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\* SMM denotes composite severe maternal morbidity and maternal morbidity and NMM denotes composite serious neonatal morbidity and neonatal mortality.

Table 1. Components of composite severe maternal morbidity and associated International Classification of Diseases (ICD-10 CA), and Canadian Classification of Intervention (CCI) codes. Note: This list of severe maternal morbidity components is a modified version of the list proposed by the Canadian Perinatal Surveillance System<sup>23</sup> (it does not include maternal Intensive Care Unit admission).

Severe maternal morbidity subtypes	Diagnosis (ICD-10CA), procedure (CCI) codes and other variables
Placenta previa with hemorrhage with RBC transfusion	O44.1 + RBCTRNSF='Y'
Placental abruption with coagulation defect	O45.0
Antepartum hemorrhage with coagulation defect	O46.0
Intrapartum hemorrhage with coagulation defect	O67.0
Intrapartum hemorrhage with RBC transfusion	O67 + RBCTRNSF='Y'
Postpartum hemorrhage with (RBC transfusion or procedures to the uterus or hysterectomy)	O72 + any of the following: <ul style="list-style-type: none"> <li>• RBCTRNSF='Y', or</li> <li>• (1.RM.13, 1.KT.51, 5.PC.91.LA or 5.PC.91.HV) + RBCTRNSF = 1, or</li> <li>• (5.MD.60.RC, 5.MD.60.RD, 5.MD.60.KE, 5.MD.60.CB or 1.RM.89.LA<sup>b</sup>), or</li> <li>• 1.RM.87.LA-GX</li> </ul> <sup>b</sup> Note: 1.RM.89.LA is included only if codes 1.PL.74, 1.RS.74 or 1.RS.80 are NOT also present
Curettage with RBC transfusion	(5.PC.91.GA, 5.PC.91.GC or 5.PC.91.GD) + RBCTRNSF='Y'
Complications of obstetric surgery and procedures	O75.4
Repair of bladder, urethra, or intestine	5.PC.80.JR, 1.NK.80 or 1.NM.80
Evacuation of incisional hematoma with RBC transfusion	5.PC.73.JS + RBCTRNSF='Y'
Re-closure of caesarean wound	(5.PC.80.JM or 5.PC.80.JH) + RBCTRNSF='Y'
Rupture of the uterus with (RBC transfusion or procedures to the uterus or hysterectomy)	(O71.0 or O71.1) + any of the following: <ul style="list-style-type: none"> <li>• RBCTRNSF='Y', or</li> <li>• (1.RM.13, 1.KT.51, 5.PC.91.LA or 5.PC.91.HV) + RBCTRNSF='Y', or</li> <li>• (5.MD.60.RC, 5.MD.60.RD, 5.MD.60.KE, 5.MD.60.CB or 1.RM.89.LA<sup>a</sup>), or</li> <li>• 1.RM.87.LA-GX</li> </ul> <sup>a</sup> Note: 1.RM.89.LA is included only if codes 1.PL.74, 1.RS.74 or 1.RS.80 are NOT also present

<b>Severe maternal morbidity subtypes</b>	<b>Diagnosis (ICD-10CA), procedure (CCI) codes and other variables</b>
Hysterectomy	5.MD.60.RC, 5.MD.60.RD, 5.MD.60.KE, 5.MD.60.CB, 1.RM.89.LA <sup>c</sup> (exclude if 1.PL.74, 1.RS.74 or 1.RS.80 code also present) or 1.RM.87.LA-GX <sup>c</sup> Note: 1.RM.89.LA is included only if codes 1.PL.74, 1.RS.74 or 1.RS.80 are NOT also present
HIV disease	B20-24
Septicemia during labour	O75.3
Puerperal sepsis	O85
Obstetric embolism	O88
Obstetric shock	O75.1, R57, T80.5 or T88.6
Disseminated intravascular coagulation	D65
Acute renal failure	O90.4, N17, N19 or N99.0
Dialysis	1.PZ.21
Sickle cell anemia with crisis	D57.0
Acute psychosis	F53.1 or F23
Status epilepticus	G41
Cardiac conditions	O74.2, O89.1, O90.3, I21, I22, I42, I43, I46, I49.0, I50, J81, 1.HZ.09, 1.HZ.30
Cerebrovascular diseases: subarachnoid and intracranial hemorrhage, cerebral infarction, stroke	I60, I61, I62, I63 or I64
Cerebral edema or coma	G93.6 or R40.2
Cerebral venous thrombosis in pregnancy, or in the puerperium	O22.5 or O87.3
Acute abdomen	K35, K37, K65, N73.3 or N73.5
Acute fatty liver with (RBC transfusion or plasma transfusion)	O26.6 + (RBCTRNSF='Y' or PLSTRNSF='Y')
Hepatic failure	K71 or K72
Status asthmaticus	J45.01, J45.11, J45.81 or J45.91
Adult respiratory distress syndrome	J80
Assisted ventilation through endotracheal tube	1.GZ.31.CA-ND
Assisted ventilation through tracheostomy	1.GZ.31.CR-ND
Pulmonary, cardiac, and CNS complications of anaesthesia during pregnancy, or labour and delivery or the puerperium,	O29.0, O29.1, O29.2, O89.0, O89.1, O89.2, O74.0, O74.1, O74.2 or O74.3
Surgical or manual correction of inverted uterus for vaginal births only	5.PC.91.HQ or 5.PC.91.HP, restricted to vaginal births (i.e., absence of caesarean code 5.MD.60)

Table 2. Components of composite severe neonatal morbidity and associated International Classification of Diseases (ICD-10 CA), Canadian Classification of Intervention (CCI) and related codes.

<b>Severe neonatal morbidity subtypes</b>	<b>Diagnosis (ICD-10CA), procedure (CCI) codes and other variables</b>
Neonatal seizure	P90
Intubation	1GZ31CAND, 1GZ31CRND
Congenital malformations	Q

Table 3. Variables used for restriction, adjustment and other process variables, and associated International Classification of Diseases (ICD-10 CA), Canadian Classification of Intervention (CCI) and related codes.

<b>Maternal conditions and procedures</b>	<b>Diagnosis (ICD-10CA), procedure (CCI) codes and other variables</b>
Multi-fetal pregnancy	O30, O31, O840, O849, O632, Z372, Z373, Z374, Z375, Z376, Z377, Z383, Z384, Z385, Z386, Z387, Z388, Z3790
Previous cesarean delivery	O3420, O757, O6640
Pre-existing diabetes mellitus	E10, E11, O245, O246, O247
Pre-existing hypertension	I10, I11, I12, I13, I15, O10, O11
Gestational hypertension with/without pre-eclampsia	O13, O16
Gestational diabetes	O248
Cesarean delivery	5MD60
Trial of labour	O757, O61, O62, O63, O64, O65, O66, O67, O68, O69, 5AC30

Table 4. Modeling tier of obstetric service without adjustment for hospital volume of delivery. Results of negative binomial regression showing the associations between tiers of obstetric service hospitals and i) composite severe maternal morbidity and maternal mortality; and ii) composite serious neonatal morbidity and neonatal mortality among women with a previous cesarean delivery and a parity of one, Canada (excluding Quebec), April 2013 to March 2019.

Variable	Unadjusted			Adjusted		
	Rate ratio	95% CI	P value	Rate ratio	95% CI	P value
Severe maternal morbidity and maternal mortality						
Tier of service: 1	0.65	0.50-0.84	0.001	0.69	0.53-0.90	0.006
2 (reference)	1.00	( - )	-	1.00	( - )	-
3	0.84	0.68-1.03	0.10	0.87	0.71-1.06	0.18
4	1.53	1.23-1.89	<.0001	1.36	1.05-1.76	<0.02
VBAC (%)	1.01	1.00-1.02	0.08	1.00	0.99-1.01	0.69
Advanced maternal age (%)	1.00	0.99-1.01	0.63	1.00	0.99-1.01	0.77
Pre-existing diabetes (%)	1.26	1.14-1.38	<.0001	1.10	0.99-1.22	0.07
Gestational diabetes (%)	1.01	0.99-1.03	0.29	0.99	0.97-1.01	0.44
Hypertensive disorders (%)	1.05	1.03-1.07	<.0001	1.05	1.01-1.09	0.006
Serious neonatal morbidity or neonatal death						
Tier of service: 1	0.86	0.57-1.31	0.48	0.83	0.54-1.27	0.39
2 (reference)	1.00	( - )	-	1.00	( - )	-
3	1.28	0.93-1.77	0.13	1.38	1.01-1.90	0.05
4	1.20	0.85-1.71	0.31	1.01	0.66-1.56	0.96
VBAC (%)	1.02	1.00-1.04	0.01	1.02	1.01-1.04	0.01
Advanced maternal age (%)	1.00	0.99-1.01	0.61	1.00	0.99-1.01	0.91
Pre-existing diabetes (%)	1.10	0.94-1.30	0.24	1.03	0.85-1.26	0.76
Gestational diabetes (%)	0.99	0.96-1.02	0.55	0.98	0.94-1.01	0.16
Hypertensive disorders (%)	1.02	0.97-1.08	0.39	1.03	0.96-1.11	0.35

Table 5. Modeling hospital volume of delivery without adjustment for tier of obstetric service. Results of Poisson regression showing the associations between tiers of obstetric service hospitals and i) composite severe maternal morbidity and maternal mortality; and ii) composite serious neonatal morbidity and neonatal mortality among women with a previous caesarean delivery and a parity of one, Canada (excluding Quebec), April 2013 to March 2019.

Variable	Unadjusted			Adjusted		
	Rate ratio	95% CI	P value	Rate ratio	95% CI	P value
<b>Severe maternal morbidity and maternal mortality</b>						
Delivery volume (100s)	1.02	0.99-1.05	0.29	1.01	1.00-1.02	0.29
VBAC (%)	1.01	1.00-1.02	0.08	1.01	1.00-1.02	0.21
Advanced maternal age (%)	1.00	0.99-1.01	0.63	1.00	0.99-1.01	0.49
Pre-existing diabetes (%)	1.26	1.14-1.38	<.0001	1.20	1.10-1.32	<0.0001
Gestational diabetes (%)	1.01	0.99-1.03	0.29	0.98	0.96-1.01	0.14
Hypertensive disorders (%)	1.05	1.03-1.07	<.0001	1.06	1.03-1.10	<0.003
<b>Serious neonatal morbidity or neonatal death</b>						
Delivery volume (100s)	1.02	1.00-1.03	0.05	1.02	1.00-1.04	0.02
VBAC (%)	1.02	1.00-1.04	0.01	1.02	1.00-1.04	0.04
Advanced maternal age (%)	1.00	0.99-1.01	0.61	0.99	0.86-1.14	0.32
Pre-existing diabetes (%)	1.10	0.94-1.30	0.24	1.03	0.87-1.23	0.70
Gestational diabetes (%)	0.99	0.96-1.02	0.55	0.98	0.95-1.01	0.26
Hypertensive disorders (%)	1.02	0.97-1.08	0.39	1.01	0.95-1.08	0.72

Table 6. Number and rate (%) of hospitals with outlier rates of severe maternal morbidity/mortality among term, singleton deliveries to women with a previous cesarean delivery by tier of obstetric service and province/territories, Canada (excluding Quebec), April 2013 to March 2019. Tiers of service, which were province/territories-specific, were modified to create a common tiers of service framework for all provinces/territories.

Province/territories	Tiers of service		Number of hospitals	Outlier hospitals			
	Common	Province/territories		Within tier		Reference	
				Number	Percent	Number	Percent
British Columbia	0	0	1	0	0.0	0	0.0
	1	1a	3	0	0.0	0	0.0
	1	1b	36	2	5.6	9	25.0
	2	2a	6	1	16.7	2	33.3
	2	2b	3	0	0.0	0	0.0
	3	3	3	1	33.3	1	33.3
	4	4	1	1	100.0	-	-
	All	All	53	5	9.4	12	22.6
Alberta	0	0	3	0	0.0	0	0.0
	1	1	6	0	0.0	0	0.0
	2	2	30	2	6.7	8	26.7
	3	3	8	1	12.5	3	37.5
	4	4	5	2	40.0	1	20.0
	All	All	52	5	9.6	12	23.1
Saskatchewan	0	0	1	0	0.0	0	0.0
	1	1	5	0	0.0	0	0.0
	2	2	8	2	25.0	2	25.0
	4	4	2	0	0.0	0	0.0
	All	All	16	2	12.5	2	12.5
Manitoba	0	0	2	0	0.0	0	0.0
	1	1	0	0	-	0	-
	2	2	12	1	8.3	2	16.7
	4	3	2	0	0.0	0	0.0
	All	All	16	1	6.3	2	12.5
Ontario	0	0	3	0	0.0	0	0.0
	1	1a	12	0	0.0	0	0.0
	1	1b	33	2	6.1	8	24.2
	2	2a	10	1	10.0	2	20.0
	2	2b	21	2	9.5	4	19.0
	3	2c	17	3	17.6	7	41.2
	4	3	8	2	25.0	1	12.5
	All	All	104	10	9.6	22	21.2

Table 6 (cont). Number and rate (%) of hospitals with outlier rates of severe maternal morbidity/mortality among term, singleton deliveries to women with a previous cesarean delivery by tier of service and province/territories, Canada (excluding Quebec), April 2013 to March 2019. Tiers of service, which were province/territories-specific, were modified to create a common tiers of service framework for all provinces/territories.

