



Institute for Health  
Metrics and Evaluation

# Global, regional, and national stillbirths at 20 weeks' gestation or longer in 204 countries and territories, 1990 to 2021: findings from the Global Burden of Disease Study 2021

**Haley Comfort**

[hcomfo95@uw.edu](mailto:hcomfo95@uw.edu)

April 12, 2025

# Outline

- Background
- Objective of Analysis
- Outline of Analytical Strategy
  - Data Extraction
  - Data Processing (Crosswalking)
  - Modeling (Ensemble Model, ST-GPR)
- Results
- Summary



# Background

A stillbirth (or fetal death) is the death or loss of a fetus (before or during delivery) at a gestational age and/or birthweight that is considered viable or conducive to surviving ex utero.



# Background

Thresholds to define a viable pregnancy are inconsistent across countries and institutions:

Group or Dataset	Acronym	Keyword	Threshold
Centers for Disease Control and Prevention	CDC	stillbirth	20+ weeks
Centers for Disease Control and Prevention	CDC	early stillbirth	20 to <28 weeks
Centers for Disease Control and Prevention	CDC	late stillbirth	28 to <37 weeks
Centers for Disease Control and Prevention	CDC	term stillbirth	37+ weeks
International Classification of Diseases	ICD-10	stillbirth	20+ weeks
International Classification of Diseases	ICD-11	stillbirth	22+ weeks
Lancet Stillbirth Epidemiology Investigator Group	LSEIG	stillbirth	28+ weeks
UN Inter-agency Group for Child Mortality Estimation	UN IGME	stillbirth	28+ weeks
World Health Organization (registration purposes)	WHO	stillbirth	22+ weeks
World Health Organization (international	WHO	stillbirth	28+ weeks

# Objective of Analysis

- To estimate total stillbirths and stillbirth rate by gestational age (20, 22, and 28 weeks) annually from 1990 to 2021 for all GBD geographies.
- This analysis is the first to comprehensively estimate all stillbirths at  $\geq 20$  weeks' gestation.

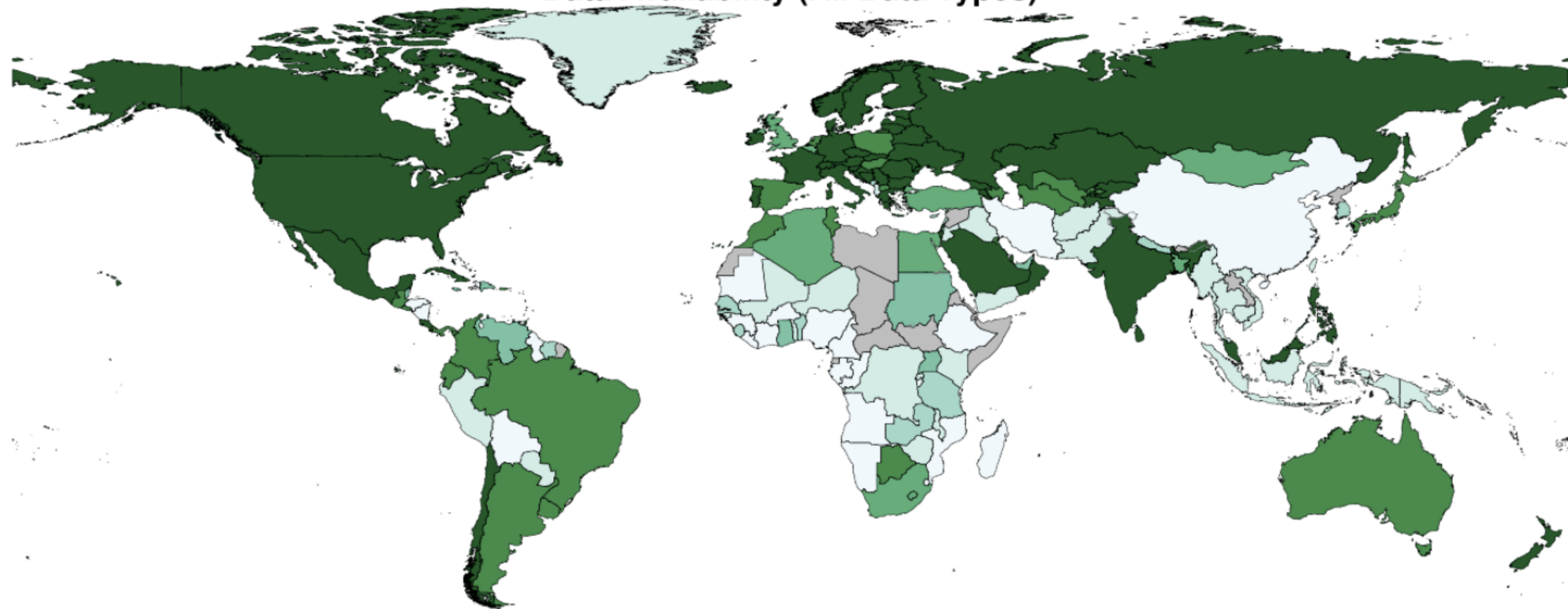


# Data Extraction

- Final dataset covered 186 countries and territories
  - 235 surveys
  - 232 published studies
  - 1,827 vital statistics reports
  - 11,425 location-years of vital registration (VR)
- Performed systematic outliering
  - Ex:  $0.001 < \text{SBR} < 0.2$

Threshold	# Data Points	Distribution
<b>20 weeks</b>	<b>5796</b>	<b>23.7%</b>
22 weeks	1804	7.4%
24 weeks	1358	5.5%
26 weeks	244	1%
<b>28 weeks</b>	<b>10824</b>	<b>44.2%</b>
500 grams	642	2.6%
1000 grams	1997	8.2%
22 weeks OR 500 grams	976	4%
22 weeks AND 500 grams	94	0.4%
28 weeks OR 1000 grams	97	0.4%
28 weeks AND 1000 grams	104	0.4%

