

HEALTHY BIRTH, GROWTH & DEVELOPMENT

knowledge integration

December 5, 2017

From data to discovery to decision making: What we've learned from “Rallies”

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HBGDki data science

How do we progress in answering our research questions in an organized and efficient fashion?

- ~35 data scientists from ~19 organizations in ~6 countries
- Data covering more than 170 studies
- Over 60 prioritized HBGD research questions



Make sure we are focusing on the most important questions and using the right data



Maximize use of data scientist resources

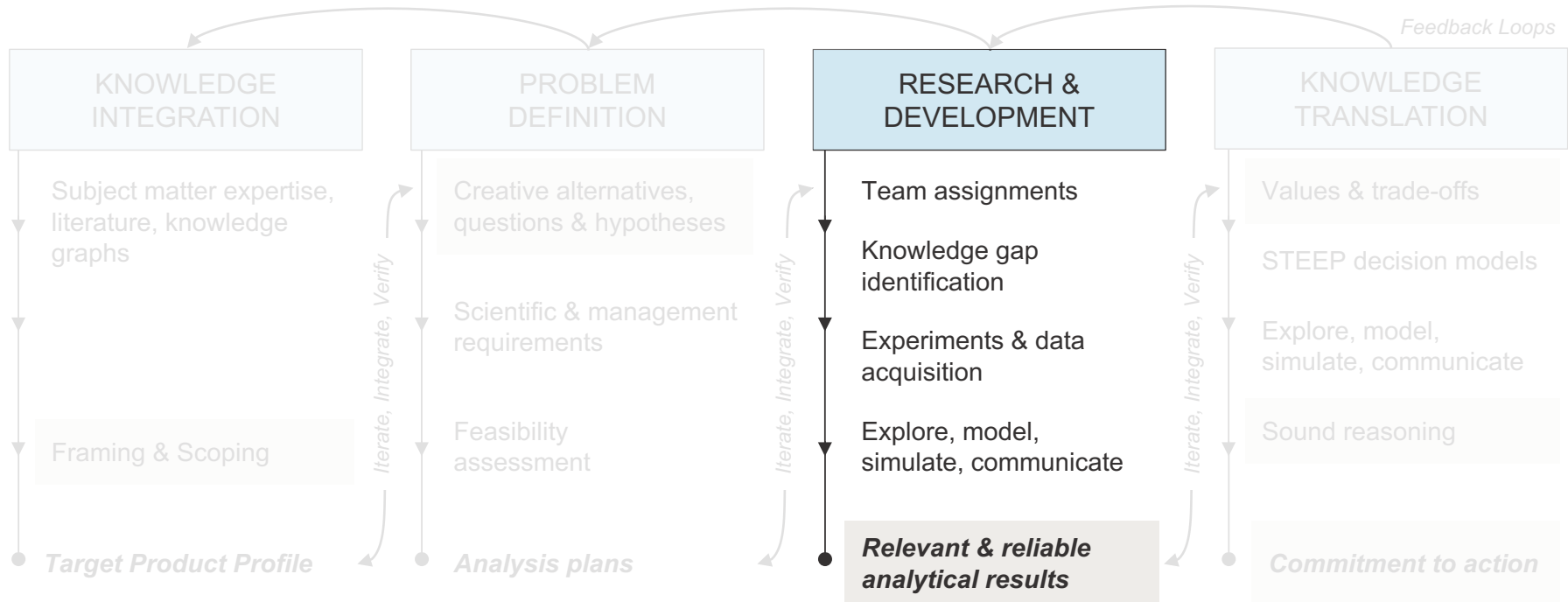


Be constantly informed by domain scientists



Capture and document all work performed

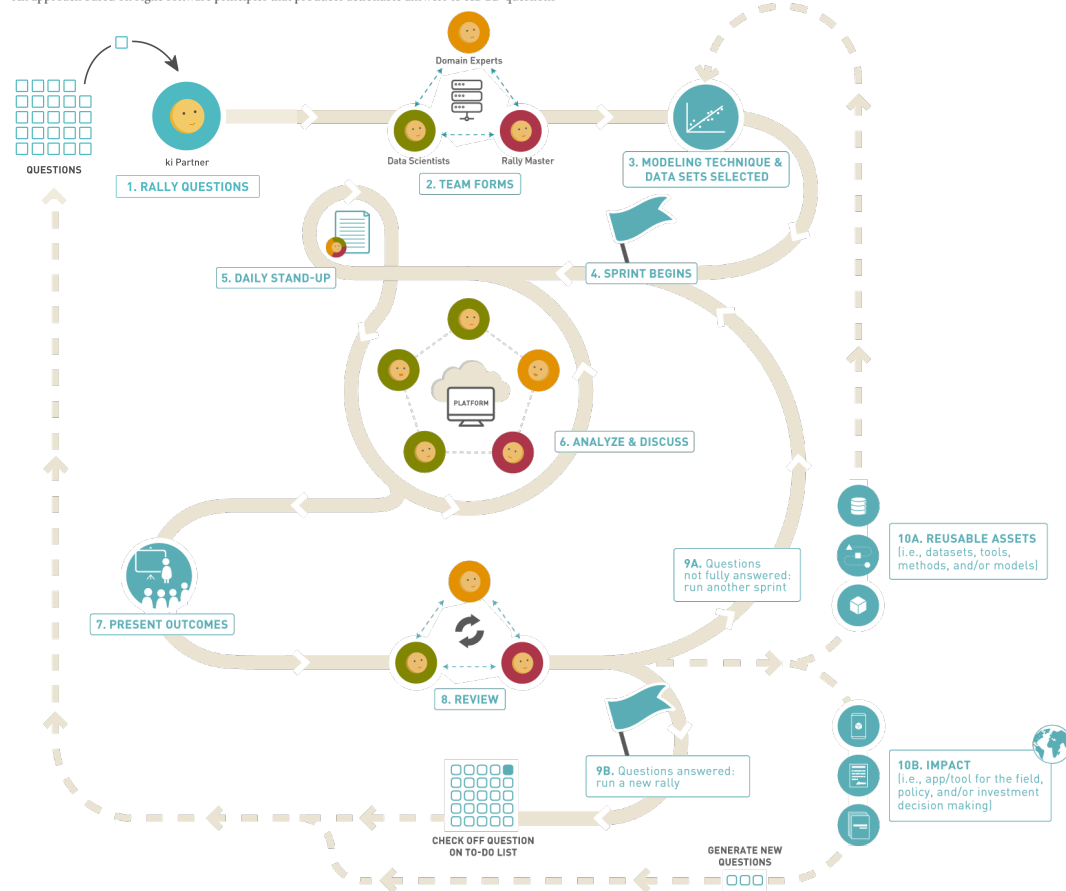
Rallies: A structured approach to research and development



STEEP: Societal, Technological, Environmental, Economic, and Political.

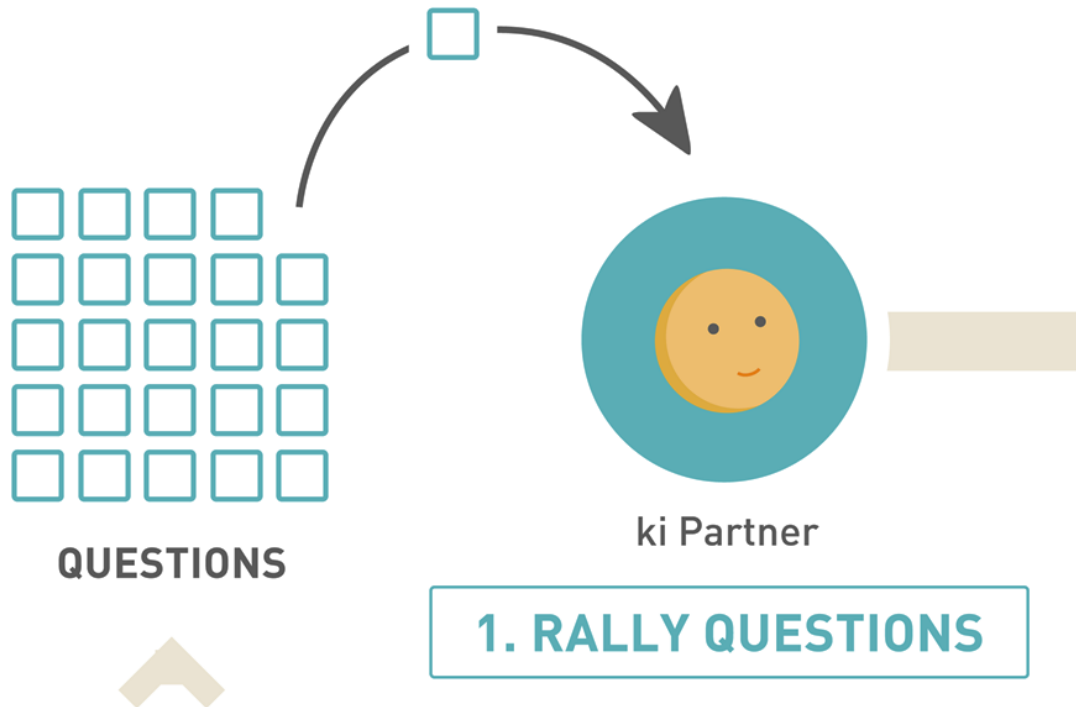
HBGDki data science rally process

An approach based on Agile software principles that produces actionable answers to HBGD questions