Province/territories	Tier of service		Number of hospitals	Outlier hospitals			
	Common	Province/territories		Within tier		Reference	
				Number	Percent	Number	Percent
New Brunswick	0	0	0	0	-	0	-
	1	1	1	0	0.0	0	0.0
	2	2a	4	0	0.0	1	25.0
	2	2b	1	0	0.0	0	0.0
	3	3	3	0	0.0	1	33.3
	All	All	9	0	0.0	2	22.2
Nova Scotia	0	0	1	0	0.0	0	0.0
	2	2a	5	0	0.0	1	20.0
	2	2b	3	0	0.0	1	33.3
	4	3	1	0	0.0	-	-
	All	All	10	0	0.0	2	20.0
Prince Edward	2	2	1	0	0.0	-	-
	2	2.5	1	0	0.0	-	-
	All	All	2	0	0.0	-	-
Newfoundland and Labrador	1	1	0	0	0.0	0	0
	2	2	9	0	0.0	2	22.2
	3	3	1	0	0.0	-	-
	4	4	1	0	0.0	-	-
	All	All	11	0	0.0	2	11.1
Combined	0	0	0	0	-	0	-
	1	1	1	0	0.0	0	0.0
	2	2	4	1	25.0	1	25.0
	All	All	5	1	20.0	1	20.0
Canada (excluding Quebec)	All	All	278	24	8.6	57	20.5



Table 7. Number and rate (%) of hospitals with outlier rates of severe maternal morbidity/mortality among term, singleton deliveries to women with a previous cesarean delivery by modified tier of service, Canada (excluding Quebec), April 2013 to March 2019.

Tier of service	Number of hospitals	Outliers hospitals					
		Within-tier comparison			Reference comparison		
		Number	Percent	P for trend	Number	Percent	P for trend
0	11	0	0.0	-	0	-	-
1	97	4	4.1	-	17	17.5	-
2	115	10	8.7	-	25	21.7	-
3	35	5	14.3	-	13	37.1	-
4	20	5	25.0	-	2	10.0	-
All	278	24	8.6	0.0009	57	20.5	0.43

Table 8. Number and rate (%) of hospitals with outlier rates of serious neonatal morbidity/mortality among term, singleton deliveries to women with a previous cesarean delivery by tier of service and province/territories, Canada (excluding Quebec), April 2013 to March 2019.

Province/territories	Tiers of service		Number of hospitals	Outlier hospitals			
	Common	Province/territories		Within tier		Reference	
				Number	Percent	Number	Percent
British Columbia	0	0	1	0	0.0	0	0.0
	1	1a	3	0	0.0	0	0.0
	1	1b	36	1	2.8	7	19.4
	2	2a	6	0	0.0	1	16.7
	2	2b	3	0	0.0	1	33.3
	3	3	3	1	33.3	1	33.3
	4	4	1	0	0.0	0	-
	All	All	53	2	3.8	10	18.9
Alberta	0	0	3	0	0.0	0	0.0
	1	1	6	0	0.0	0	0.0
	2	2	30	1	3.3	6	20.0
	3	3	8	1	12.5	2	25.0
	4	4	5	0	0.0	1	20.0
	All	All	52	2	3.8	9	17.3
Saskatchewan	0	0	1	0	0.0	0	0.0
	1	1	5	0	0.0	1	20.0
	2	2	8	1	12.5	1	12.5
	4	4	2	0	0.0	0	0.0
	All	All	16	1	6.3	2	12.5
Manitoba	0	0	2	0	0.0	0	0.0
	1	1	0	0	-	0	-
	2	2	12	1	8.3	1	8.3
	4	3	2	1	50.0	1	50.0
	All	All	16	2	12.5	2	12.5
Ontario	0	0	3	0	0.0	0	0.0
	1	1a	12	0	0.0	0	0.0
	1	1b	33	1	3.0	10	30.3
	2	2a	10	2	20.0	2	20.0
	2	2b	21	1	4.8	6	28.6
	3	2c	17	1	5.9	5	29.4
	4	3	8	0	0.0	3	37.5
	All	All	104	5	4.8	26	25.0

Table 8 (cont). Number and rate (%) of hospitals with outlier rates of serious neonatal morbidity/mortality among term, singleton deliveries to women with a previous cesarean delivery by tier of service and province/territories, Canada (excluding Quebec), April 2013 to March 2019.

Province/territories	Tier of service		Number of hospitals	Outlier hospitals			
	Common	Province/territories		Within tier		Reference	
				Number	Percent	Number	Percent
New Brunswick	0	0	0	0	-	0	-
	1	1	1	0	0.0	0	0.0
	2	2a	4	1	25.0	1	25.0
	2	2b	1	0	0.0	0	0.0
	3	3	3	0	0.0	1	33.3
	All	All	9	1	11.1	2	22.2
Nova Scotia	0	0	1	0	0.0	0	0.0
	2	2a	5	0	0.0	1	20.0
	2	2b	3	1	33.3	1	33.3
	4	3	1	0	0.0	-	-
	All	All	10	1	10.0	2	20.0
Prince Edward	2	2	1	-	-	-	-
	2	2.5	1	-	-	-	-
	All	All	2	0	0.0	0	0.0
Newfoundland and Labrador	1	1	0	0	0.0	0	0.0
	2	2	9	0	0.0	2	22.2
	3	3	1	0	0.0	-	-
	4	4	1	0	0.0	-	-
	All	All	11	0	0.0	2	11.1
Combined	0	0	0	0	-	0	-
	1	1	1	0	0.0	0	0.0
	2	2	4	0	0.0	1	25.0
	All	All	5	0	0.0	1	20.0
Canada (excluding Quebec)	All	All	278	14	5.0	56	20.1

Table 9. Number and rate (%) of hospitals with outlier rates of serious neonatal morbidity/mortality among term, singleton deliveries to women with a previous cesarean delivery by modified tier of service, Canada (excluding Quebec), April 2013 to March 2019.

Tier of service	Number of hospitals	Outliers hospitals					
		Within-tier comparison			Reference comparison		
		Number	Percent	P for trend	Number	Percent	P for trend
0	11	0	0.0	-	0	0.0	-
1	97	2	2.1	-	18	18.6	-
2	115	7	6.1	-	23	20.0	-
3	35	4	11.4	-	10	28.6	-
4	20	1	5.0	-	5	25.0	-
All	278	14	5.0	0.07	56	20.1	0.26

Figure 1. SMM and NMM rates among women with a parity of one by tiers of service, Canada (excluding Quebec).

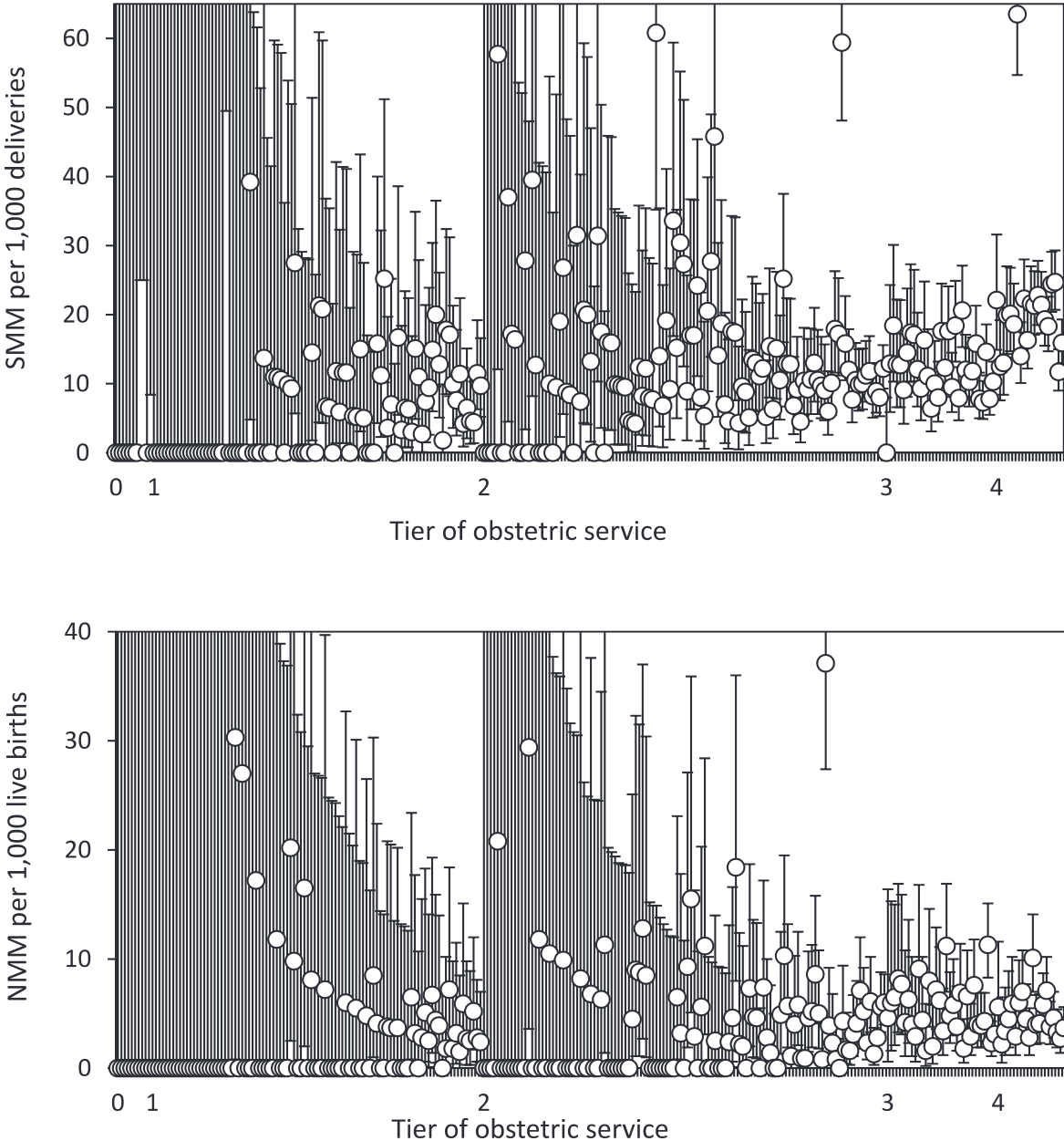


Figure 2. SMM and NMM rates among women with a parity of one by hospital delivery volume, Canada excluding Quebec).