## Data Availability (All Data Types)

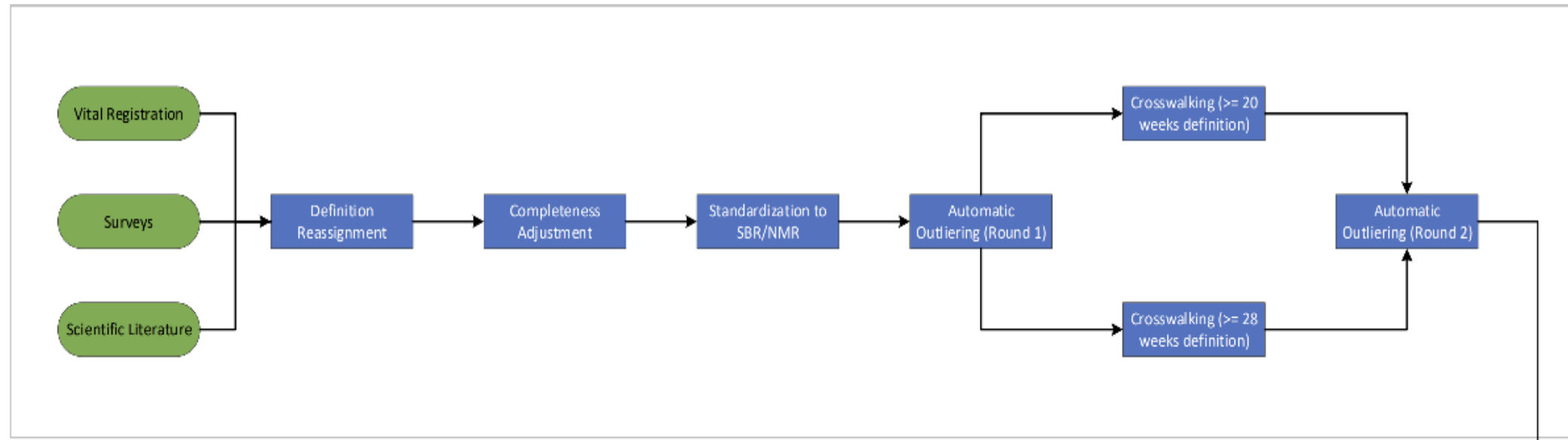


### # Location-Yrs

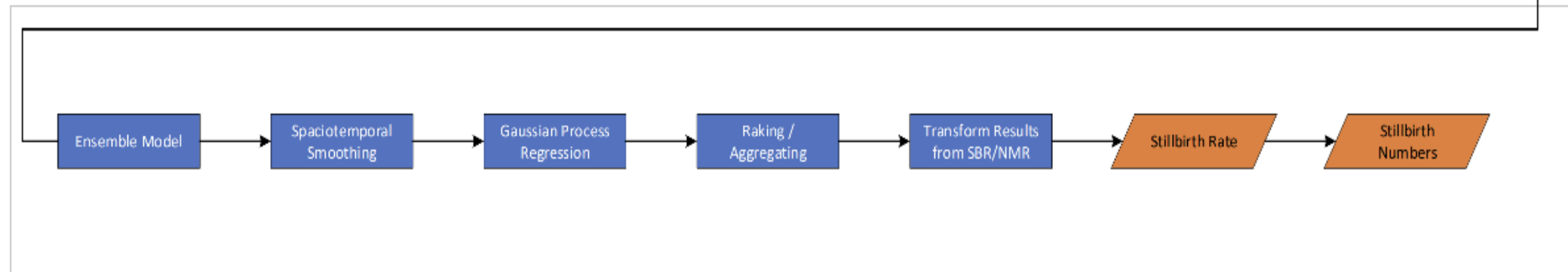


# Modeling Flowchart

## Step 1: Data Processing



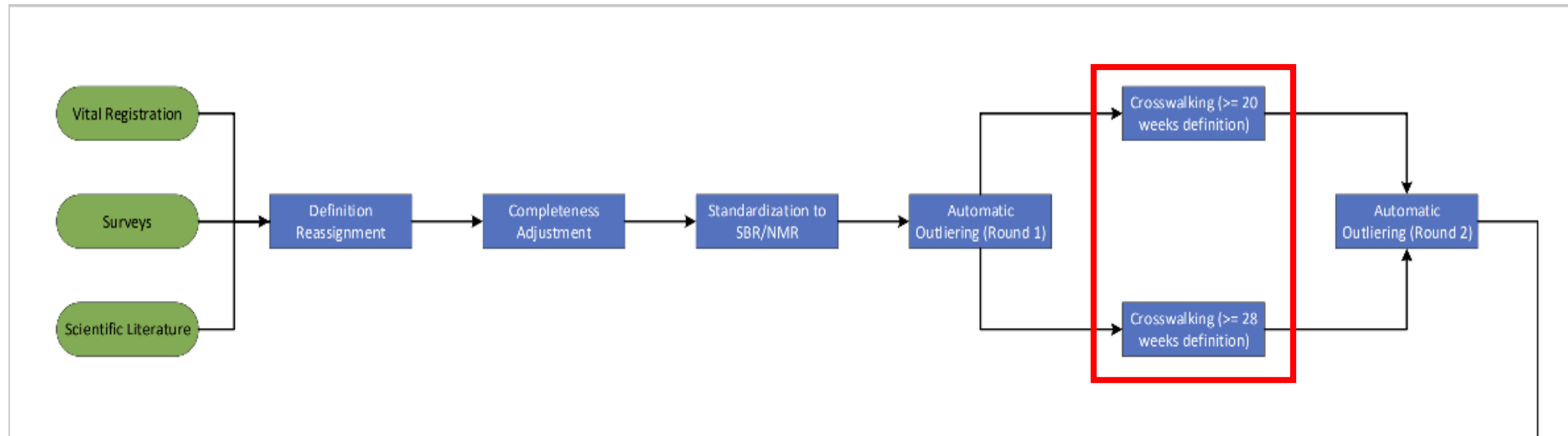
## Step 2: Modeling x2 (Run for >= 20 weeks and >=28 weeks)



