can we better support more women in surgery?"

With medicine being traditionally a male-dominated profession, more structural barriers exist for female career advancement at all levels. Despite increased female representation in medical student class sizes in recent years, women remain underrepresented in surgery in Canada with only 30% of Canadian surgeons, and 43% of surgical trainees being women<sup>2</sup>. In a systematic review by Lim et al. (2021), female surgeons and train-

ees in Canada reported a lack of female mentorship and role models and felt that they miss out on professional opportunities as a result<sup>3</sup>.

While the event aimed to build awareness of existing barriers for women within the surgical profession at a system level and generate solutions, the event also aimed to break down barriers for female medical students at Dalhousie, allowing them to network with surgeons and better explore their own potential career goals by attending the event. Furthermore, ideas and solutions generated during the event have the potential to contribute to real-world change within our healthcare system.

The event was organized and hosted by two female medical students at Dalhousie in collaboration with the Dalhousie Womxn in Surgery Interest Group. At the Dalhousie Medicine New Brunswick Campus (DMNB), Dr. Alison Wong, a reconstructive, hand and peripheral nerve plastic surgeon with a Master of Science in innovation from Johns Hopkins University was recruited to be a mentor and judge for the event. Dr. Wong also supervised and supported the planning of the initial design of this event in months prior. At the Dalhousie Medicine Nova Scotia Campus (DMNS), mentors/judges included Dr. Gwynedd Pickett, a cerebrovascular neurosurgeon and program director for the Dalhousie Neurosurgery residency program, Dr. Becky Power, a 1st year urology resident and ex-world cup Team Canada athlete, and Dr. Noreen Kamal, an industrial engineer with a research focus on health systems and quality improvement.

Advertisements and a link to register for the event were posted to the Dalhousie Womxn in Surgery Inter-

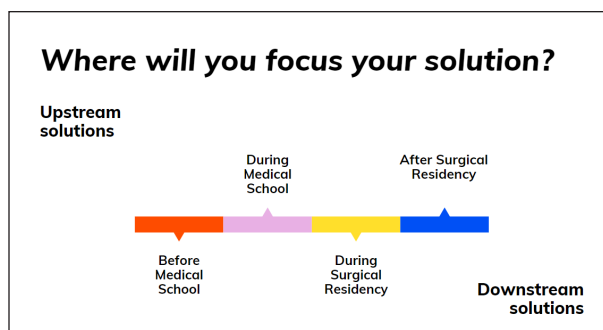


Figure 1. Graphic displayed during the hackathon to assist students in deciding on a barrier affecting women in surgery.

est Group social media pages. Upon registration, students were asked why they wanted to participate and if they had any experience related to innovation. We created balanced teams based on graduation year and any relevant innovation experience. Nova Scotia students were grouped with those in Nova Scotia and New Brunswick students were grouped with those in New Brunswick.

The timeline of the event was as follows: 20 minutes for introductions and initial presentation discussing the event timeline and how to determine a barrier to focus on, 20 minutes for initial team brainstorming, 20 minutes for further prompts and isolating solutions, 35 minutes for turning the solution into a pitch, 30 minutes for team presentations, and 20 minutes for judges to deliberate, announce winners, and event wrap up. The event was 2.5 hours in total.

The event was hosted from the DMNS campus and the team at DMNB participated via teleconference. Participants arrived, were introduced to their teammates, given a short presentation, and then were given the following prompt: “How can we better support more Womxn in Surgery?”

Teams had to first identify a barrier that women pursuing surgical careers face. Teams were guided with a systems-based approach to focus on a barrier from either upstream, for example: barriers within medical school vs. downstream, for example: barriers after resi-

dency training (Figure 1). From there, teams were guided to isolate the root cause of their problem by differentiating it as a source or a symptom of a larger underlying barrier. Once teams determined their barrier’s root cause, they worked to develop a solution. Throughout this process, mentors supervised and supported each group, giving guiding prompts or helping to focus their ideas (Figure 2). Teams were also prompted to consider how their solution related to the success of existing initiatives through identifying relevant stakeholders, determining potential funding avenues, evaluating limitations to existing initiatives, and theorizing potential unforeseen circumstances of their solution (Figure 3). The teams presented a 2-minute pitch outlining their innovative solution to the other groups and the judges/mentors. Judges asked follow-up questions about logistics, design, or execution of their solution and ultimately judges awarded points based on creativity, systems thinking, cost-effectiveness, inclusivity, and ease of implementation.

