Supplementary material

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Supplementary Table 1: Risk ratios between different points on the restricted cubic spline on expected hospital volume for all outcomes

The numbers are the results of the main analyses. Estimates computed within woman (left column) were adjusted for age, parity, study year and expected travel time. The alternative analysis (right column) was computed within neighbouring women, adjusted for age and education, parity, and expected travel time. Standard errors were clustered by woman and municipality.

Perinatal mortality

	Moving women	Neighbouring women
500 births p.a.	1·55 (1·03 to 2·34)	1·63 (1·13 to 2·35)
1000 births p.a.	1·29 (1·03 to 1·62)	1·35 (1·10 to 1·66)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	1·04 (0·76 to 1·44)	0·84 (0·61 to 1·16)
5000 births p.a.	1·04 (0·76 to 1·42)	0·86 (0·59 to 1·27)
Per 1000 births p.a.	0·96 (0·90 to 1·02)	0·88 (0·82 to 0·95)

Apgar-score < 7

	Moving women	Neighbouring women
500 births p.a.	1·02 (0·79 to 1·31)	1·27 (1·06 to 1·53)
1000 births p.a.	1·01 (0·88 to 1·16)	1·14 (1·02 to 1·26)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	1·08 (0·89 to 1·31)	1·16 (0·98 to 1·37)
5000 births p.a.	1·15 (0·94 to 1·40)	1·18 (0·98 to 1·41)
Per 1000 births p.a.	1·03 (0·99 to 1·07)	1·01 (0·96 to 1·06)

Transport delivery

	Moving women	Neighbouring women
500 births p.a.	0·90 (0·61 to 1·32)	0·63 (0·47 to 0·84)
1000 births p.a.	0·92 (0·74 to 1·14)	0·77 (0·65 to 0·91)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	1·30 (0·94 to 1·79)	1·04 (0·82 to 1·33)
5000 births p.a.	1·32 (0·96 to 1·84)	1·36 (1·01 to 1·81)
Per 1000 births p.a.	1·04 (0·97 to 1·12)	1·17 (1·08 to 1·27)

Induced delivery

	Moving women	Neighbouring women
500 births p.a.	1·02 (0·95 to 1·10)	0·92 (0·85 to 1·00)
1000 births p.a.	1·02 (0·98 to 1·06)	0·96 (0·92 to 1·00)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	0·98 (0·93 to 1·05)	0·94 (0·87 to 1·01)
5000 births p.a.	1·03 (0·97 to 1·09)	0·99 (0·91 to 1·07)
Per 1000 births p.a.	1·01 (1·00 to 1·03)	1·02 (1·00 to 1·04)

Infant mortality

	Moving women	Neighbouring women
500 births p.a.	1·37 (0·93 to 2·03)	1·54 (1·10 to 2·14)
1000 births p.a.	1·21 (0·98 to 1·50)	1·30 (1·07 to 1·56)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	0·90 (0·65 to 1·25)	0·91 (0·67 to 1·22)
5000 births p.a.	0·90 (0·66 to 1·24)	0·91 (0·64 to 1·30)
Per 1000 births p.a.	0·94 (0·89 to 1·00)	0·90 (0·84 to 0·97)

Cæsarean section

	Moving women	Neighbouring women
500 births p.a.	1·12 (1·06 to 1·18)	1·41 (1·32 to 1·51)
1000 births p.a.	1·07 (1·04 to 1·10)	1·22 (1·17 to 1·26)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	0·98 (0·94 to 1·02)	1·06 (0·98 to 1·14)
5000 births p.a.	0·99 (0·95 to 1·02)	1·07 (1·00 to 1·14)
Per 1000 births p.a.	0·99 (0·98 to 0·99)	0·96 (0·94 to 0·99)

Preterm birth and perinatal death

	Moving women	Neighbouring women
500 births p.a.	1·22 (0·74 to 2·03)	1·90 (1·22 to 2·95)
1000 births p.a.	1·14 (0·86 to 1·51)	1·49 (1·15 to 1·91)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	0·87 (0·59 to 1·30)	0·82 (0·57 to 1·16)
5000 births p.a.	0·89 (0·61 to 1·30)	0·95 (0·62 to 1·45)
Per 1000 births p.a.	0·95 (0·87 to 1·02)	0·88 (0·80 to 0·97)

Instrumental delivery (vacuum or forceps)

	Moving women	Neighbouring women
500 births p.a.	0·85 (0·75 to 0·97)	0·91 (0·81 to 1·03)
1000 births p.a.	0·91 (0·84 to 0·98)	0·95 (0·88 to 1·01)
2000 births p.a.	*Reference*	*Reference*
4000 births p.a.	1·06 (0·95 to 1·18)	1·01 (0·90 to 1·13)
5000 births p.a.	1·05 (0·95 to 1·16)	0·97 (0·87 to 1·09)
Per 1000 births p.a.	1.03 (1.01 to 1.05)	1.00 (0.98 to 1.02

Supplementary Table 2: Risk ratios between different points on the restricted cubic spline on expected travel time to hospital for all outcomes

The numbers are the results of the main analyses. Estimates computed within woman (left column) were adjusted for age, parity, study year and expected travel time. The alternative analysis (right column) was computed within neighbouring women, adjusted for age and education, parity, and expected travel time. Standard errors were clustered by woman and municipality.

Perinatal mortality

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	0·90 (0·74 to 1·10)	1·11 (0·91 to 1·35)
120 min.	0·92 (0·66 to 1·28)	1·11 (0·75 to 1·65)
180 min.	0·97 (0·54 to 1·72)	1·09 (0·54 to 2·17)
240 min.	1·02 (0·43 to 2·38)	1·06 (0·38 to 2·94)
Per 30 min.	0·99 (0·90 to 1·09)	1·01 (0·90 to 1·13)

Apgar-score < 7

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	1·10 (0·98 to 1·24)	0·92 (0·84 to 1·01)
120 min.	1·23 (1·02 to 1·49)	0·80 (0·63 to 1·02)
180 min.	1·36 (0·98 to 1·89)	0·70 (0·46 to 1·08)
240 min.	1·50 (0·92 to 2·44)	0·61 (0·33 to 1·16)
Per 30 min.	1·05 (1·00 to 1·11)	0·96 (0·90 to 1·03)