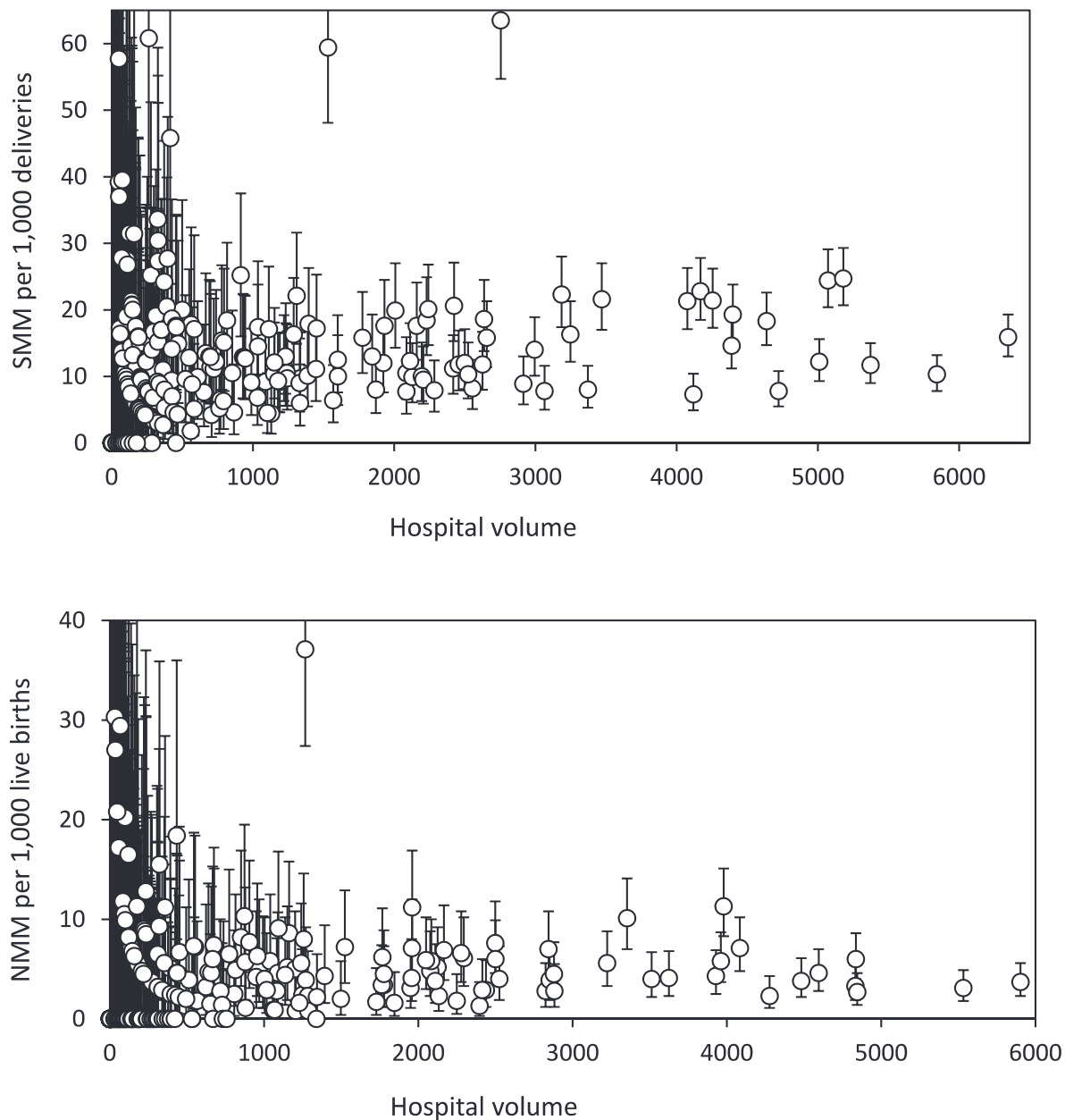


Figure 3. SMM and NMM rates by tiers of service, British Columbia.

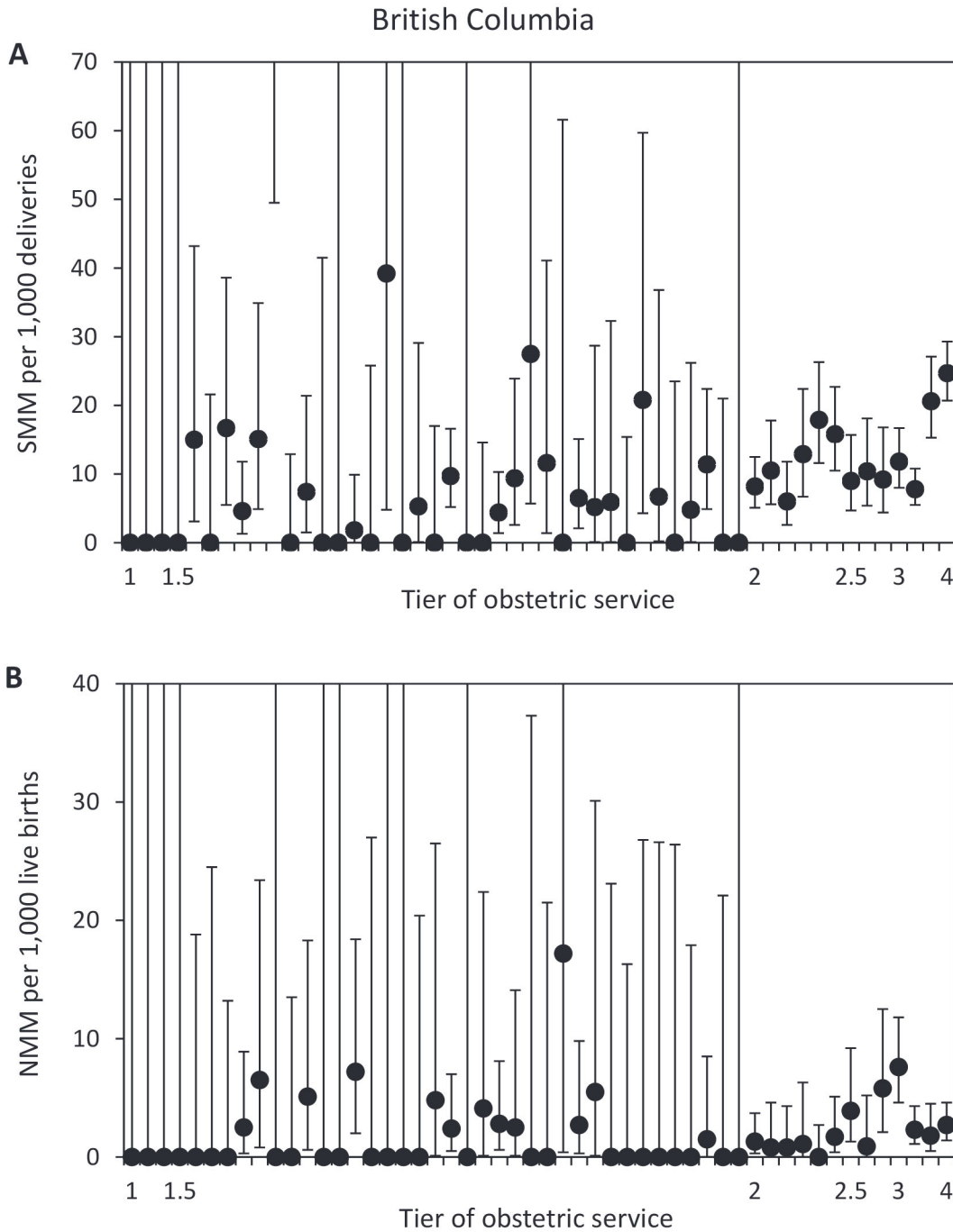


Figure 4. SMM and NMM rates by tiers of service, Alberta.

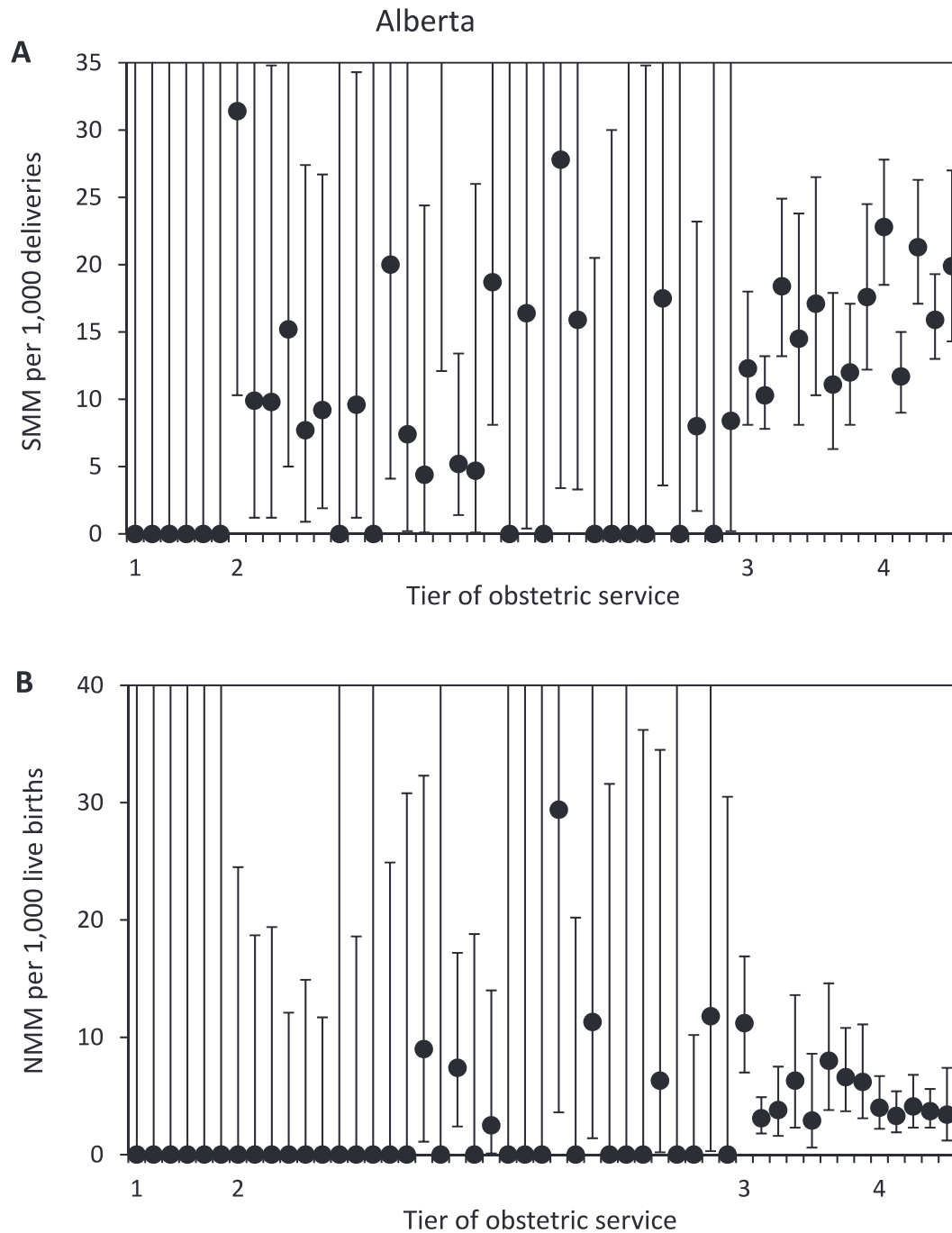




Figure 5. SMM and NMM rates by tiers of service, Saskatchewan.

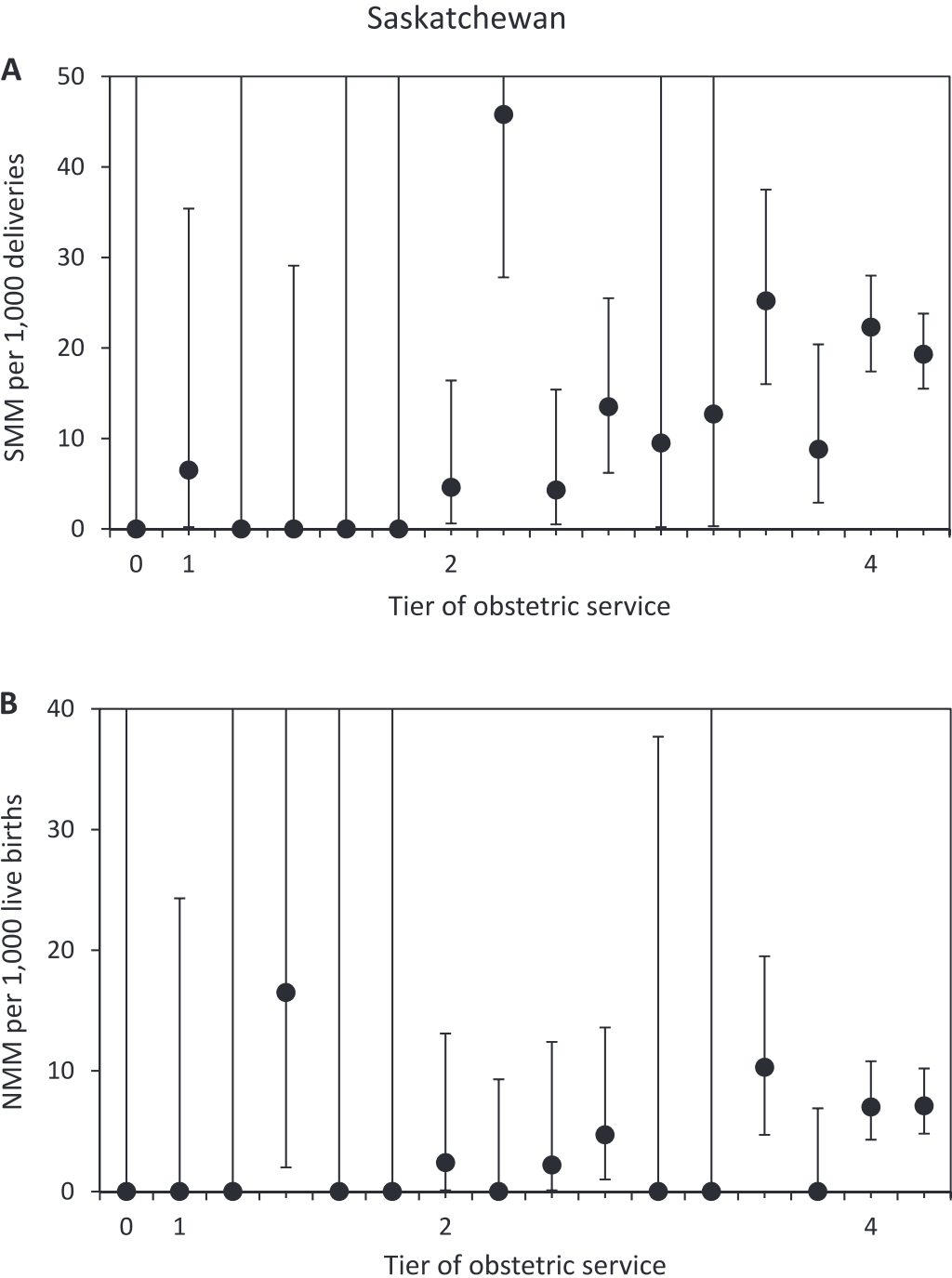


Figure 6. SMM and NMM rates by tiers of service, Manitoba.