1. Rally Questions

- Domain expert forms the rally question(s) from the prioritized list of questions.
- This question is broken up into manageable pieces, each of which a small group of data scientists can interrogate in a small period of time.
- Each sub-question is addressed in a separate rally **sprint**, which is a 2-4 week period of focused work.
- Often the first sub-question is a deep evaluation and exploration of available datasets and the feasibility of the data and methods to be able to answer the question.



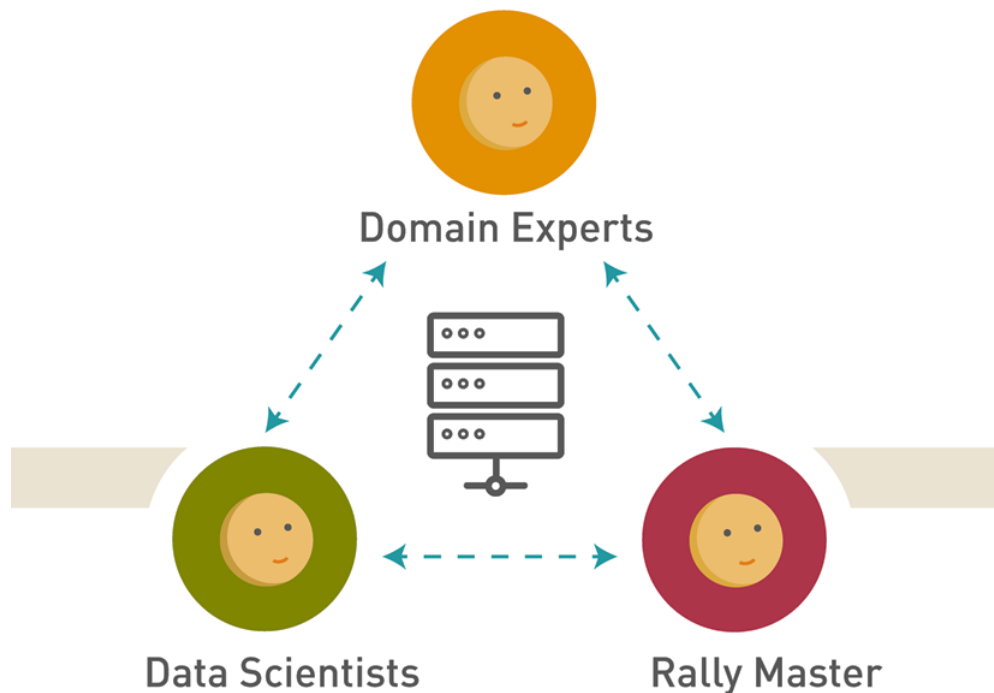
2. Team forms

Around the same time, a pre-rally planning meeting is held by the **rally team**.

Rally team:

- **Domain Experts:** help target the questions and guide the analysis throughout the rally
- **Data Scientists:** perform the data analysis
- **Rally Master:** guides the rally organization and keeps things working

All three roles are critical to a successful Rally.

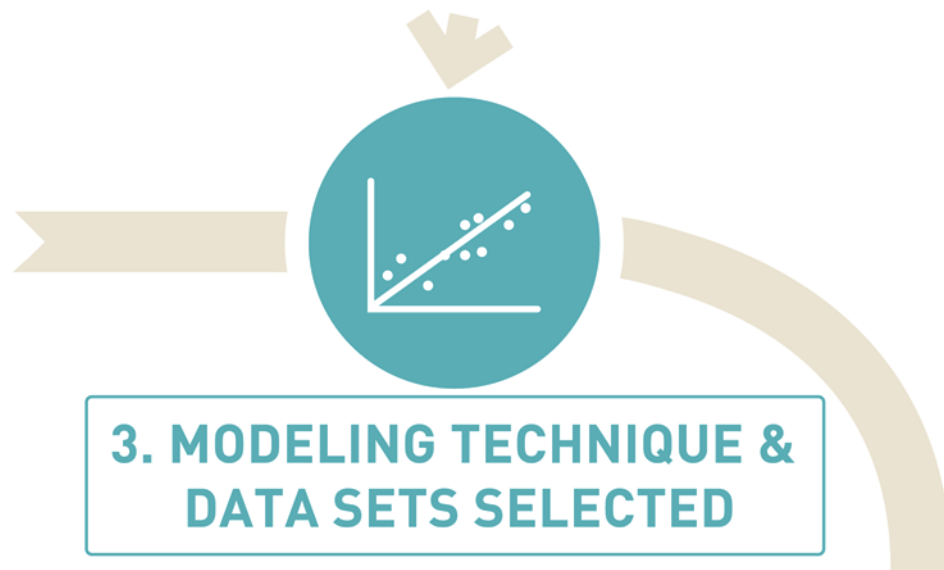


2. TEAM FORMS

3. Modeling techniques and data sets selected

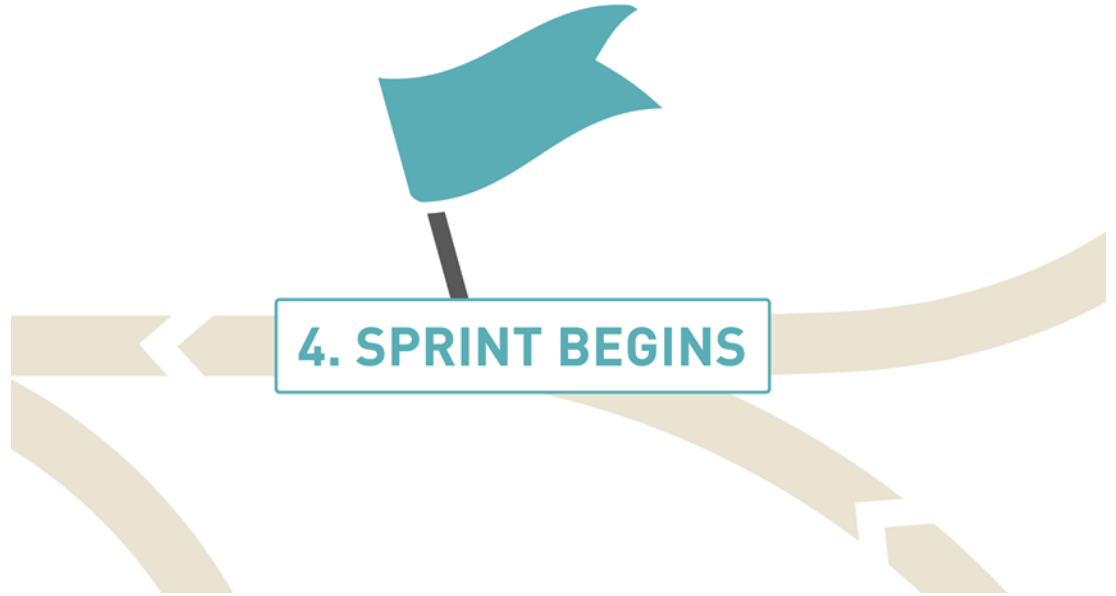
A preliminary analysis plan is established, which includes:

- Proposed statistical modeling techniques.
- Datasets that can be used to answer the question, including data both in the Global Health Analytics Platform's (GHAP) data repository, which contains over 170M observations from 174 studies, or from other sources if necessary.
- A determination as to whether the proposed datasets and methods are available and ready to use right away.