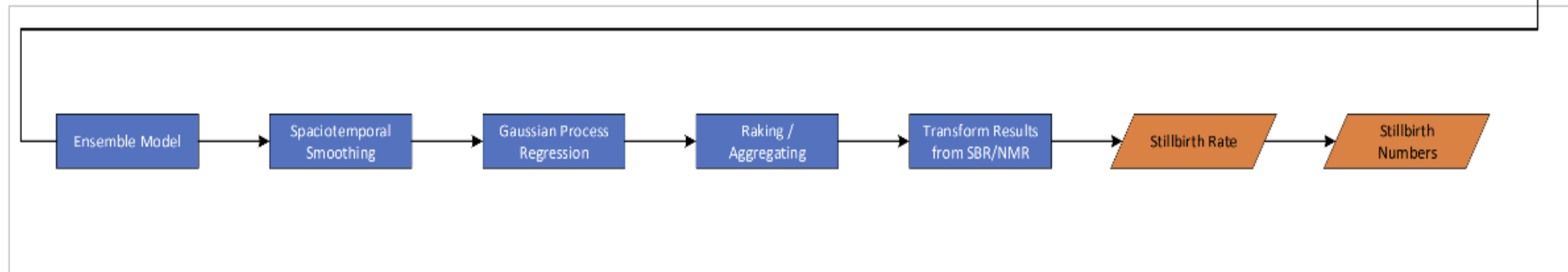


# Modeling Flowchart

## Step 1: Data Processing

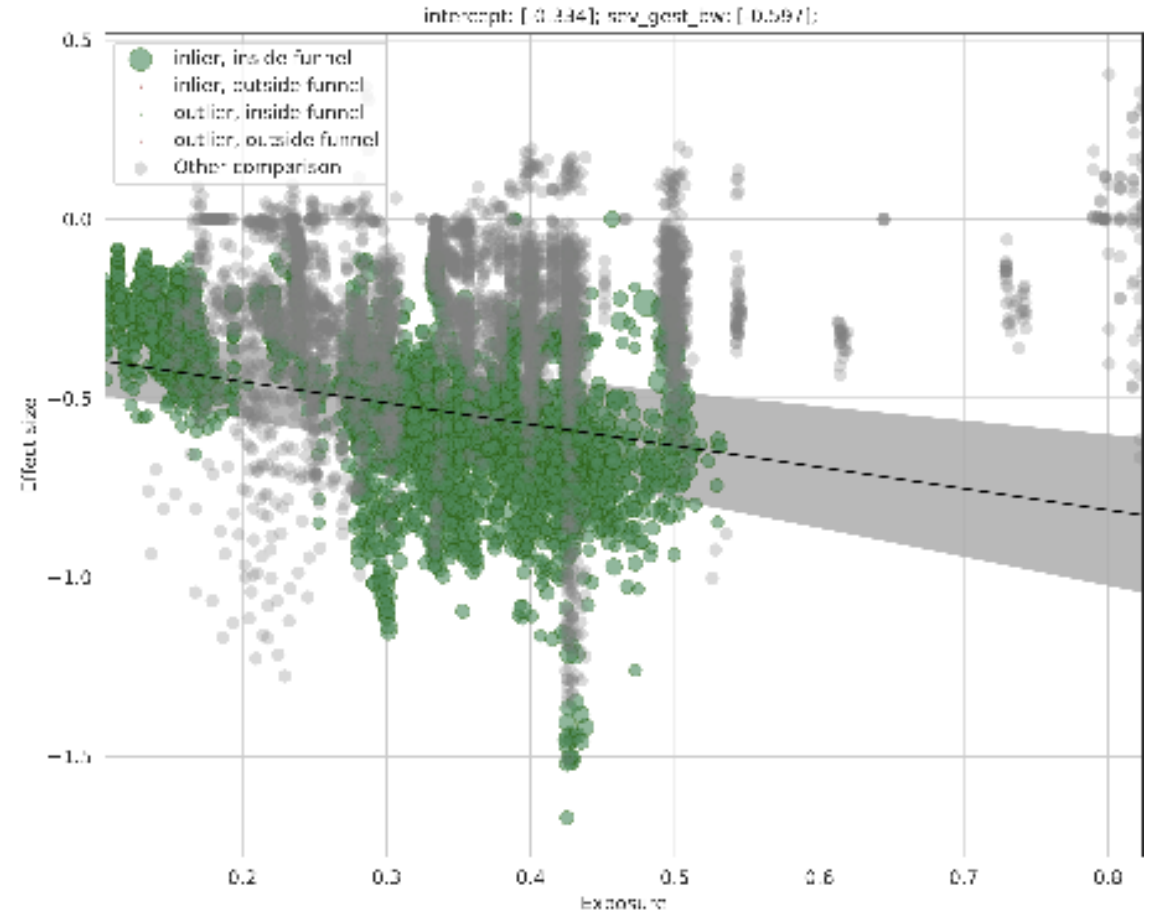


## Step 2: Modeling x2 (Run for $\geq 20$ weeks and $\geq 28$ weeks)



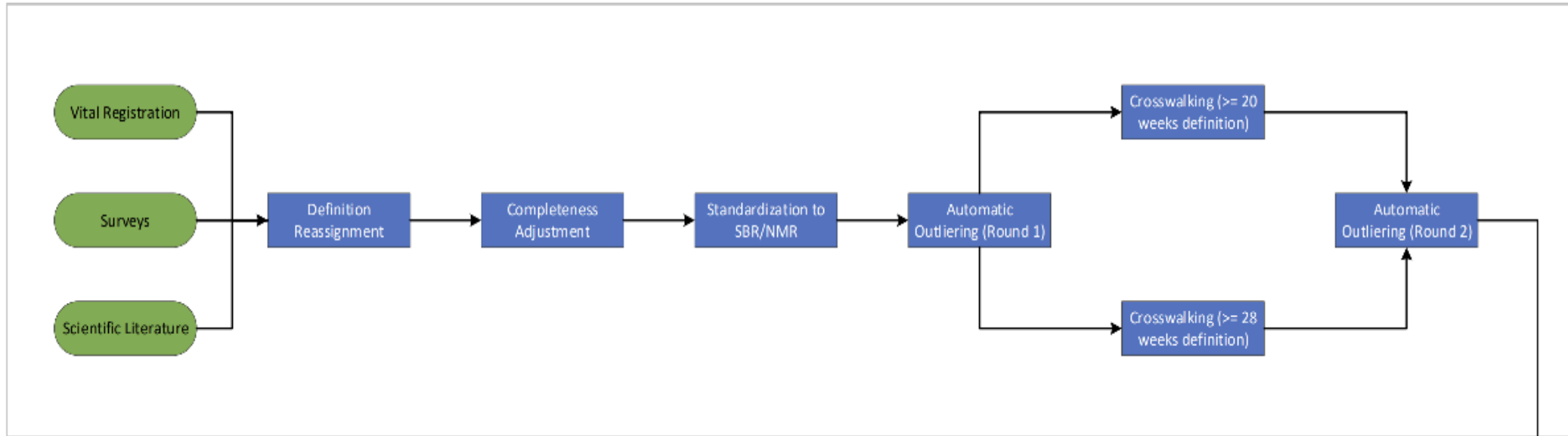
# Outline of Analytical Strategy – Crosswalking

- Meta-regression modeling tool used to adjust all data to specified reference definition ( $\geq 20$  weeks and  $\geq 28$  weeks)
- Direct comparisons = pair of data points (reference:alternate definition) for the same location-year
- Indirect comparisons = pair of data points (alternate:alternate definition) for the same location-year
- Compiled these ratios to generate adjustments using the delta method

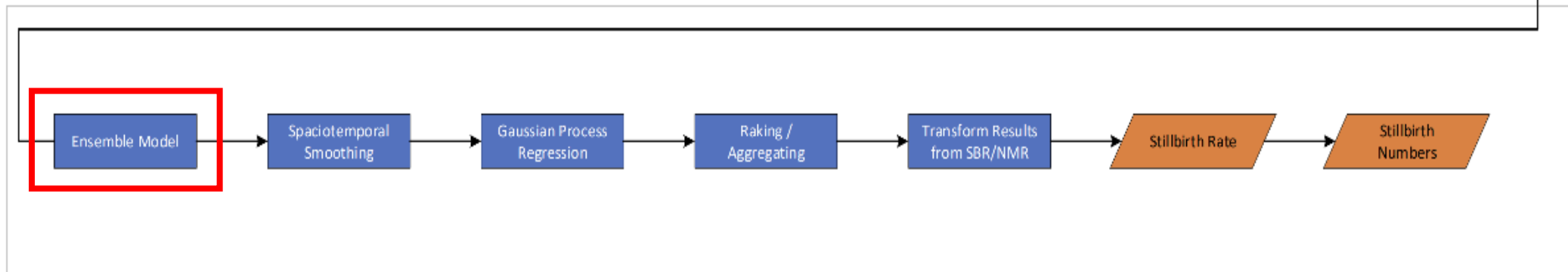


# Modeling Flowchart

## Step 1: Data Processing



## Step 2: Modeling x2 (Run for $\geq 20$ weeks and $\geq 28$ weeks)



# Outline of Analytical Strategy – Ensemble Model

- Tests candidate models consisting of all combinations of 10 covariates
  - Eliminates models with insignificant betas or betas representing the ‘wrong’ direction of a relationship with the outcome
- Creates out-of-sample predictive validity-weighted predictions (1<sup>st</sup> stage)

Covariate Themes
Socio-demographic Index (SDI)
Healthcare access and quality index (HAQI)
Antenatal Care Coverage (proportion)
In-Facility Delivery (proportion)
Skilled Birth Attendance (proportion)
Maternal Care and Immunization
Education (years per capita)