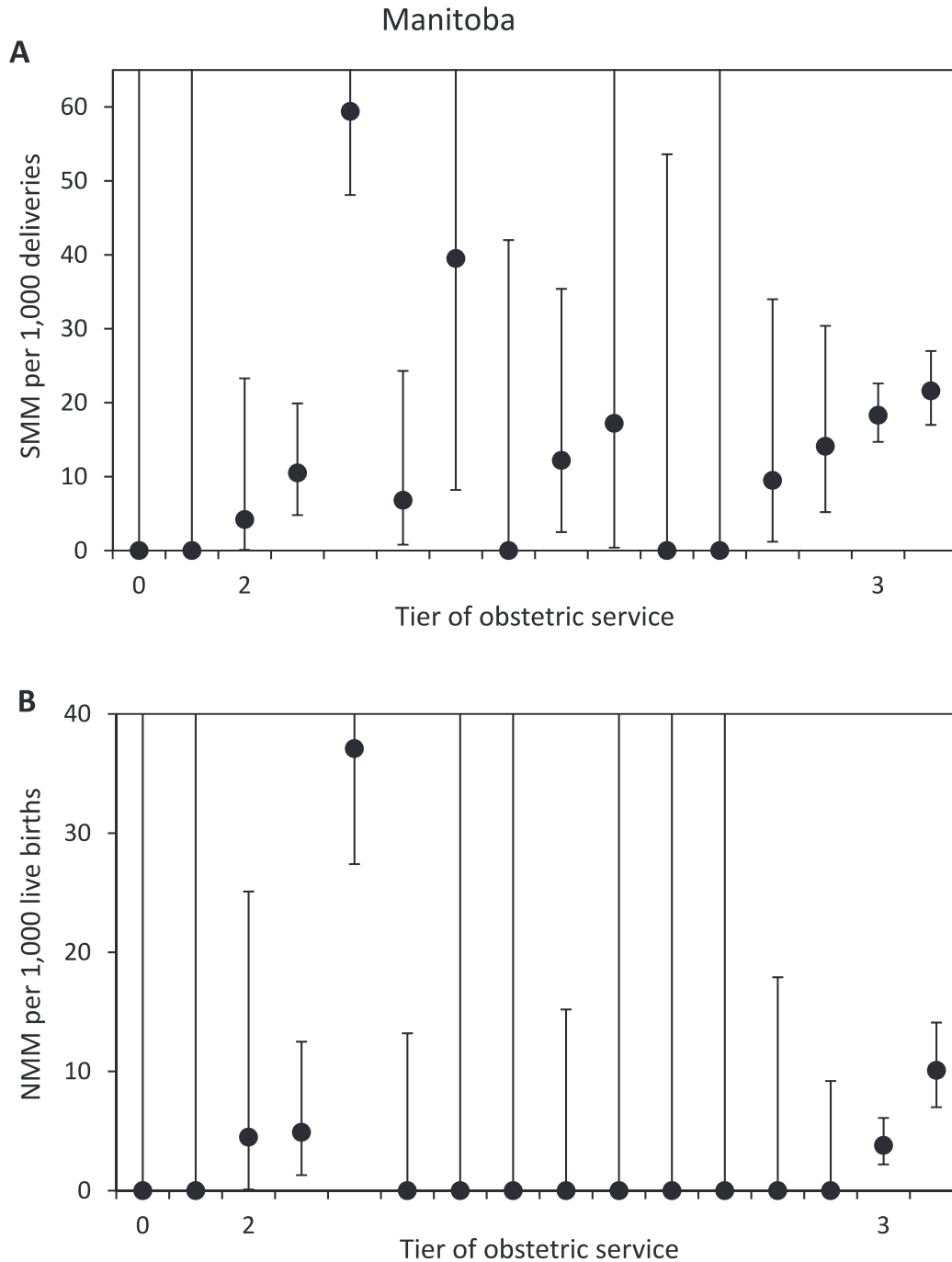


Figure 7. SMM and NMM rates by tiers of service, Ontario.

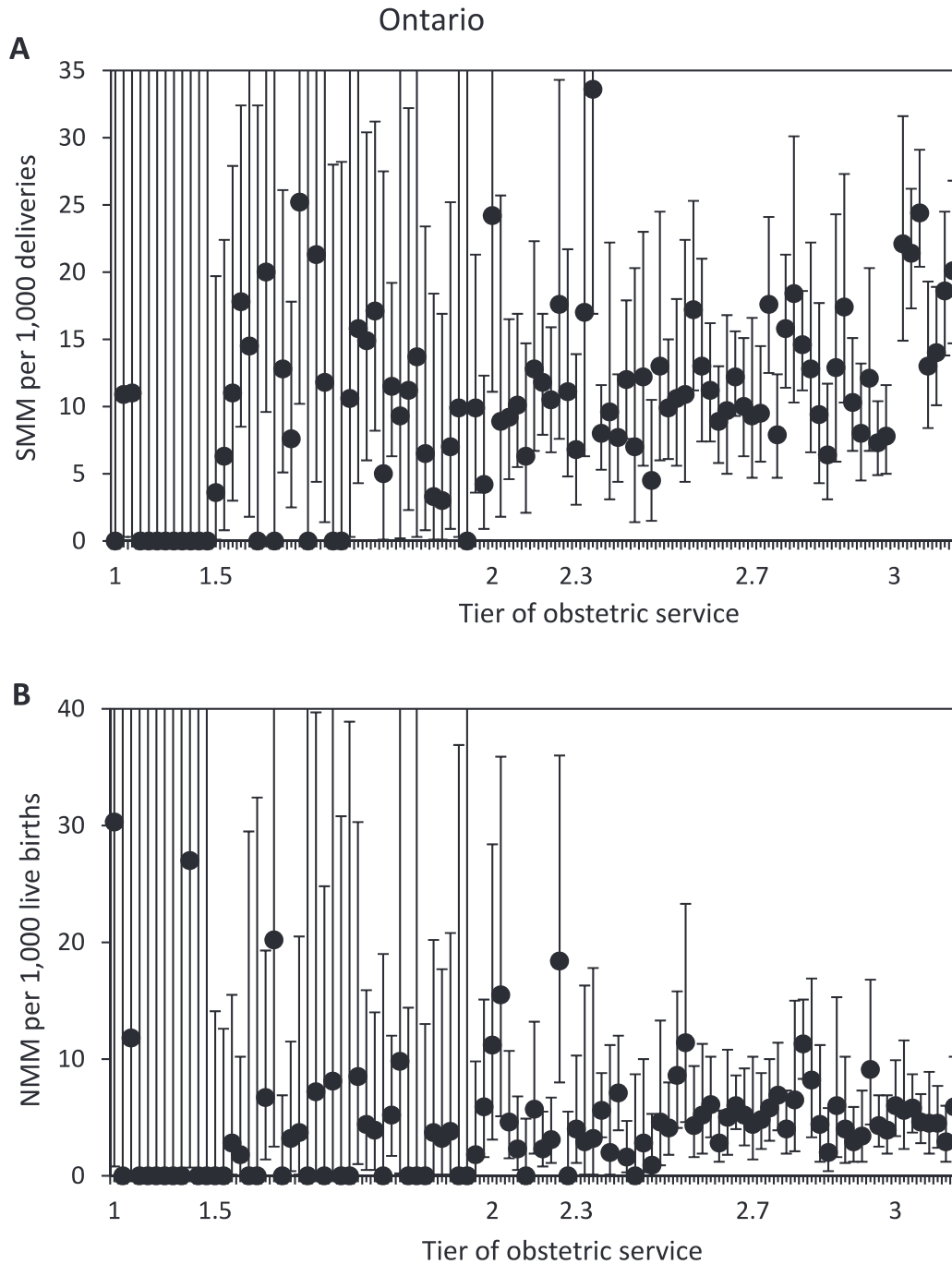


Figure 8. SMM and NMM rates by tiers of service, New Brunswick.

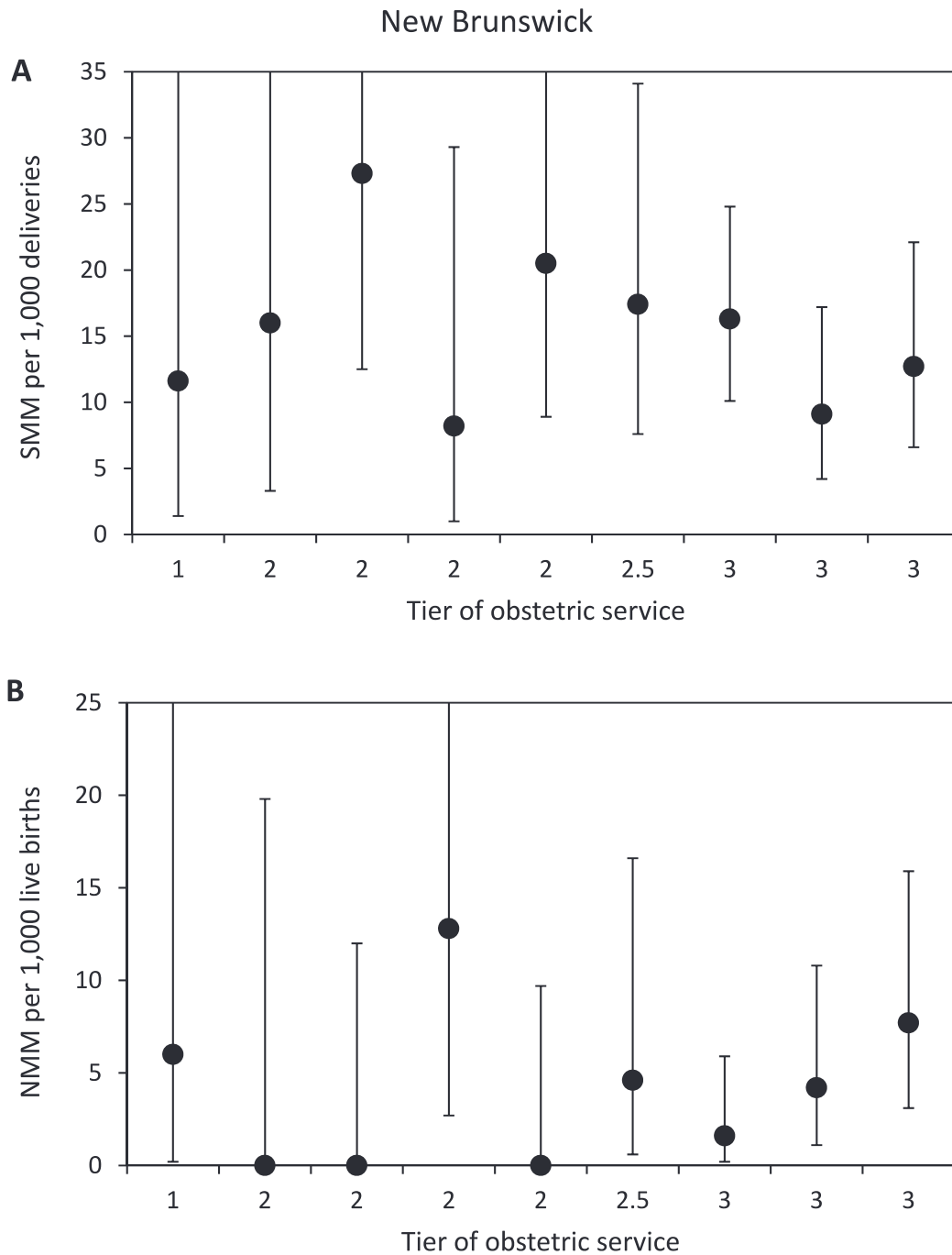


Figure 9. SMM and NMM rates by tiers of service, Nova Scotia.