Transport delivery

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	1·85 (1·54 to 2·23)	2·31 (1·95 to 2·74)
120 min.	2·81 (2·15 to 3·68)	3·42 (2·64 to 4·42)
180 min.	3·85 (2·53 to 5·85)	4·28 (2·88 to 6·35)
240 min.	5·26 (2·87 to 9·63)	5·35 (3·05 to 9·38)
Per 30 min.	1·39 (1·27 to 1·52)	1·47 (1·31 to 1·64)

Induced delivery

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	0·99 (0·95 to 1·02)	0·94 (0·89 to 0·98)
120 min.	0·96 (0·91 to 1·01)	0·91 (0·82 to 1·00)
180 min.	0·94 (0·85 to 1·03)	0·89 (0·75 to 1·06)
240 min.	0·91 (0·79 to 1·05)	0·87 (0·68 to 1·13)
Per 30 min.	1·00 (0·98 to 1·02)	0·98 (0·95 to 1·01)

Infant mortality

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	0·94 (0·78 to 1·13)	1·11 (0·92 to 1·34)
120 min.	0·91 (0·68 to 1·22)	1·03 (0·73 to 1·47)
180 min.	0·90 (0·54 to 1·50)	0·93 (0·51 to 1·67)
240 min.	0·89 (0·41 to 1·90)	0·83 (0·35 to 1·96)
Per 30 min.	0·99 (0·91 to 1·07)	0·99 (0·90 to 1·09)

Cæsarean section

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	0·99 (0·97 to 1·02)	0·97 (0·93 to 1·01)
120 min.	1·01 (0·97 to 1·05)	1·01 (0·94 to 1·08)
180 min.	1·03 (0·95 to 1·11)	1·07 (0·95 to 1·20)
240 min.	1·05 (0·93 to 1·17)	1·13 (0·95 to 1·35)
Per 30 min.	1·01 (1·00 to 1·02)	0·98 (0·96 to 1·01)

Preterm delivery and perinatal death

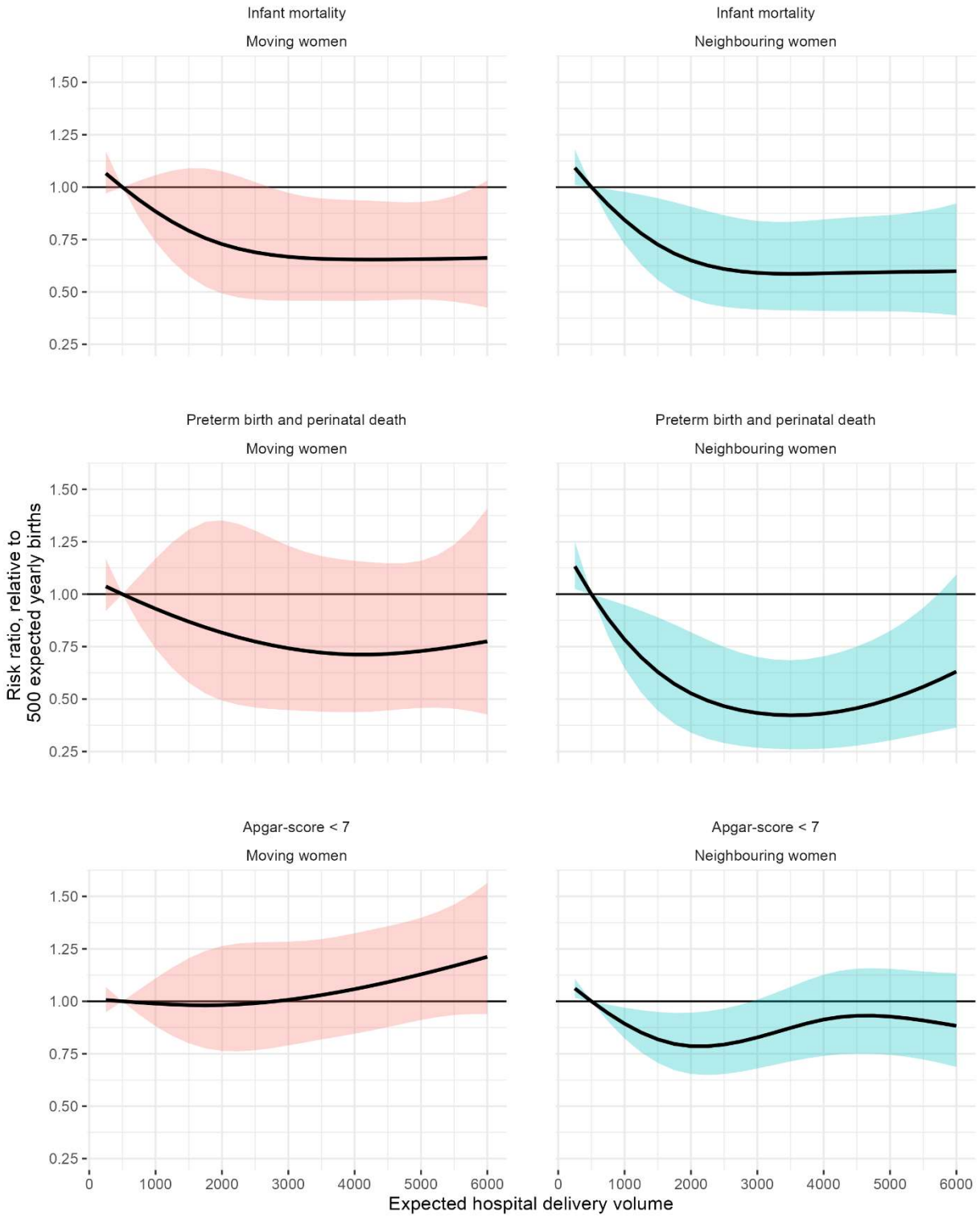
	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	1·06 (0·80 to 1·40)	1·27 (0·98 to 1·65)
120 min.	0·99 (0·65 to 1·52)	1·29 (0·83 to 2·01)
180 min.	0·91 (0·45 to 1·83)	1·24 (0·59 to 2·59)
240 min.	0·83 (0·29 to 2·33)	1·19 (0·41 to 3·47)
Per 30 min.	0·99 (0·86 to 1·13)	1·04 (0·91 to 1·19)

Instrumental delivery (vacuum or forceps)