# Modeling Flowchart

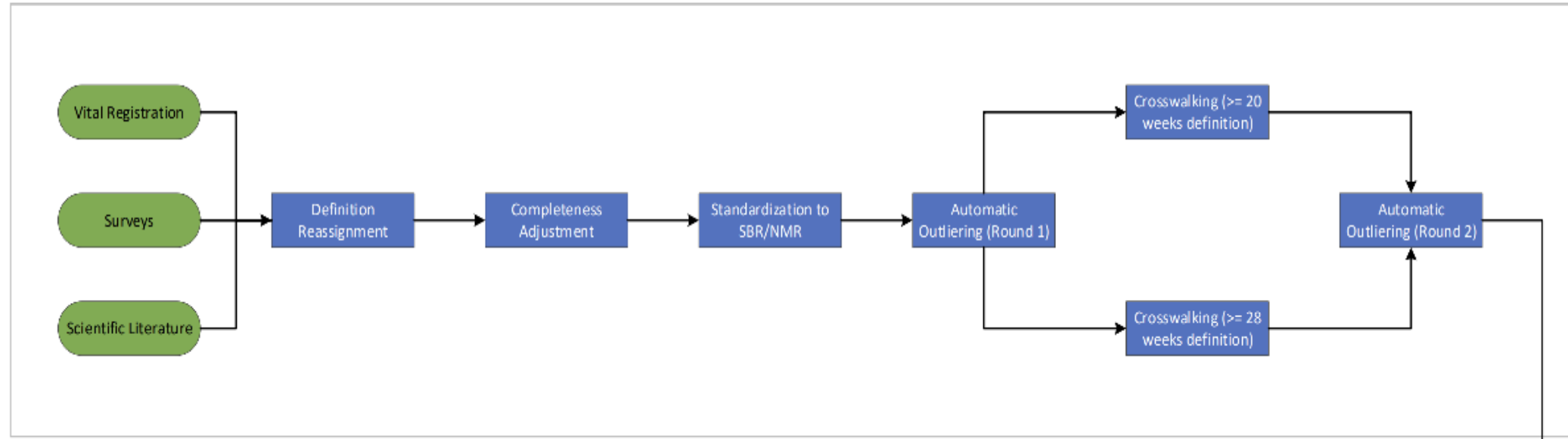
## Step 1: Data Processing

### Legend

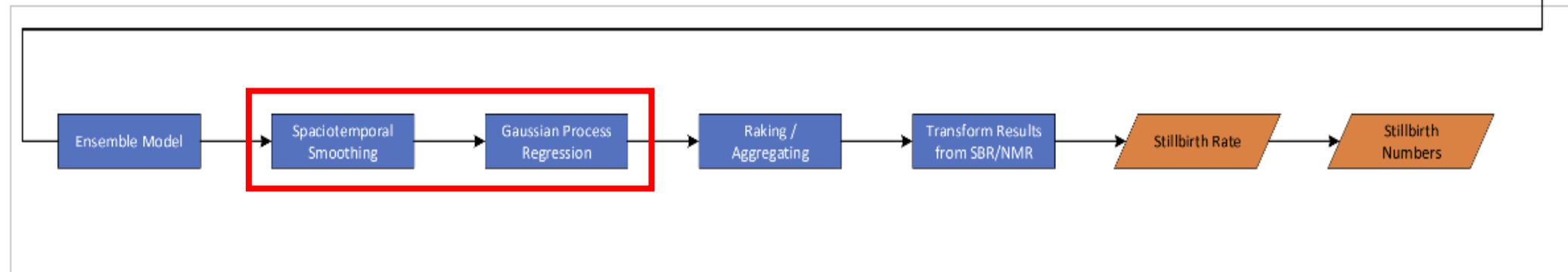
Data Inputs

Process

Final Results

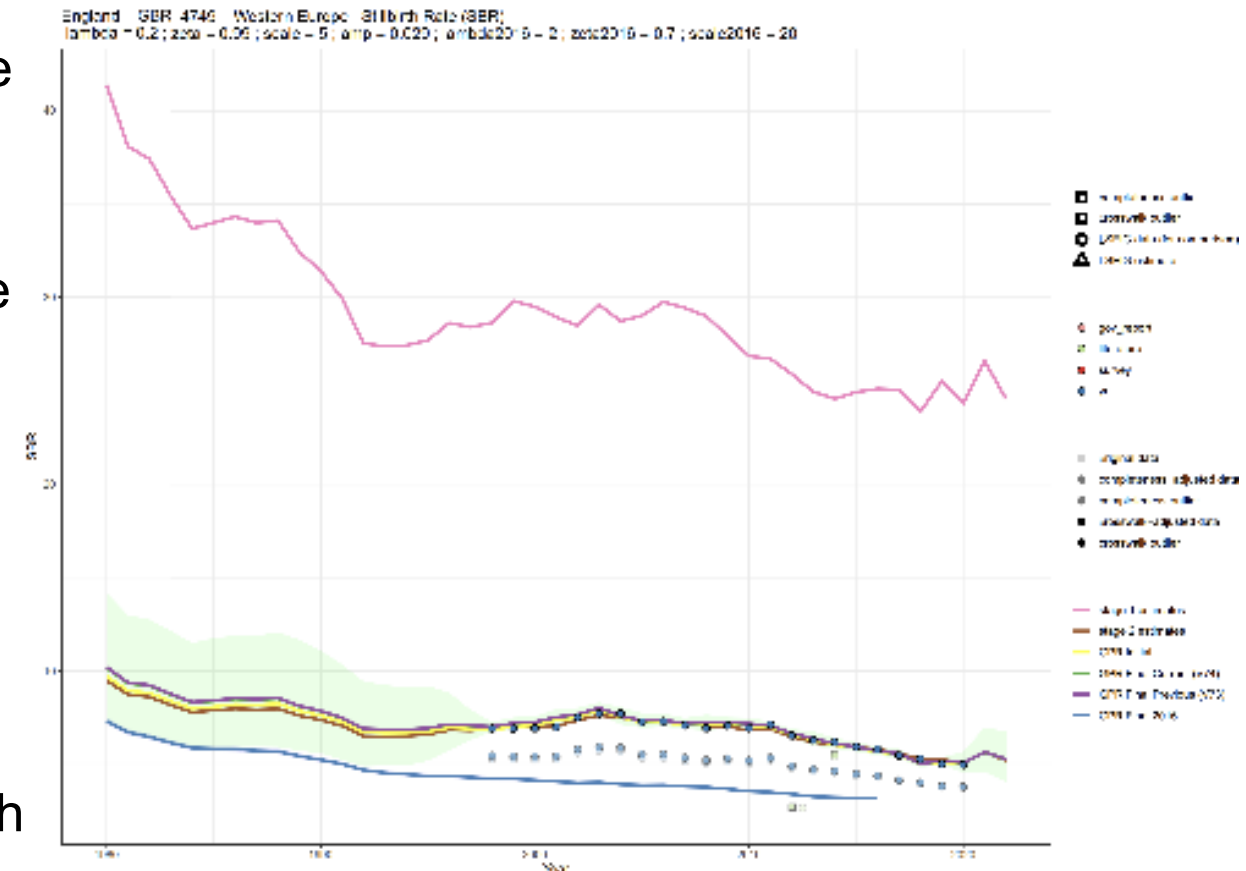


## Step 2: Modeling x2 (Run for $\geq 20$ weeks and $\geq 28$ weeks)



# Outline of Analytical Strategy – ST-GPR

- Spatio-temporal smoothing (ST)
  - Uses time and space weights to determine smoothness over time and weighting of regional data
  - Smoothed residuals are added to 1<sup>st</sup> stage prediction to get 2<sup>nd</sup> stage prediction
- Gaussian Process Regression (GPR)
  - Incorporates data with associated data variance
  - Uses 2<sup>nd</sup> stage prediction (ST) as a prior
  - Generates full time series of estimates with uncertainty (95% UI)



