

Travel Time and Perinatal Outcomes: Global Evidence and Regional Realities

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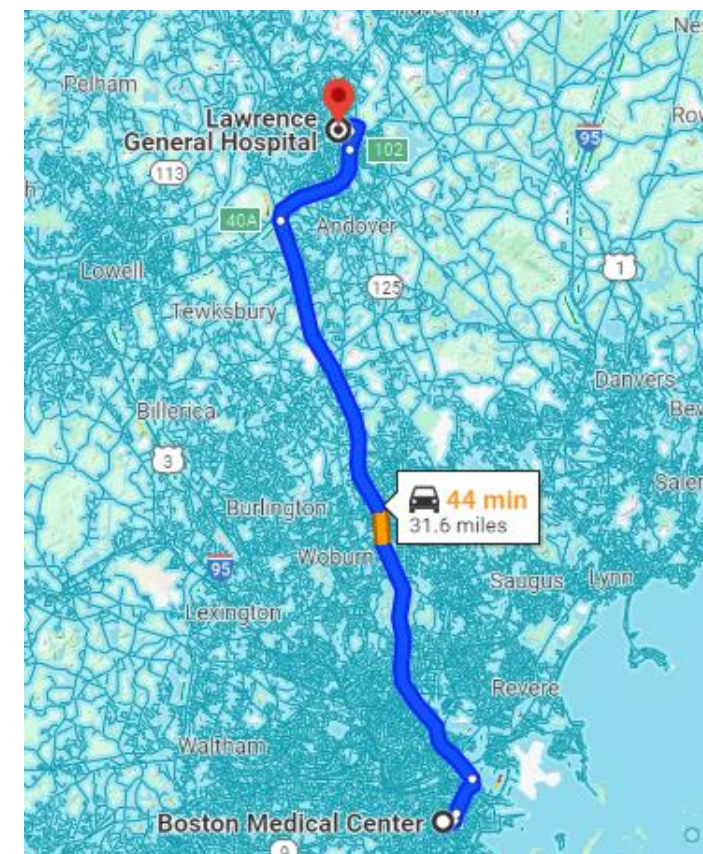
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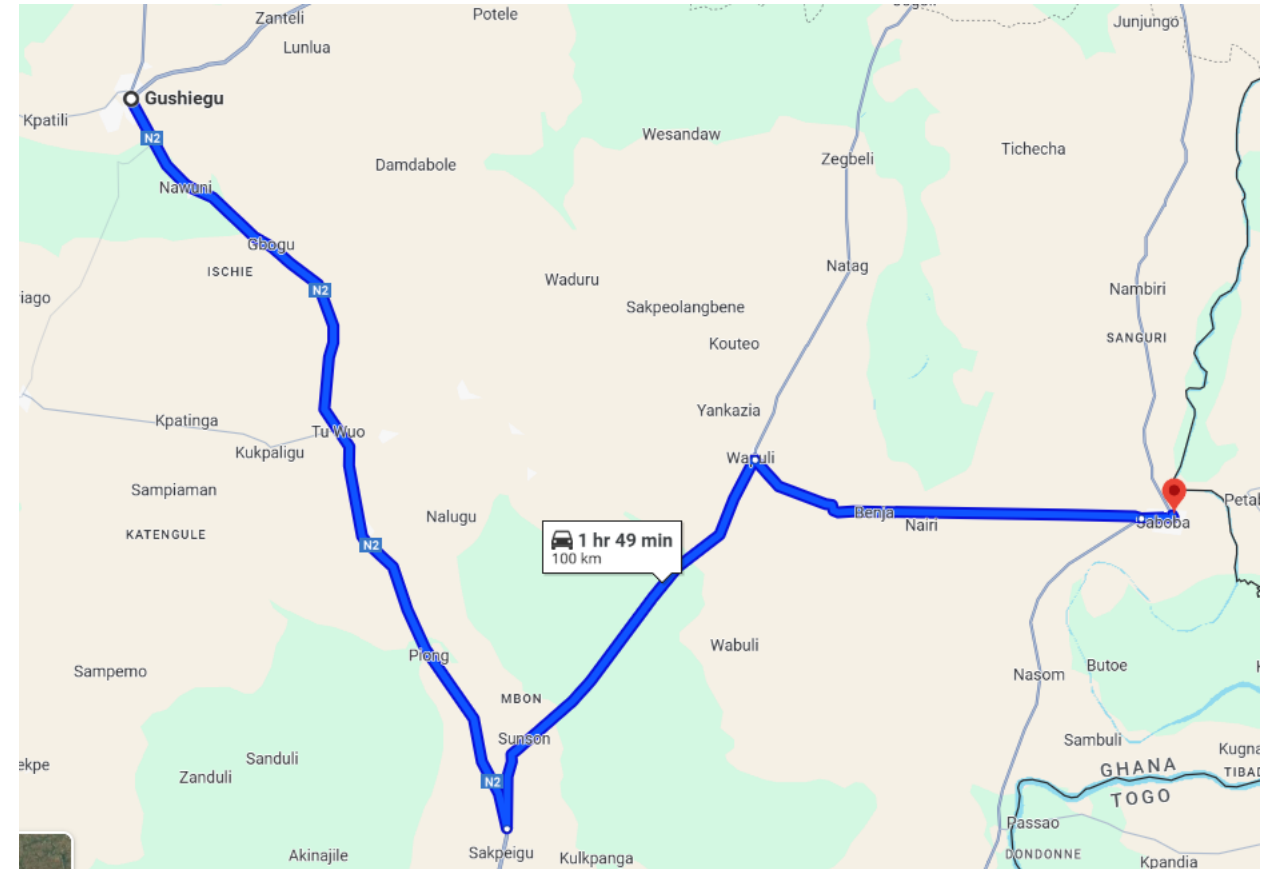
I have no disclosures



98.4% of births
occur in hospitals

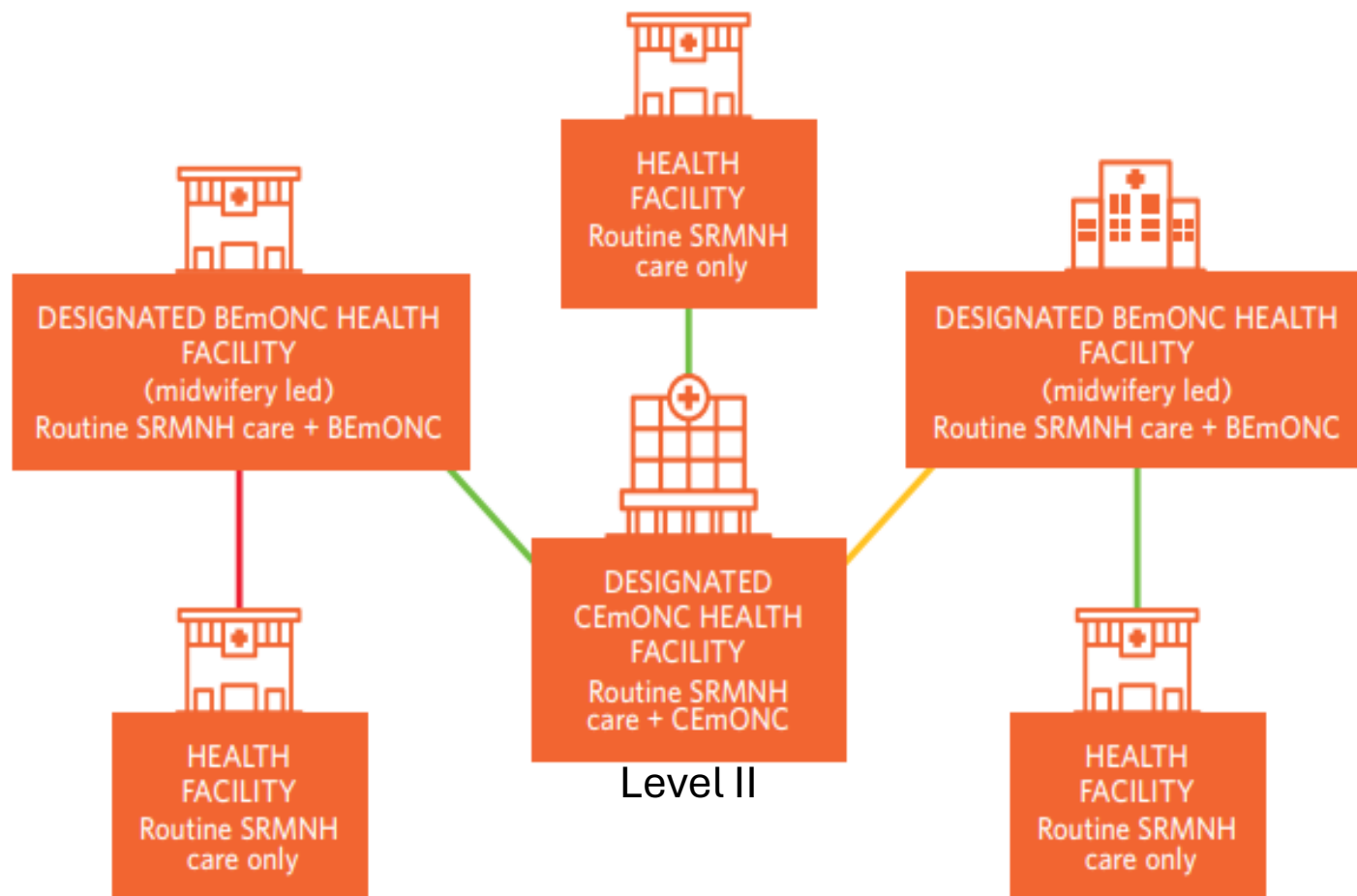


<60% of births occur in hospitals



Brun et al 2020

How much time do we really have between
diagnosing an intrapartum complication
and providing definitive care?

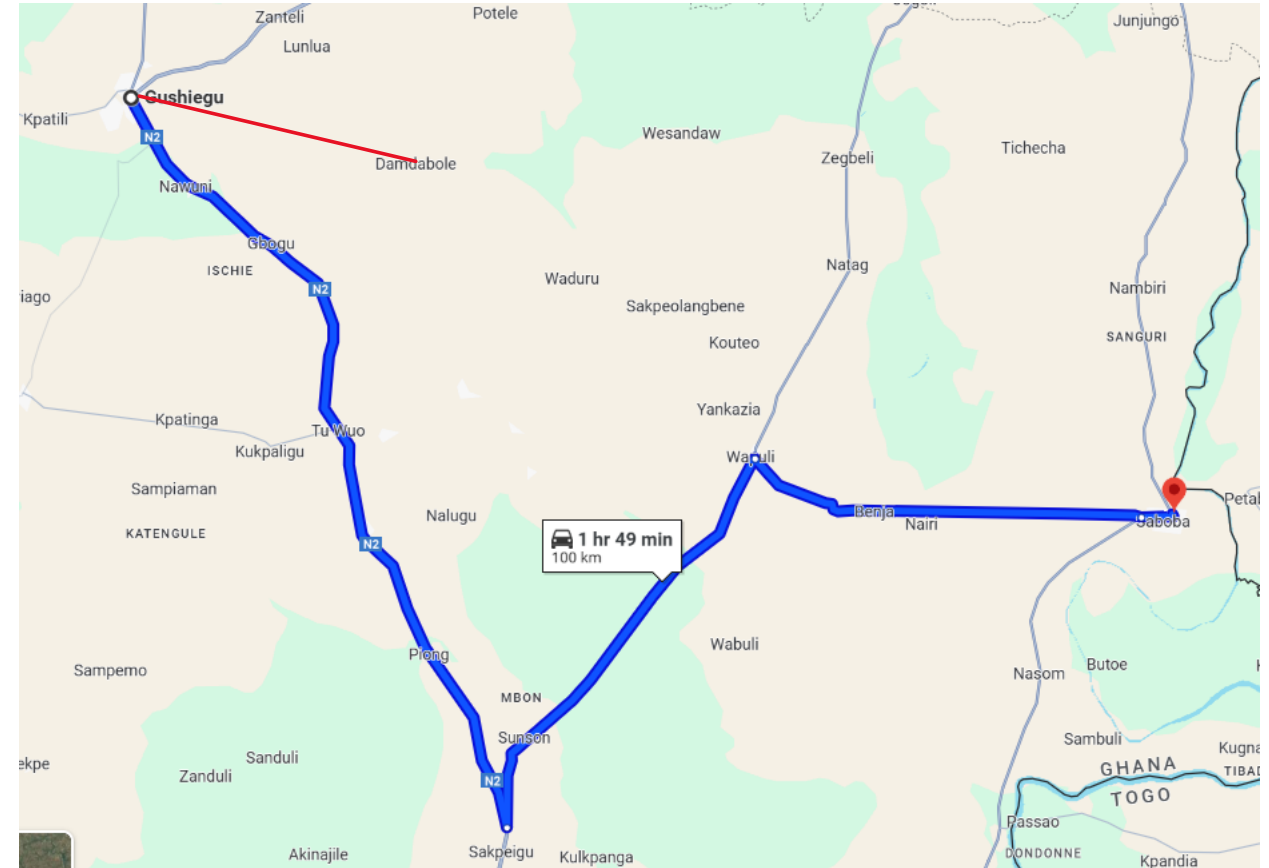


“We consider an acceptable coverage to be more than 50 per cent of the population covered by the designated EmONC network within two hours’ travel time (two hours corresponding to the estimated time between onset of postpartum hemorrhage and death).”