4. Sprint begins

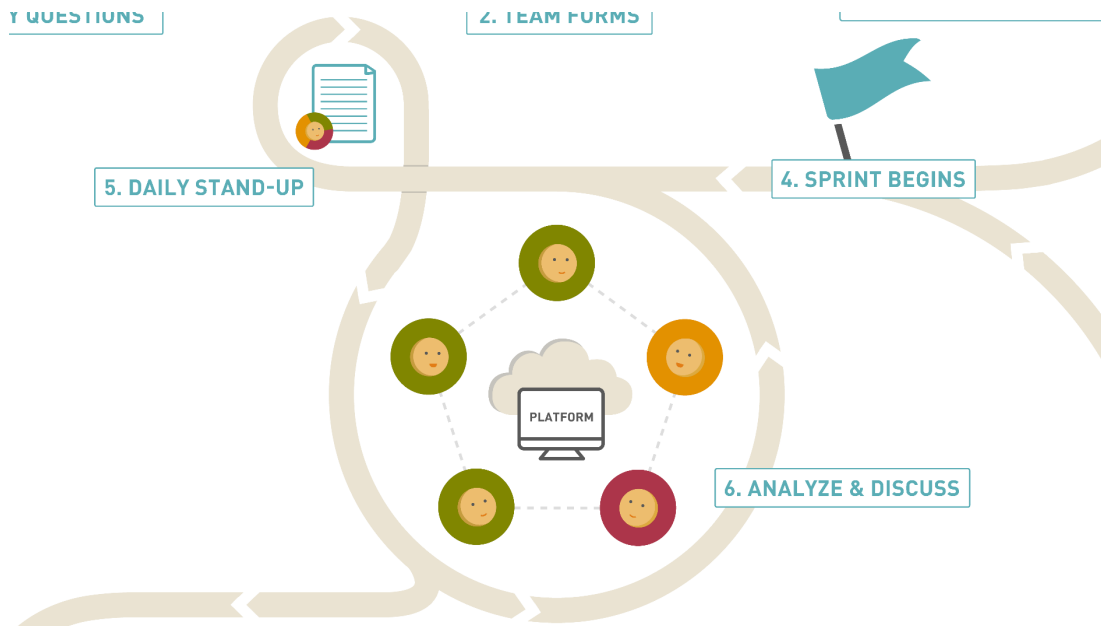
Each rally (represented by a number, i.e., Rally 1) is made up of a series of sprints (represented by a letter, i.e., Rally 1A) which will each last for about 2 to 4 weeks.



5. Daily stand-up

6. Analyze & discuss

- Throughout the sprint, data scientists analyze the data and intermediate results are discussed with domain experts.
- Every day members report on the rally's progress and any impediments. This meeting lasts 15 minutes or less.
- The data scientist / domain expert interaction drives iteration toward answering the rally question(s).
- As results are validated, rally members document the methods, results, and key findings in a rally template on Open Science Framework.



7. Present outcomes

- At the end of each sprint, the results are presented to a working group of stakeholders in the research questions.
- Feedback from the stakeholders is noted and used in the review process to determine next steps for the rally.



7. PRESENT OUTCOMES

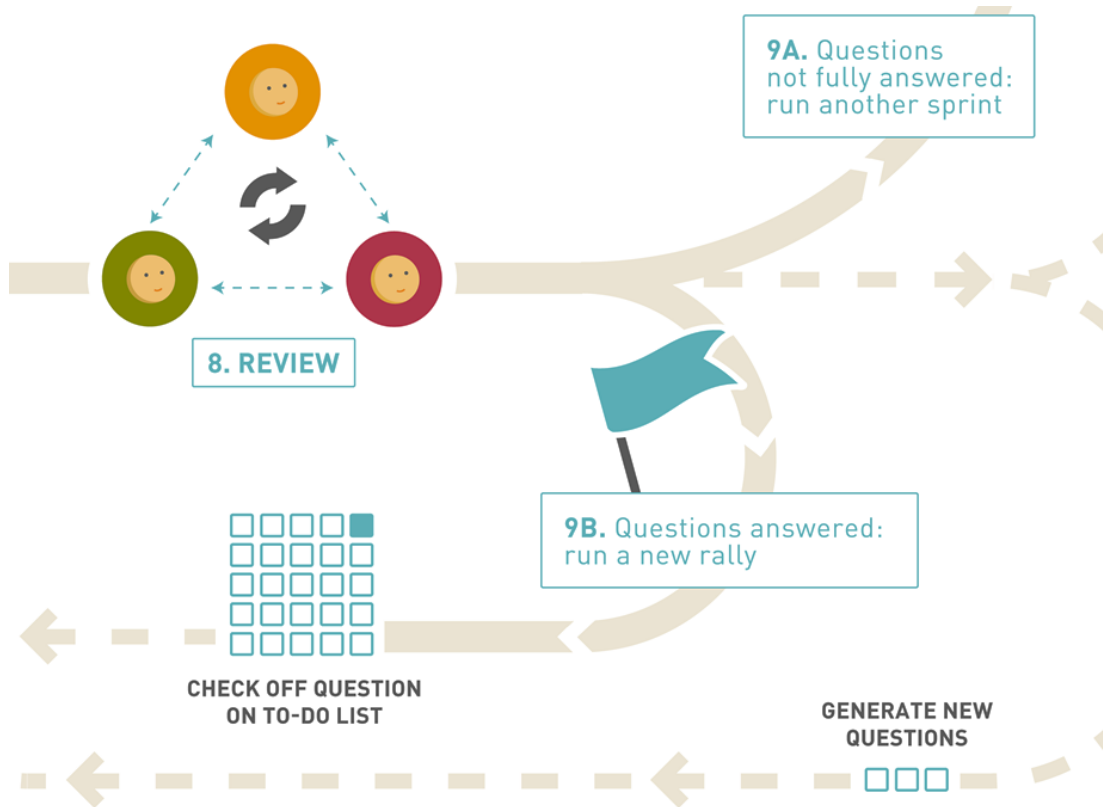
8. Review

9. Question

In a post-sprint meeting, rally team members reflect and review to inform future sprints or rallies.

Following this point, there are three paths to go down:

- Continue with another iteration of the same rally
- Start a new, different rally
- End the rally when all the questions have been answered



10. Reusable assets and external impact

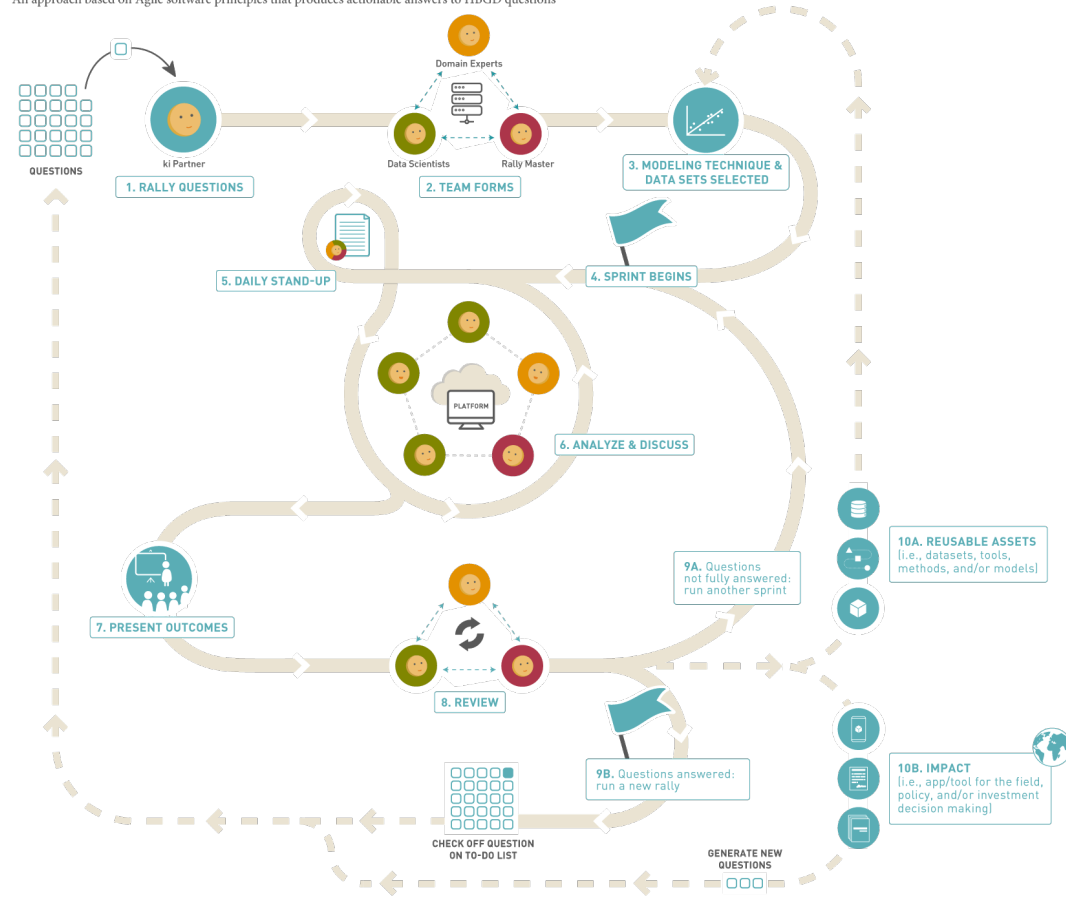
When a rally has been completed, it is only useful if it generates outcomes of value. These can include one or both of the following:

- Reusable assets such as tools, models, and methods (A)
- Artifacts for external impact such as apps / tools for the field, a publication, and / or insights to inform policies (B)



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What have we learned about the rally process?

Is it effective?

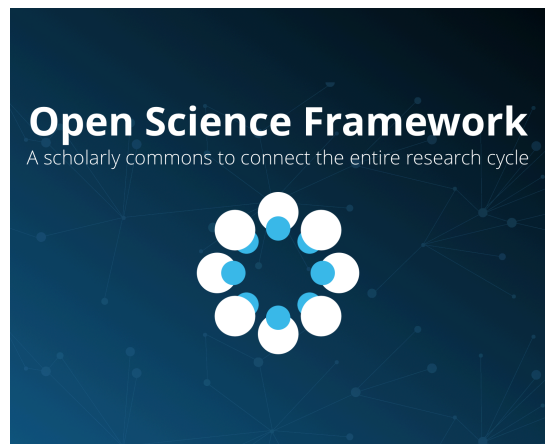
- Engagement with domain experts has been much stronger under the rally model
- The organization and planning enforced by rallies has promoted focus on priority research questions
- The structured documentation imposed by rallies has led to better communication and organizational awareness of work that has been done

Insights for improvement:

- ✓ Rally duration and mode of communication needs to be tailored to the team and the problem
- ✓ Deep, broadly defined R&D efforts may not fit well into the rally structure

Rally infrastructure: Analysis, artifacts, collaboration, and reporting

Analysis artifacts (e.g., plots, tables, reports) are centrally stored, shared, and discussed in the Open Science Framework (OSF) <https://osf.io>



Rally information is documented and tracked in a rally master template, collaboratively filled out by the rally team as a wiki page on OSF.

```

42 - ## Rally Title
43
44 [id: title]
45 [description: The title of the rally - be descriptive.]
46 [content_type: single line]
47 [required: true]
48 [assignee: rally master]
49 [due: rally kickoff]
50
51 Accuracy and Precision in Gestational Age Measurement: Physical Assessment Tools
52
53 - ## Rally Focus
54
55 [id: focus]
56 [description: What is the focus for this rally?]
57 [content_type: single paragraph]
58 [required: true]
59 [assignee: rally master]
60 [due: rally kickoff]
61
62 Improve the postnatal estimation of gestational age in order to determine preterm
63 birth rates and small for gestational age rates with the goal of 90% to be ± 2 weeks
64 across the gestational age spectrum to 28 weeks out to 42 weeks. Evaluate across
65 sites and by sex.
66
67 - ## Tags
68
69 [id: tags]
70 [description: A comma-separated list of terms that describe the rally.]
71 [content_type: comma separated]
72 [required: true]
  
```

The information in the rally master template is used to **generate many outputs**, including rally overviews and a rally dashboard.

HBGDki Rally Dashboard

0 Active Sprints and 9 Completed Sprints from 4 Rallies

Sort: Most Recent | Text Filter: search text in any fi | Participant Filter: | Tag Filter: | View Active Sprints Only: ☐

Showing 9 of 9

<p>Rally 5. GA Shift Analysis</p> <p>Sprint A. Gestational Age Shift Analysis</p> <p>Focus: The focus of this first two-week rally sprint: using US data, if we could shift the gestational age of 26-29 week-olds by 1, 2, 3, 4 weeks, what would be the impact on mortality?</p> <p>Participants: Jeff Murray; Zach Charat; Jayson Wilbur; Ramon Garcia; Kathleen Parsons;</p> <p>Tags: gestational age, neonatal mortality</p> <p>Start Date: 2017-09-25 - End Date: 2017-10-10</p> <p>Status: Complete Overview PPT OSF</p>	<p>Rally 4. Wasting</p> <p>Sprint D. Wasting Analysis Clean-Up and Documentation</p> <p>Focus: In this rally, we will: 1. Clean up and document prior analyses. 2. Verify accuracy of incidence calculations against simulated data with a known incidence rate. 3. Combine prior analysis results with a more extensive literature review in</p> <p>Participants: Ken Brown; Ben Arnold; Andrew Mertens; Jack Colford; Alan Hubbard; Oleg Sofrygin;</p> <p>Tags: data checking, documentation, planning</p> <p>Start Date: 2017-09-25 - End Date: 2017-10-10</p> <p>Status: Complete Overview PPT OSF</p>
<p>Rally 4. Wasting</p> <p>Sprint B. Plot of the Analysis of Birth Outcomes for</p>	<p>Rally 4. Wasting</p> <p>Sprint C. Plot of the Analysis of Birth Outcomes for</p>

Demonstration

Rally highlights

Rally 1: Gestational Age Estimation	1A	1B			
Rally 2: Fetal Growth Patterns		2A	2B		
Rally 3: GA Estimation Ultrasound					
Rally 4: Wasting		4A	4B	4C	4D
Rally 5: GA Shift Analysis					5A
	n 2017	Jul	Aug	Sep	Oct

Rally 1

Accuracy and precision in gestational age measurement: physical assessment tools

Goals / Questions:

- Improve the postnatal estimation of gestational age in order to determine preterm birth rates and small for gestational age rates with the goal of 90% to be ± 2 weeks across the gestational age spectrum from 28 weeks out to 42 weeks.

Data:

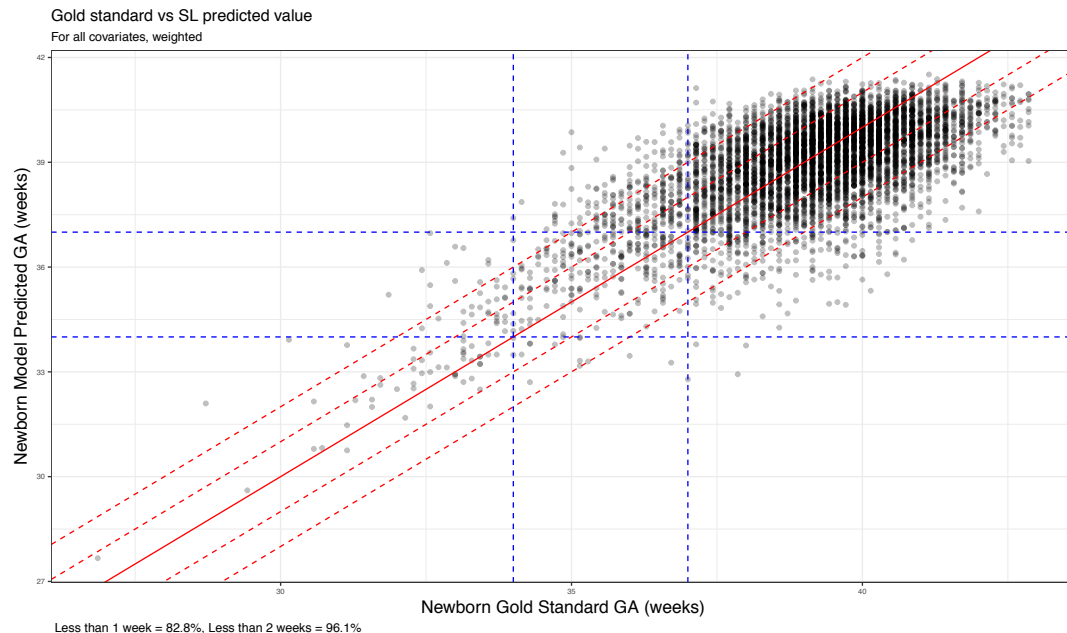
- Alliance for Maternal and Newborn Health Improvement (AMANHI) Objective #3 study, 6204 subjects.
- Sites: Bangladesh, 1733 subjects; Pakistan (Karachi), 2273 subjects; Tanzania (Pemba), 2198 subjects.