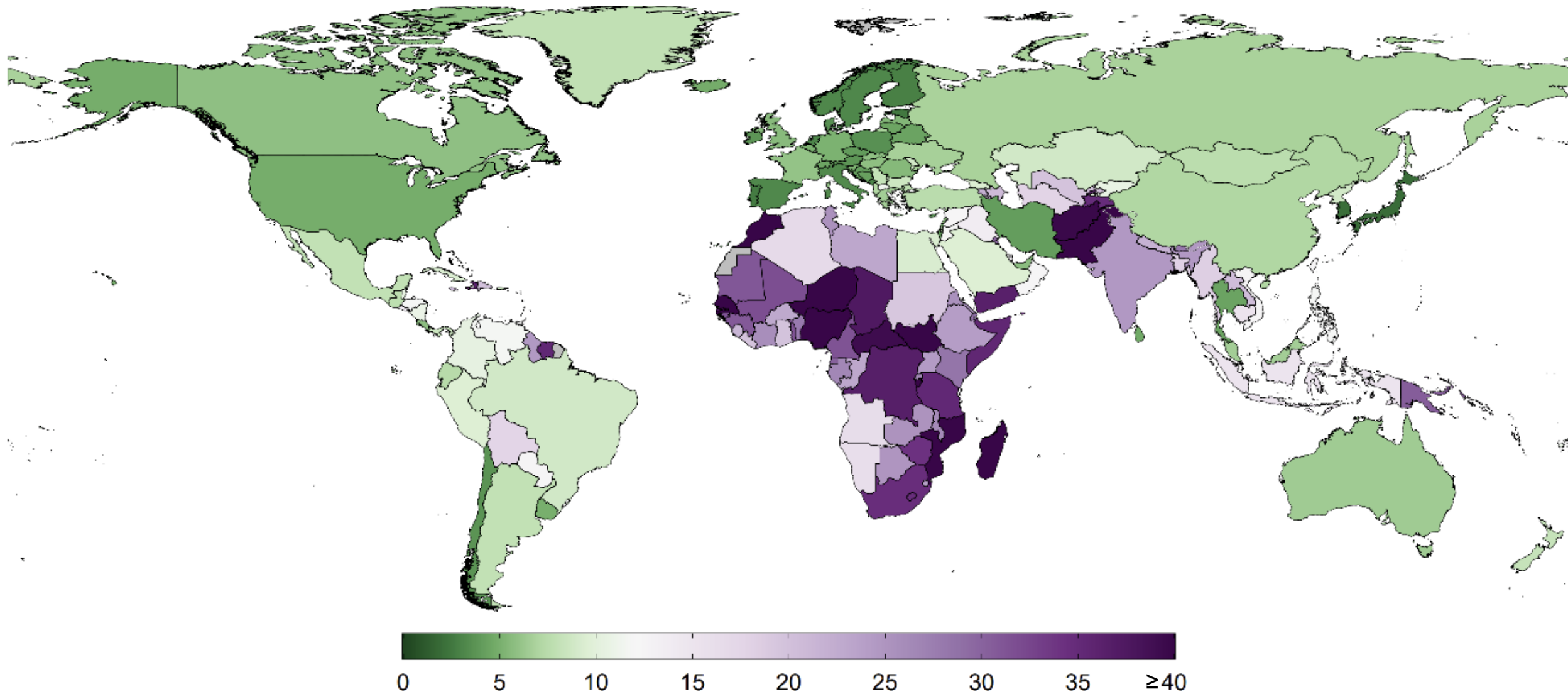
# Global Results for 2021

Gestational Threshold	Total Stillbirths (thousands)	SBR (per 1000 births)
20	3040 (2610–3620)	23·0 (19·7–27·2)
28	2110 (1820 to 2510)	16·1 (13·9 to 19)

- Nearly 1/3 of stillbirths were uncounted in the estimates when using the  $\geq 28$  weeks' definition
- Between 20 and 28 weeks' gestation is a crucial window for pregnancy loss

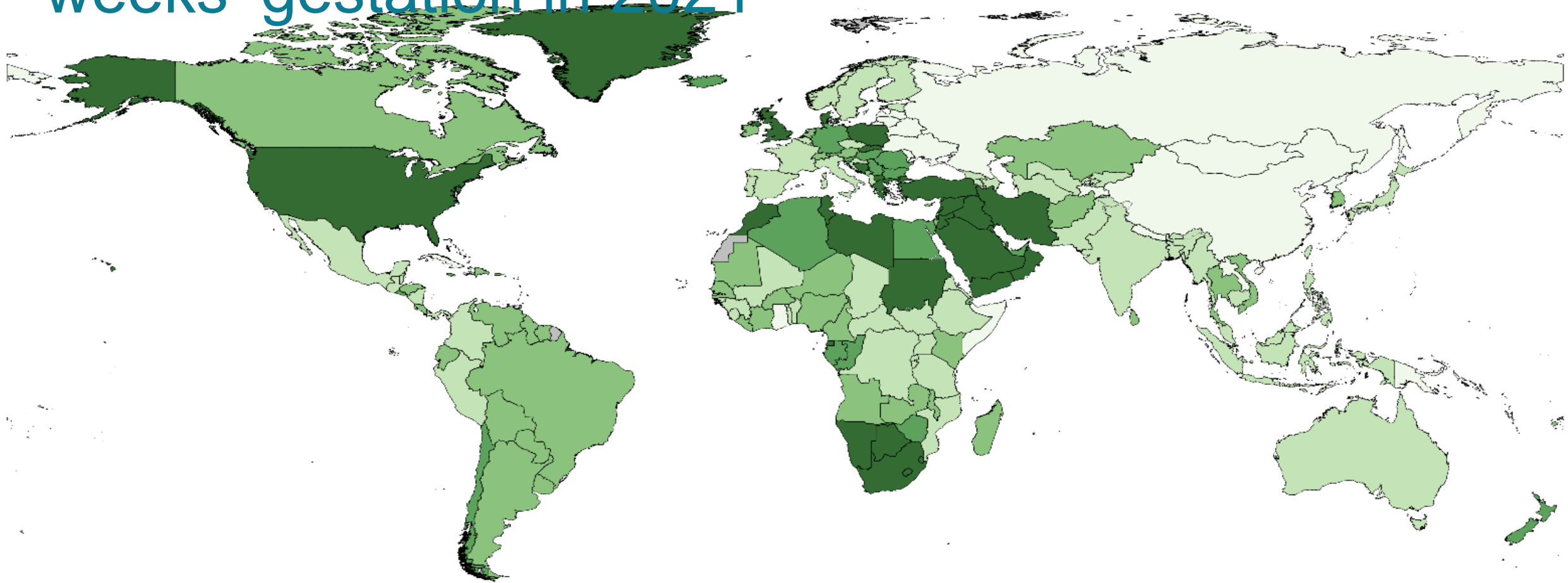


# SBR in 2021





# Percentage of stillbirths between 20 and <28 weeks' gestation in 2021



Less than 25% 25% to <30% 30% to <35% 35% to <40% Greater than 40%



# Summary

- First analysis to estimate all stillbirths at  $\geq 20$  weeks' gestation
- Accounting for different definitions is necessary to ensure accurate estimates and identify true global burden
  - Analytical strategy: data extraction  $\rightarrow$  crosswalking  $\rightarrow$  ensemble model  $\rightarrow$  ST-GPR
  - Number of stillbirths in 2021 increase from 2.1 to 3.0 million when including 20-28 weeks' gestation
- Addressing inequity in universal access to high-quality maternal care, especially antenatal care and delivery, is necessary to end preventable stillbirths