LEGEND

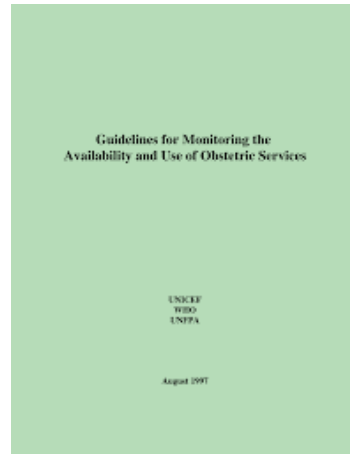
- Referral links with no major obstacles and within 2 h
- Referral links with obstacles requiring improvement through health system and between 2-4h
- Referral links with obstacles requiring multi sectoral interventions and more than 4h

4-hour travel time!?



The 2-hr benchmark

Estimates of time-to-death made during a safe motherhood conference in Nairobi



Monitoring Emergency Obstetric Care



Ending Preventable Maternal Mortality; Target 4

1987

1997

2009

2018

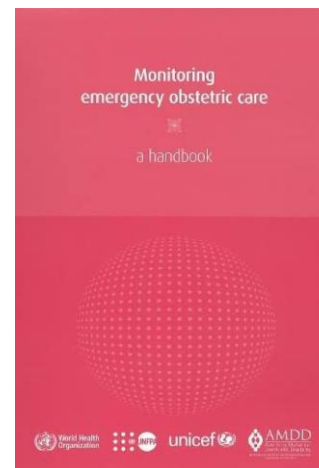
2021

Table 6. Estimated average interval between onset of major obstetric complications and death, in the absence of medical interventions

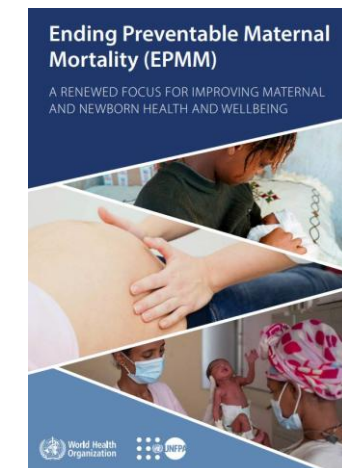
Complication	Hours	Days
Haemorrhage <ul style="list-style-type: none">• Postpartum• Antepartum	2 12	
Ruptured uterus		1
Eclampsia		2
Obstructed labour		3
Infection		6

From Maine, D. *Prevention of Maternal Deaths in Developing Countries: Program Options and Practical Considerations, in International Safe Motherhood Conference*. 1987. Unpublished data: Nairobi.

Guidelines for Monitoring the Availability and Use of Obstetric Services



WHO Global reference list of 100 core health indicators



The 30-minute benchmark (decision-to-incision)

High-income studies

- 1972 (Myers) monkeys: 25 minutes
- 1982 (Katz) bradycardia → acidemia: 15 minutes
- 1986 (Brann) monkeys: 10 minutes
- 1987 US hospital study: 88% of hospitals report being able to prepare for c/s in 30 minutes
- 1994 (Korhonen) IUFD with delays: 20 minutes
- 2010 (Kamoshita) bradycardia-to-delivery and normal development at age 2: 25 minutes
- 2013 (Leung & Lao) review: more rapid the better
- 2017 (Heller) 39,291 neonates improved Apgars: 20 minutes

vs

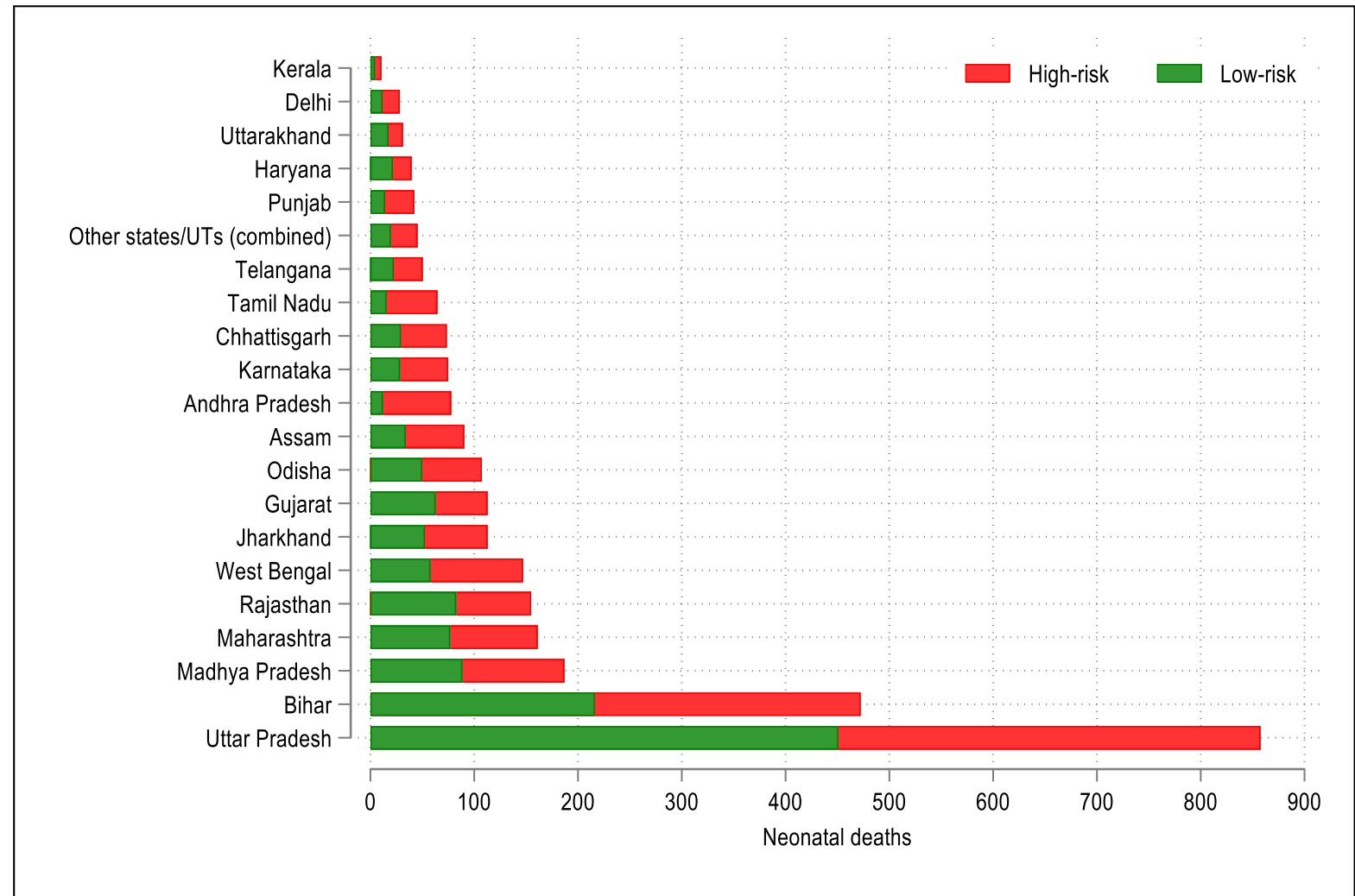
- Worse outcomes in babies born more quickly (sicker babies? babies without a time-

High-income guidelines

- 1982 *Standards for Obstetric Care*: 15 minutes
 - 1988 *Standards for Obstetric Care*: 30 minutes
 - 1988 *Guidelines for Perinatal Care*: 30 minutes
 - 2021 NHS: 30 minutes for category 1 (cord prolapse, fetal bradycardia, major abruption), 75 minutes for category 2 and acknowledges the risk of rapid delivery
 - Birth center regulations: vary
- vs
- 2017 AAP/ACOG – “The decision-to incision should be based on the timing that best incorporates maternal and fetal risks and benefits..”

Adverse perinatal outcomes are common in low-risk women

- **India:** 43% of newborn deaths and 58% of stillbirths occurred in women considered low-risk
- **USA:** 29% of low-risk women had an unexpected complication



A double standard



Service Delivery Redesign
is the intentional
reorganization of health
services to improve equity
and outcomes



1

Intrapartum complications are difficult to predict; **all women** need timely access to high-quality care for complications.

2

The best outcomes occur in births within **30 minutes of definitive care**.

3

High quality obstetric care is challenging to deliver in **low-volume facilities**; these facilities need additional training and support to achieve desired outcomes.

4

Transportation and referral are safer and more cost-effective antenatally than in the post-partum period (**get people to the right level of care before birth**).

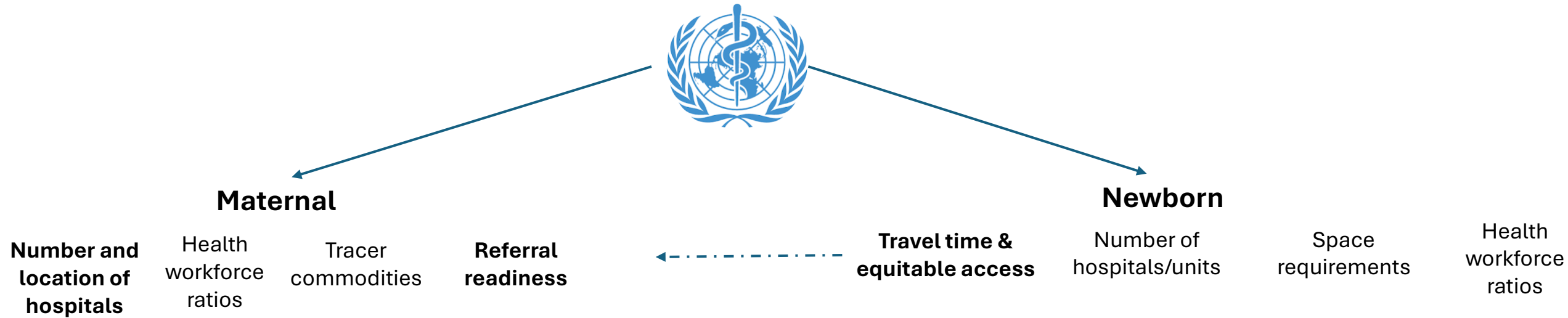
5

Equity needs to be at the forefront of all plans to centralize, regionalize, or redesign maternal and newborn health services.

Roder-DeWan S, Nimako K, Twum-Danso N, Amatya A, Langer A, Kruk ME, 2020. Health system redesign for maternal and newborn survival: Rethinking care models to close the global equity gap. *BMJ Global Health*.