Methods:

- Super Learner: a prediction method designed to find the optimal combination of a collection of prediction algorithms.

Rally 1: Selected results

Group	Within ± 7 days (%)	Within ± 14 days (%)	90% within (days)	95% within (days)
Overall	82.8%	96.1%	10.1	13.0
Term (n=5596)	88.5%	97.9%	7.2	10.5
Late Preterm (n=508)	58.5%	83.1%	17.1	20.8
Early Preterm (n=87)	72.4%	86.2%	16.9	24.3
Bangladesh	86.0%	96.1%	9.3	13.3
Karachi	87.1%	96.3%	8.2	12.0
Pemba	84.3%	97.1%	9.3	12.3
Male	84.4%	96.1%	9.5	13.1
Female	87.3%	97.0%	8.3	11.2
SGA (Weight)	46.0%	78.9%	17.8	21.1
AGA (Weight)	65.7%	94.8%	12.2	14.1
LGA (Weight)	47.5%	80.4%	17.7	21.4

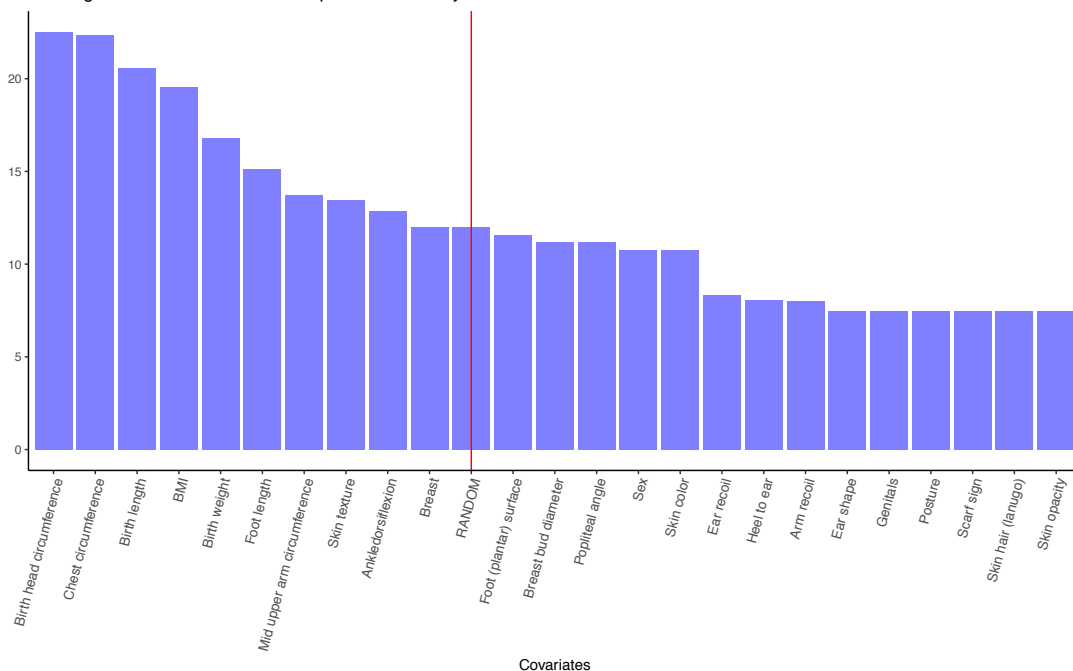


Key takeaway: Preterm & SGA kids not quite ± 2 weeks

Rally 1: Selected results

Predictors	Within ± 7 days (%)	Within ± 14 days (%)	90% within (days)	95% within (days)
Full Model	82.8%	96.1%	10.1	13.0
Top 10 predictors	84.0%	96.1%	9.5	12.9
Size measures + Sex	85.9%	96.5%	9.0	12.5
Ballard measures + Sex	50.8%	82.4%	17.2	20.8
WT, LN, HC + Sex	43.5%	74.9%	20.9	25.5

Ranking of Covariates included in Super Learner Analysis



Key takeaway: Most useful measurements are anthropometry and easy to perform

Rally 2

Fetal growth: One size fits all?

Goals / Questions:

- Are SGA/LGA proportions different across countries?
- Construction of population growth curves combining all available datasets and comparison with intergrowth standards

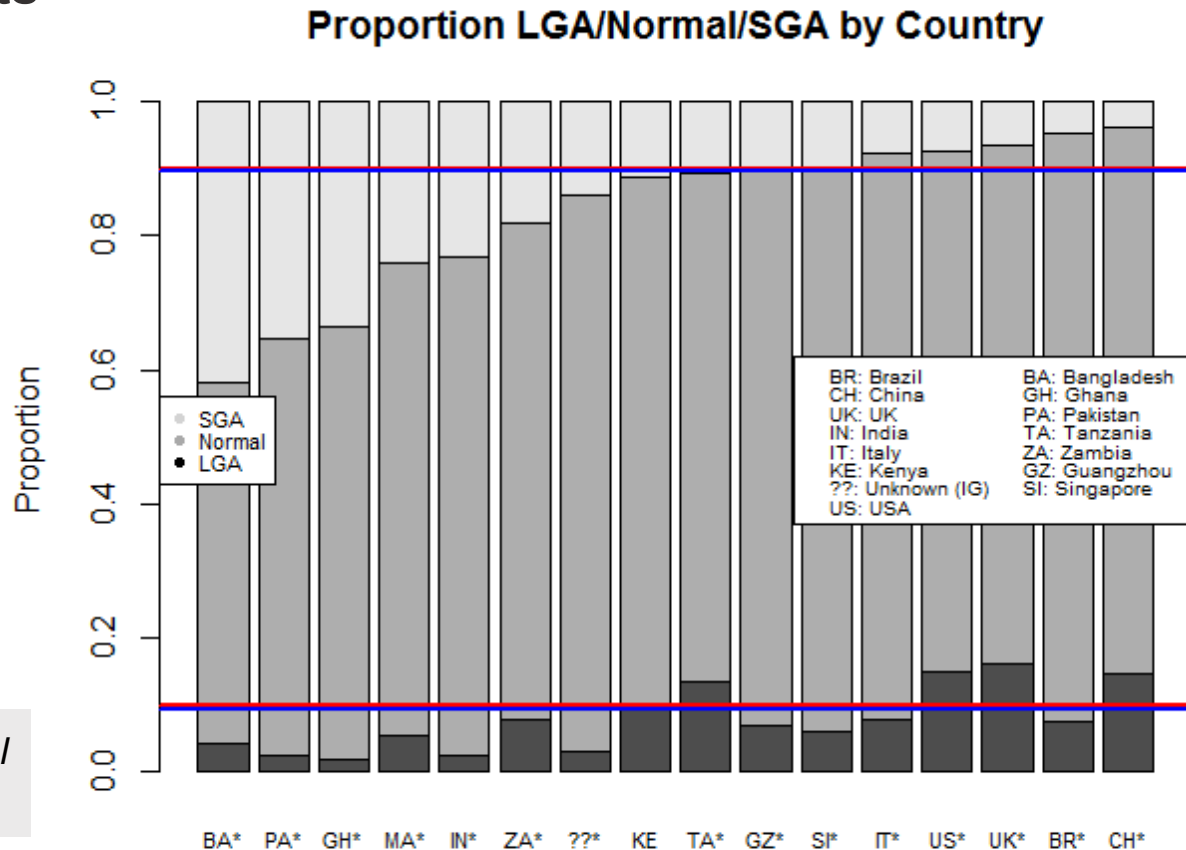
Data:

- Intergrowth-21 (8 countries)
- Guangzhou (China)
- Malawi
- GUSTO (Singapore)
- AMANHI (5 countries)

Methods:

- Exploratory analysis and nonparametric function estimation methods (FPCA) to model growth curves

Rally 2: Selected results



Key takeaway: SGA / LGA / Normal varies greatly by country

Rally 4

Descriptive epidemiology of wasting

Goals / Questions:

- How does incident wasting and recovery vary over region and child age?
- What characteristics are associated with incident wasting and recovery?
- What are the effects of nutritional intervention on wasting and recovery?

