# WASH BENEFITS

## Introduction with focus on Height-for-Age Measurement

Methods and Rationale (how + why)

The WASH Benefits Team

# Topics



- Brief Overview of WASH Benefits
- Height-for-age (HAZ): How + Why
  1. What is the target population for intervention?
  2. How should we measure length?
  3. How should we measure age?
  4. How frequently should we measure height?

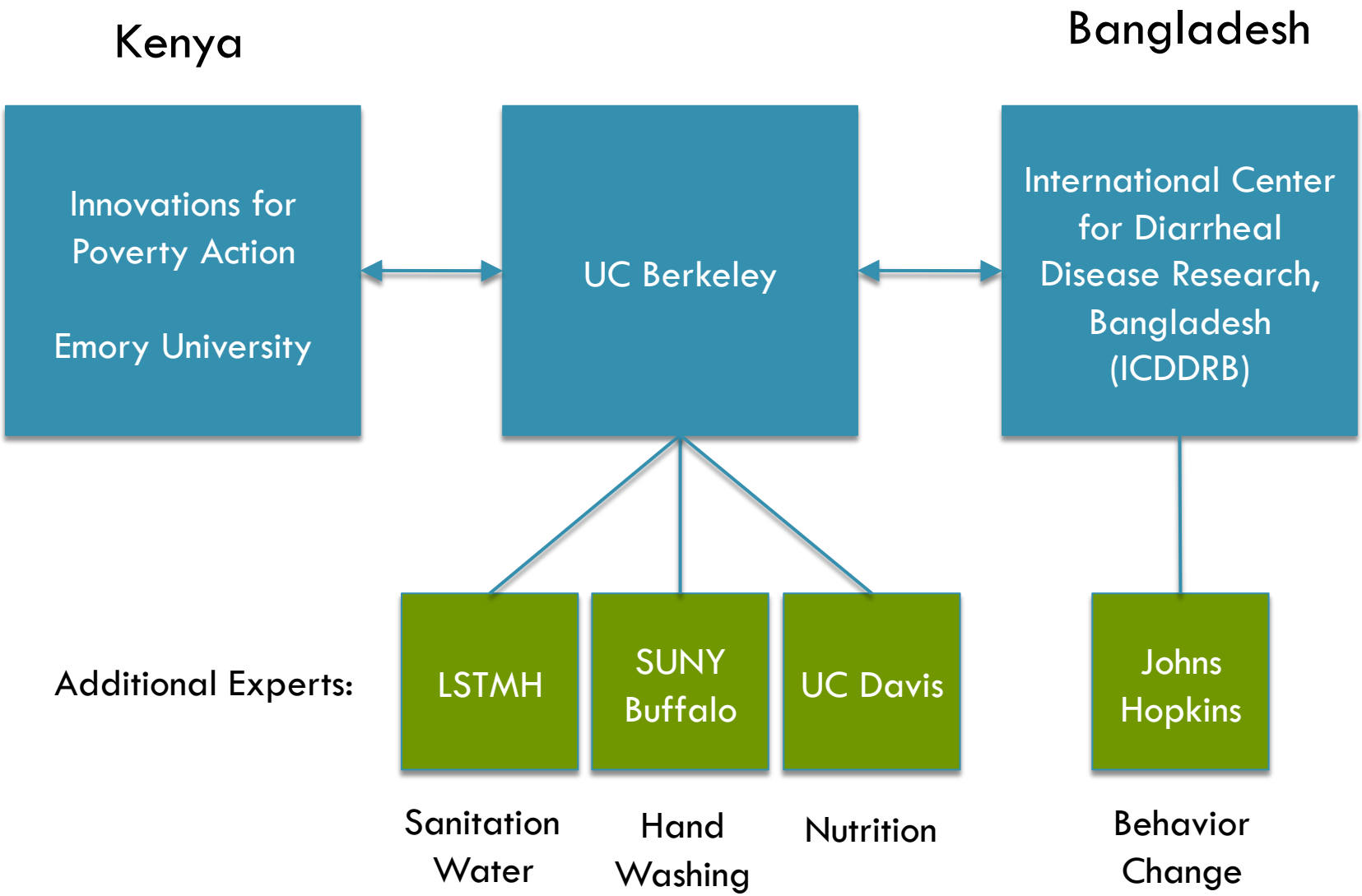
# WASH Benefits: Goals



- Measure the impact of sanitation, water quality, and handwashing interventions on child growth and development
- Determine whether there is added benefit to providing combined interventions compared to single interventions
- Primary outcomes
  1. Child height-for-age (length-for-age)
  2. Child development at 21 – 30 months (motor, verbal, personal/social)
  3. Acute diarrhea

# WASH Benefits: Team





# Study Design



- Villages will be randomized into 5 different arms
- We are actively considering the addition of 2 nutrition-related arms (pending funding*)
- Plan to enroll 7,500 children < 6 months in ~750 villages in each country and measure them 3 times over 2 years

# Rural Environments – but very different



Kenya
Distributed household compounds
Drier conditions, higher elevation

Bangladesh
Highly clustered baris
Water everywhere, low elevation

# Sanitation
# Household hardware + promotion



Example from Kenya:

Sani-scoop
("kipupu")

Child
Potties