Food and drinks were provided for participants and mentors funded by the Dalhousie Medical Students’ Society. The winning team won a small prize, and the event was concluded.

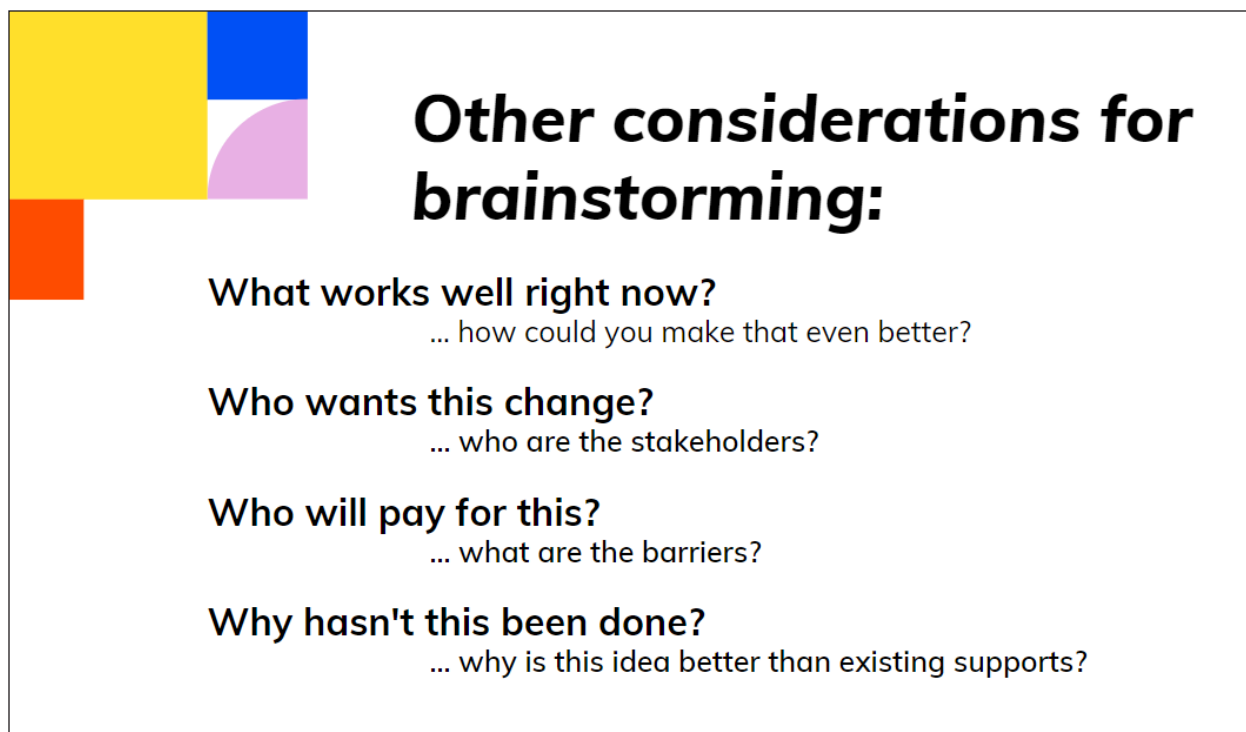
Following the event, participants were sent a feedback survey to complete asking about the biggest learning takeaways, how we could improve the event, or any skills gained from attending the event.

The event took place on November 22, 2022. Nineteen students applied to attend the event, and 15 students were in attendance. Of the 15 students who attended, three students reported previous experiences related to healthcare innovation. We had students with backgrounds prior to medicine varying from engineering, nursing, policy design, and community advocacy. We generated five teams, one at DMNB and four at DMNS, each with two to four participants.

The winning team created an implementation plan for on-site childcare services at the Halifax Infirmary. Other solutions generated involved: (1) virtual networking platforms as a space to provide mentorship



Figure 2. Photo taken during the event of participants and mentors brainstorming potential solutions.