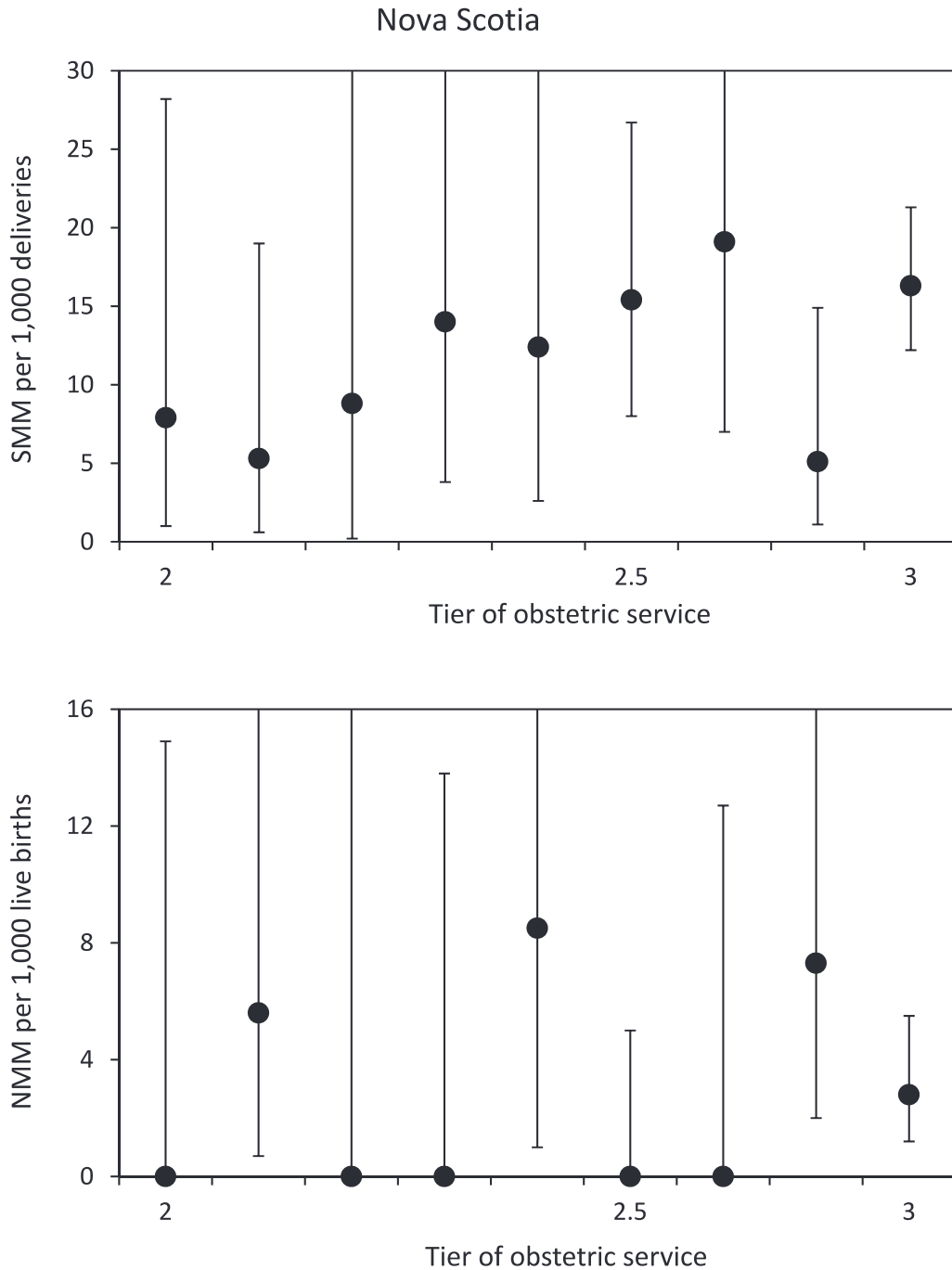


Figure 10. SMM and NMM rates by tiers of service, Prince Edward Island.

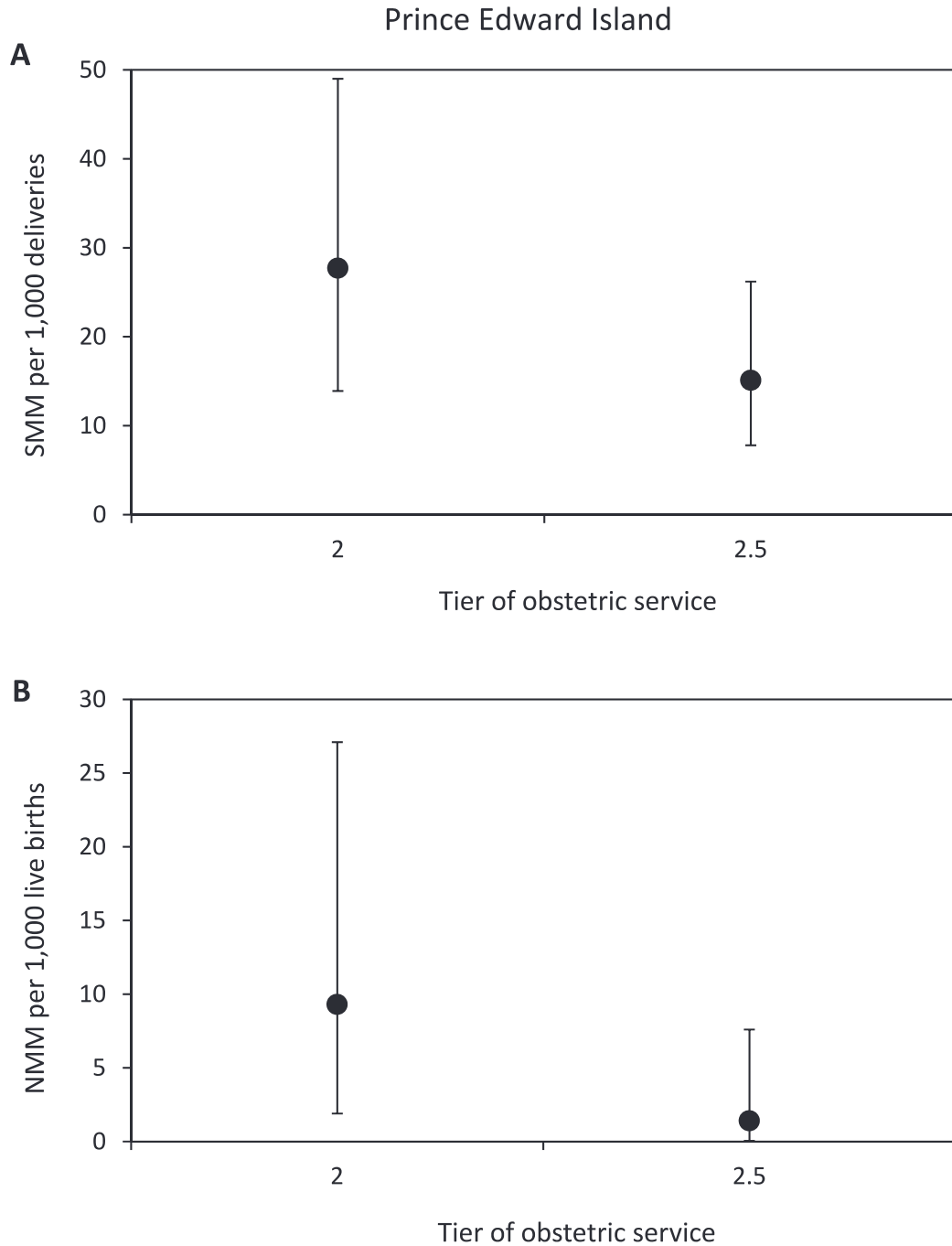


Figure 11. SMM and NMM rates by tiers of service, Newfoundland & Labrador.

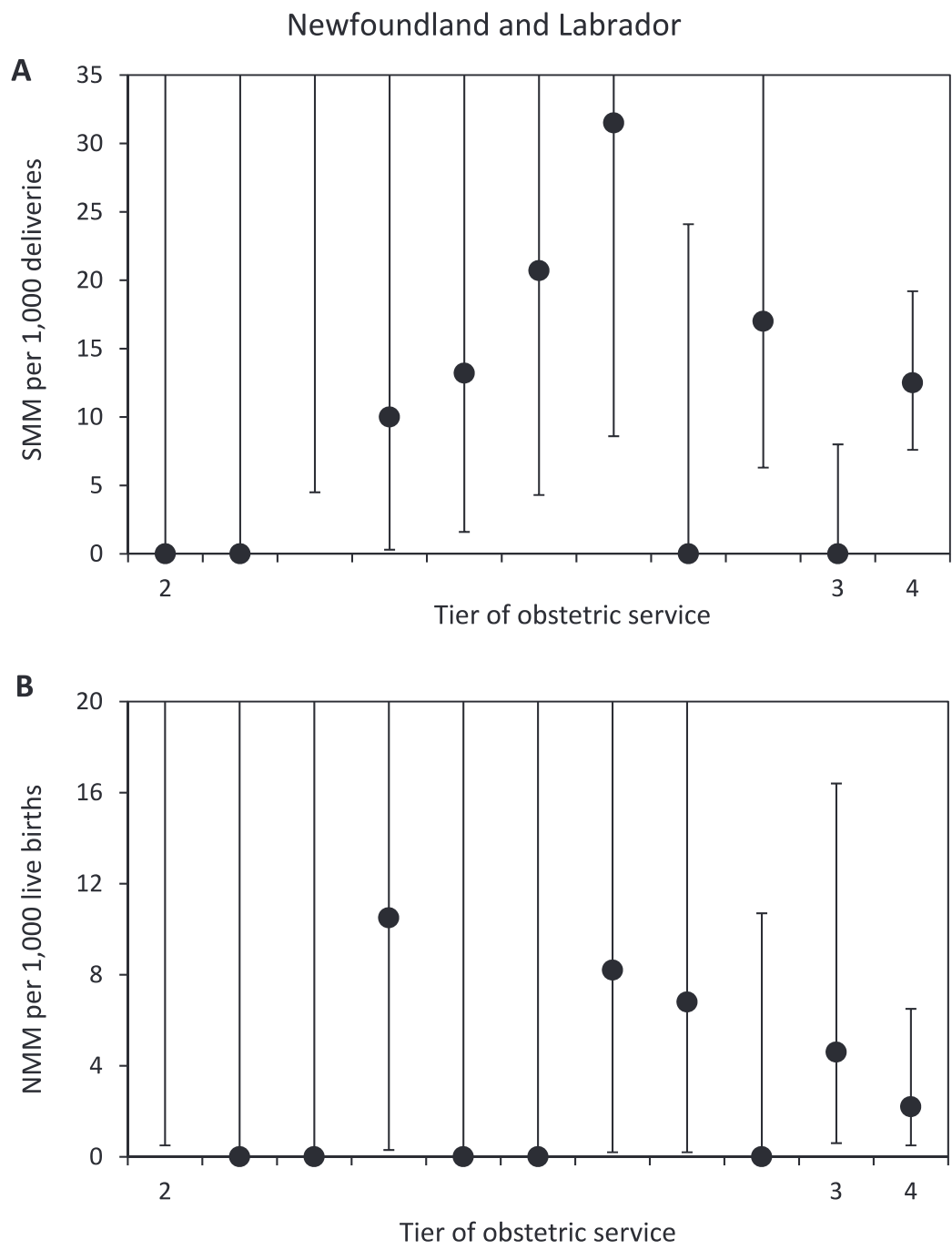


Figure 12. SMM and NMM rates by tiers of service, Combined Territories.