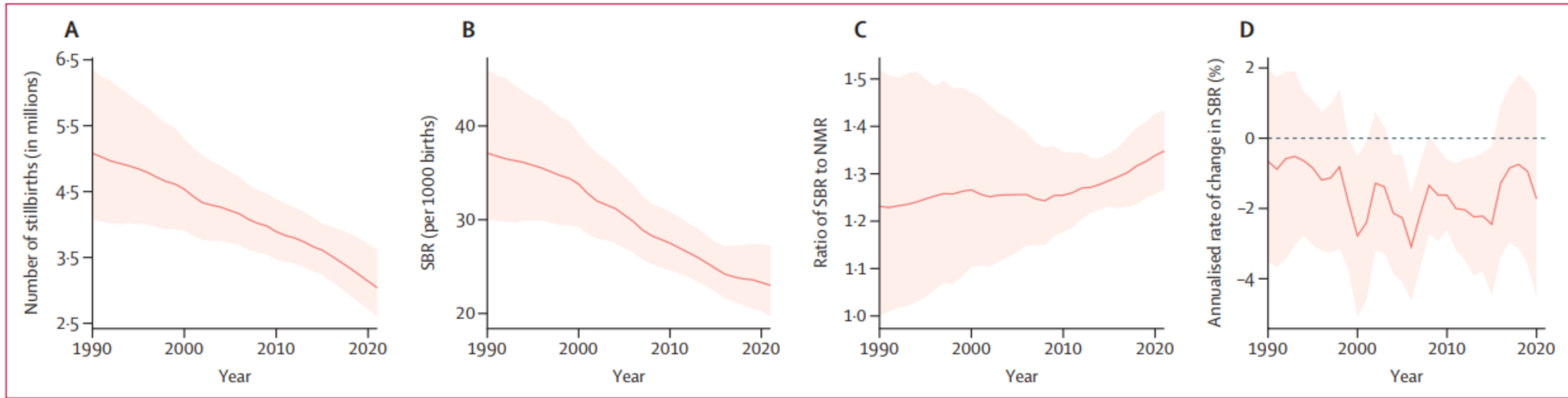
# Additional Slides

# Abstract

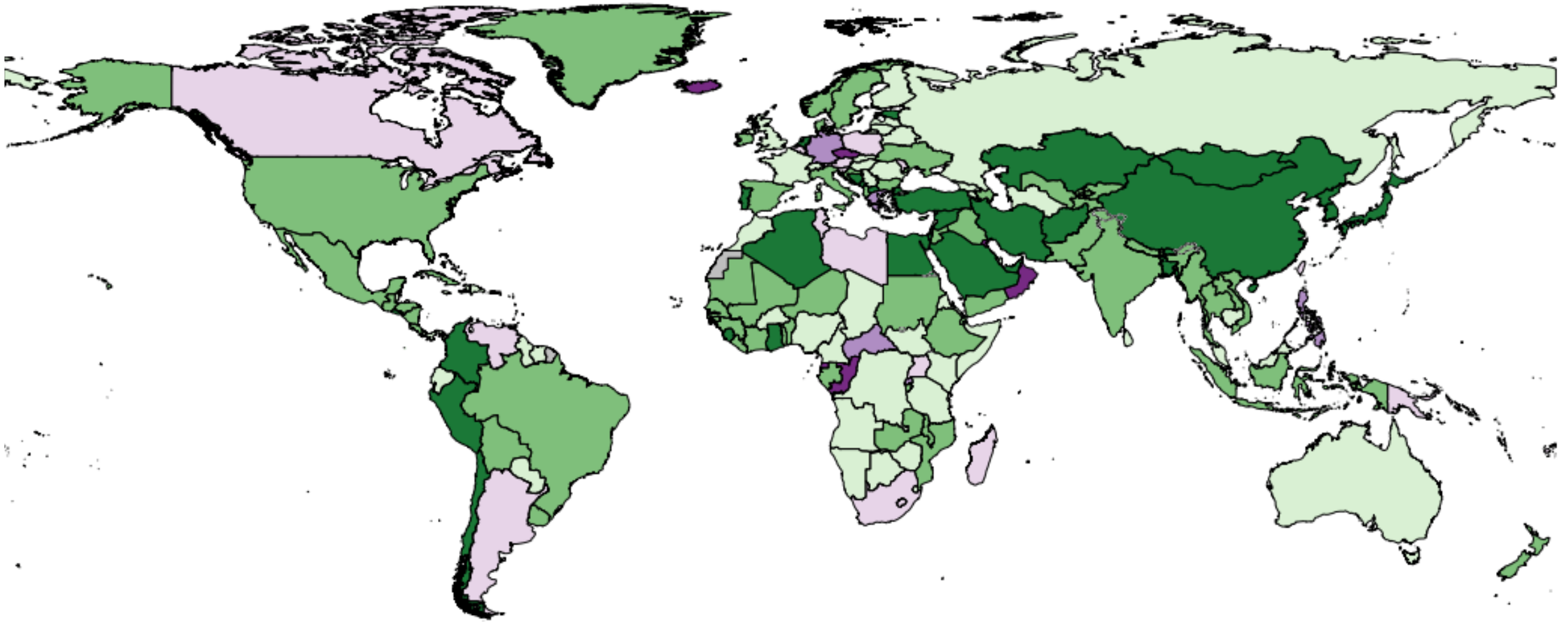
Monitoring stillbirth trends is imperative for continuing progress in pregnancy loss reduction. This study, part of GBD 2021, estimates all stillbirths  $\geq 20$ ,  $\geq 22$ , and  $\geq 28$  weeks' gestation for 204 countries and territories from 1990-2021. We extracted stillbirth data from 11,412 sources, adjusted for 11 different definitions, modelled the ratio of stillbirth rate / neonatal mortality rate using spatiotemporal Gaussian process regression, and used fertility and all-cause neonatal mortality estimates to calculate total stillbirths. In 2021, the global stillbirth rate at  $\geq 20$  weeks' gestation was 23.0 stillbirths (95% UI 19.7–27.2) per 1000 births, compared to 16.1 (13.9–19.0) at  $\geq 28$  weeks' gestation. There were 3.04 million (2.61–3.62) stillbirths, a 39.8% (31.8–48.0) reduction from 1990. Approximately 30.5% of stillbirths, close to 1 million in total, occurred at gestational ages between the  $\geq 20$  weeks and  $\geq 28$  weeks thresholds and are left uncounted when only measuring at the  $\geq 28$  weeks threshold.