	Moving women	Neighbouring women
30 min.	*Reference*	*Reference*
60 min.	0·95 (0·90 to 1·01)	0·92 (0·87 to 0·96)
120 min.	0·99 (0·89 to 1·10)	0·92 (0·82 to 1·02)
180 min.	1·04 (0·86 to 1·27)	0·94 (0·77 to 1·14)
240 min.	1·10 (0·82 to 1·47)	0·96 (0·73 to 1·28)
Per 30 min.	0·98 (0·96 to 1·02)	0·97 (0·94 to 1·00)

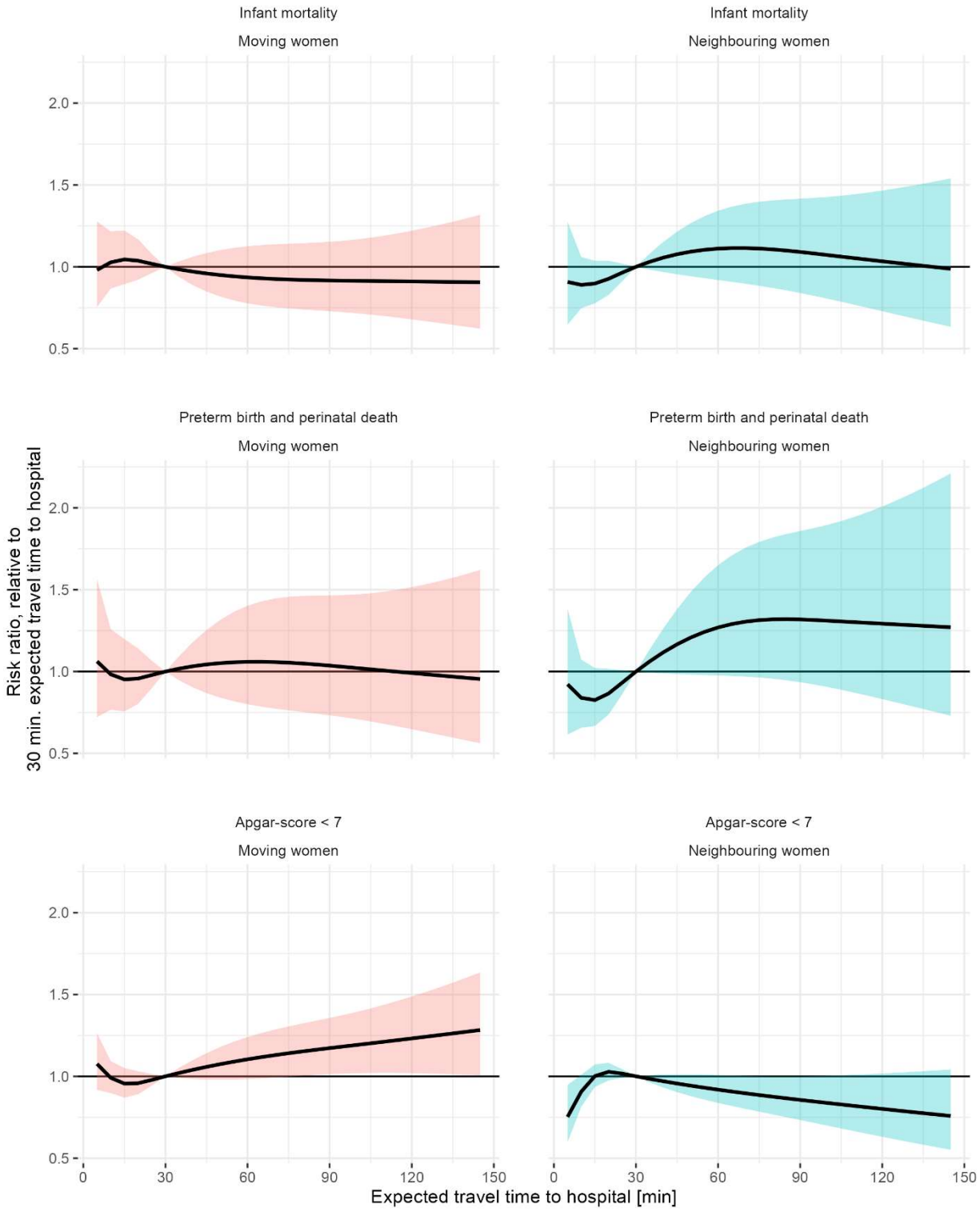
Supplementary Figure 1: Associations between expected hospital volume and secondary outcomes, infant mortality, preterm birth with perinatal death, and Apgar-score <7

Numbers can be found in Supplementary Table 1. Estimates computed within woman (left column) were adjusted for age, parity, study year and expected travel time. The alternative analysis (right column) was computed within neighbouring women, adjusted for age and education, parity, and expected travel time. Standard errors were clustered by woman and municipality.