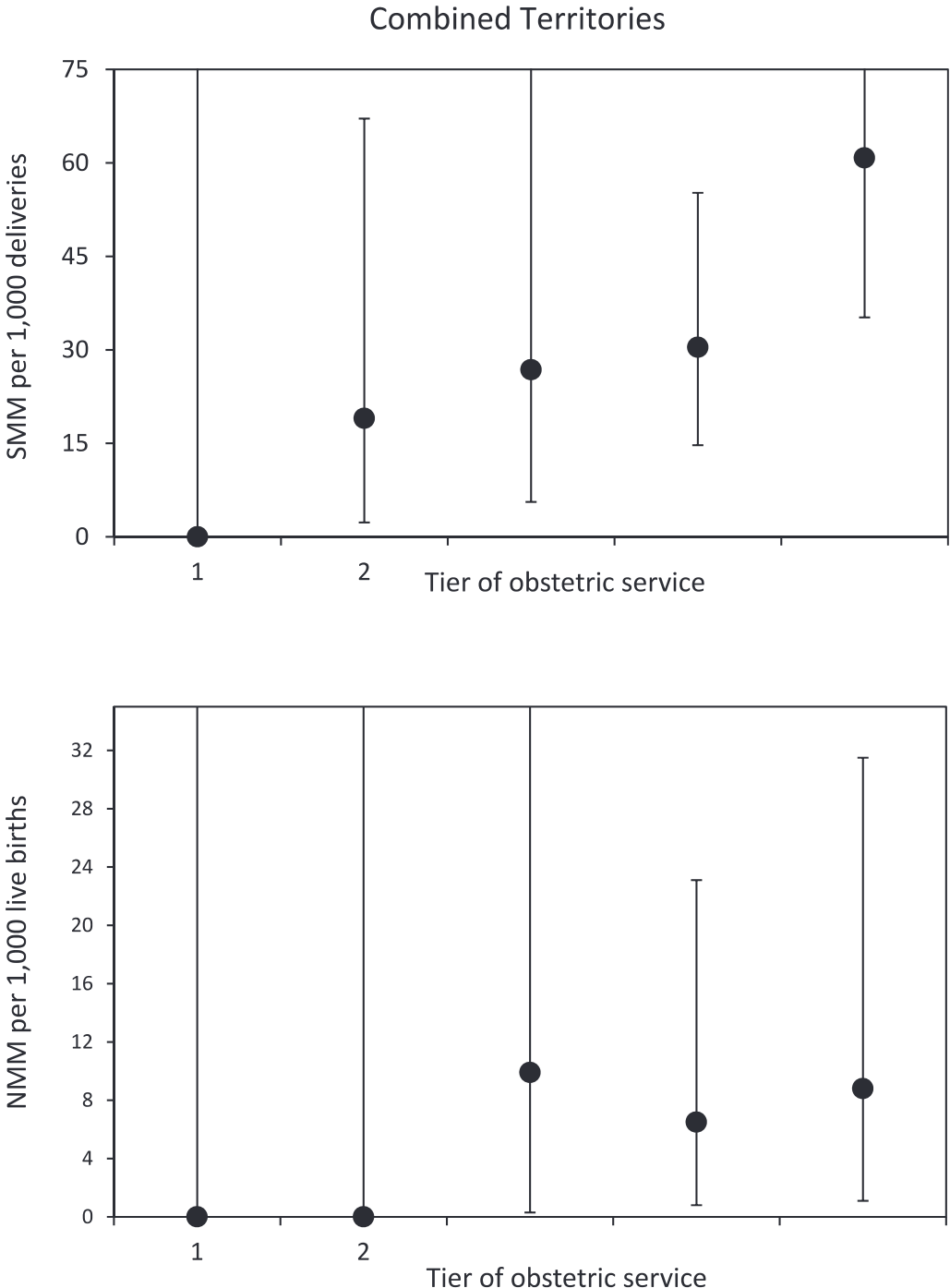




Figure 13. SMM and NMM rates by hospital volume, British Columbia.

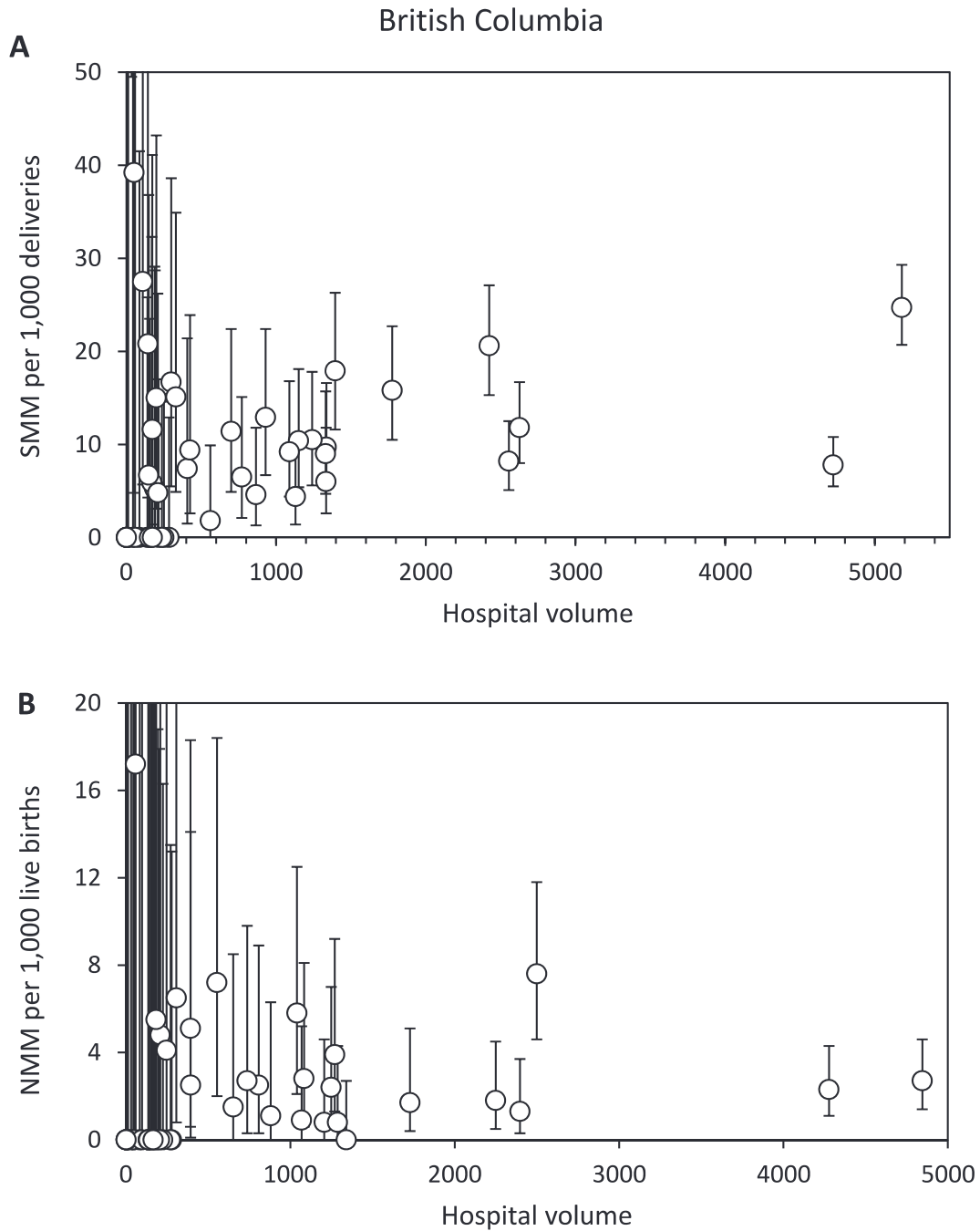


Figure 14. SMM and NMM rates by hospital volume, Alberta.

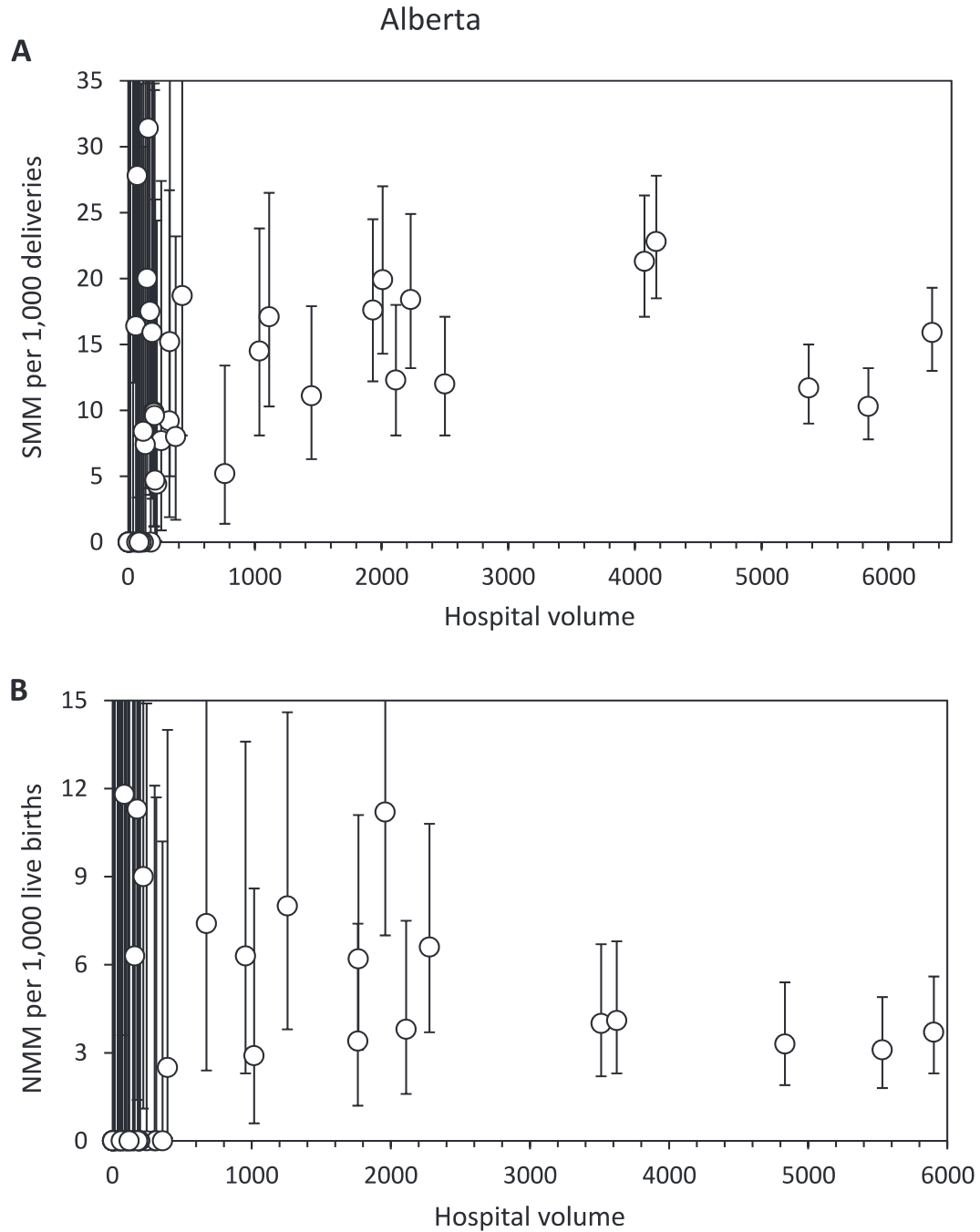


Figure 15. SMM and NMM rates by hospital volume, Saskatchewan.