**Figure 3.** Graphic displayed during the hackathon to assist students in designing their solution to better support women in surgery.

and peer support among female trainees and surgeons; (2) teaching features of gender-based discrimination within existing simulation training; (3) small group case-based learning modules during pre-clerkship years to explore barriers faced by women in surgery; (4) shared full-time equivalent (FTE) contracts for surgeons to ensure sufficient coverage of a service with flexibility for the surgeon to raise a family.

Results from the post-event survey indicated that the majority of participants surveyed found that the event helped build problem-solving skills, communication skills, and the opportunity to network with like-minded peers. Roughly half of the participants surveyed felt the event provided an opportunity to network with surgeon mentors and helped them better understand the barriers and possibilities of a career in surgery.

The Cutting-Edge Hackathon Innovation event provided an opportunity for students to work in teams with the support of representative mentors to generate creative, innovative solutions for real-world surgical problems.

When registering for the event, students were asked why they wanted to participate. In response to this question, most participants indicated they were interested in pursuing a surgical specialty. Students voiced themes articulating a desire for increased representation in surgical mentorship, opportunities to discuss barriers related to pursuing surgical careers,

networking with peers, and opportunities to begin learning how to innovate within their future desired field. Many of these themes are echoed on a larger scale across Canada, with female trainees reporting insufficient female mentorship and role models<sup>3</sup>. The solutions generated at our event tackle these barriers and others existing among Canadian trainees such as lack of maternal support for female surgeons and gender-based discrimination<sup>3</sup>.

We believed the event timeline worked well as did the small mentor-to-student ratio. Students reported that the biggest takeaways from the event were “learning barriers in implementing change...”, “hope that these changes can be implemented in the future!”, “ways to communicate/brainstorm/receive and apply constructive feedback when working with a group under pressure”, and “that it is possible to create services that benefit surgeons...”

Improvements for the next event could involve increasing momentum with funding opportunities post-competition to continue pursuing solutions, and potentially involving hospital administrators as mentors/judges. Participants voiced a desire to work with the other teams over the course of the event as well as to connect with more peers. Some students reported in the survey they didn’t feel they had sufficient opportunity to network specifically with surgeons and recommendations for future events were to host a networking/cocktail hour before or after the hackathon

so participants could chat with surgeons one on one and discuss specific career questions. Finally, gender is one of many marginalized identities within surgery and moving forward more emphasis on intersectionality and other underrepresented perspectives within surgery is needed with the design of our future hackathons.

With the reproducibility of our hackathon design structure, future directions following this hackathon are abundant. We are currently planning a second hackathon with a focus on global health in collaboration with Dalhousie's Canadian Global Surgery Trainee Alliance scheduled for February 2023. We are also reaching out to collaborators to hopefully launch a similar hackathon for attendees during upcoming student conferences. We hope to launch future hackathons with a focus on creative solutions to reduce existing surgical wait times in Nova Scotia, or to tackle the growing list of Nova Scotians without a family doctor.

Hackathons can contribute to healthcare advancement at an individual and system level. Events such as these offer the potential for students to build problem-solving skills, communication skills, teamwork, and creativity, all skills relevant to future practice. Providing students with the opportunity to tackle relevant barriers to their future careers is empowering, but post-event momentum is needed to ensure meaningful change.

Thank you to the Womxn in Surgery Interest Group for their collaboration with this hackathon and to the mentors who participated in our hackathon event, it would not have been a success without your excitement, patience, and guidance.

### Conflict of Interest

AM is an editor for the Dalhousie Medical Journal but was not involved in the editorial process for this article.

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# EDUCATION

## Cutting edge hackathon competition winners strive to better support more surgeons with primary childcare responsibilities

Mary Kathryn McIntosh PhD<sup>1</sup>, Megan Smith BEng<sup>1</sup>, Maggie Flemming BHSc<sup>1</sup>, Taylor Jordan MD<sup>1</sup>

*1. Faculty of Medicine, Dalhousie University*

In November of 2022 the cutting-edge hackathon took place and brought together a group of medical students and residents from all different levels of training to talk about innovation in surgery with a focus on women in surgery. A Hackathon is traditionally a competitive event where groups work with software or hardware platforms to achieve an outcome, create a functioning product or solve a problem by the end of the allotted time. This hackathon presented a social question: How can we better support womxn in surgery. The competition involved five teams of Dalhousie medical students all with an interest in entering surgery. Using problem solving techniques drawn from their backgrounds in engineering, clinical medicine, and research, they leveraged their diverse training to collaborate on solutions to barriers faced on the road to the operating room. Fifteen participants entered the challenge and were assigned a team at random by the organizing committee. The competition winners comprised a team of medical students from first year to fourth year who chose to focus on tackling barriers for primary childcare providers in surgery.