Data:

- Data from 35 studies representing 43 cohorts and ~123,000 children
- Only studies representing low- or middle-income countries measuring weight and height multiple times in the first 24 months and that are representative of their respective populations.

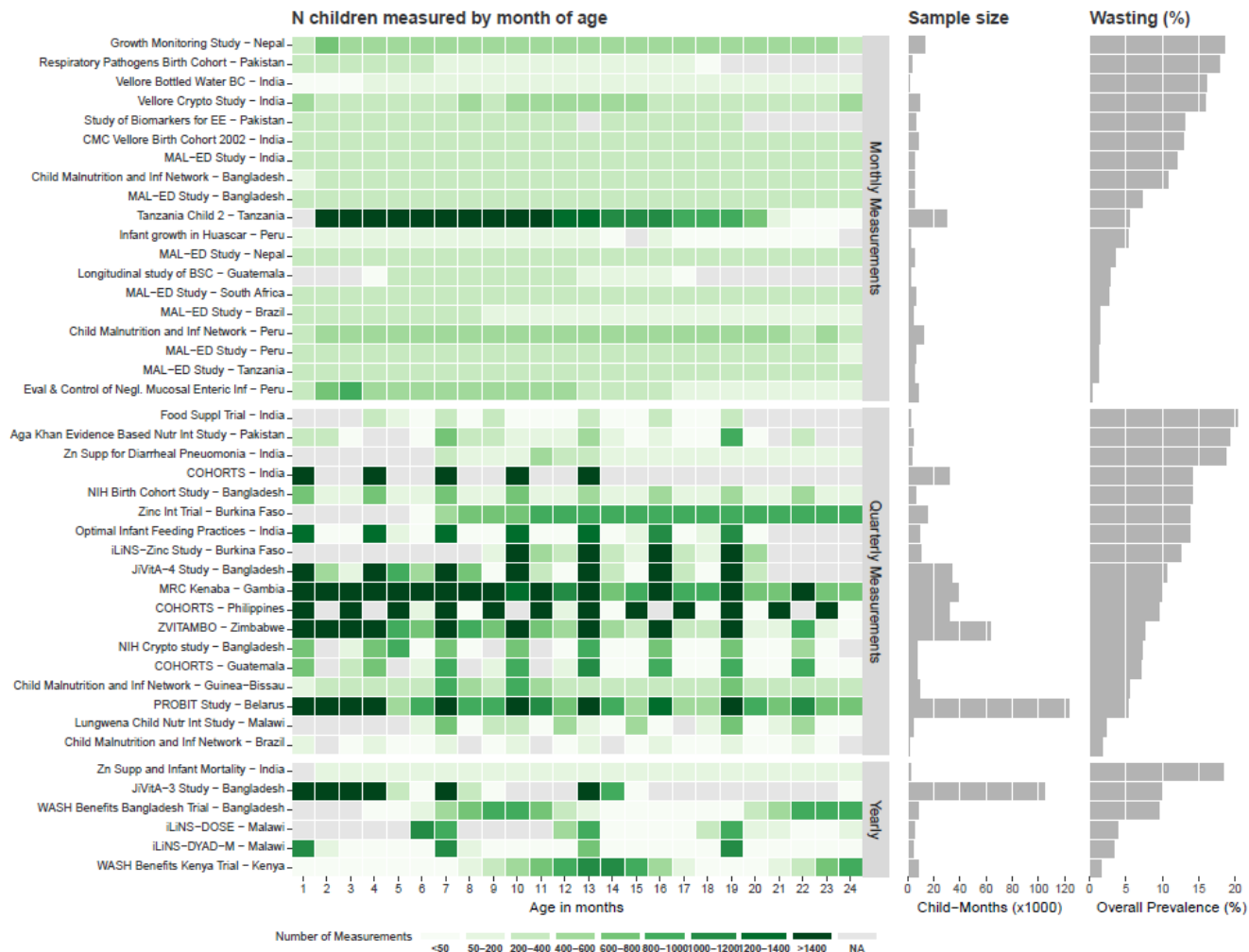
Methods:

- A systematic review of the data sets in GHAP to look for data sets with longitudinal measurements and monthly anthropometric measurements from the kids.
- Descriptive statistics and visualizations to look at the incidence of wasting between the identified studies and recovery from wasting.

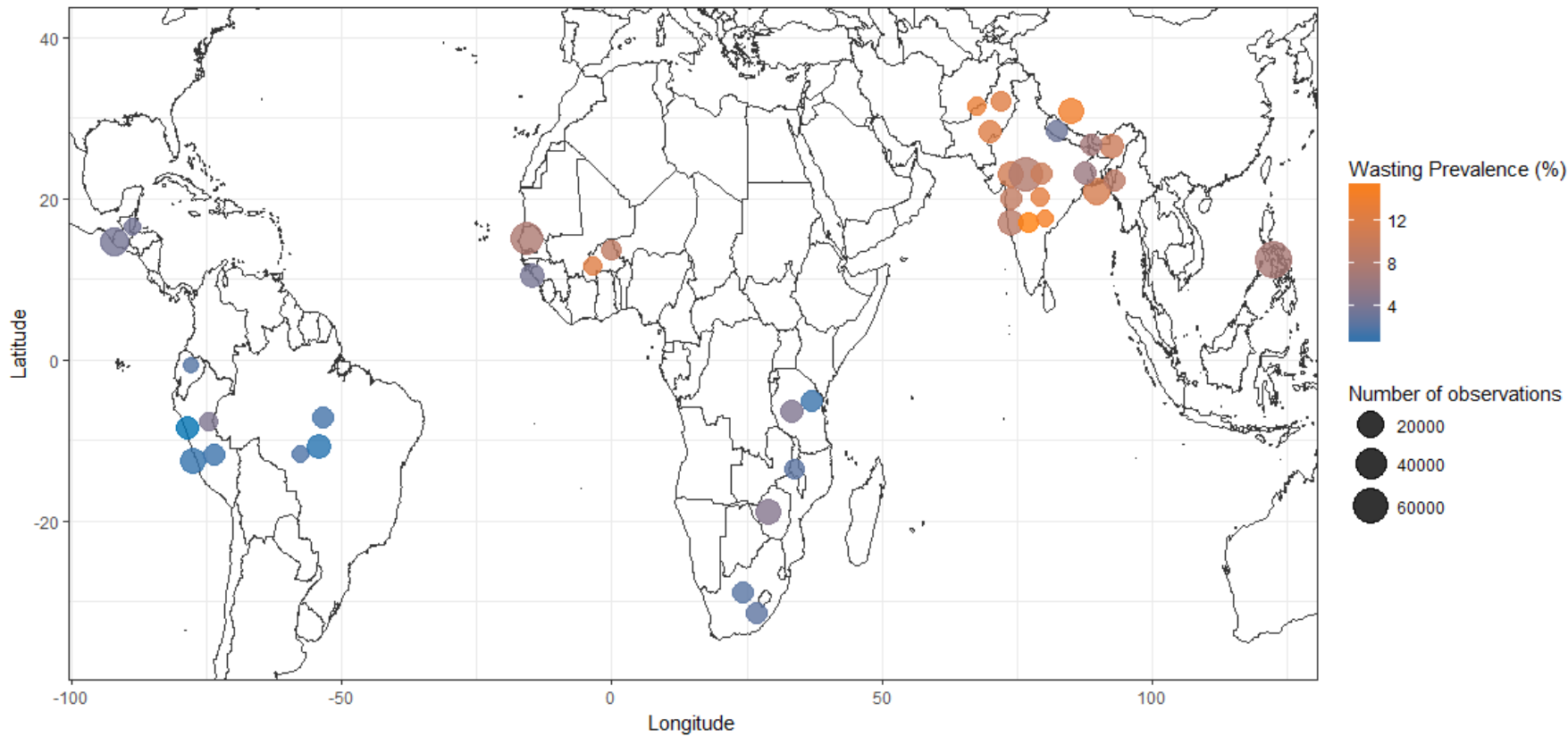
Rally 4: Data

Included all longitudinal cohorts with anthropometric measurements meeting the following criteria:

1. Conducted in low- or middle-income countries.
2. Measured weight and height between birth and age 24 months.
3. Did not restrict enrollment to acutely ill children.
4. Enrolled at least 200 children.
5. Collected anthropometry measurements at least every month, at least every 3 months, or at least every year.