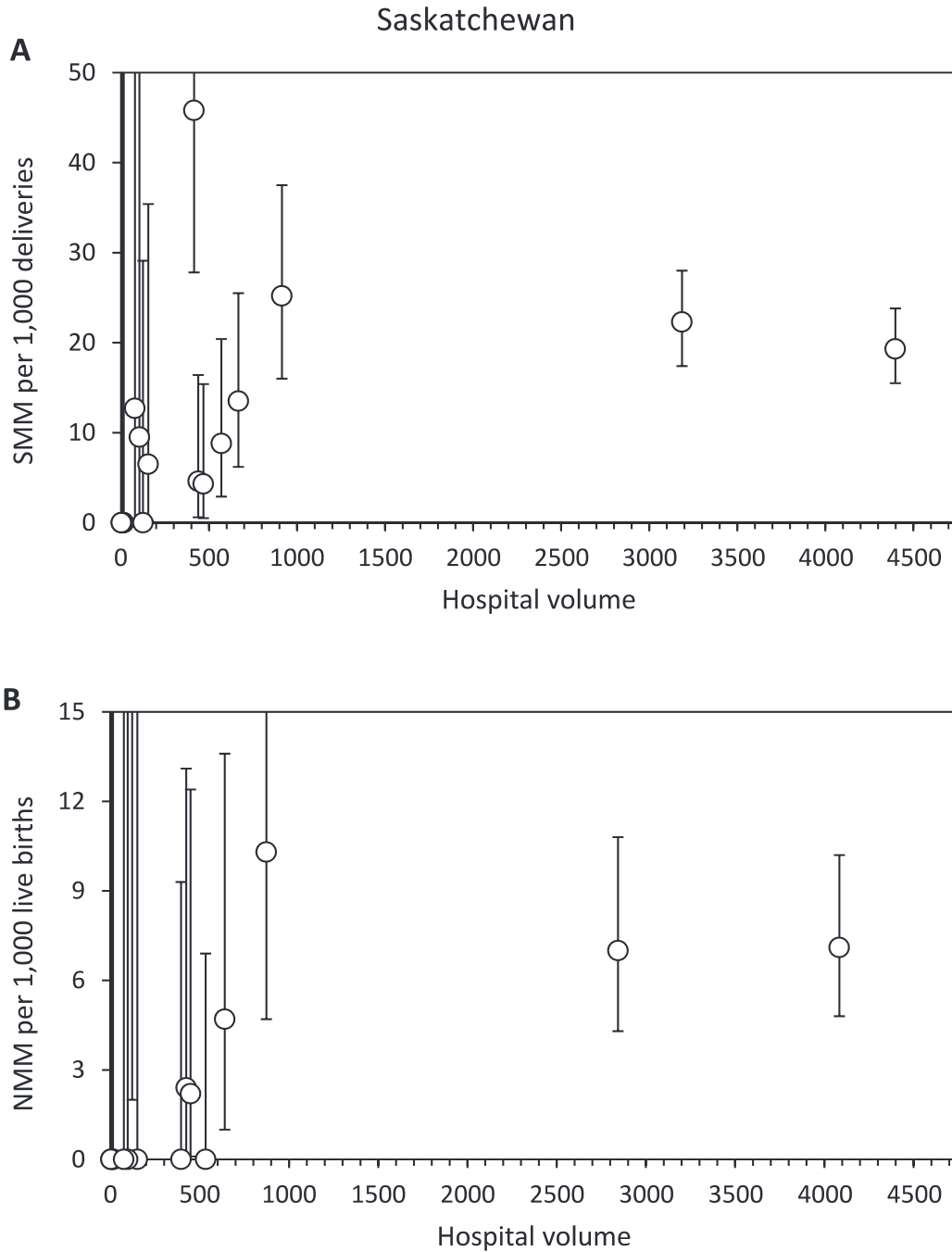


Figure 16. SMM and NMM rates by hospital volume, Manitoba.

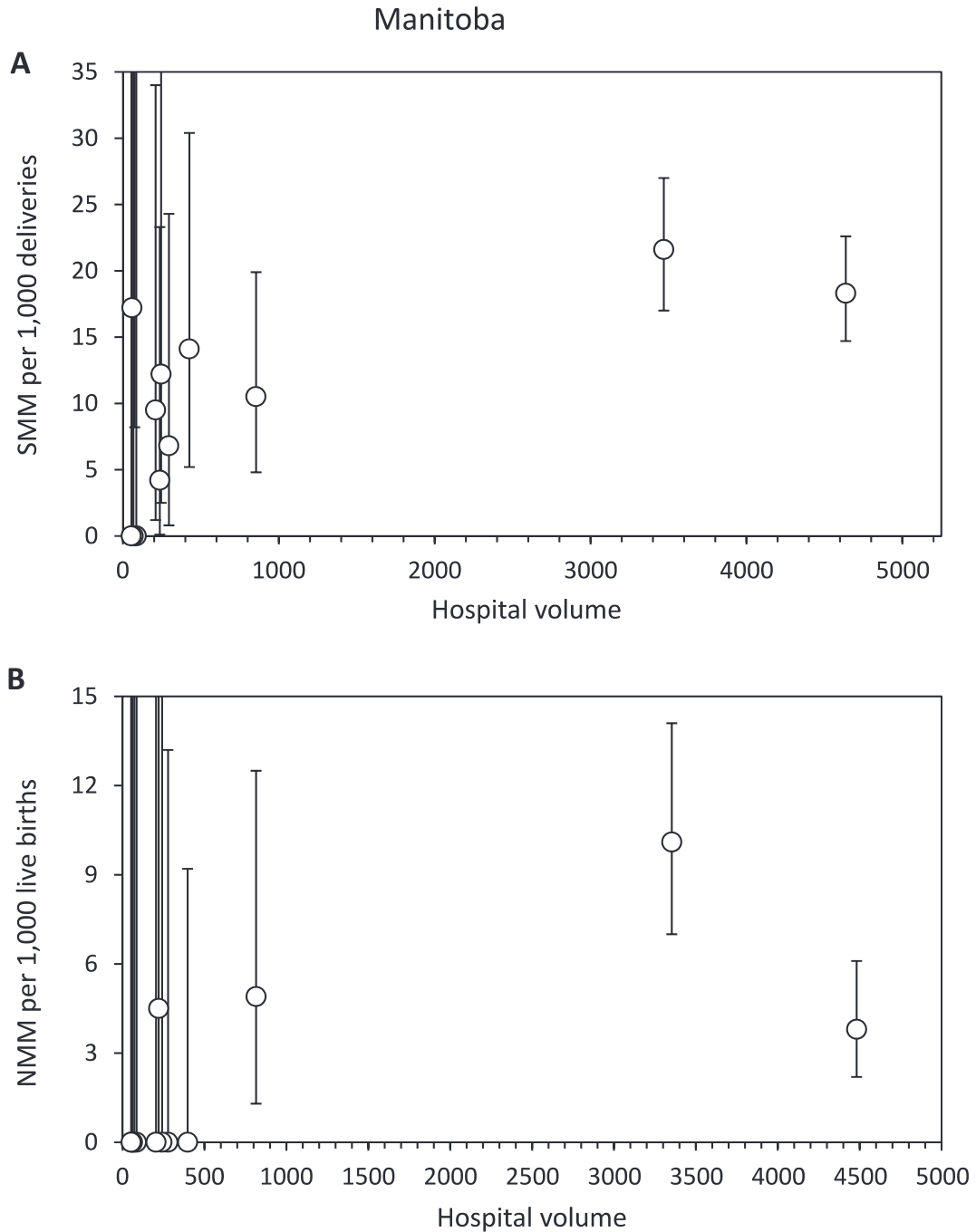


Figure 17. SMM and NMM rates by hospital volume, Ontario.

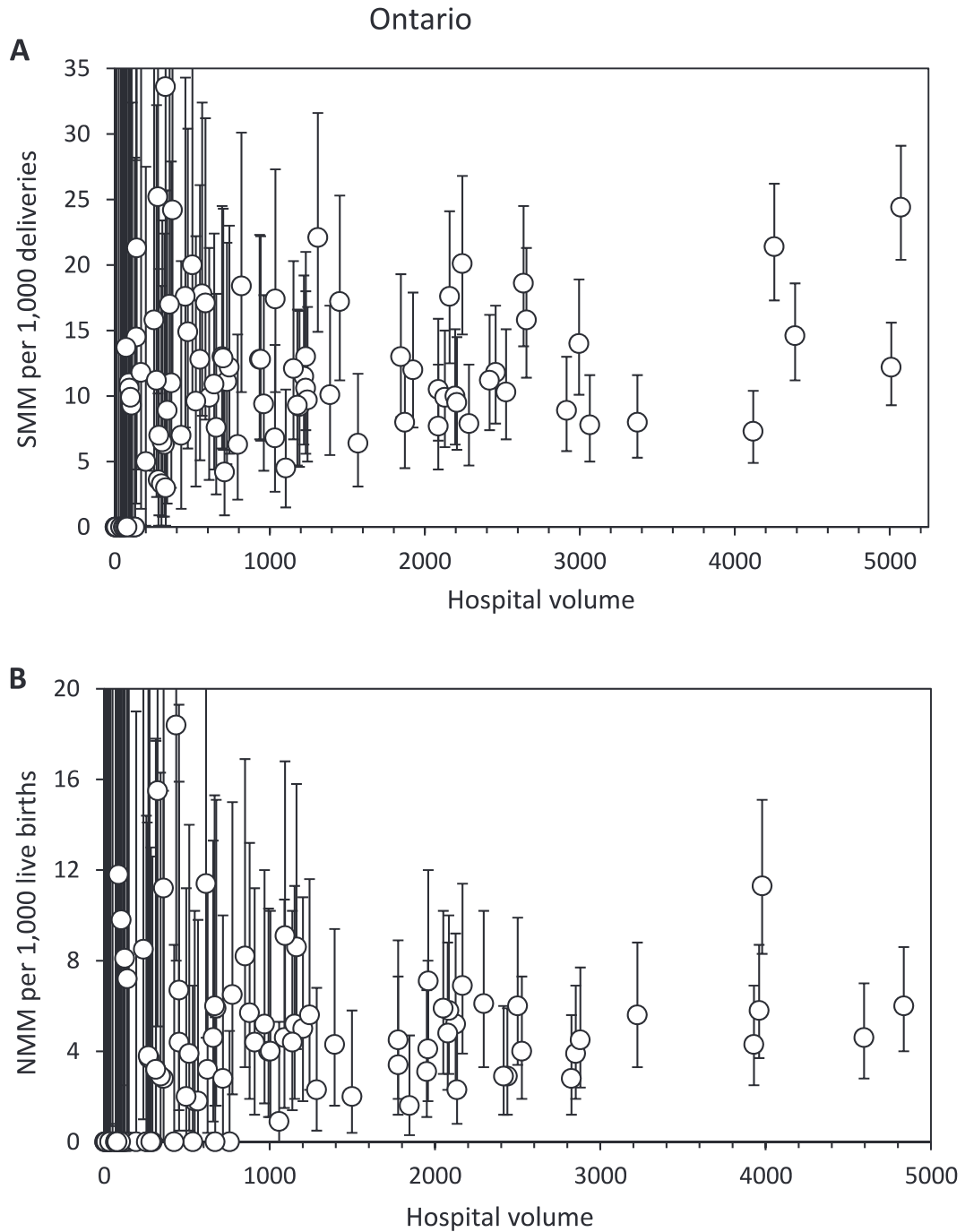


Figure 18. SMM and NMM rates by hospital volume, New Brunswick.

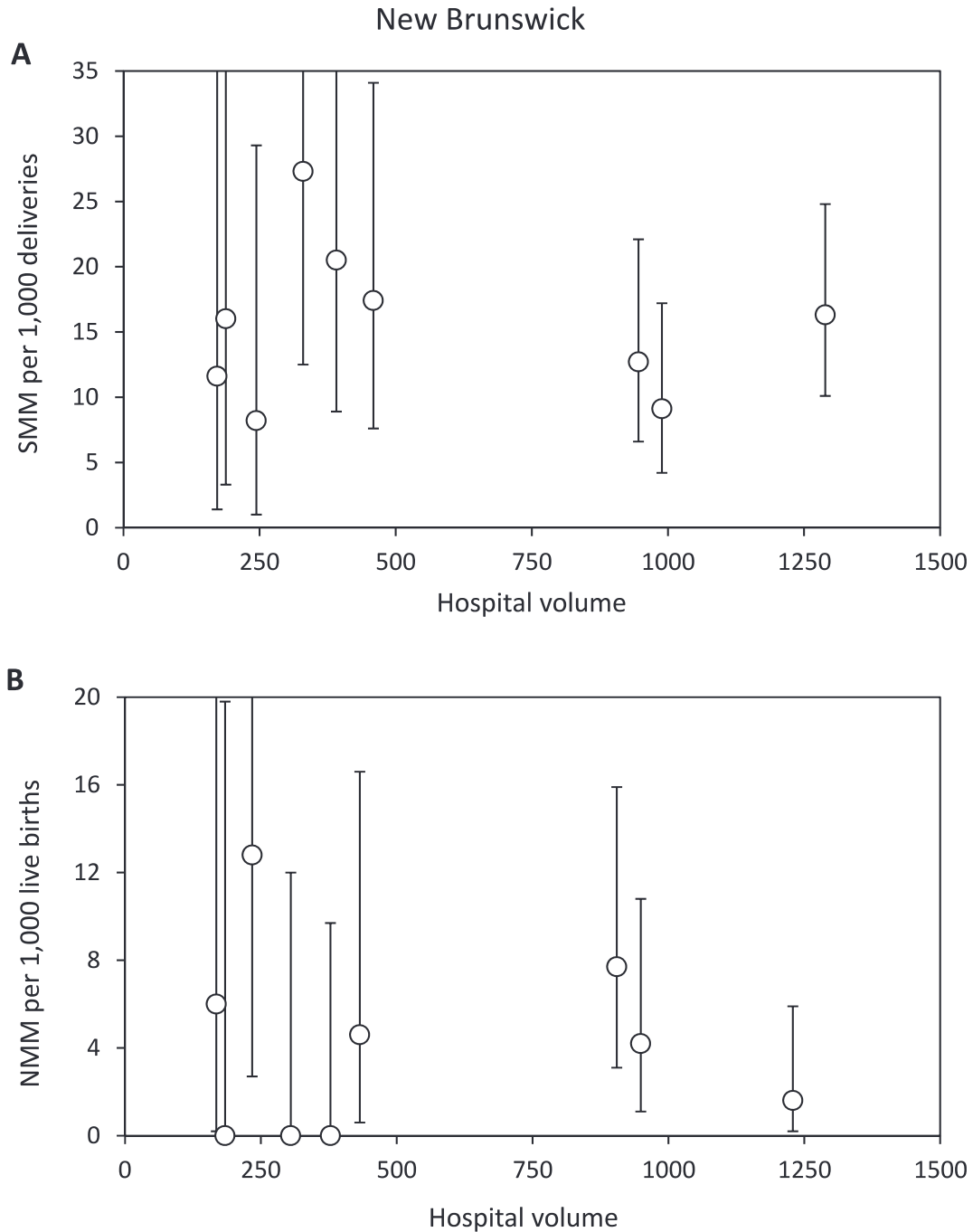


Figure 19. SMM and NMM rates by hospital volume, Nova Scotia.