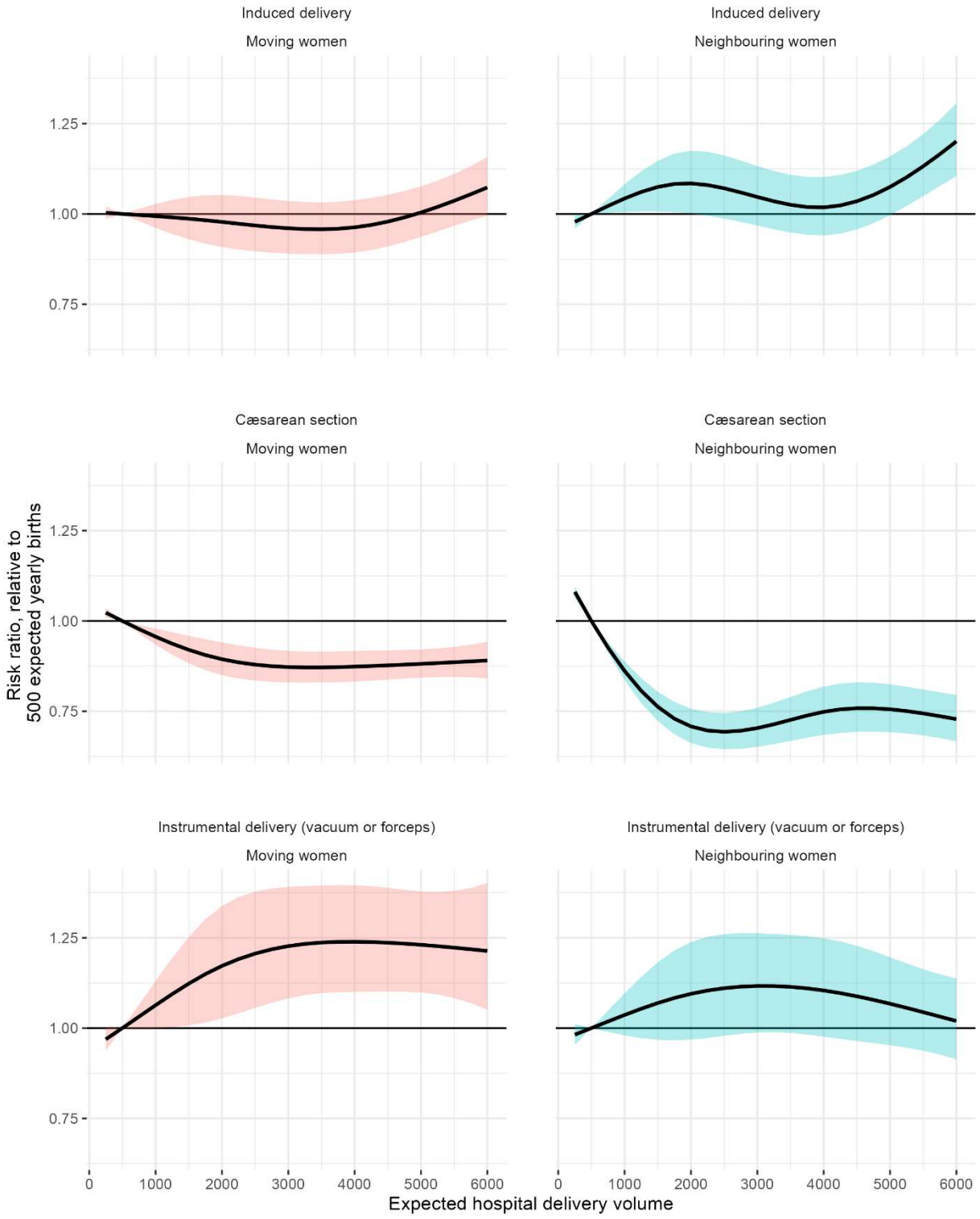
Supplementary Figure 2: Associations between expected travel time to hospital and secondary outcomes, infant mortality, preterm birth with perinatal death, and Apgar-score <7

Numbers can be found in Supplementary Table 2. Estimates computed within woman (left column) were adjusted for age, parity, study year and expected travel time. The alternative analysis (right column) was computed within neighbouring women, adjusted for age and education, parity, and expected travel time. Standard errors were clustered by woman and municipality.



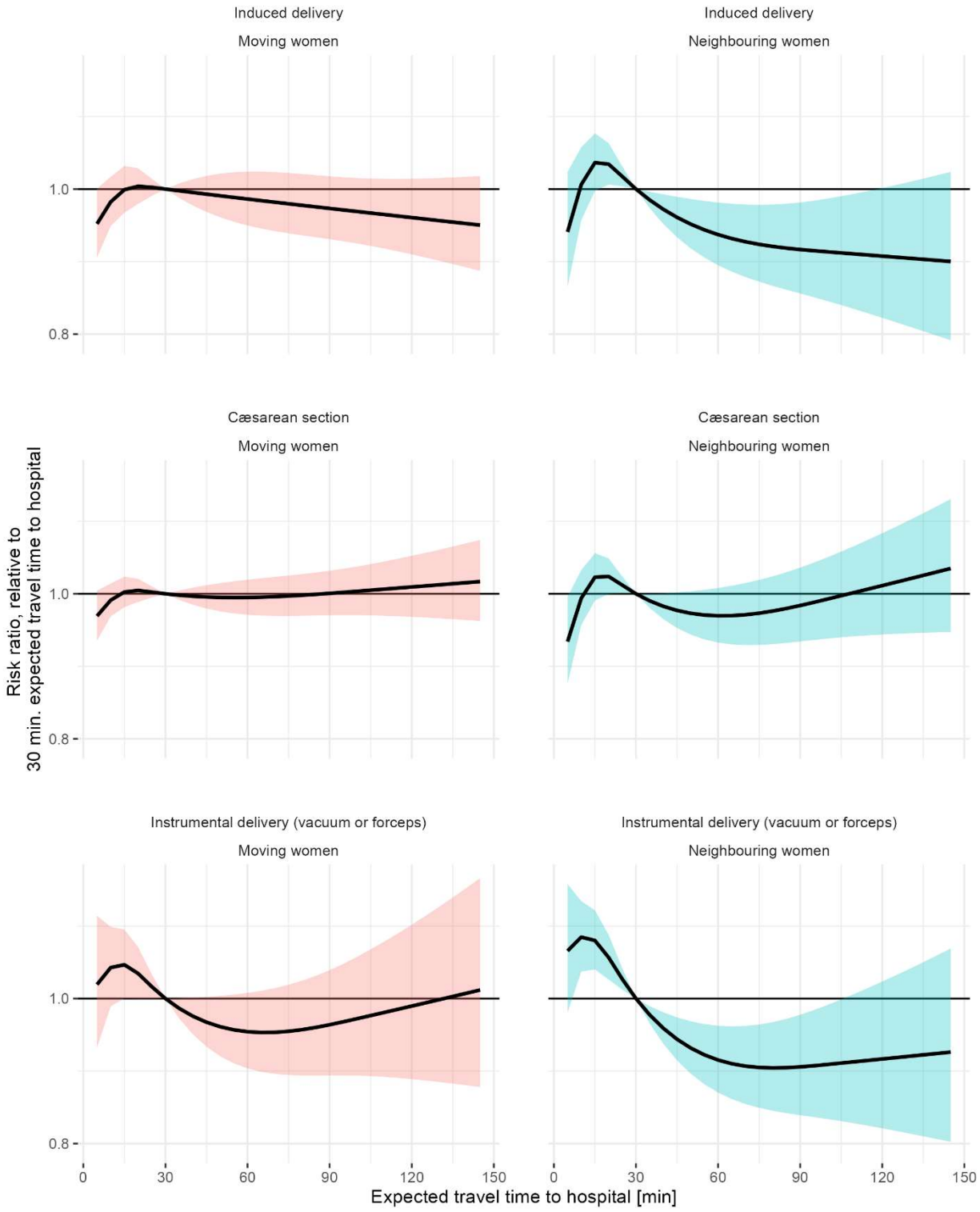
Supplementary Figure 3: Associations between expected hospital volume and secondary outcomes, induced delivery, Caesarean section, and instrumental delivery

Numbers can be found in Supplementary Table 1. Estimates computed within woman (left column) were adjusted for age, parity, study year and expected travel time. The alternative analysis (right column) was computed within neighbouring women, adjusted for age and education, parity, and expected travel time. Standard errors were clustered by woman and municipality.