In Canada, women account for just 30.3% of all surgeons across the country<sup>1</sup>. Given the widespread understanding that surgical training and practice is quite demanding, the team chose to investigate how they could better support this group. Speaking with practitioners at the event, they endorsed that a significant portion of their stress could be accounted for by worries of childcare as currently, there are no in-hospital childcare supports for healthcare workers in Nova Scotia or New Brunswick. Parents seeking childcare have the option to seek care from licensed childcare providers or family/friends. However, with the ongoing shortage of licensed childcare available and variable schedules, healthcare workers are not fully supported.

A peer-reviewed survey of 347 American surgeons investigated issues for women who had children during surgical residency or as staff and reported the following:

- Inability to breast feed for the length of time they desired due to a lack of facility/ childcare that supported this<sup>2</sup>
- The variable nature of parental leave based on location and local policy<sup>2,3</sup>
- Need for childcare, particularly emergency childcare<sup>2,3</sup>
- Considered leaving residency and would discourage female medical students from pursuing surgery because of the struggles of balancing motherhood and residency<sup>2</sup>

The idea of support for childcare facilities that are near or within hospitals is an idea that has been around for decades. It has been supported in American Medical Association policy, and there is great interest in this concept<sup>4,5</sup>. However, still a very small number of hospitals offer these kinds of programs currently in Canada<sup>6</sup>. There is a lack of supportive studies on the topic of childcare for healthcare providers which would serve to motivate development of initiatives that could impart benefit. Investigations may additionally highlight the impact of the stress that is associated with insufficient childcare support, particularly so in Canada.

With significant renovations underway at the Queen Elizabeth II Health Sciences Centre in Halifax, the group thought the addition of a childcare facility would support Halifax-based surgeons, surgeons in training and other healthcare providers. The group designed a plan for 24/7 childcare, available to any surgeon at any stage of training. The pilot would initially open to surgeons, but the initiative would be designed to scale to all hospital staff if successful and the capacity was available. This service would not be out of taxpayers' pocket, but paid for by the users, like any other childcare service. However, given the potential to become an incentive unique to Nova Scotia, there could be a possible partnership with Physician Recruitment & Retention in the province to cover part of these costs. In recruitment and retention at two Georgia-based

hospitals, they found that their on-site childcare is a hugely incentivizing feature for employees<sup>7</sup>. The possible associated outcomes could be reduced commuting time and more dependable OR times if staff do not have to be so cognizant of pick-up and drop-off times of an external daycare.

The team accounted for the limitations of physical space in the hospital, planning so that this program would not take away from patient care. They also acknowledged that logistical planning on a strapped healthcare industry would need a dedicated team of stakeholders with the vision to support this initiative.

In summary, the addition of childcare in the hospital addresses human resource issues, recruitment and retention, and disadvantages surgeon parents experience with childcare duties. This program development is a call to action for those with systems planning and decision-making power, as well as each of us in the medical system to continue working to bring this program to fruition to tackle barriers to the practice of surgery.

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# EDUCATION

## A discussion of contemporary platforms for women in surgery

Olivia MacIntyre BSc<sup>1</sup>, Sophie Gaube BSc<sup>1</sup>, Hannah Price BKinH<sup>1</sup>

*1. Faculty of Medicine, Dalhousie University*

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### Abstract

While the number of females entering medical training has been increasing in recent years, only 30% of surgeons in Canada are women. This discrepancy can be attributed to many aspects, and the lack of representation is a notable barrier that aspiring female surgeons face early in their medical careers. With the growing popularity of virtual platforms, many thread-based discussion websites have placed connecting with like-minded individuals at our fingertips. An accessible platform for women interested in surgery is a natural progression to help bridge the gender gap within the field, and yet it has not been created. While there are many pre-existing women in surgery organizations that promote a mentorship ideology, accessibility is limited by membership fees. A completely free, thread-based platform that connects both prospective and current women in surgery may serve to advance the field through the lens of diversity and collaboration.

