

# The association between regional growth in U.S. neonatal intensive care capacity and neonatal mortality from 1991 to 2020

Gwenyth Gasper MS<sup>1</sup>, Patrick Stuchlik PhD<sup>2</sup>, Therese Stukel PhD<sup>3</sup> & David C. Goodman MD, MS<sup>2</sup>

<sup>1</sup>Geisel School of Medicine; <sup>2</sup>The Dartmouth Institute for Health Policy and Clinical Practice; <sup>3</sup>ICES, University of Toronto, Canada

Funding: Kettering Family Foundation, National Institute for Child and Human Development (NICHD 1R01HD101523)



## Introduction

Neonatal intensive care has proven highly effective in the treatment of serious newborn illness, leading to dramatic reductions in neonatal morbidity and mortality since the advent of the first neonatal intensive care unit (NICU) in the late 1960s. However, growth in NICU capacity varies markedly across regions with little correlation to perinatal risk factors. This raises questions about whether newborns born in regions of higher growth experienced better outcomes.

## Objective

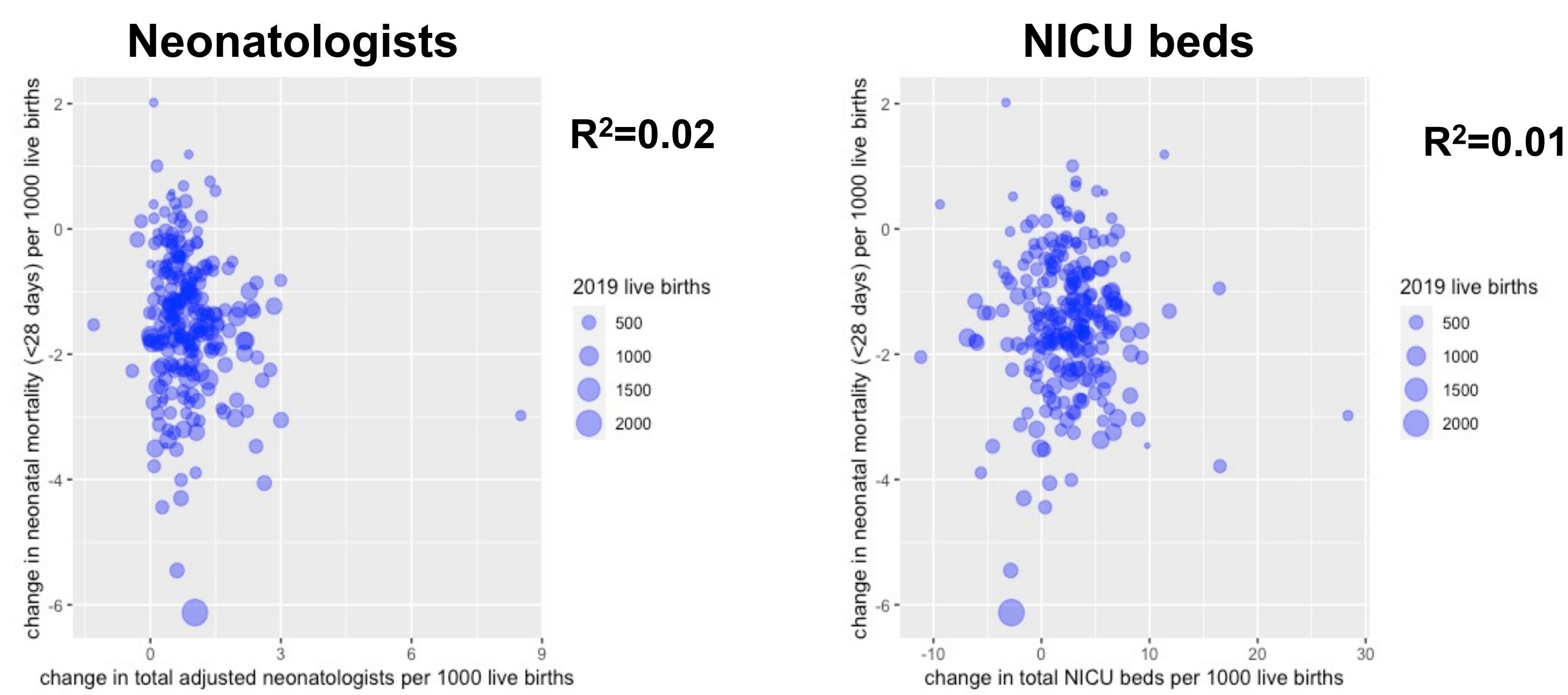
Controlling for individual need, is growth in regional neonatal intensive care capacity (total neonatologists and NICU beds) associated with better newborn outcomes, specifically lower rates of neonatal mortality (death <28 days)?