Tandon A; Roder-DeWan S. et al 2023. Adverse Birth Outcomes Among Women with 'Low-Risk' Pregnancies in India: Findings from the Fifth National Family Health Survey, 2019-21 *Lancet Regional Health Southeast Asia*

World Health Organization Norms Project



Global Systematic Review and Meta-analysis of the Impact of Travel Time on Perinatal Outcome

Systematic Review and Meta-analysis

Dartmouth Health

Sanam Roder-DeWan (PI)
Marwa Ramadan
Paul Elvis Onyango Ouma

KEMRI-Wellcome
Trust

Emelda Okiro (PI)
Bibian Roberts
Emily Odipo
Peter Macharia

University of Ghana

Alexander Manu (PI)

Edith Cowan
University

Natalie Strobel (PI)
Georgia Whisson

Roder-DeWan S, et al Impact of travel time to health facilities on perinatal outcomes: A systematic review with narrative synthesis and meta-analysis. J Glob Health. 2026

Official Use Only

Research Questions

1. How does travel time from home to healthcare facilities for childbirth services impact birth outcomes?
2. How does interfacility travel time for childbirth complications impact birth outcomes?



Methods

- Systematic review
 - Narrative Synthesis
 - Meta-analysis
- Publication in last 10 years
- Databases searched
 - Embase
 - Medline
 - Central
- Registered with Prospero (CRD42023460423)
- Population
 - Newborns aged under 28 days chronological age (preterm and term), fetuses (i.e. stillbirth), pregnant women, postpartum women (up to 6wks)
- Exposure
 - Travel time or distance from home-to-facility
 - Travel time or distance from facility-to-facility
- Outcomes
 - All-cause neonatal mortality
 - Stillbirth
 - All-cause maternal
 - Perinatal mortality
 - Secondary outcomes: cause-specific mortality

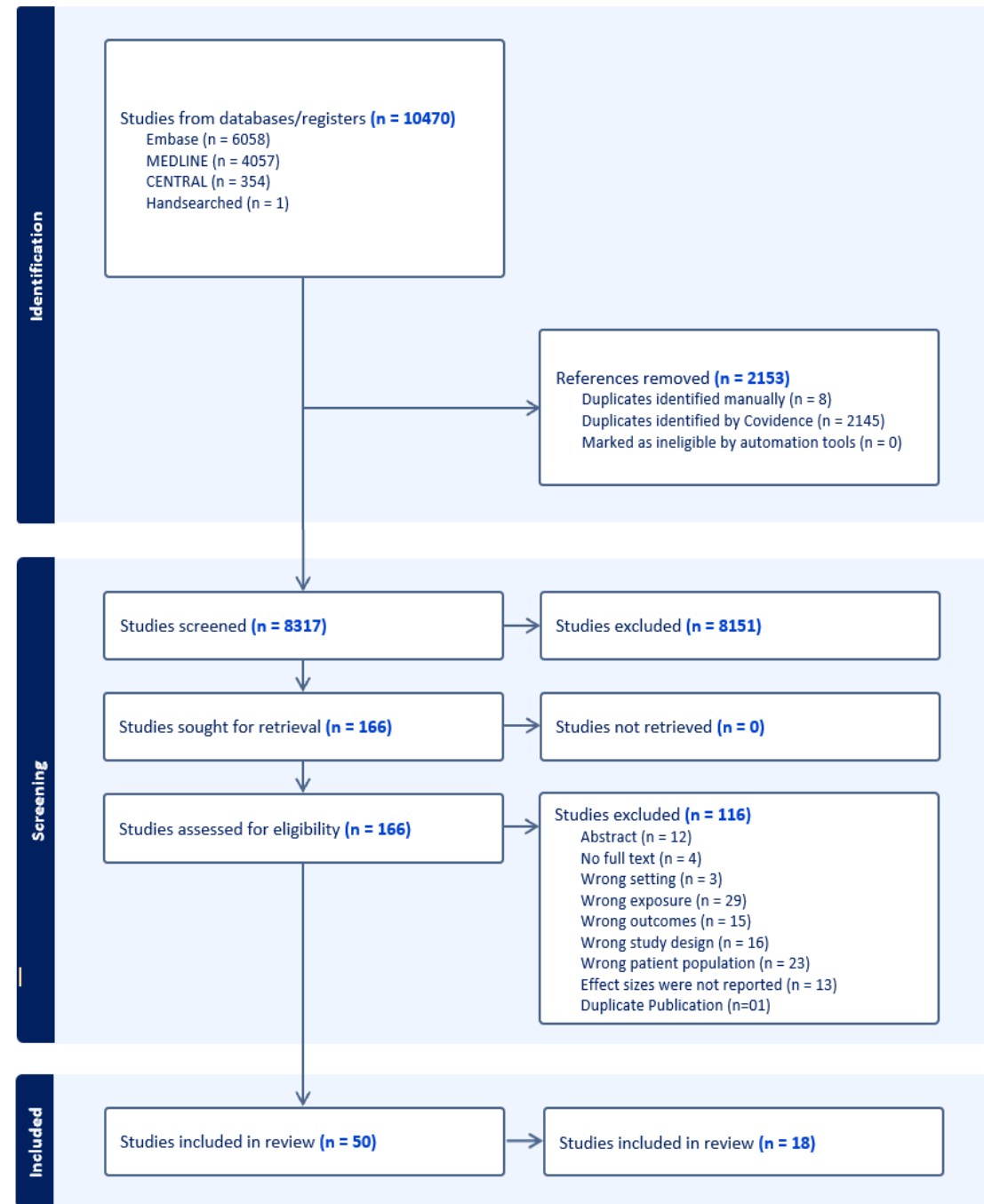
Prisma flow charts

10470 imported studies
(8317 unique)

166 assessed for eligibility
(4641 excluded)

50 studies included in the
systematic review (116 excluded)

18 studies: estimated effect sizes
(6 Continuous (SMD), 13 categorical
(ORs))



Risk of Bias Assessment using North Ottawa Scale

1. Case-Control Studies [9 Studies]:

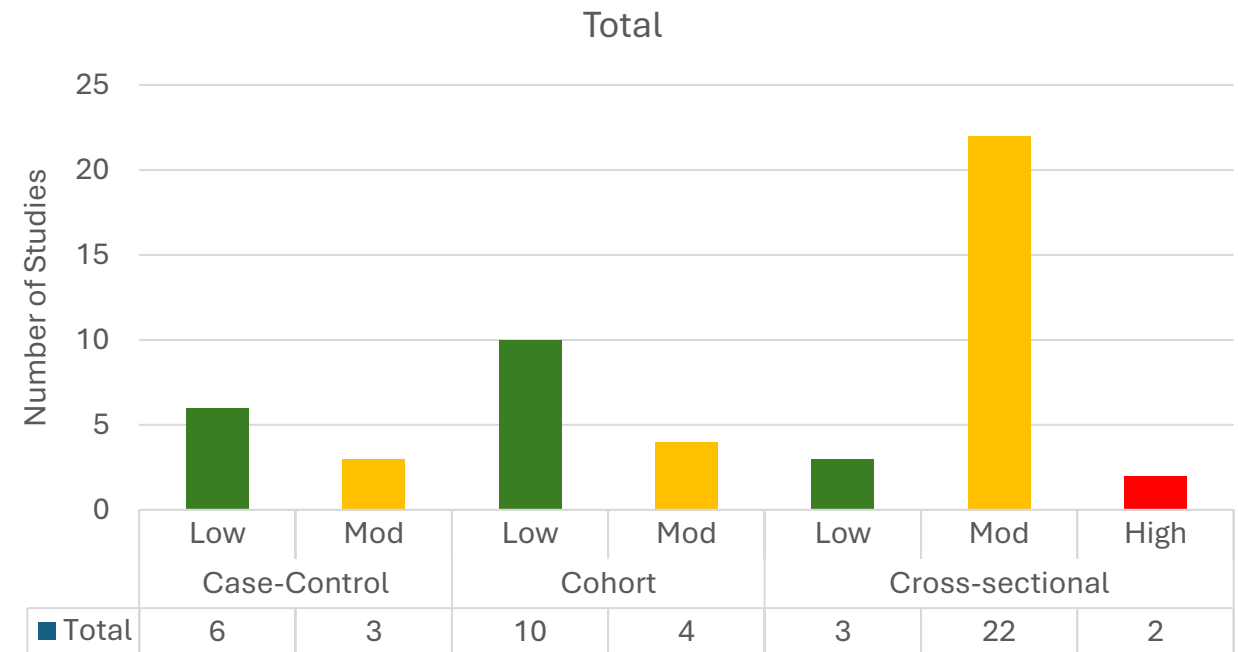
1. Low Risk of Bias (Score ≥ 7): 6 studies
2. Moderate Risk of Bias (Score 4–6): 3 studies
3. High Risk of Bias (Score ≤ 3): 0 studies

2. Cohort Studies [14 Studies]:

1. Low Risk of Bias (Score ≥ 7): 10 studies
2. Moderate Risk of Bias (Score 4–6): 4 studies
3. High Risk of Bias (Score ≤ 3): 0 studies

3. Cross-Sectional Studies [27 Studies]:

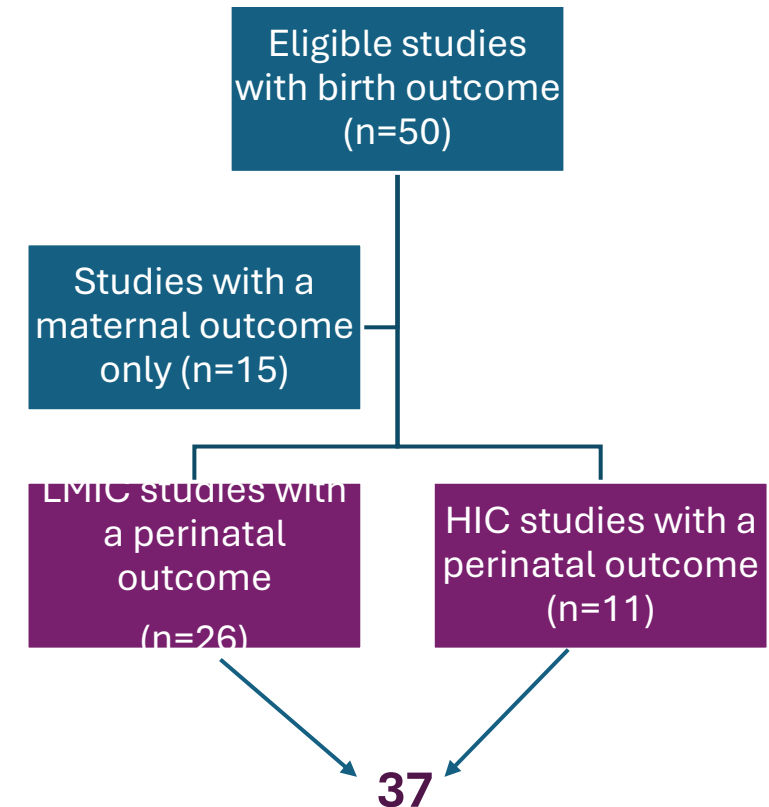
1. Low Risk of Bias (Score ≥ 7): 3 studies
2. Moderate Risk of Bias (Score 4–6): 22 studies
3. High Risk of Bias (Score ≤ 3): 2 studies



There are 19 studies with low risk of bias, 29 with moderate risk, and 2 with high risk.