# Figure 1: Global Trends, 1990-2021



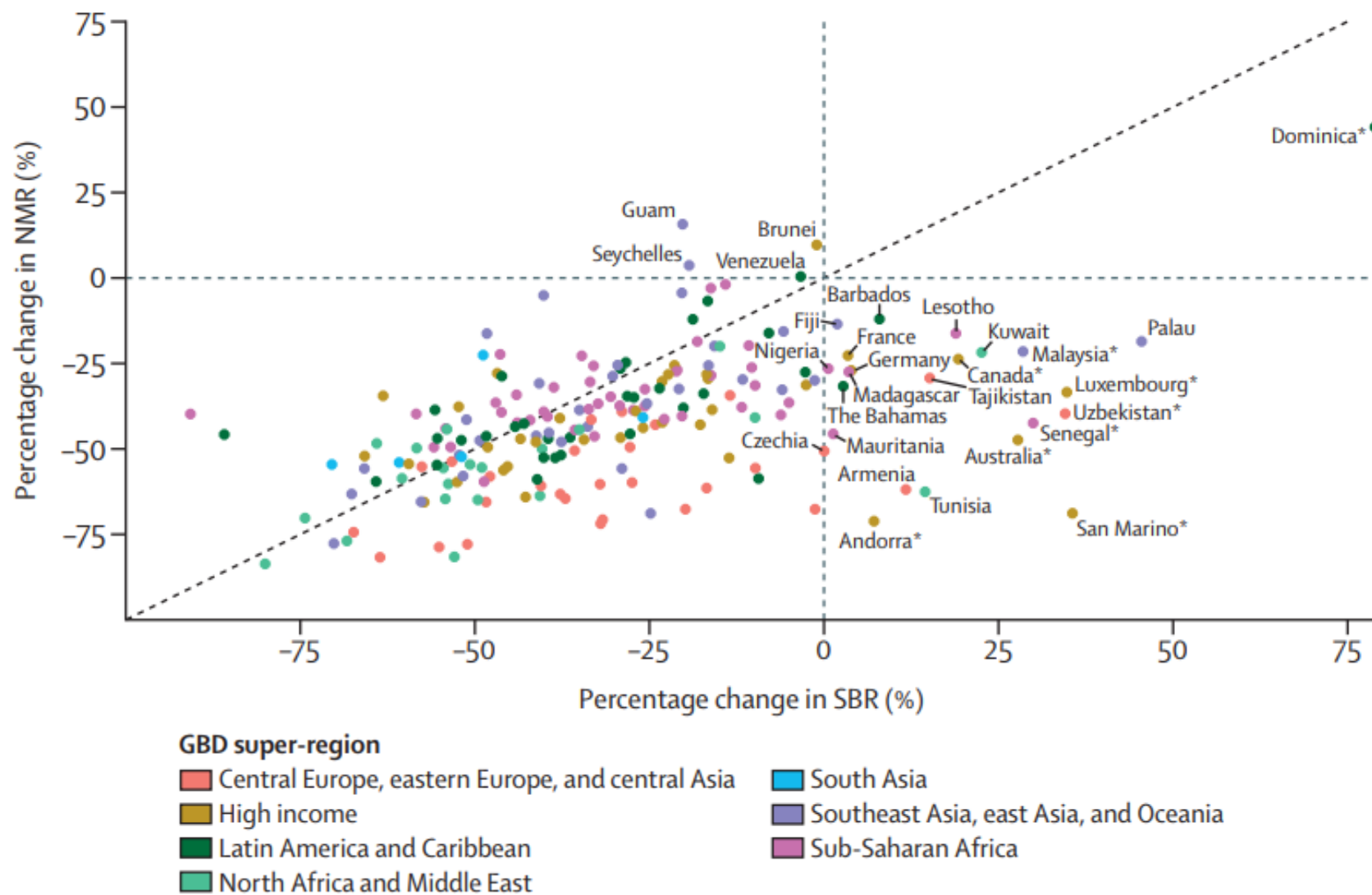
# Figure 2B: % Change in SBR, 2015 to 2021



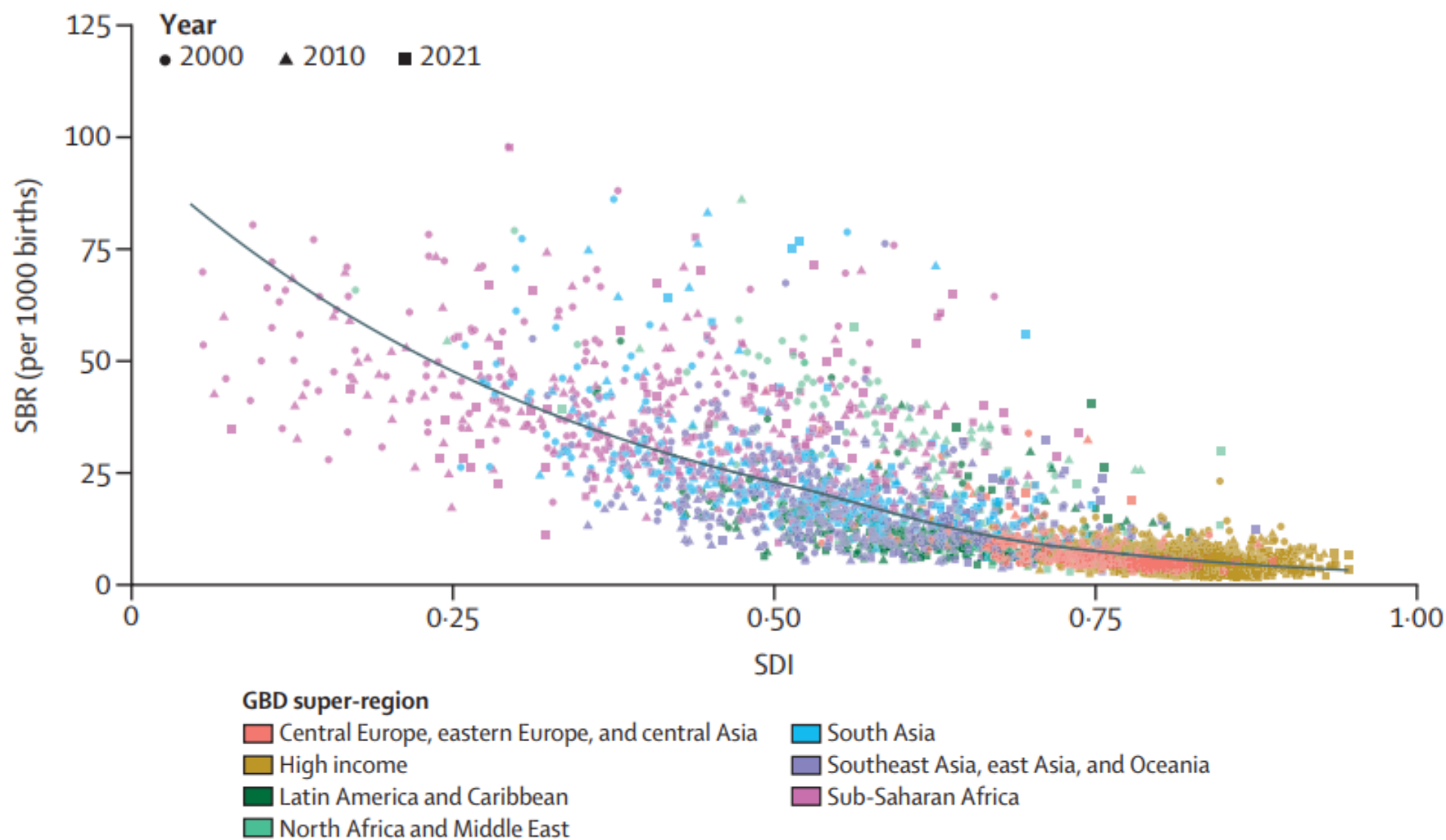
■ >20% Decrease ■ 10 to <20% Decrease ■ 0 to <10% Decrease ■ 0 to <10% Increase ■ 10 to <20% Increase ■ >20% Increase