Improved latrines
(slabs)

# Water Quality: Hardware + promotion



## Kenya

Community Source Chlorine Dispensers

## Bangladesh

Household candle or ceramic filters

# Handwashing: Hardware + community promotion



## Kenya

Dual "Tippy Taps"
(water + soapy water)

## Bangladesh

Soapy water bottles next to hand pumps

# Why measure HAZ in WASH studies (1)



- It is an objective outcome
  - Avoids the problems of caregiver-reported illness

- Relatively stable – not temporally and spatially hyper-variable like diarrhea
  - Can characterize individual children well with a small number of measurements

# Why measure HAZ in WASH studies (2)



- It captures impact from multiple types of infection that WASH interventions attempt to interrupt:
  - Acute diarrheal episodes (Checkley 2008)
  - Intestinal parasitic infections (numerous, e.g., Checkley 1998)
  - In theory: chronic nutrient malabsorption and immune system stimulation from repeated ingestion of fecal bacteria (Environmental Enteropathy) (Lunn 2000)
- Why HAZ vs. raw height measurements?
  - HAZ is a common metric to help standardize across populations and studies with different age distributions
  - "Stunting" is defined using HAZ ($< -2$ Z)

# What is the target population for interventions that hope to improve HAZ?



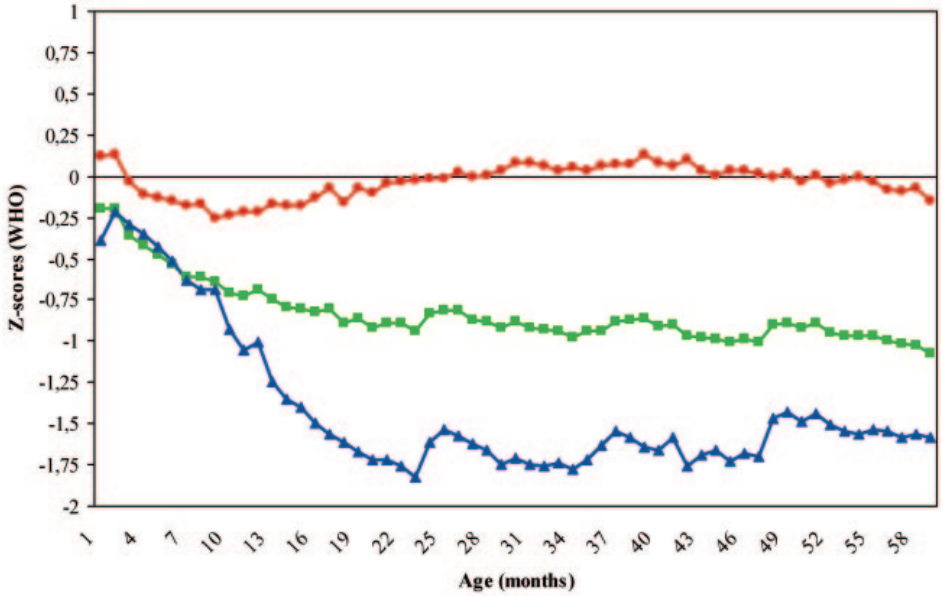
- **Enroll children < 6 months or in their 3rd trimester**
- **Why enroll children so young?**