Study sample description

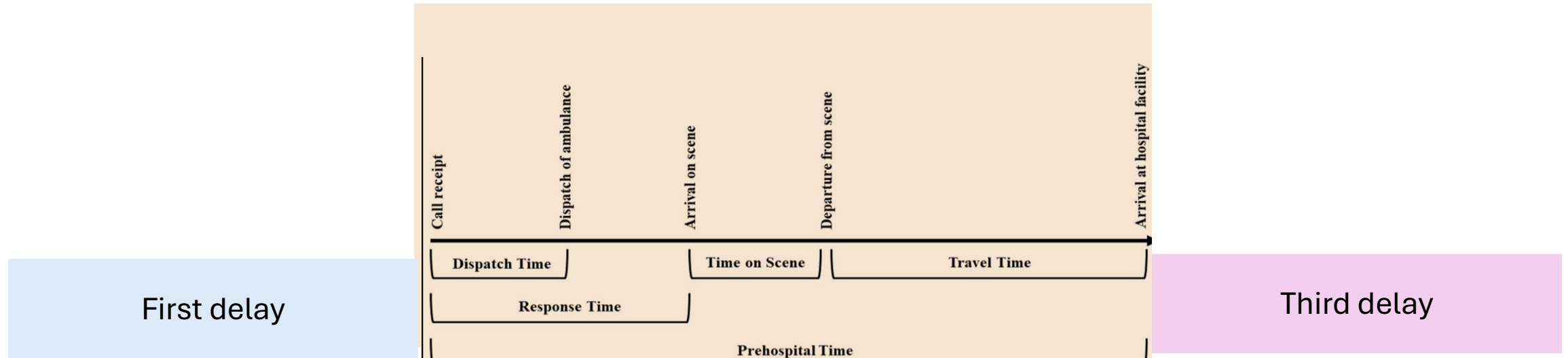
- 37 of 50 studies include a perinatal outcome (stillbirth, neonatal mortality, or perinatal mortality)
- 39 of 50 studies are from low- or middle-income countries
 - Ethiopia (4), Nigeria (2), Sierra Leone (2), Uganda (2), Angola, Burkina Faso, Burundi, Gambia, Ghana, Kenya, Morocco, Rwanda, South Africa, Tanzania
 - India (4), Bangladesh
 - One multi-country analysis across 21 LMICs
- 11 of 37 studies are from high-income settings
 - United States (6), France (3), Korea, UK (Wales)



Travel endpoints were primarily hospitals

- For all studies of patients (n=26), travel endpoints were hospitals
 - The majority of LMIC studies (12/15) specified regional or tertiary care
 - District hospitals were specified in 3 LMIC studies
 - HIC studies included tertiary care (n=4) and any hospital (n=7)
- Ecological studies either did not specify facility type (n=6) or included hospitals (n=5)

Studies underestimate time to definitive care



- Of the 15 patient studies from LMICs with a perinatal outcome, 11 included a time variable (4 used distance)
- 7 of these 11 used patient reported time, 3 used ambulance records, and 1 modeled time
- 5 specified travel time, 2 specified prehospital time, 1 did both, and 1 measured time from birth to definitive care.

Care in transport varied widely

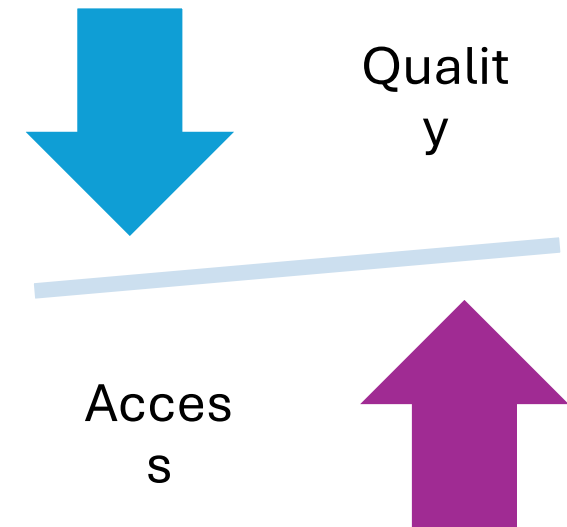
- 8 of the 15 LMIC patient studies with a perinatal outcome included information on transportation
 - Vehicle type ranged from no ambulance transfers to all ambulance transfers
 - Care during transport was described as limited to basic monitoring and life-support at most
- HIC papers described advanced care during transport
 - Dedicated pediatric transport teams including physicians and nurses
 - Air and ground transport
 - ECMO

Sick babies are frequently transported without clinical support in low-and-middle-income countries



Context matters

- Nearly all (n=24, **92%**) of LMIC papers showed that longer travel times/distances are associated with higher perinatal mortality
- A majority (**55%**) of HIC papers reported a positive relationship between time/distance and perinatal outcomes
 - Prenatal risk stratification, quality of care, and quality of transport higher
 - Four of five papers that showed no relationship documented transfers from secondary to tertiary care facilities



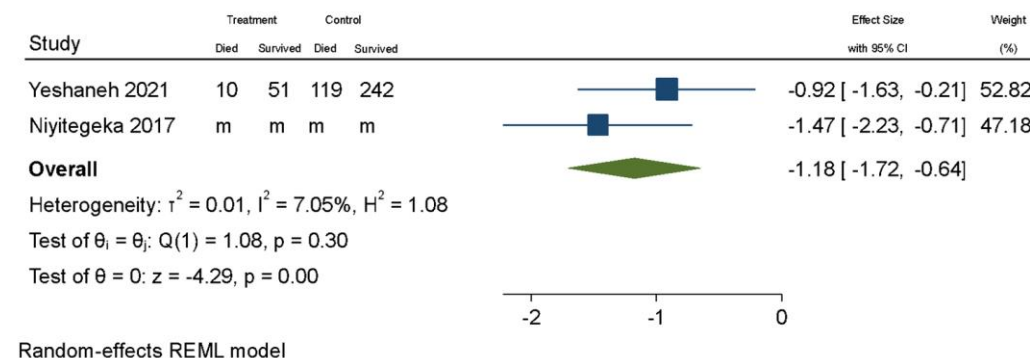
Confounders **do not** explain the relationship

- Of the 26 papers with a positive relationship, most (n=22) adjusted for confounding
 - 19 reported a persistent relationship
 - 3 lost statistical significance

In a sample of 1,163 interfacility transfers, travel time <30 minutes between facilities tripled the odds of survival

Categorical Exposure: Interfacility transfer (time)

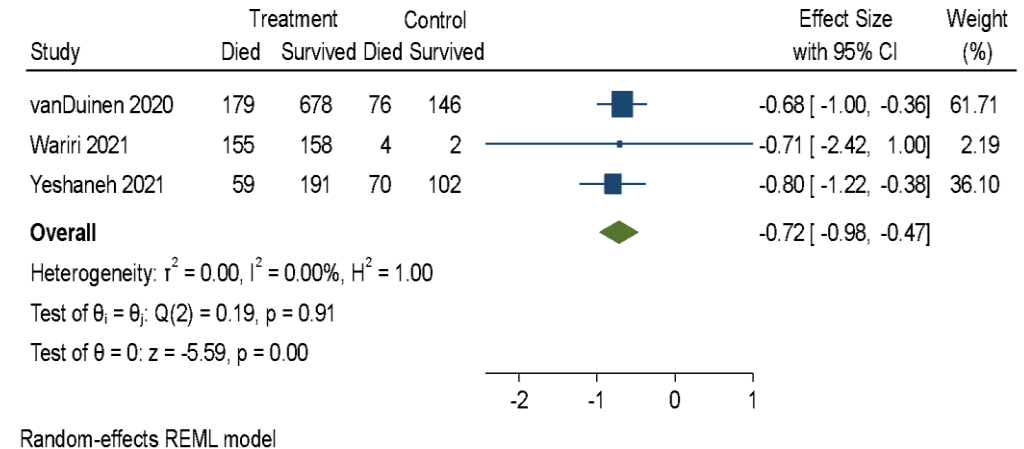
Study	Outcome	OR[30 min] (95% CI)	OR[1 hr] (95% CI)	OR[2 hr] (95% CI)	Sample Size
Yeshaneh 2021	Neonatal mortality	2.51 (CI:1.23,5.11)	2.02 (CI:1.23,3.31)	2.22 (CI:1.46,3.39)	422
Niyitegeka 2017	Neonatal Mortality	4.35 (CI:2,9.09)	-		441
Narang 2013	Neonatal Mortality		5.58 (CI:1.41,22.01)		300
Total					1163



- OR (30 min) = 3.25 (CI: 1.90, 5.57)
- OR (1 hour) = 2.72 (CI: 1.10, 6.73)

In a sample of 115,592 newborns, shorter travel times from home or level 1 facilities doubled the odds of survival

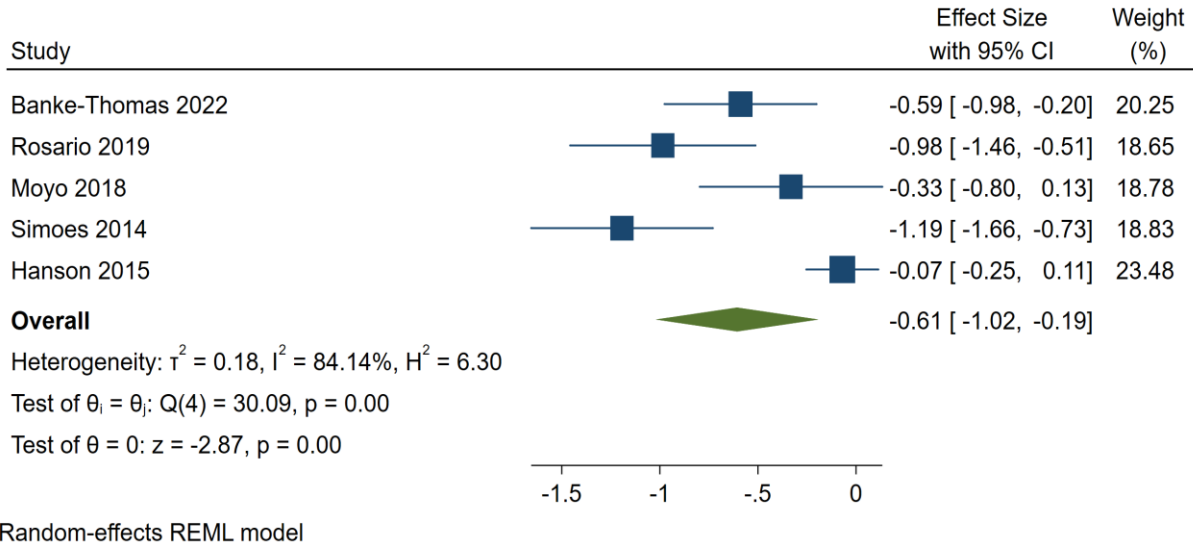
Study	Outcome	Journey	OR [2 Hours] (95 % CI)	OR [1 Hour] (95 % CI)	OR [30 Min] (95 % CI)	Sample size
vanDuinen 2020	Perinatal Mortality	Home→cesarean	1.97 (CI: 1.43,2.72)			1079
Wariri 2021	Stillbirth	Home→tertiary	2.04 (CI:0.37,11.29)	1.98 (CI:0.81,4.81)	2.92 (CI:1.58,5.41)	319
Narang 2013	Neonatal Mortality	Mixed→Tertiary		5.58 (CI:1.41,22.01)		300
Featherstone 2016	Neonatal mortality	Home→Hospital			1.01 (CI:0.71,1.43)	2030
Yeshaneh 2021	Neonatal mortality	Mixed→Hospital	2.22 (CI:1.46,3.39)	2.02 (CI:1.23,3.31)	2.51 (CI:1.23,5.11)	422
Niyitegeka 2017	Neonatal Mortality	Health center→District		-	4.35 (CI:2,9.09)	441
Combier 2013	Perinatal Mortality	Home→maternity			1.13 (CI:0.87,1.47)	111001
Total						115,592