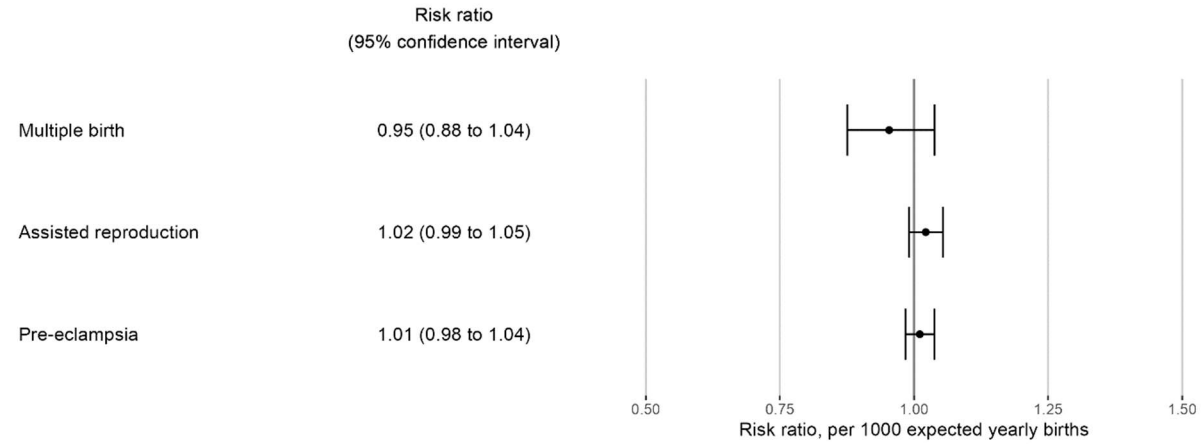
Supplementary Figure 4: Associations between expected travel time to hospital with secondary outcomes, induced delivery, Caesarean section, and instrumental delivery

Numbers can be found in Supplementary Table 2. Estimates computed within woman (left column) were adjusted for age, parity, study year and expected travel time. The alternative analysis (right column) was computed within neighbouring women, adjusted for age and education, parity, and expected travel time. Standard errors were clustered by woman and municipality.



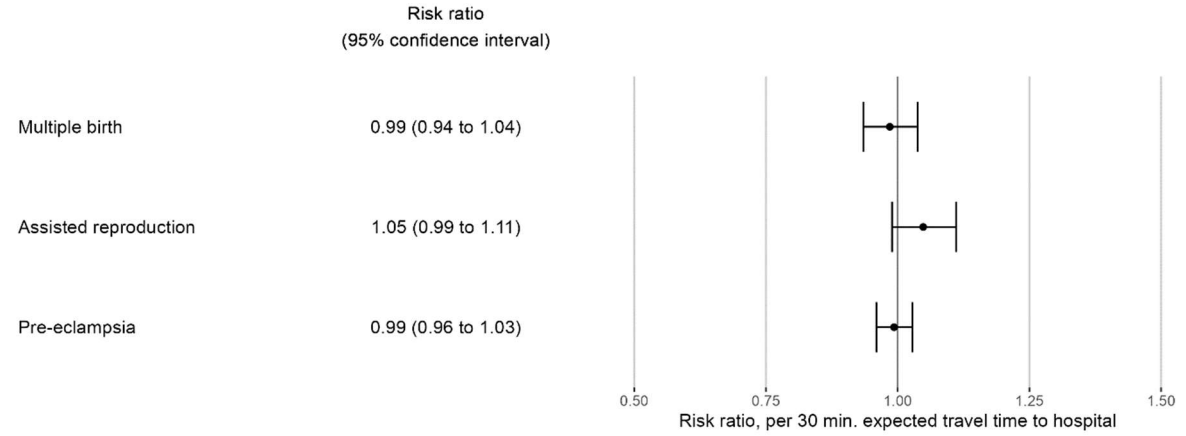
Supplementary figure 5: Associations between expected hospital volume (per 1,000 yearly births) and characteristics of pregnancy

Estimates computed within woman, adjusted for age and education level, parity, study year, and expected travel time to hospital. Standard errors were clustered by woman and municipality