## Methods

- This longitudinal cross-sectional study utilized data from the American Medical Association, the American Hospital Association, and the CDC's birth-linked death files to measure changes in total adjusted neonatologists, staffed NICU beds, and trends in neonatal mortality, respectively, from 1991 to 2020.
- A pure ecological study using 246 neonatal intensive care regions (NICRs) as the unit of analysis was used to assess regional changes in capacity and mortality from 1991 to 2019. Associations were tested with bivariate linear models and weighted using the number of live births per NICR. Separate models were developed for each capacity measure.
- Multi-level Poisson models using the newborn as the unit of analysis were also analyzed to estimate neonatal mortality exposure at the individual level from 1991 to 2020. Covariates were newborn birthweight, maternal age, maternal race, maternal education, marital status, parity, extent of prenatal care, plurality, infant sex, and maternal Hispanic ethnicity. Models included a 20% random sample of each region-year with clustering by NICR-year of birth.

## Results

## Results



Change in Neonatologists (birth year – 1991)    Change in NICU beds (birth year – 1991)

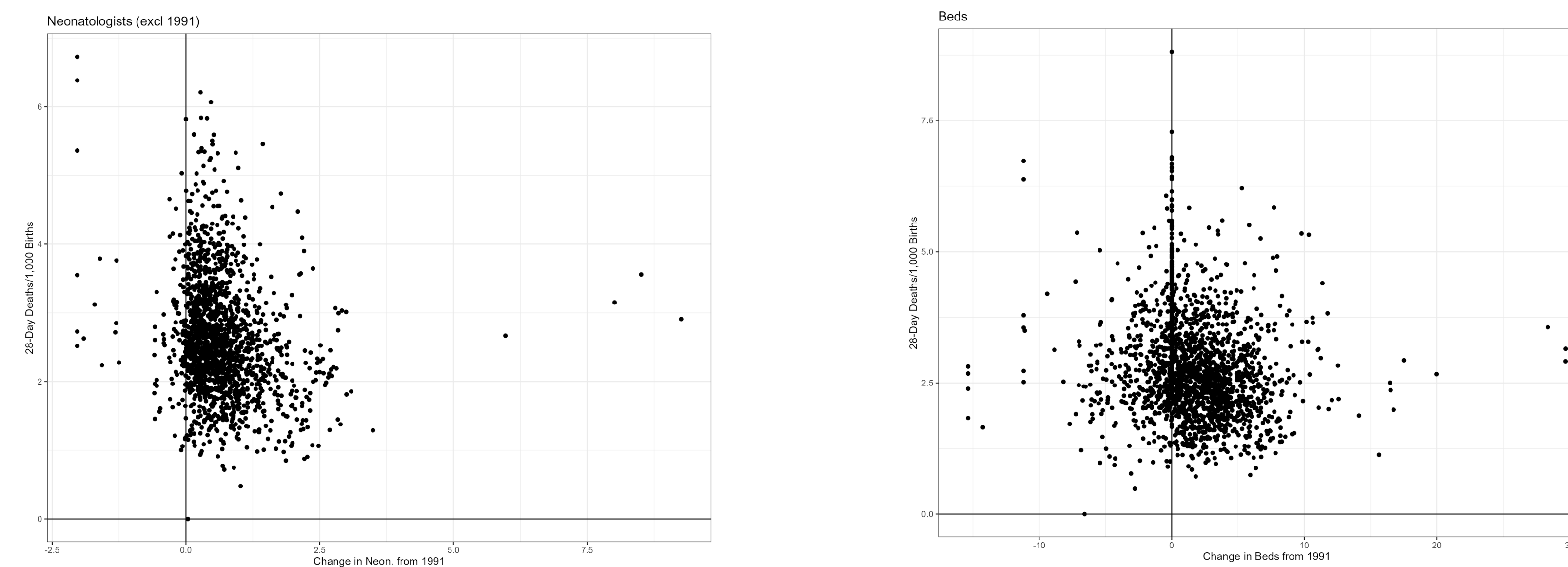


Figure 3. Plots of change in regional capacity vs. neonatal death (<28 days) from 1991 to newborn birth year (n=1968 NICRs x periods of capacity change).

- From 1991 to 2019, mean total adjusted neonatologists per live birth grew 225% while overall NICU bed capacity grew 44%.
- At the ecological level, there was no meaningful association between change in capacity and change in mortality across NICRs. Lack of an association persisted with analyses restricted to newborns with very low birth weight (<1500g).
- At the individual level, change in regional exposure versus change in mortality revealed no meaningful association.
- There was high regional variation in both cross-sectional distributions and change in NICU capacity across NICRs.