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The field of surgery has long been a male-dominated one, with women making up a significantly smaller percentage of practicing surgeons. According to the Canadian Medical Association, 43% of practicing physicians in Canada are female, yet only 30.3% of physicians in surgical specialties are women<sup>1</sup>. This finding is similar in the United States, where women make up only 28% of surgeons<sup>2</sup>. While the number of women entering medical school has been on the rise in recent years, with 57.9% of Canadian medical students being female in 2020/21<sup>3</sup>, this trend has yet to translate over into the surgical specialties. This lack of representation can make it difficult for female medical students, who are interested in surgery, to find female mentors and role models to provide guidance and support, as they navigate their training and career. This issue can be exacerbated when there are particularly lower female numbers in one's local area. Studies have found that the absence of a female mentor in surgery can discourage female medical students from pursuing a certain surgical specialty<sup>4</sup>. This lack of mentorship can make it difficult for students to gain the confidence and skills they need to succeed in the field and can also make it harder to find opportunities to build a network of peers and connect with other female surgeons.

Another challenge facing female medical students interested in surgery is the lack of personal connections with upper-year students, residents, and attendings. Without pre-existing relationships, it can be difficult for students to build the connections they need to succeed in the field. Not only can this make it harder for them to find opportunities to learn from more experienced surgeons, but it can also make it more dif-

icult for them to find guidance throughout medical school. According to a study published in the *Journal of Surgical Education*, female medical students are more likely to enter a residency program that has a significantly higher proportion of female residents in the year ahead<sup>4</sup>.

Organizations such as the Association of Women Surgeons (AWS) and the Women in Surgery Network (WiSN) in the UK are valuable resources for female surgeons to connect and support each other; however, memberships like these often require a yearly fee, which limits their accessibility. Mentorship can take many forms and can come from many different sources. While programs currently exist to connect female mentors with mentees, it can be difficult for mentors to maintain a 1-on-1 commitment with their already busy schedules. Female medical students interested in surgery should not limit themselves to only finding a traditional mentor, but also look for role models, peers and sponsors who can provide guidance and support in their journey.

To ameliorate this current issue facing women with surgical interests, an online platform to connect women in surgery and female medical students interested in surgery from across the Atlantic provinces should be considered. Prior to the Covid-19 pandemic, online platforms were seldom used for education; however now, they are here to stay. This online platform could provide medical students, residents, and attendings an area to discuss topics all from the comfort of their own home. The platform could be restricted to those enrolled in undergraduate or postgraduate medical education programs along with practicing physicians to

maintain its integrity.

Similar to pre-existing forum websites, a thread-based platform could be used to enable members to post and receive feedback from anyone on the platform and allow freedom for users to communicate whenever convenient. This design eliminates the burdensome relationship that a mentee and mentor relationship can often create. Further, it may enable mentees to develop relationships with more than one mentor, which may provide multiple perspectives on a given matter. All users could have their first and last name as well as a photo linked to the account to limit the potential toxicity that anonymous online forums can sometimes create. This may also aid in bridging the disconnect that exists when using virtual platforms. Profiles could be customizable, where one can share personal achievements and interests to aid in networking and potentially further one's career. Finally, it could have a catchy title like "SurgX" to attract the younger generation of surgeons.

A limitation in this platform's implementation would be funding, which could be remedied through funding from institutions or provincial health authorities. A yearly maintenance fee could provide the platform with enough funding not only for its implementation, but also its routine maintenance. Departments of Surgery at various universities may find this to be a valuable investment if their goal is to increase the diversity of their departments. Lack of time for professionals to provide their input also poses an issue, which could be remedied by having quarterly webinars for physicians to attend whenever their schedule allows. Further, having multiple surgeons from across the Atlantic provinces on this platform would increase the pool of available mentors at any given time. Visibility may also be limited in the preliminary stages; however, Women in Surgery Interest Groups are commonplace in medical schools and would be inclined to help promote this platform.