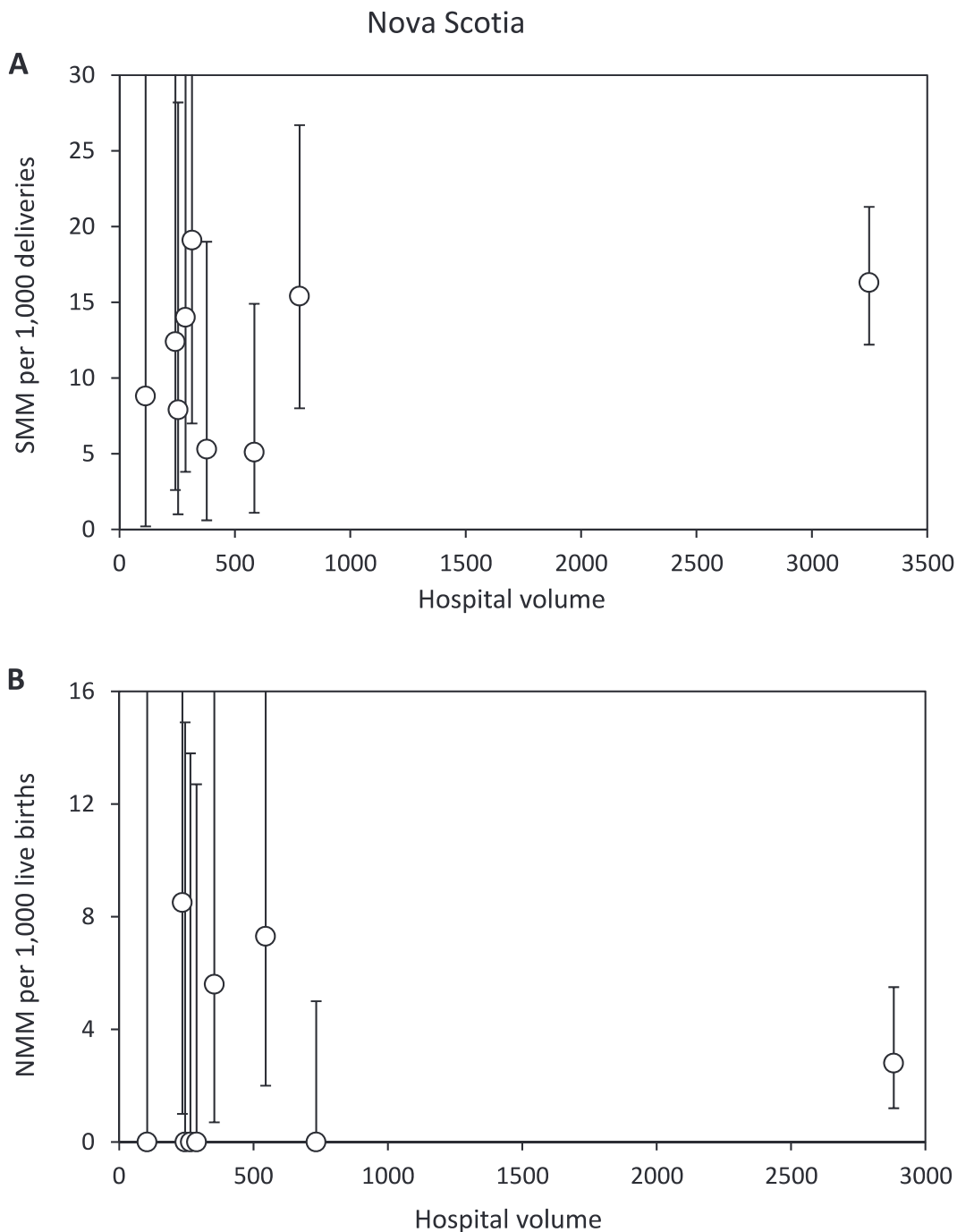


Figure 20. SMM and NMM rates by hospital volume, Prince Edward Island.

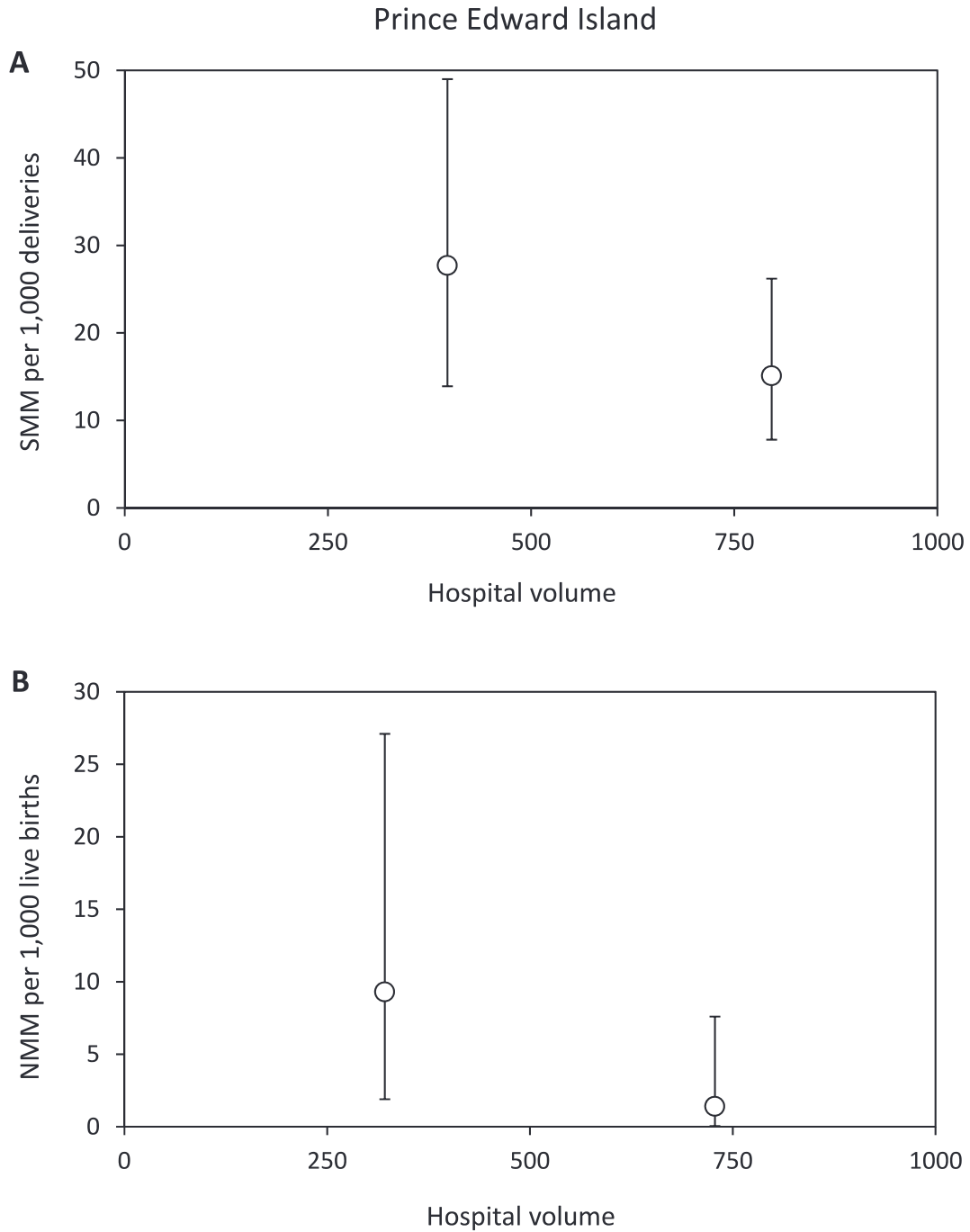




Figure 21. SMM and NMM rates by hospital volume, Newfoundland & Labrador.

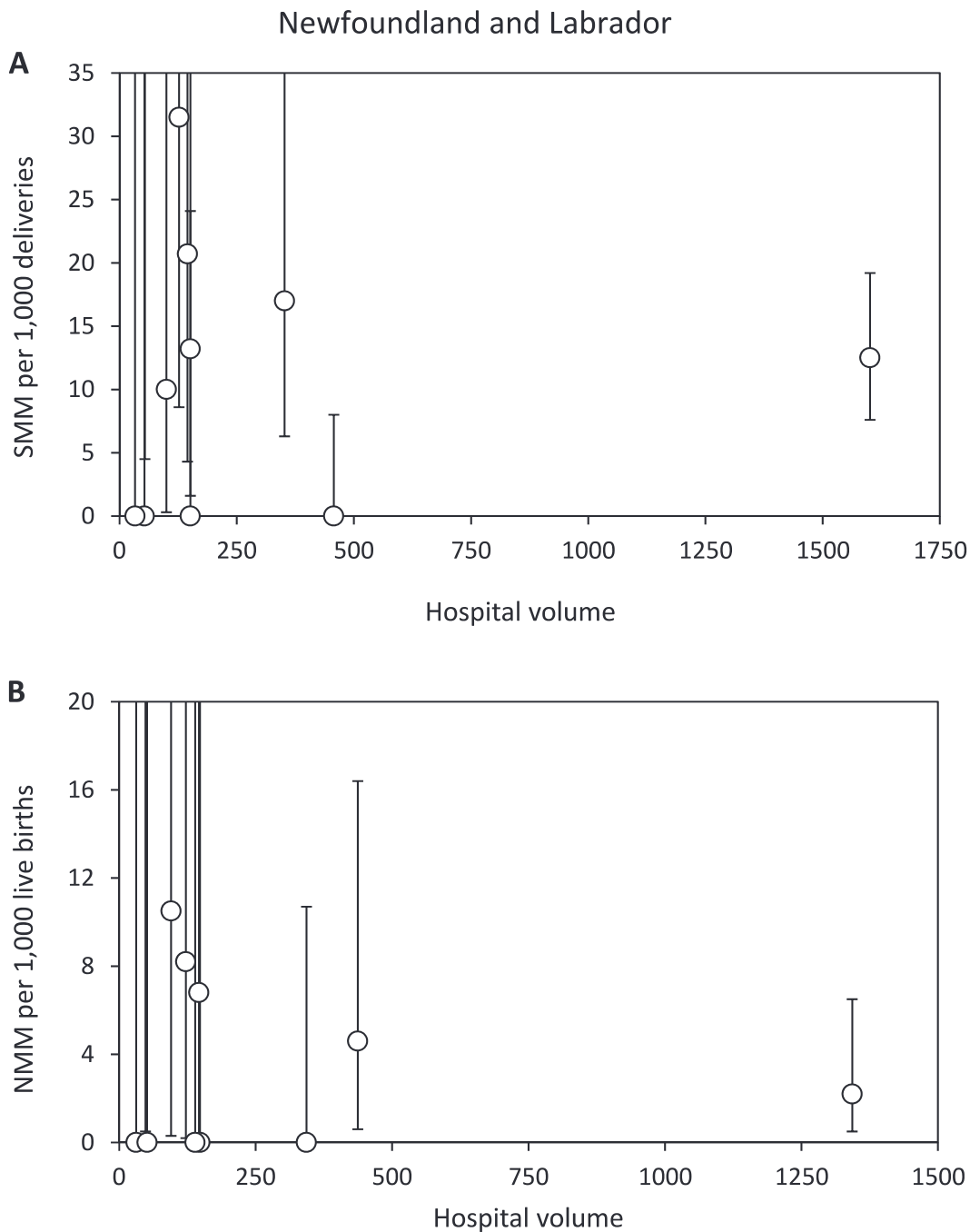


Figure 22. SMM and NMM rates by hospital volume, Combined Territories.