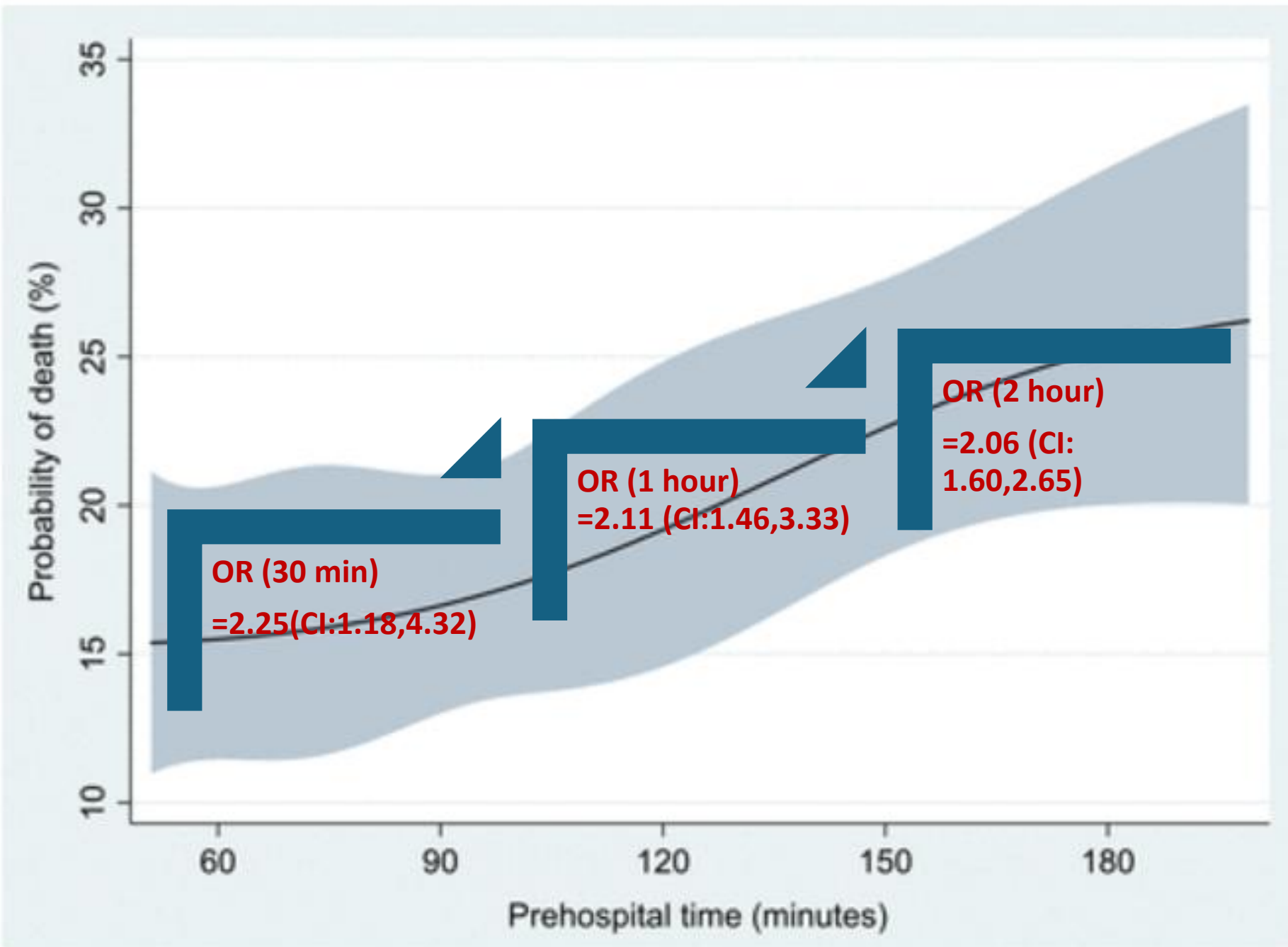
- OR (2 hour) = 2.06 (CI: 1.60, 2.65)
- OR (1 hour) = 2.20 (CI: 1.46, 3.33)
- OR (30 min) = 2.25 (CI: 1.18, 4.32) [LMICS]
- OR (30 min) = 1.92 (CI: 1.10, 3.34) [LMICS & HIC]

In a sample of 208,438 mothers or newborns, travel distance of <3.1miles/5km from home to facility doubled the odds of survival

Study	Outcome	OR [15 km] (95 % CI)	OR [10 km] (95 % CI)	OR [5km] (95 % CI)	Sample size
Banke-Thomas 2022	Maternal Mortality	0.42 (0.27, 0.64)	1.22 (0.85, 1.75))	1.82 (1.23, 2.70)	2,978
Rosario 2019	Stillbirth	2.00, 1.03, 3.85)	3.57 (1.41, 4.17)		10,289
Moyo 2018	Maternal Mortality			4.17 (1.67, 4.35)	400
Simoes 2014	Maternal Mortality	-	-	1.39 (0.88, 2.22)	904
Hanson 2015	Maternal Mortality	-	-		193867
Total					208,438



OR(5km/3.1 miles/) =2.17(CI:1.64, 2.94)



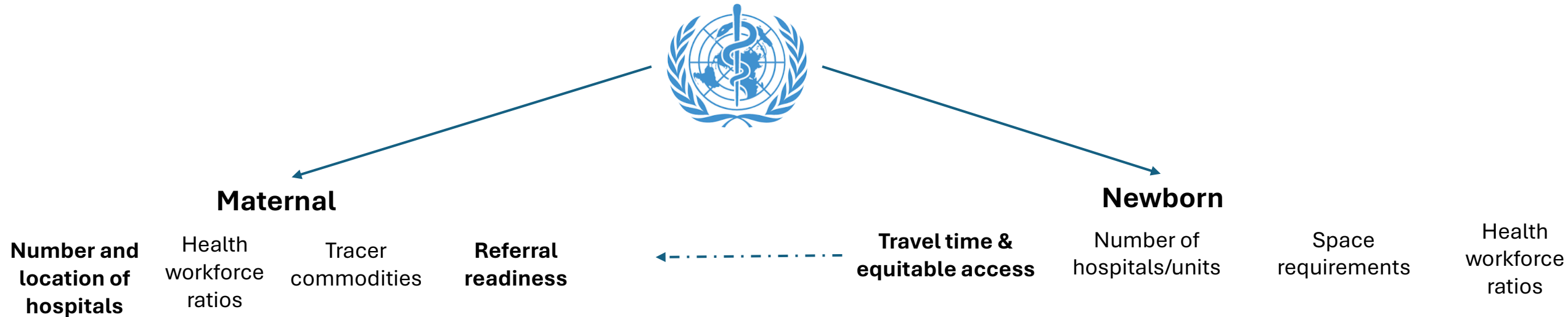
Crude mortality rates across thresholds

				Deaths/1000 live births by travel time band							
Study	Mortality measure	Journey type	Proportion transported by ambulance	<30 minutes	>30 minutes	<1-hour	>1-hour	<2 hours	>2 hours	<3 hours	>3 hours
Yeshaneh (2021)	Neonatal	Interfacility	74%	79	335	190	350	236	407		
Singh (2021)	Neonatal	Interfacility	97%					280	500		
Van Duinen (2020)	Perinatal	Home to hospital	42%	140	277	175	300	193	308		
Viswanath (2015)	Perinatal	Any	Unspecified					210	420		
Tayler-Smith (2013)	Early neonatal	Interfacility	100%							90	210

Policy implications

- The poorly specified “2-hour threshold” is inadequate for health system planning
- Tolerance for risk and mortality will determine choice of threshold at the country level
- A travel time norm should be combined with other norms to prevent incentivizing quantity over quality
- Targeted access interventions are needed
 - Low-density geographies may not be able to support a hospital; families will need support to travel before labor begins
 - Dense urban areas will require solutions that account for congestion and traffic
- All families should be counseled on the risk of long travel times to facilities
- Transport availability and quality need urgent attention in LMIC settings

World Health Organization Norms Projects



1. Interfacility travel time from a lower-level facility to a birth hospital should be no more than 30
2. Travel time from home to a hospital should be no more than 1 hour

Regional Realities

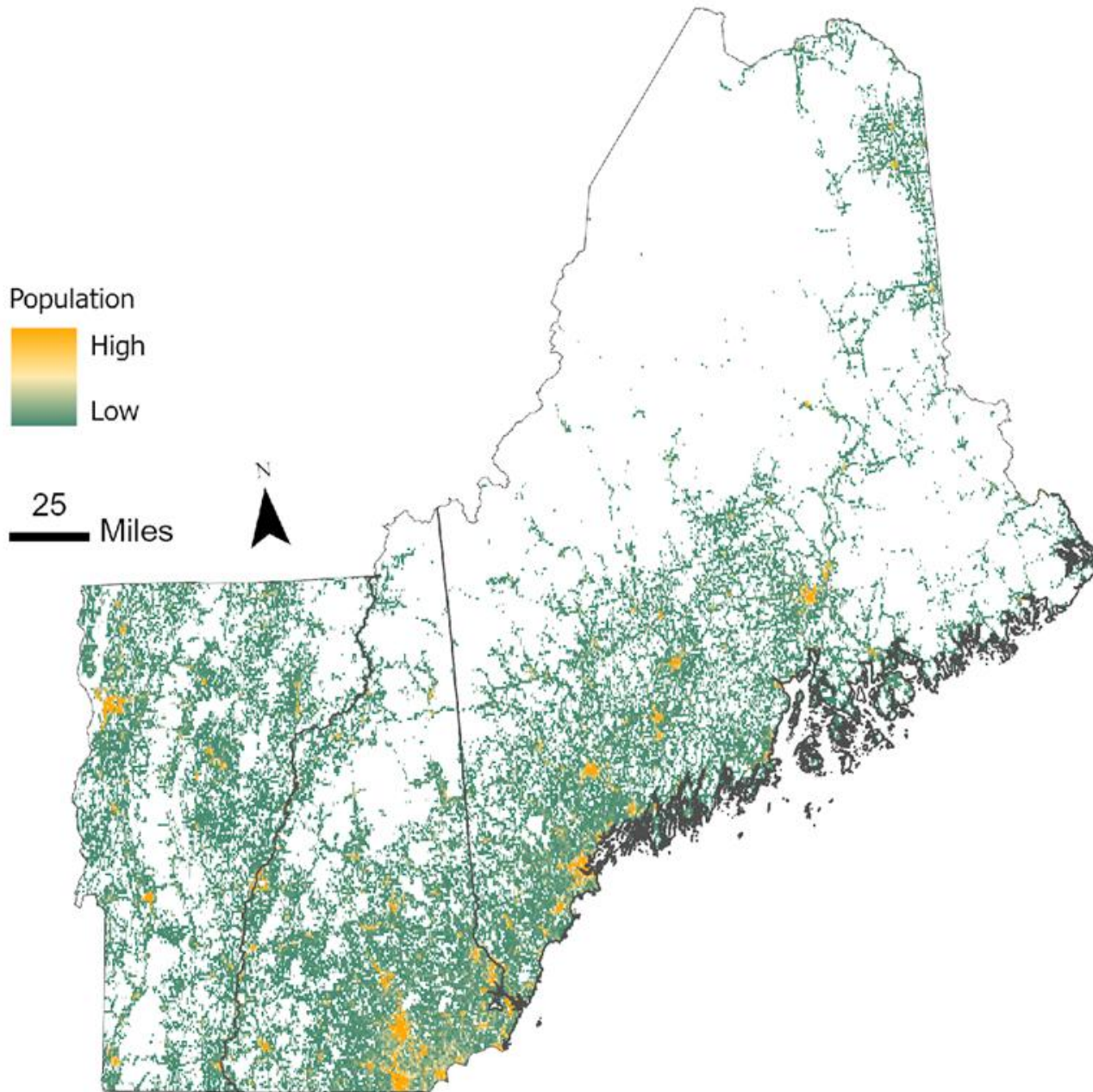
Sanam Roder-DeWan

Paul Ouma

Heather Carlos

David LaFlamme

NH RMOMS



Rurality (% of population)