# Figure 3A: % Change in SBR & NMR, 2000-2021

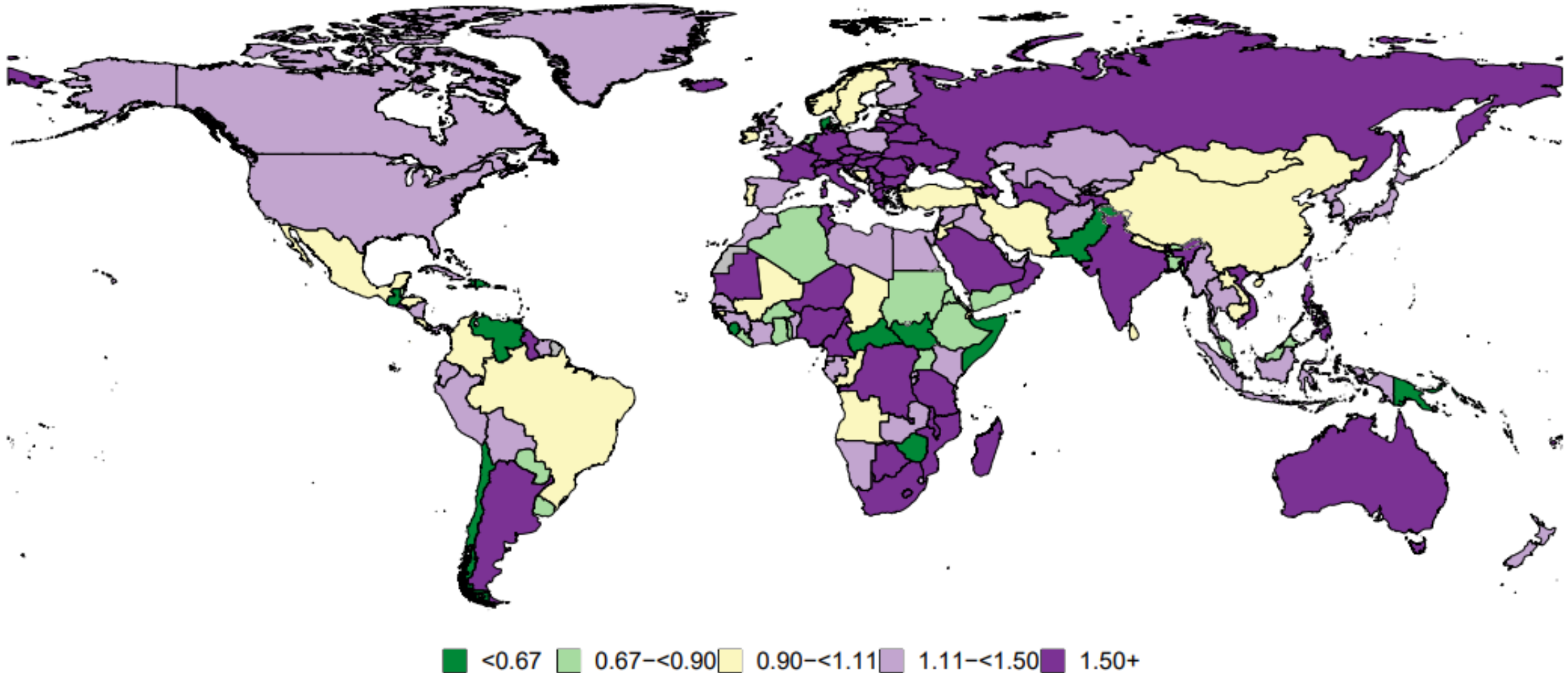


# Figure 3B: SBR and SDI Association, 2000-2021

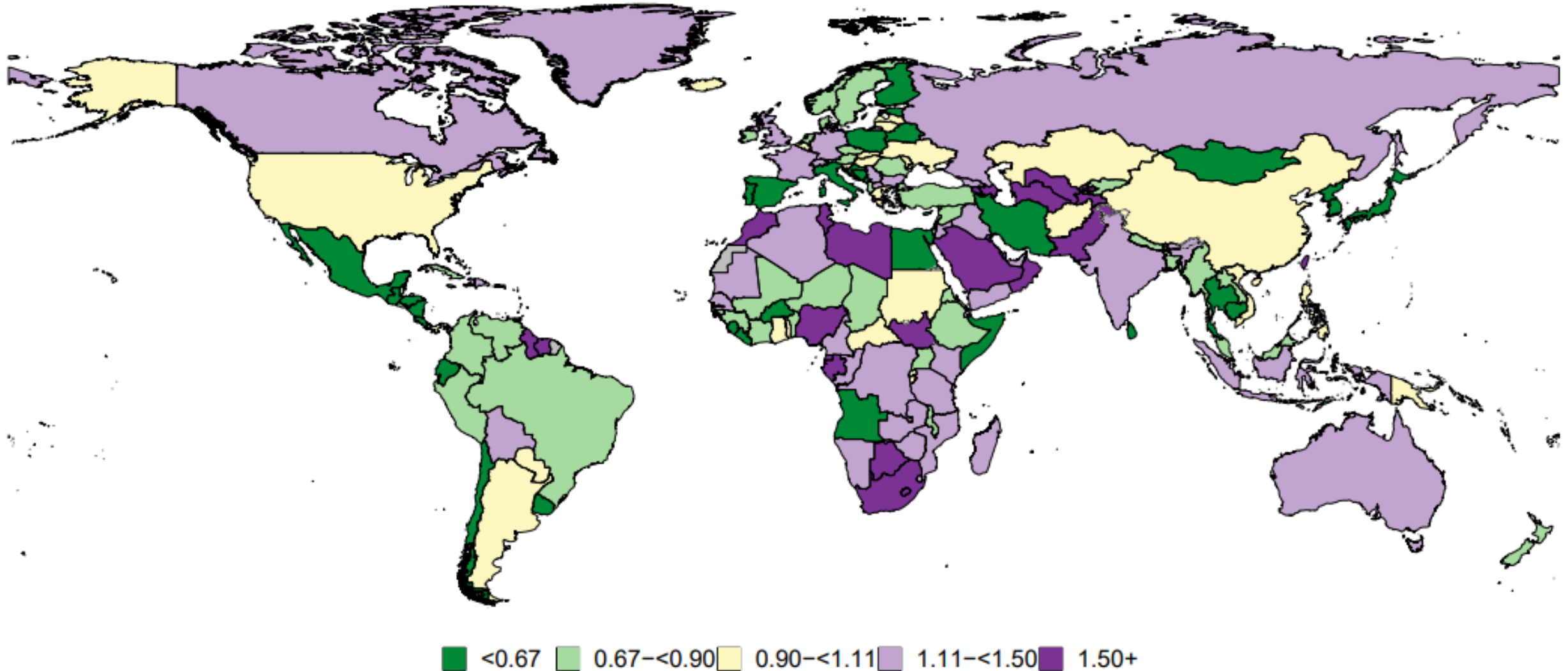




# Figure 4A: $\Delta\text{SBR} / \Delta\text{NMR}$ , 2000 to 2021



# Figure 4B: O:E SBR based on SDI, 2021



# Figure 4C: # Countries by SBR & NMR Performance