In conclusion, the lack of female representation in the surgical specialties has created a large barrier for female medical students interested in surgery. With so few female mentors and role models to look up to, it can be difficult for these students to gain the confidence and skills they need to succeed. However, female medical students could overcome these challenges by using an accessible platform such as the one described in this article to build connections with like-minded individuals and mentors which may help them succeed in their chosen field. Overall, discussions aimed at increasing the diversity and representation of the surgical field must be supported by institutions, societies, and organizations before any real change can be seen in this field.

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# EDUCATION

## Two for the price of one: The benefits of job sharing to increase women representation in surgical specialties

Gizelle Francis BSc<sup>1</sup>, Emma MacLean BScN<sup>1</sup>, Emma McDermott MD<sup>1</sup>

*1. Faculty of Medicine, Dalhousie University*

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### Abstract

**Background:** Women represent over 50% of medical school classes in Canada, yet only 36.8% of surgical residency applicants identified as female from 1995-2019. One potential explanation for this discrepancy is the lack of work-life balance. Job sharing is an alternative work schedule in which two employees share the responsibilities of one full-time job. Although job sharing is not common in medicine, it may provide a solution to this issue. This paper proposes the implementation of job sharing to increase women representation in surgical specialties and discusses the benefits it would provide to patients, physicians, and the healthcare system.

**Methods:** The authors developed a pitch for job sharing in medicine after conducting a review of the literature as part of their participation in the Cutting Edge Womxn in Surgery Hackathon at Dalhousie University.

**Results:** Job sharing has been successfully implemented in other industries and could have numerous benefits in medicine, such as preventing burnout and increasing women representation in surgical specialties. Physicians who practice job sharing report feeling supported while having improved work-life balance.

**Conclusion:** Job sharing is a promising solution to increase women representation in surgical specialties and prevent burnout among physicians. The implementation of job sharing would benefit patients, physicians, and administration. By targeting excessive workload and promoting work-life balance, physicians can feel more satisfied in their roles and provide higher quality care to their patients. Job sharing warrants further exploration as a potential solution to the underrepresentation of women in surgical specialties and the burnout epidemic in the medical profession.

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### The Gap in Our System

Today, women account for more than 50% of Canadian medical school classes; yet, not all medical specialties are seeing this increase in female representation. When looking at Canadian medical graduate R-1 entry match applicants from 1995-2019, Lorello and colleagues found that as little as 36.8% of surgical specialty applicants identified as female<sup>1</sup>. While this number has increased in recent years, the majority of surgical subspecialties continue to see less than 50% of their applicants identifying as female<sup>1</sup>. There are many hypotheses to explain this discrepancy, including female-identifying students being discouraged by the lack of work-life balance in surgical specialties<sup>2</sup>.

As a potential solution to this issue, we propose the implementation of job sharing to increase the representation of women in surgical specialties. Job sharing is a term used to describe an “alternative work schedule in which two employees voluntarily share the responsibilities of one full time job”<sup>3</sup>. However, more innovative arrangements exist, such as a family practice in Ontario, where seven physicians share a funding package initially designed for six full time positions<sup>4</sup>. Despite its uncommon use in medicine, job sharing has been successfully used in other industries such as retail, finance, government, and education<sup>5</sup>. In this paper we will dis-

cuss how this unique arrangement would benefit patients, physicians, and administration alike.

### Preventing Burnout in Surgery

Burnout, a work-related syndrome involving emotional exhaustion, depersonalization, and a sense of reduced personal accomplishment, is all too common amongst physicians today<sup>6,7</sup>. The profession of medicine is built in such a way that it can be difficult for physicians to avoid burnout, albeit engaging in self-care and wellness. The long hours and constant demand for compassion and empathy, while inherent to the nature of this profession, can leave physicians feeling defeated. These overwhelming negative emotions make it easy for physicians to forget what drew them to this career. When caring for others is at the cost of their own happiness, the once rewarding aspects of healthcare can become what physicians resent most. Moreover, given the compassionate nature of physicians and the emotional demands of their profession, they often carry the emotional burdens of their work back home with them. When faced with these feelings on a constant basis, it should come as no surprise that burnout has been linked to higher rates of depression, alcohol and drug dependence, divorce, and suicide in physicians<sup>6,7</sup>.