Vermont 65-66%

Maine 61-64%

New Hampshire 42-27%

2020 census

Northern New England Region

70-28=42

Lost 40%

Maine

31-14=17

Lost 45%

New Hampshire

26-11=15

Lost 42%

Vermont

13-3 =10

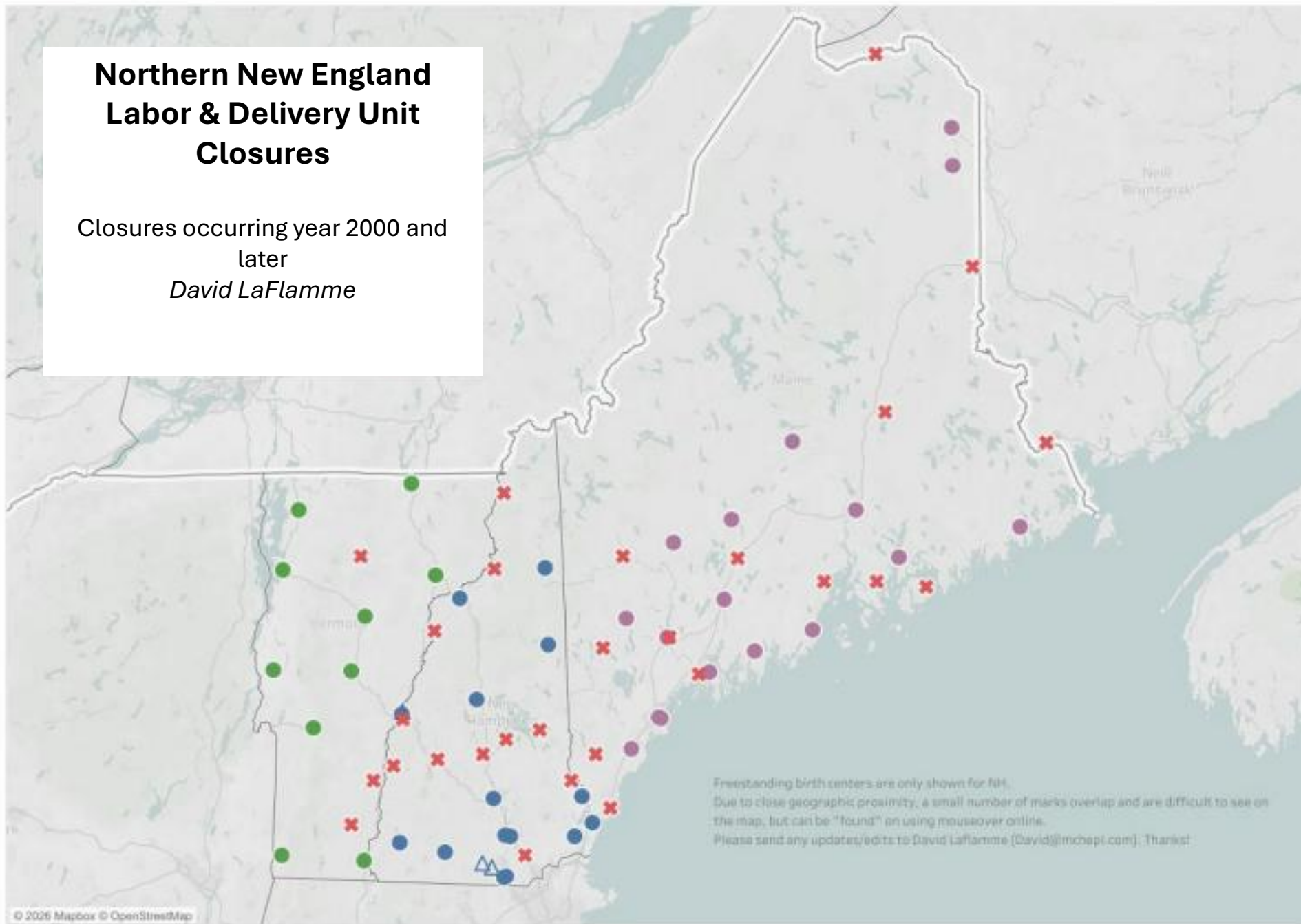
Lost 23%

43% of the region's rural hospitals have closed their labor & delivery units

Northern New England Labor & Delivery Unit Closures

Closures occurring year 2000 and
later

David LaFlamme



Closure List

Copley Hospital	VT	Nov 2025
Mt Desert Island Hosp	ME	Jul 2025
Inland Hospital	ME	May 2025
Houlton Regional Hospital	ME	May 2025
Waldo County General Hosp	ME	Apr 2025
York Hospital	ME	Sep 2023
Northern Maine Med Ctr	ME	May 2023
Rumford Hospital	ME	Mar 2023
Frisbie Memorial Hospital	NH	Nov 2022
St Mary's Regional Med Ctr	ME	Jul 2022
Bridgton Hospital	ME	Sep 2021
Parkland Medical Center	NH	Nov 2020
Springfield Hospital	VT	Jun 2019
Alice Peck Day Memorial Hosp	NH	Jul 2018
Lakes Region General Hosp	NH	May 2018
Calais Regional Hospital	ME	Aug 2017
Cottage Hospital	NH	Jul 2014
Penobscot Valley Hospital	ME	May 2014
Henrietta Goodall Hospital	ME	Jan 2014
Valley Regional Hospital	NH	Jan 2012
Huggins Hospital	NH	Sep 2009
Blue Hill Memorial Hospital	ME	May 2009
Parkview Adventist Med Ctr	ME	Dec 2008
Weeks Medical Center	NH	Mar 2008
Franklin Regional Hospital	NH	Dec 2005
Upper Connecticut Valley Hosp	NH	Oct 2003
New London Hospital	NH	Apr 2002
Grace Cottage Hospital	VT	Sep 2002

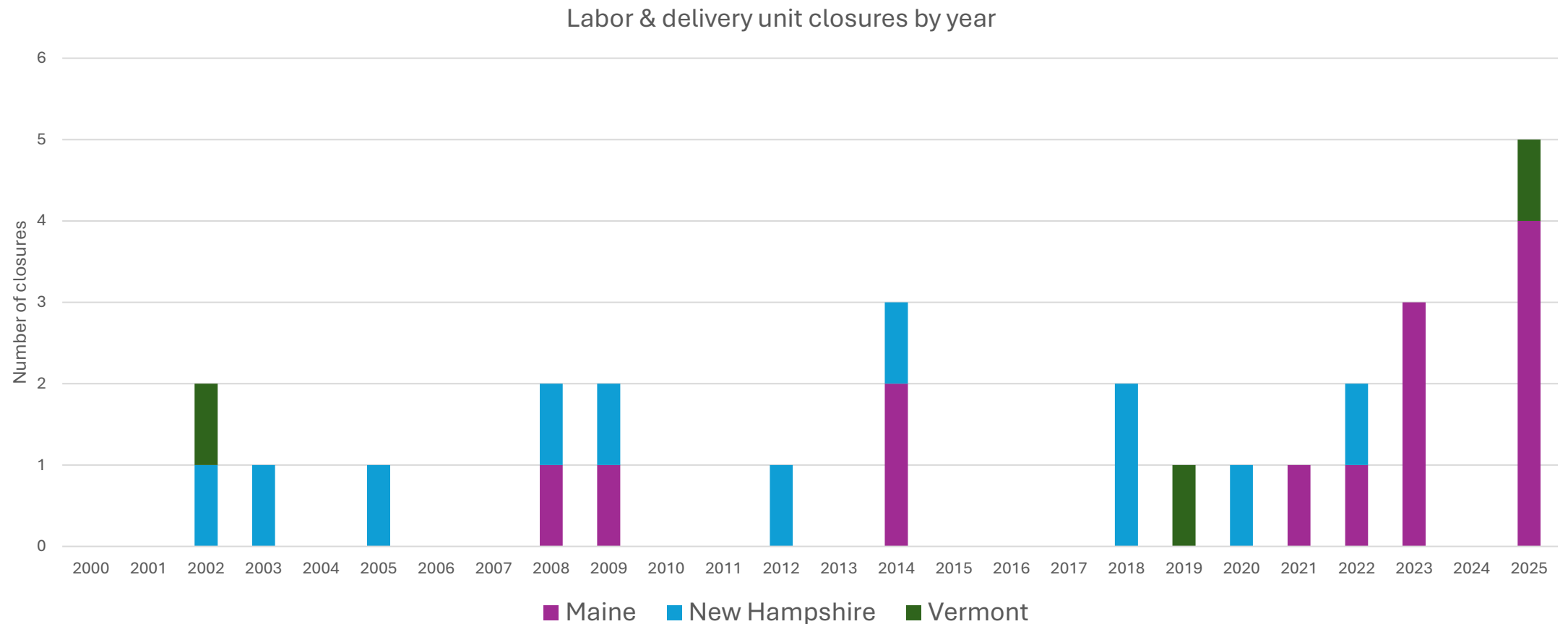
Shape Legend (Status)

- ✕ L&D Closed
- L&D Open
- △ Open Freestanding Birth Center

Color Legend

- Red = Closed in any state
- Green = VT
- Blue = NH
- Purple = ME

Closures have accelerated

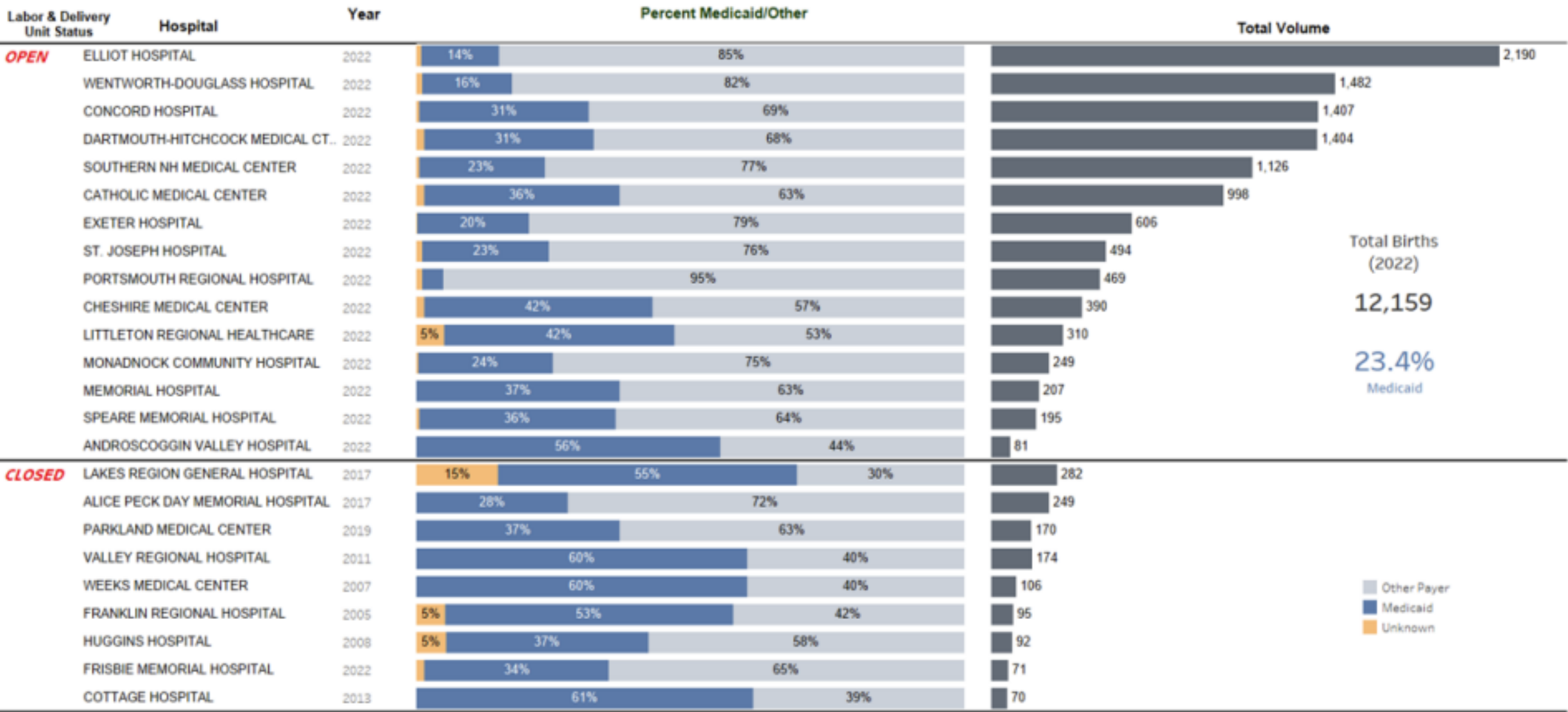


Hospitals with closed units are more likely to be rural, critical access, and independent