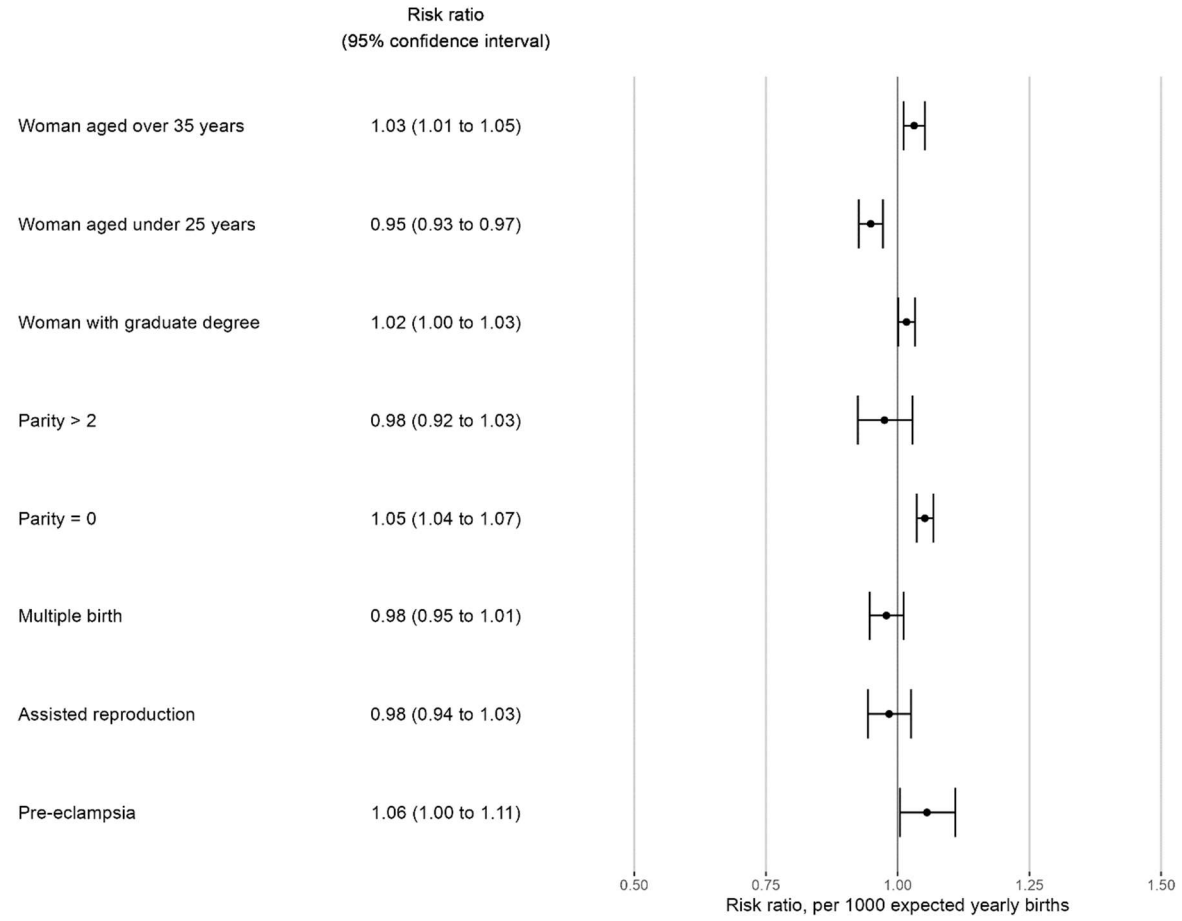
Supplementary figure 6: Associations between expected travel time (per 30 minutes) and characteristics of pregnancy

Estimates computed within woman, adjusted for age and education level, parity, study year, and expected hospital delivery volume. Standard errors were clustered by woman and municipality



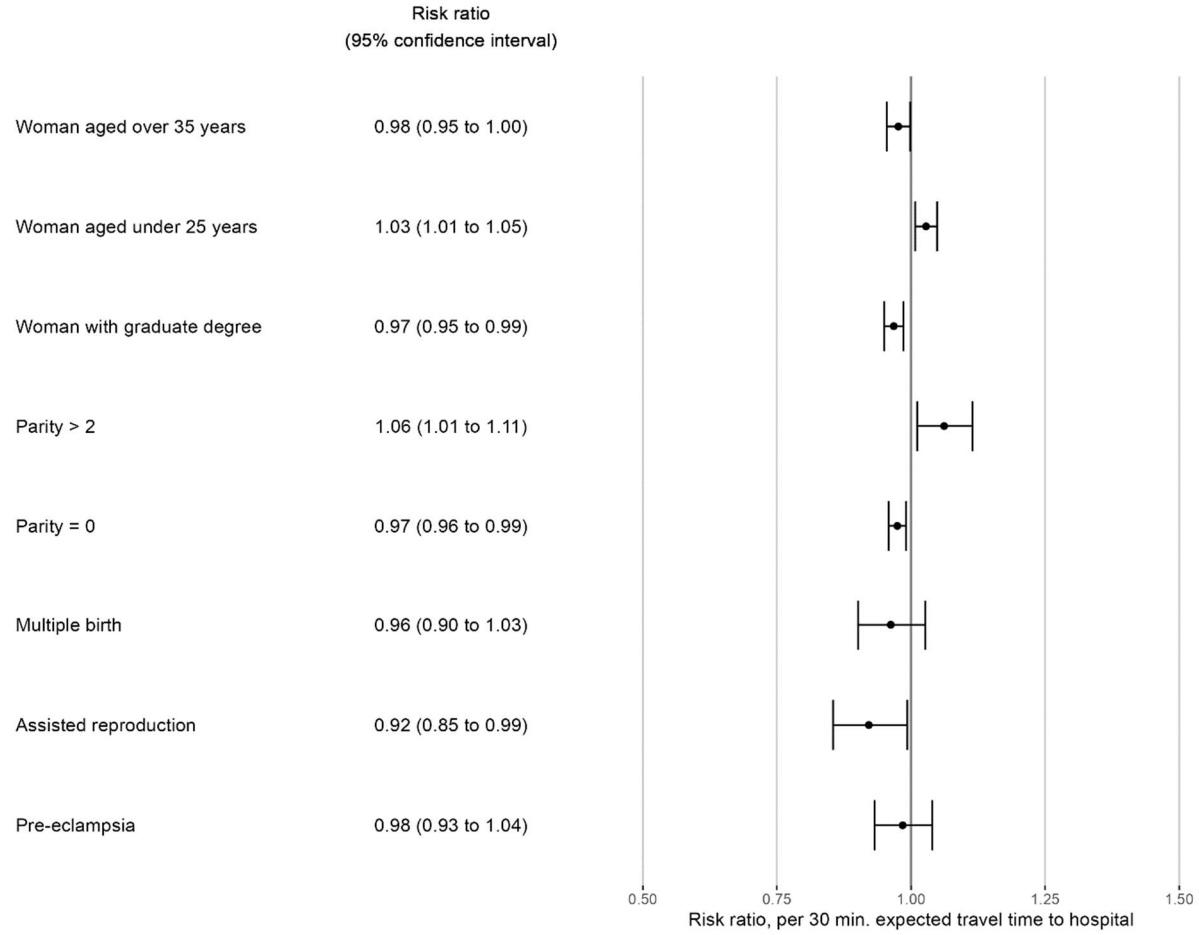
Supplementary figure 7: Associations between expected hospital volume (per 1,000 yearly births) and characteristics of woman and pregnancy

Estimates computed within neighbouring women, adjusted for age and education, parity, study year and expected travel time to hospital. Standard errors were clustered by woman and municipality