Not only does burnout take a toll on physicians' health and wellbeing, but when physicians are emotionally and physically exhausted, it compromises patient care and the healthcare system as a whole. Physicians have reported feeling less productive and underappreciated for their efforts<sup>7</sup>. This explains why physician burnout has been linked to lower quality care, higher rates of medical errors, longer recovery times, and poor patient satisfaction<sup>6</sup>. It is no secret that access to healthcare is a growing problem in Nova Scotia with incredibly long wait times for most services and 14.3% of Nova Scotians currently seeking a primary care provider<sup>8</sup>. Physician burnout may be a modifiable factor in addressing this public health crisis. From a systems perspective, burnout can reduce physician productivity while increasing physician turnover<sup>6</sup>. Additionally, from a financial standpoint, burnout is costly on the healthcare system. It has been shown to increase the rate of referrals and resource utilization. US data measure the cost of burnout-related turnover to exceed 5,000-10,000USD per physician per year<sup>6</sup>.

There are certainly aspects of medicine that strongly contribute to burnout yet are difficult to modify, such as the inherent need for compassion and empathy previously mentioned. However, by targeting this issue from a different angle, we can mitigate the emotional exhaustion associated with these integral aspects of healthcare. We believe this change starts with targeting the excessive workload that inevitably contributes to the burnout epidemic. The long hours and frequent call shifts are a common complaint amongst surgeons. One study assessing the causes of burnout in 7905 surgeons in America identified long work hours to be a large contributor<sup>7</sup>. The number of hours worked showed a strong relationship with the prevalence of burnout amongst those surgeons such that there was a 30%, 44%, and 50% prevalence for those working 60, 60-80, and 80+ hours per week, respectively<sup>7</sup>. Interestingly, these rates were highest when their spouse was also a surgeon<sup>7</sup>. These numbers clearly outline an opportunity for change. This is where the concept of job sharing will play a pivotal role.

Despite being foreign to the field of medicine, and increasingly less common in surgical specialties, job sharing is not a new concept<sup>5</sup>. Allowing two physicians to share the role, responsibilities, and salary of one position has countless benefits for the physicians, the system, and the patients. Having a second physician involved in a medical practice provides the many advantages of collaborative leadership. While job sharing certainly allows for "collective intelligence"<sup>3</sup>, it also serves to mitigate the many aspects of medicine which contribute to physician burnout. Physicians practicing job sharing have reported their experience as keeping

them feeling "fresh and creative" in their roles<sup>3</sup>. Additionally, it allows them to truly immerse themselves in their personal lives, while knowing their patients are in safe hands while being cared for by their job sharing partner(s). From the perspective of emotional support, physicians practicing job sharing express feeling supported by seeking mentorship in each other, which improves morale and overall wellbeing<sup>3</sup>. Apart from the support this endeavor requires from an administrative standpoint, the key to job sharing amongst physicians seems to lie within the trust, communication, and shared beliefs between partners. Physicians express the importance of meeting regularly and communicating important updates, despite one partner being off work. Additionally, trust in your job sharing partner is vital to feel secure in how your partner cares for your shared patients and represents you on your behalf<sup>3</sup>. Further benefits of job sharing include having an "automatic backup" for holiday vacations, parental leave, or unforeseen absences<sup>3</sup>. Not only does this provide women physicians the career flexibility needed to promote wellness, but also the reassurance that their patients will continue to have reliable care in their absence.

While job sharing holds immense potential for success in surgical specialties, it is not without its challenges. The unique nature of surgical specialties may give rise to certain obstacles when implementing job sharing. For instance, if surgeons are sharing patients, each patient may undergo treatment from different surgeons for the same complaint, potentially leading to complexities in determining cohesive treatment plans. Moreover, surgeons may understandably feel uncomfortable dealing with complications arising from another surgeon's operation. Additionally, one must carefully consider the handling of liability issues in such cases. Thus, it becomes evident that the concept of job sharing in surgical practice is not without its complexities. However, it is essential to recognize that these potential challenges can be overcome and represent minor obstacles in the broader context. To address these issues effectively, potential solutions include fostering effective communication, establishing standardized protocols, implementing structured handover processes, and creating transparent liability agreements.