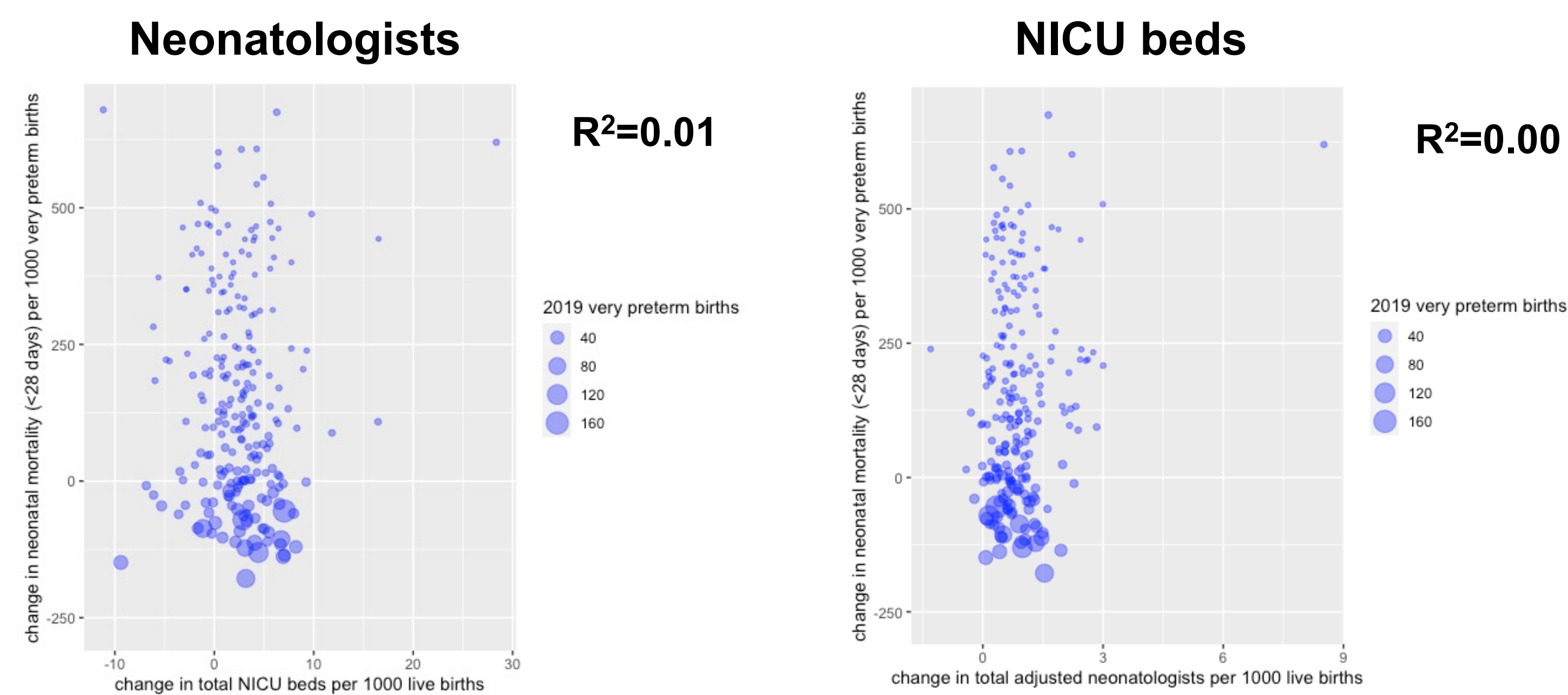


Figure 2. Plots of change in capacity vs. change in very preterm neonatal mortality (death <28 days) per 1000 live births from 1991 to 2019 across NICRs (n=246). NICRs are weighted by 2019 very preterm births.

	Model	Risk Ratio	95% CI	p-value
Change in Neonatologists /1000 births (1991 to birth year)	1	0.8	0.77-0.84	<0.001
	2	0.91	0.84-0.99	<0.05
	3	0.94	0.87-1.02	<b>NS&gt;0.05</b>
Change in NICU beds /1000 births (1991 to birth year)	1	0.98	0.98-0.99	<0.001
	2	0.98	0.97-0.99	<0.001
	3	0.993	0.985-1.001	<b>NS&gt;0.05</b>

Table 1. Summary of multi-level Poisson model outputs. Model 1 represents the bivariate association estimated in a Poisson GEE model. In Model 2, the year of birth regional capacity was included, and the associations in Model 1 persisted. In Model 3, newborn health risks at birth were included, and there was no longer an association between change in capacity and newborn level mortality risk.

## Conclusions

Although NICU care is highly effective in the treatment of serious newborn illness, recent growth in the number of total neonatologists and NICU beds has occurred in regions independent of need and demonstrates no observable benefit to neonatal mortality outcomes. Additional studies investigating the association between capacity exposure and non-mortal outcomes are needed to better access the value of higher NICU capacity.