	Total (n=70)		Open (n=42)		Closed (n=28)	
	n	%	n	%	n	%
Rural	55	79%	31	74%	24	86%
Critical access designation	34	49%	15	36%	19	68%
No system affiliation	26	37%	14	33%	12	43%

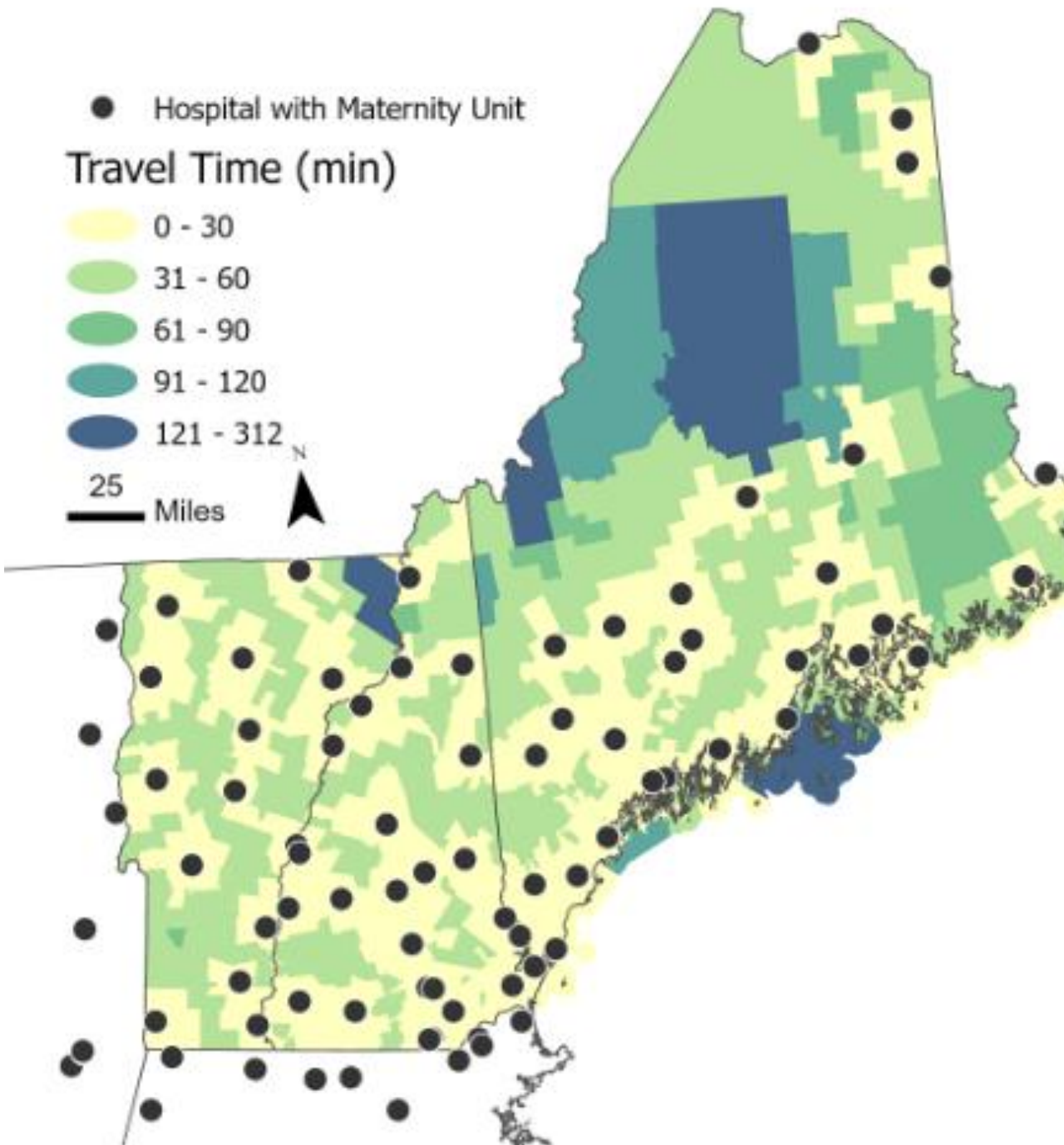
Figure 5. NH Occurrent Births by Open and closed Hospitals, Payer and Birth Volume.

Several lower volume hospitals with (mostly) higher proportions of Medicaid-paid births have closed their Labor & Delivery Units.



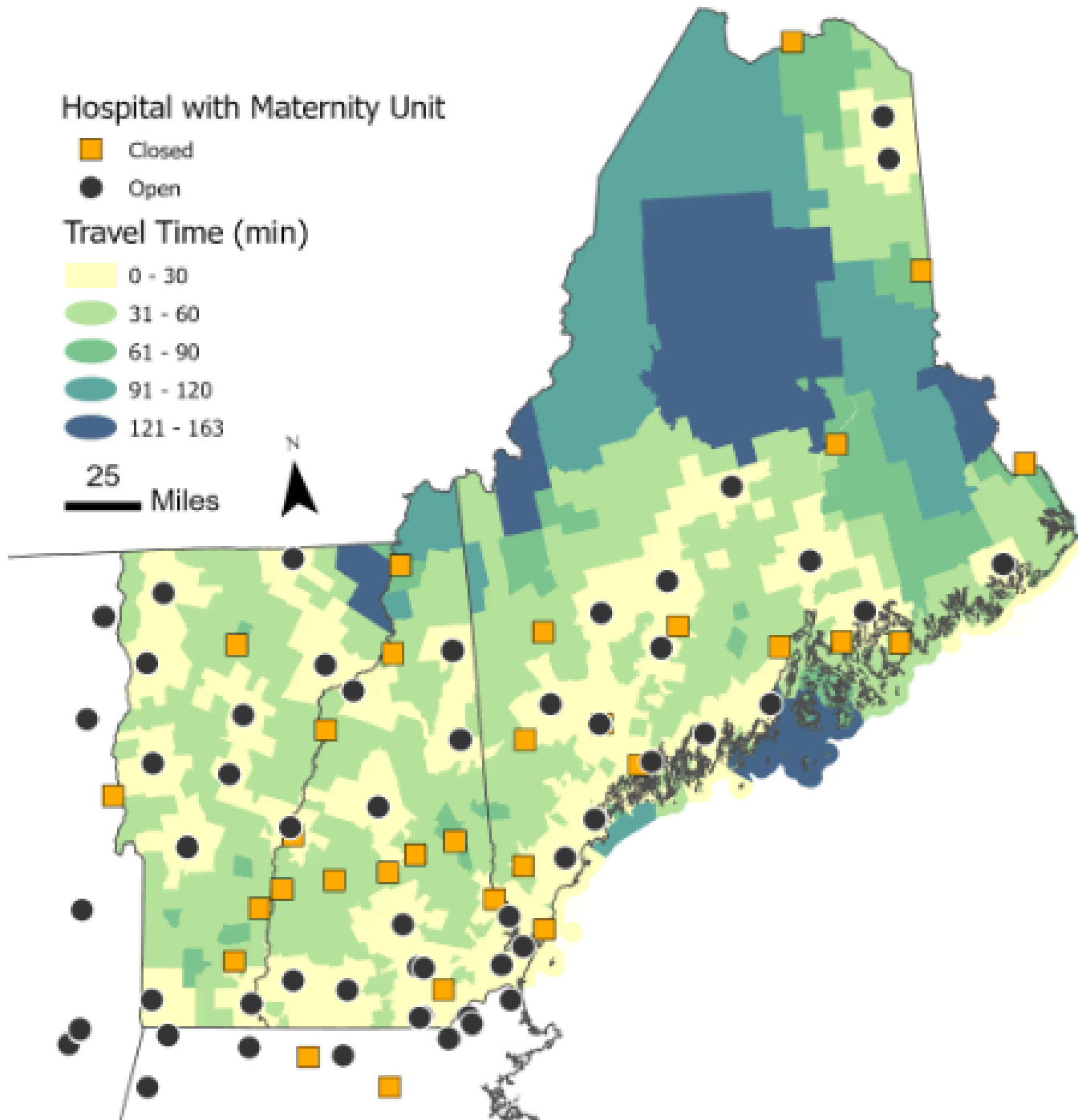
Analysis of NH Vital Records by MCH Epidemiologist | NH DPHS Maternal & Child Health Section
Notes: All births occurring in NH are included (residents/non-res). | Total Births includes out-of-hospital births. | Medicaid includes out-of-state plans for non-residents.
Data Refreshed: 6/30/2023 2:27:25 PM | Data Source: NH DHHS EBI Vital Records Births

Baseline travel time



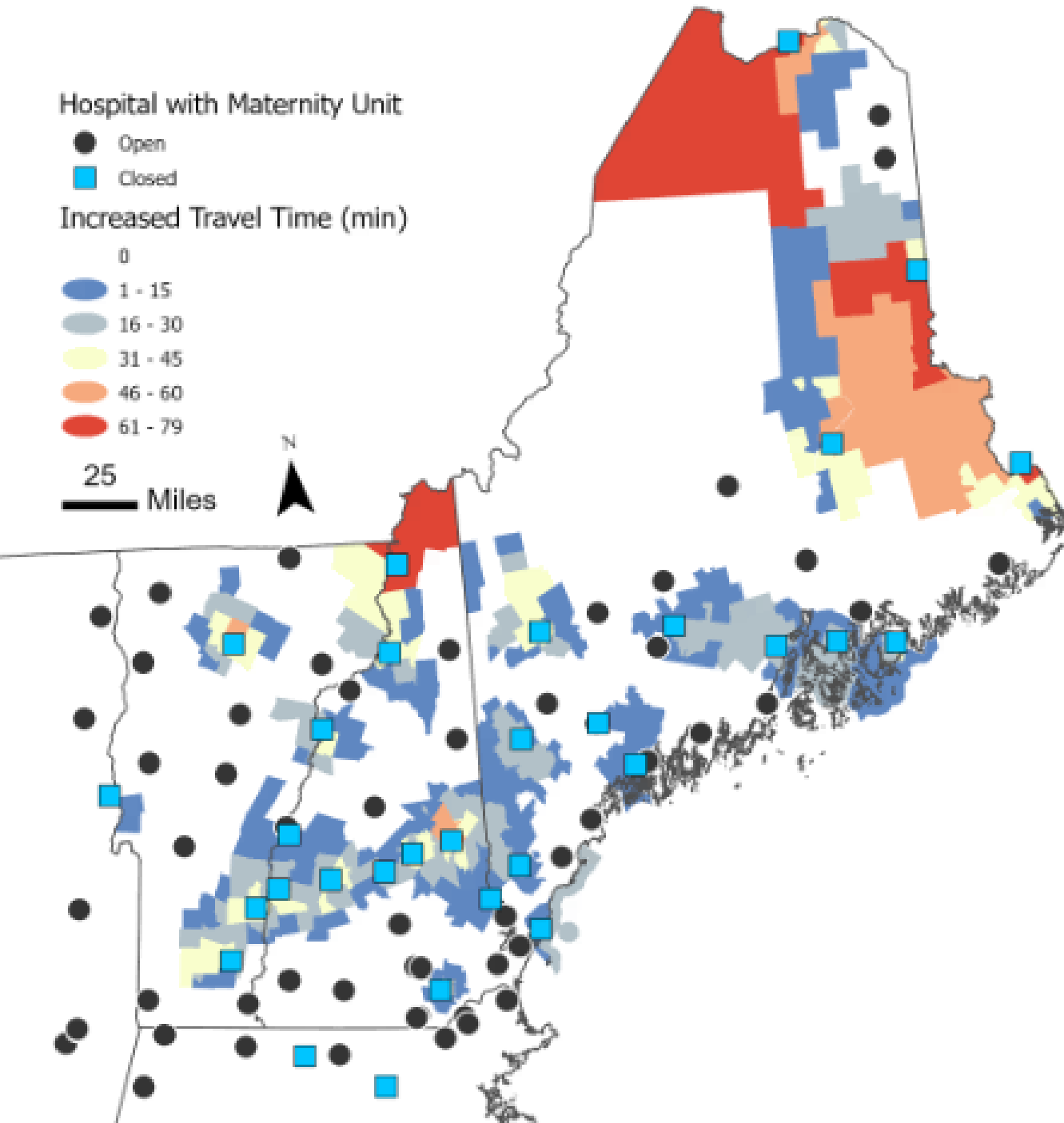
Travel time in minutes	Women ages 15-49	%
<30	578,800	87
31-60	87,937	13
61-90	1,875	0
91-120	384	0
>120	159	0
Total	669,155	100

Current travel time



Travel time in minutes	Women 15-49	%
<30	511,633	76
31-60	142,238	21
61-90	12,746	2
91-120	2,021	0
>120	517	0
Total	669,155	100

Which areas are most impacted by these closures?