Rally 4: Regional variation in wasting prevalence

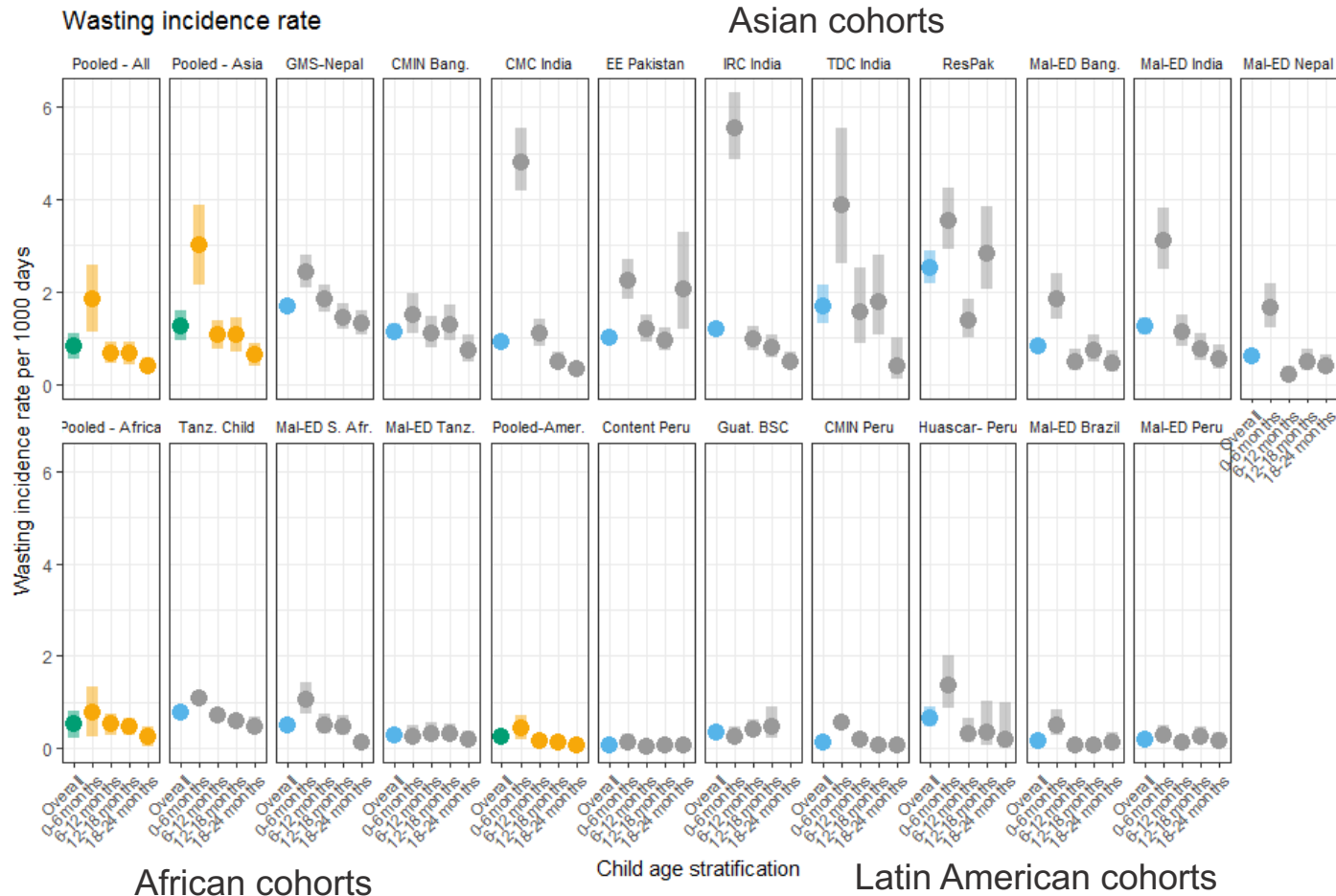


Rally 4: Wasting Incidence Rates

- Highest rates in 0-6 months in most monthly-measured cohorts
- Higher rates in south Asia and more pronounced peak early in life

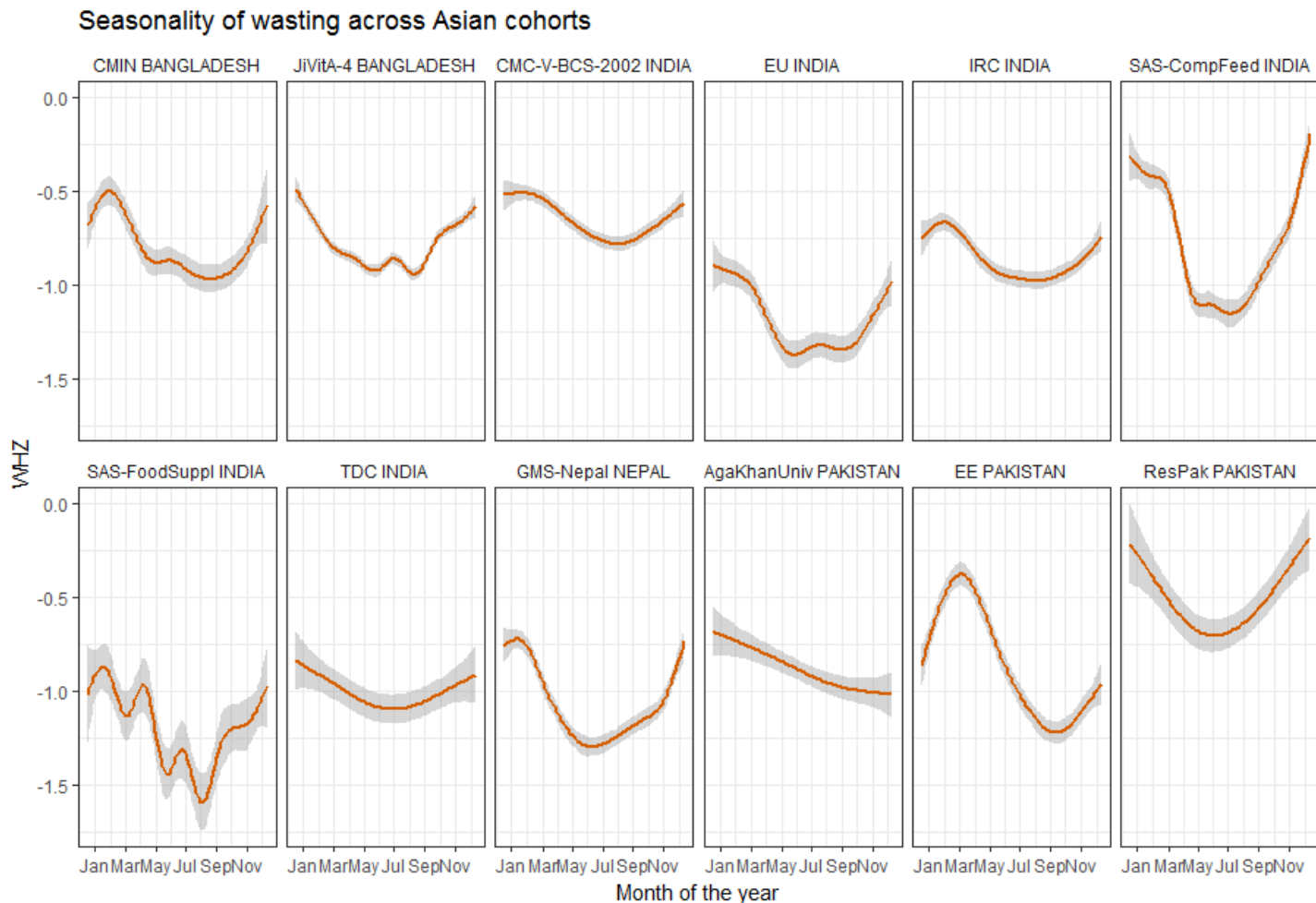
Legend

- Pooled unstratified
- Pooled age stratified
- Unstratified
- Age stratified



Rally 4: Consistent Seasonality

- Consistent and strong trough around June-July in south Asian cohorts
- Size of trough varies across cohorts
- Up to a full standard deviation change between seasonal minimums and maximums