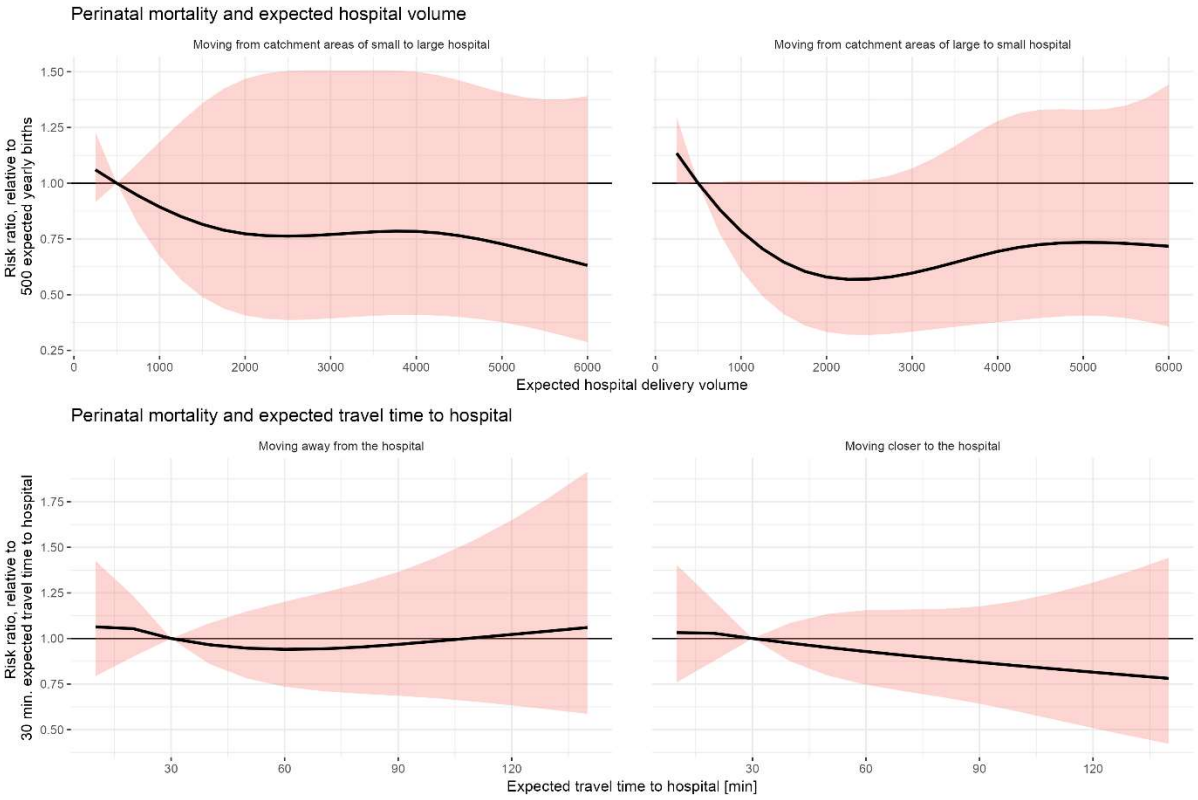
Supplementary figure 8: Associations between expected travel time to hospital (per 30 minutes) and characteristics of woman and pregnancy

Estimates computed within neighbouring women, adjusted for age and education, parity, study year and expected hospital volume. Standard errors were clustered by woman and municipality



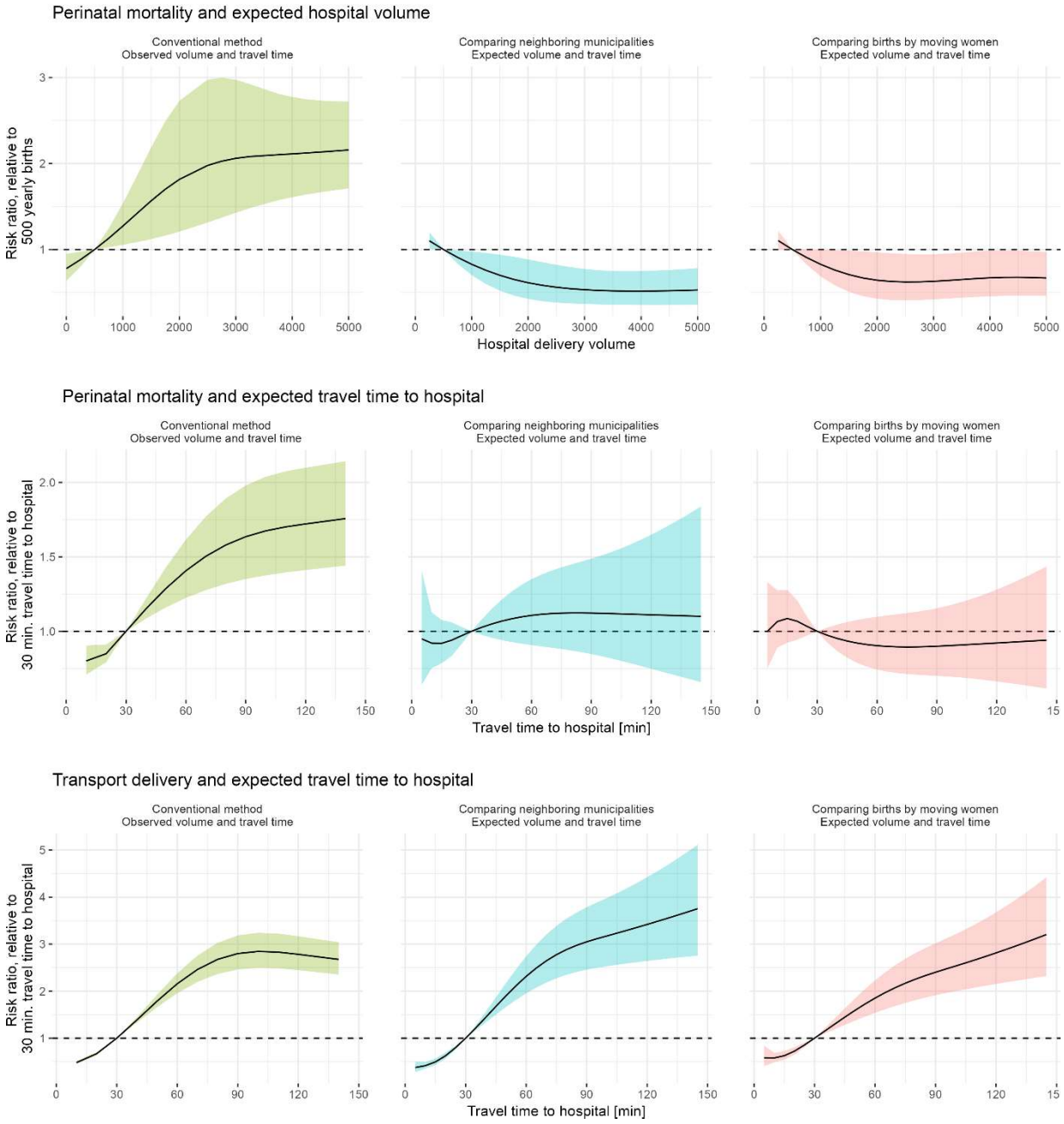
Supplementary Figure 9: Associations of expected hospital volume and travel time with perinatal mortality for moving women, stratified by direction of movement