Exhausted and Overwhelmed

As a mother in the north country, I struggled to find solace in the midst of prenatal and postnatal care challenges. The isolation and lack of access to resources weigh heavily on her, leaving her feeling drained and helpless. The North Country, a beautiful sanctuary, now feels like a reminder of the long and arduous journey in finding the high-quality care and resources needed. Despite the exhaustion and challenges, she holds on to hope, knowing that she is not alone in this struggle. The north country may be vast and unforgiving, but it is also a place of resilience and strength, where mothers like her find ways to persevere and thrive, even in the face of adversity.

-Rose Toner



Safe Travels

New England winters can be quite treacherous, but, when you have to make appointments, there's no other option than to buckle up, say your prayers, and head out in the storm.

-Maylynda Emerson



Staying with the In-Laws

Because my husband and I lived a good 45 minutes from the hospital, my FIL and his girlfriend kindly offered to let us stay at their home with them, a short 5 minutes to LRH. This was a great option for us, however, we did have to uproot our lives to go and stay with them for a little bit to ensure we would make it to the hospital safely and within a short amount of time.

- Maylynda Emerson



Weighing the Risks

As the due date for my second child approached, I was presented with the option to schedule an induction. My first delivery, three years prior and also in the dead of winter, lasted roughly four hours from the start of contractions to the time my daughter arrived. We had traveled to the hospital in the middle of the night through six inches of snow. The typical 40-minute drive alongside the chilly Androscoggin River and 13 miles of woods with scarce cell service, took over an hour that evening. After arriving to the hospital at 1am, we became a family of three shortly after 2am, leaving barely enough time for our OB to arrive. Despite this experience, I was quick to dismiss the option for an induction the second time around, hoping to naturally progress into labor when it was time. Further appointments with discussions around induction, learning what to do if the baby is born in the vehicle and the ongoing worry for my safety and whether my husband would make it to the hospital for our child's birth led me to rethink my stance. We scheduled our induction date soon after.

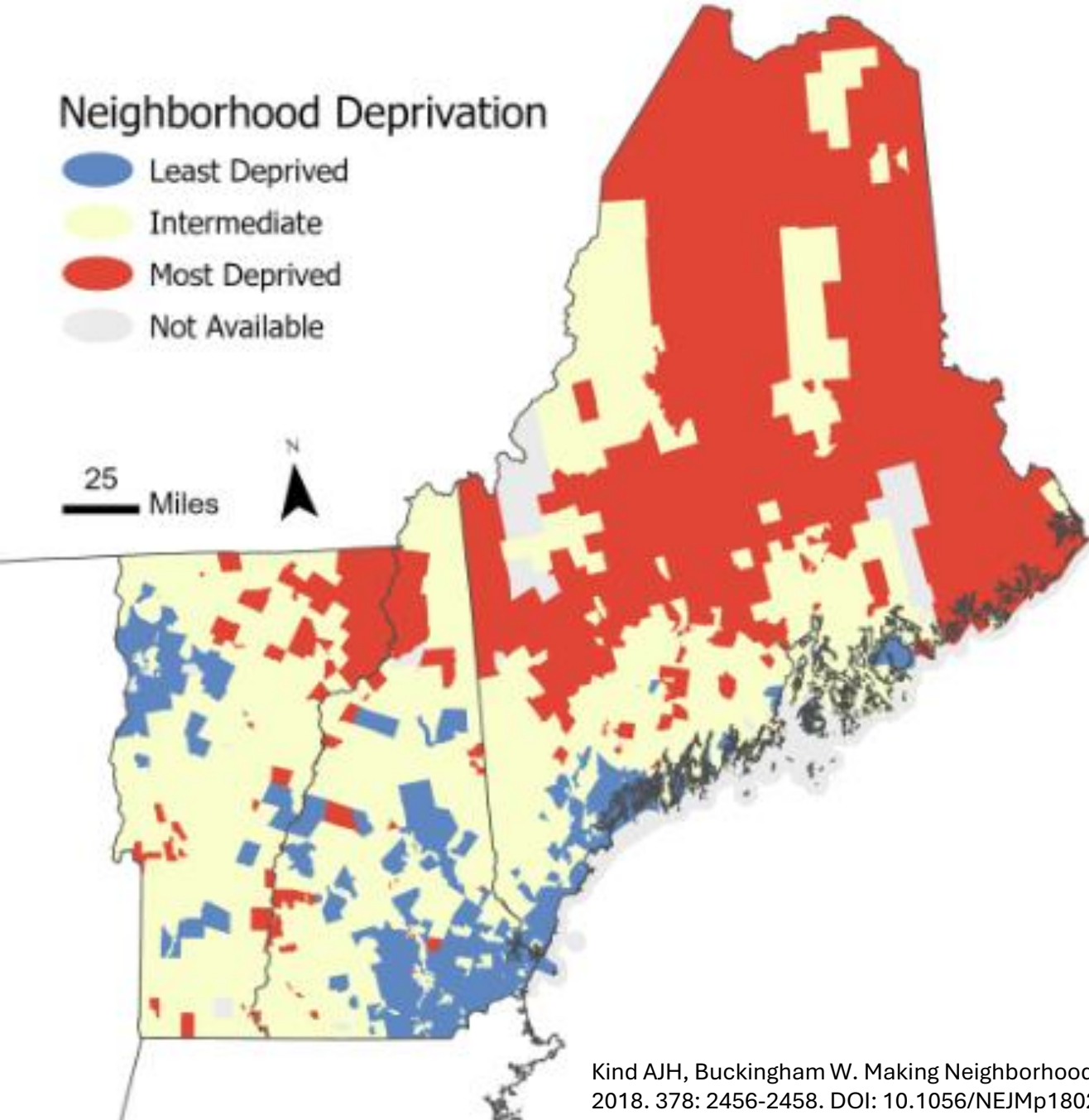
- Tiffany Sweatt

Who lives in these areas?

Neighborhood Deprivation

- Least Deprived
- Intermediate
- Most Deprived
- Not Available

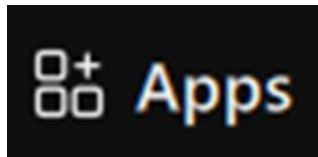
25
Miles



Area Deprivation Index: A validated measure of neighborhood disadvantage that includes income, education, employment, and housing quality

Polling through Slido

- Slido should automatically open on the Webex sidebar when the question is launched
- If it does not open, click on the “Apps” button in bottom right of your screen:



- Other ways to join:
 - on your phone by using the QR code to the right
 - Go to Slido.com and enter in the code:
1116853



Looking forward: Poll

Which 3 factors do you think are most likely to cause a hospital to close its labor & delivery unit?

A risk score?

- Theory
- The literature

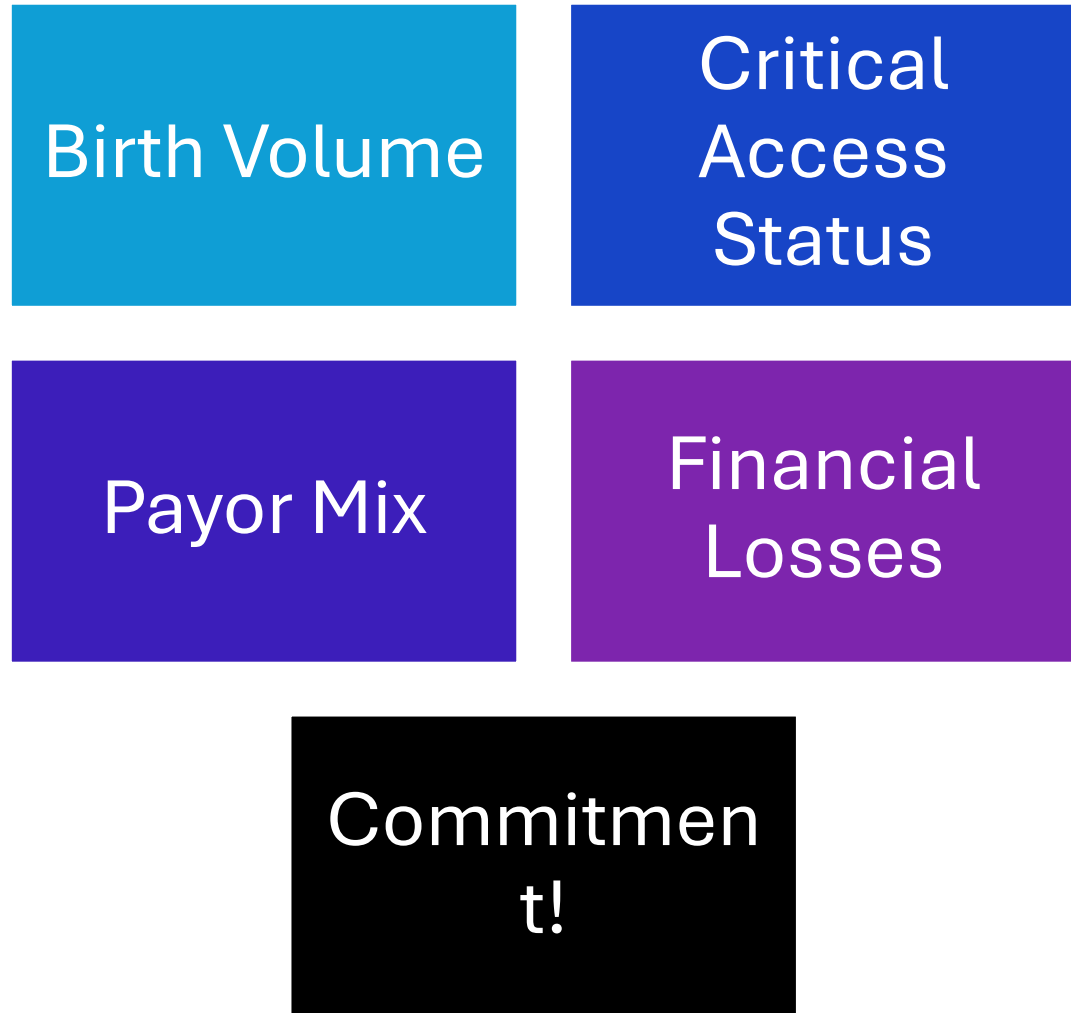
Birth Volume

Critical
Access
Status

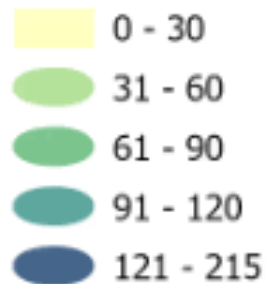
Payor Mix

Financial
Losses

A practical risk score



Travel Time (min)



25
Miles



65% of rural facilities have closed their L&D units

43,655 women ages 15-49 live outside of a safe travel time to a hospital with an open L&D unit

Travel time in minutes	Women ages 15-49	%
<30	472,182	71
31-60	153,255	23
61-90	31,529	5
91-120	6,897	1
>120	5,229	1
Total	669,155	100

Some thoughts on responding

- Leadership and community action are crucial!
- Take a systems perspective – obstetric care as a utility
- Maximize the value of community-based care
- Support small facilities with opportunities to rotate and practice skills
- Take risk-appropriate care seriously
- Consider access a healthcare responsibility and get creative
- Work regionally!

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Thank you!