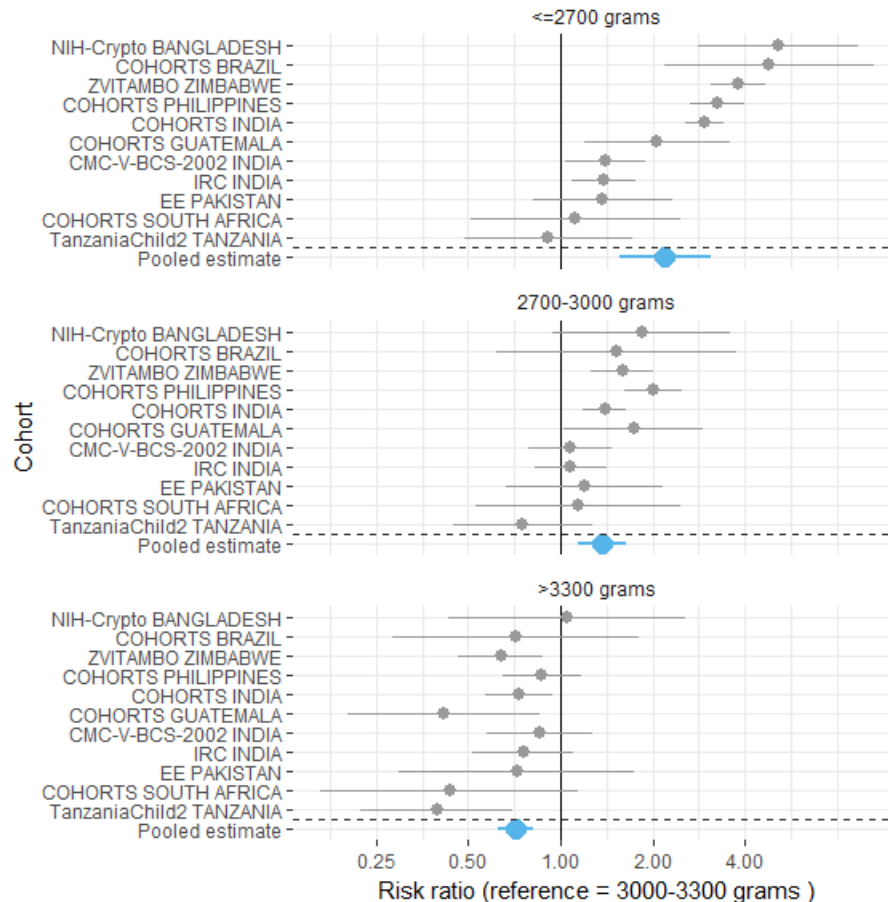


Rally 4: Key results

Preliminary analysis:

- Risk ratio of any wasting by 6 months associated with **birthweight quartile**
- Reference category of third quartile: 3000-3300 grams
- Lower birthweight associated with higher probability (risk) of wasting.

Cumulative incidence ratios:
Any wasting from 0-6 months age



Rally 5

Gestational Age Shift

Goals / Questions:

- If a GA-lengthening intervention is introduced to preterm pregnancies that are at risk for morbidity and mortality, what will be the global impact on morbidity and mortality?”
- If we could shift GA at birth of 26- to 29-week-old fetuses by 1, 2, 3, or 4 weeks, what would be the impact on mortality?

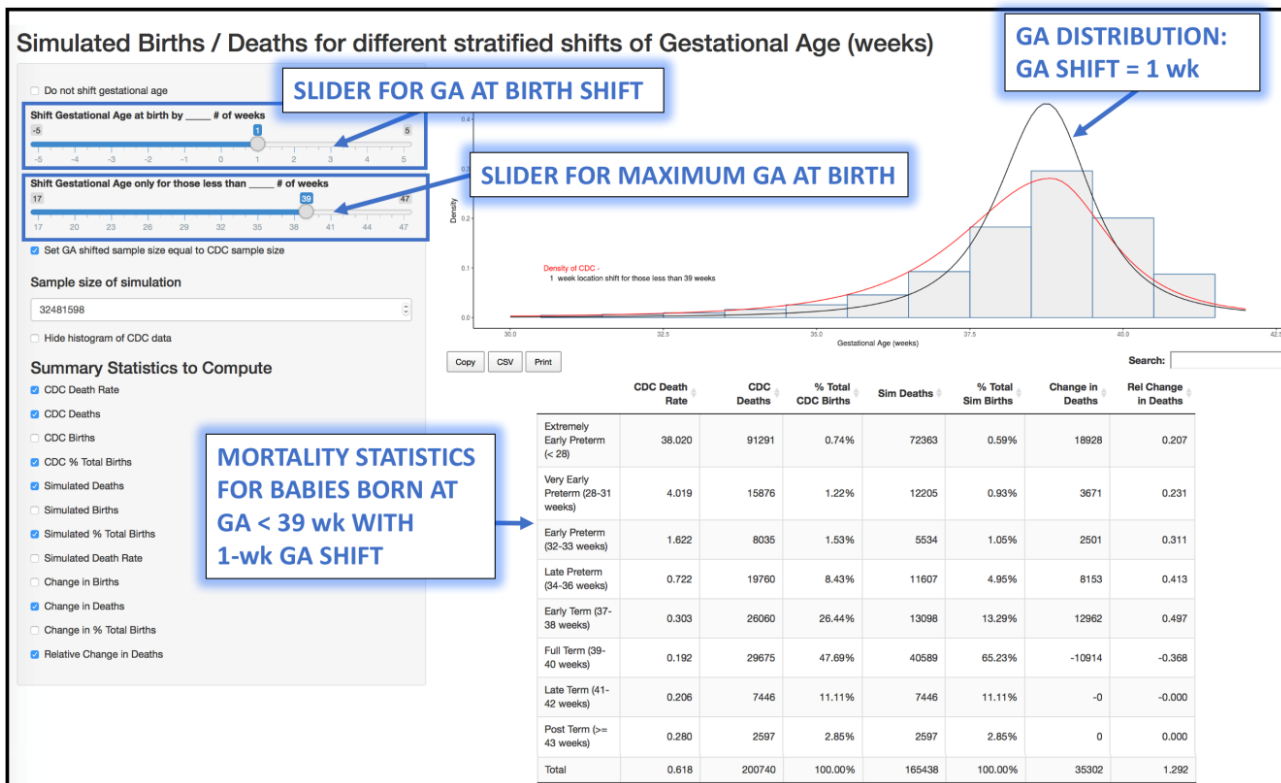
Data:

- United States Centers for Disease Control and Prevention (CDC) Linked Birth / Infant Death Records (2007-2014) provided estimates of the distribution of GA at birth and mortality.
- Alliance for Maternal and Newborn Health Improvement (AMANHI) Objective 3 (ki1119716) data were used to characterize the functional form of the distribution of GA at birth.

Methods:

- Using the CDC data, GA at birth of live births was approximated using a skewed Student *t*-distribution to enable asymmetric distributions of GA at birth. CDC birth and death data were used to calculate mortality rate ($[\text{No. of deaths}/\text{No. of births}] \times 100\%$) for various GA categories.

Rally 5: GA Age Shift Application



Q&A