Top: Associations between expected hospital delivery volume and perinatal mortality, stratified on the woman moving to the catchment area of a bigger hospital (left), and a smaller hospital (right). Bottom: Associations between expected travel time to hospital and perinatal, stratified by the woman moving further away from hospital (left), and closer to hospital (right). Estimates computed within woman adjusted for age, parity, study year, and expected travel time (top) and hospital volume (bottom). Standard errors were clustered by woman and municipality.



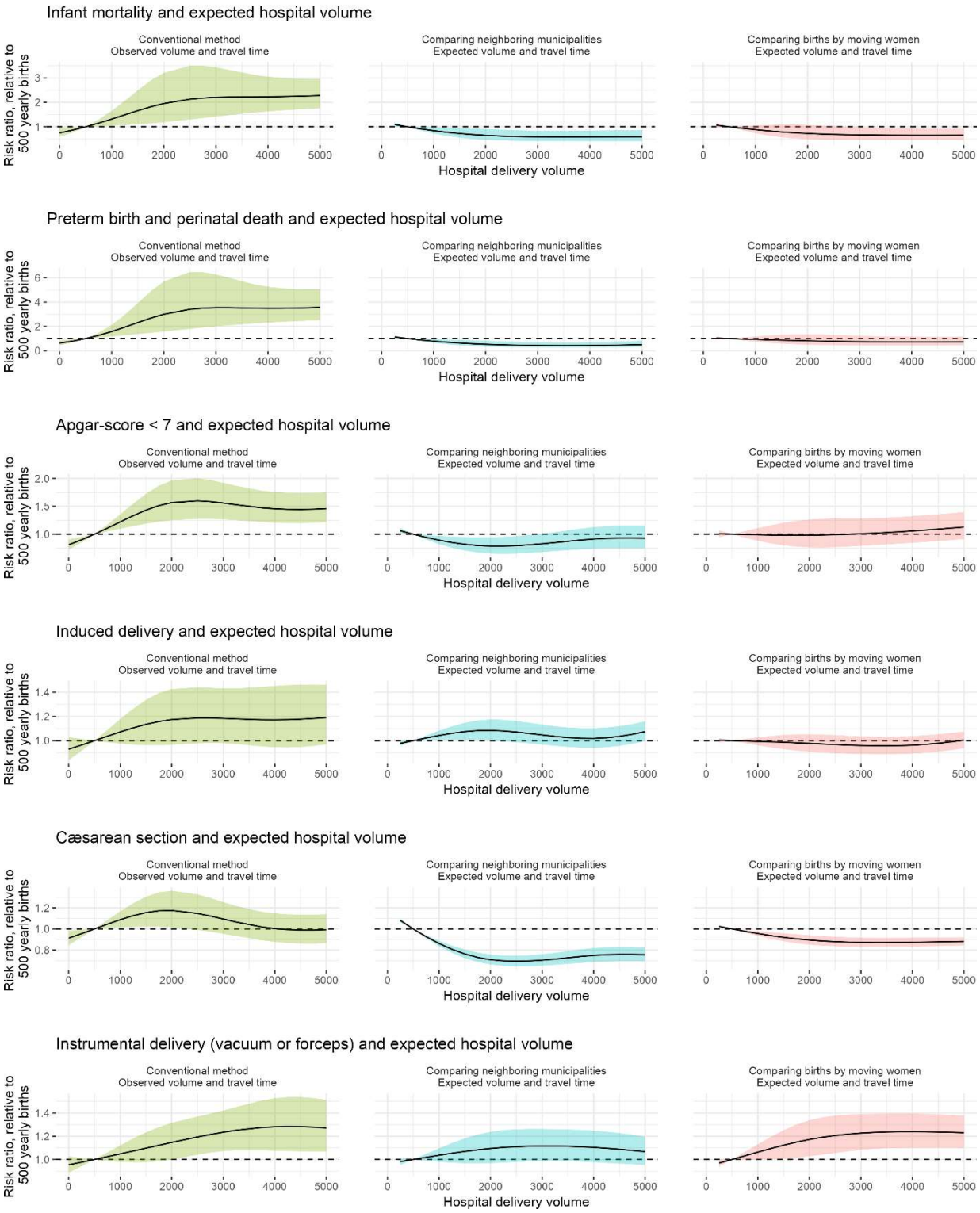
Supplementary figure 10: Associations of hospital volume and travel time with main outcomes using three different methods

From left to right: 1) conventional method comparing observed volume and travel time, comparing hospital catchment areas, 2) women in neighbouring municipalities with different expected volume/travel time (our alternative analysis), and 3) moving women (our main analysis). All associations were adjusted for woman's age, parity, study year and expected travel time/hospital volume. 1) and 2) were also adjusted for woman's education. Standard errors were clustered by woman and municipality.



Supplementary figure 11: Associations of hospital volume with secondary outcomes using three different methods

From left to right: 1) conventional method comparing observed volume and travel time, comparing hospital catchment areas, 2) women in neighbouring municipalities with different expected volume/travel time (our alternative analysis), and 3) moving women (our main analysis). All associations were adjusted for woman's age, parity, study year and expected travel time. 1) and 2) were also adjusted for woman's education. Standard errors were clustered by woman and municipality.



Supplementary figure 12: Associations of travel time with secondary outcomes using three different methods

From left to right: 1) conventional method comparing observed volume and travel time, comparing hospital catchment areas, 2) women in neighbouring municipalities with different expected volume/travel time (our alternative analysis), and 3) moving women (our main analysis). All associations were adjusted for woman's agel, parity, study year and expected hospital volume. 1) and 2) were also adjusted for woman's education. Standard errors were clustered by woman and municipality.