## Investing in the Healthcare System

Nova Scotia is currently struggling to reliably meet national surgical wait-time benchmarks, with over 22,000 cases in the surgical backlog<sup>9</sup>. While this backlog is due to a variety of systemic factors, including the COVID-19 pandemic, lack of available beds, and staffing challenges<sup>9</sup>, it further highlights existing surgical access issues for patients. Currently, if a surgeon would like to take time off of work, for whatever reason or pe-

riod of time, they are required to find a locum to cover their practice, as well as cover the hiring costs if that is not included in their current contract. Additionally, they are responsible for referring their patients to their colleagues for continuation of care, or require their patients wait until they return to practice. While this can be manageable for short term absences, extended periods of leave can cause uncertainty for both the physician and their patients. A recent study in JAMA found that the need to return to clinical responsibilities was the second most cited factor impacting the duration of maternity leave, second only to financial constraints<sup>10</sup>. Further, they report that many physician mothers felt pressured to return to work sooner than planned to reduce the workloads on their colleagues and ensure care for their patients<sup>10</sup>. Job sharing would allow for further flexibility and reduced uncertainty for surgeons wishing to take a leave of absence, without the additional barriers of ensuring uninterrupted patient care. In turn, this could improve access to care for Nova Scotians.

A common objection to the concept of job sharing is that healthcare systems might struggle to support the training of a less than full-time (LTFT) physician. Nevertheless, we firmly assert that job sharing not only serves as an investment in the healthcare system, but also in the wellbeing of physicians, leading to substantial long-term financial and mental health benefits. By addressing administration-related issues and offering potential long-term cost savings, job sharing can prove to be a valuable solution for the healthcare system. As of January 2023, Nova Scotia Health had job postings for over 200 physician positions, including vacancies in surgical specialties<sup>11</sup>. This physician shortage is being seen across the country<sup>12</sup>. As such, recruitment and retention of physicians is a key interest. In a survey conducted by Branine, National Health Service (NHS) managers listed retention of experienced and skilled workers as the second highest advantage of using job sharing in their organization<sup>5</sup>. Managers were even quoted saying that some employees “would have left the service if a job sharing policy was not made available”<sup>5</sup>. This was certainly the case for Dr. Bob Henderson, who was considering retiring from his practice. However, through collaboration with another senior colleague, he utilized a job sharing agreement to continue providing service to his community<sup>13</sup>. By extending their careers, these two physicians reduced the need for administration to find replacements and pay other associated hiring costs such as recruitment incentives, or relocation reimbursements. Therefore, job sharing can serve a dual purpose as a recruitment tool to employ more surgeons in Nova Scotia, or any province for that matter, as well as to facilitate retention by allowing surgeons to work longer careers with

more flexible work hours.

## Conclusion

While we recognize that increasing women representation in surgical specialties is a multifaceted issue requiring a variety of strategies, we firmly believe that job sharing is an innovative, wellness-oriented solution. By decreasing burnout and increasing the flexibility of surgical work hours, job sharing would attract a wider variety of medical students who value work-life balance in their career<sup>14</sup>. Moreover, this flexibility has the potential to improve recruitment and retention by attracting more women surgeons to work in Nova Scotia while promoting job longevity. In addition to the benefits job sharing provides for medical students, surgeons, and the healthcare system, patients would also benefit, as there would be more consistent access to surgical services with minimized time-off disruptions. For these reasons, we believe job sharing carries immense potential to promote women in surgery while filling various gaps in the healthcare system.

## Acknowledgements

We acknowledge the contributions of the Cutting Edge: Dalhousie Innovation Series event judges, Dr. Gwynedd Pickett, Dr. Becky Power, Dr. Alison Wong, and Dr. Noreen Kamal, for their guidance and expertise during the hackathon. A special thanks is given to the event coordinators, Madeline Tweel, Abbey MacLellan, Julia Dugandzic, and Zoya Gomes, for providing this opportunity.

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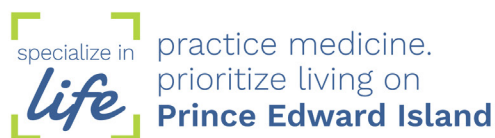
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