  HAZ growth faltering occurs between 3 and 24 months

  By 24 months the window for intervention has closed

**N = 325,760**

(Victora 2010)




Weight-for-height

Weight-for-age

Height-for-age

# HAZ Measurement Technique I: length
# How to measure infant length?



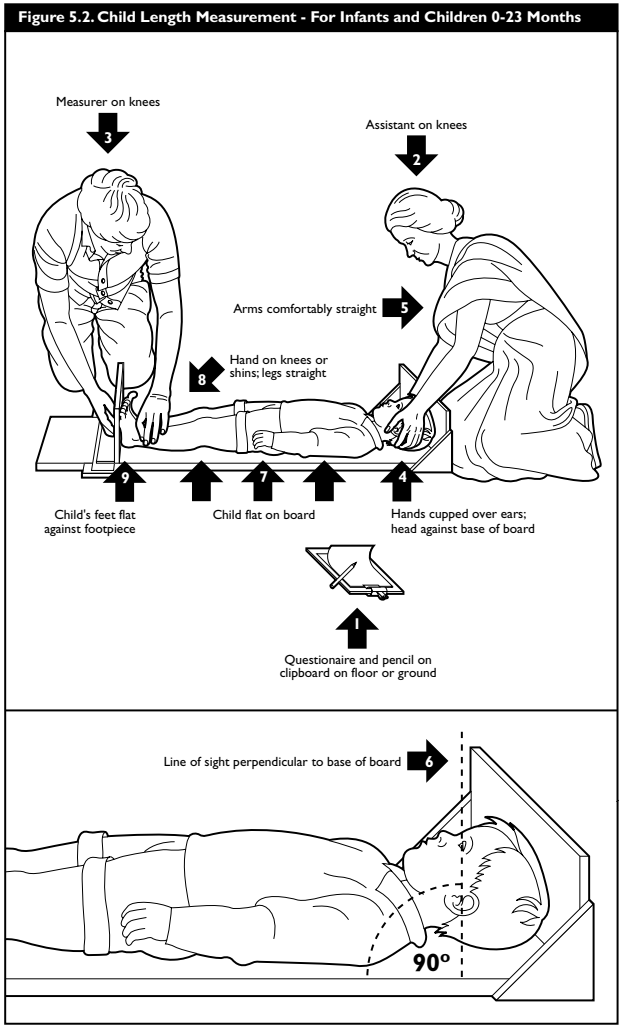
- **Suggested methods:**

  FANTA 2003 standards

  (Cogill 2003)

  (http://www.fantaproject.org/publications/anthropom.shtml)

  2 weeks of training and standardization for the field team (de Onis 2004)



# HAZ Measurement Technique I: length



- **Why so much training and standardization?:**
  - At 24 months, 1 SD in HAZ ≅ 3 cm
  - Mean HAZ increase from supplemental feeding interventions: **0.28 SDs or 0.84 cm** (Dewey 2008)
  - Our anticipated HAZ impacts from environmental interventions: **≤ 0.15 SDs or 0.45 cm**
  - Measurement error of the device = **0.10 cm**
  - Measurement error of the assessor = **varies**

# HAZ Measurement Technique II: age How to measure child age?

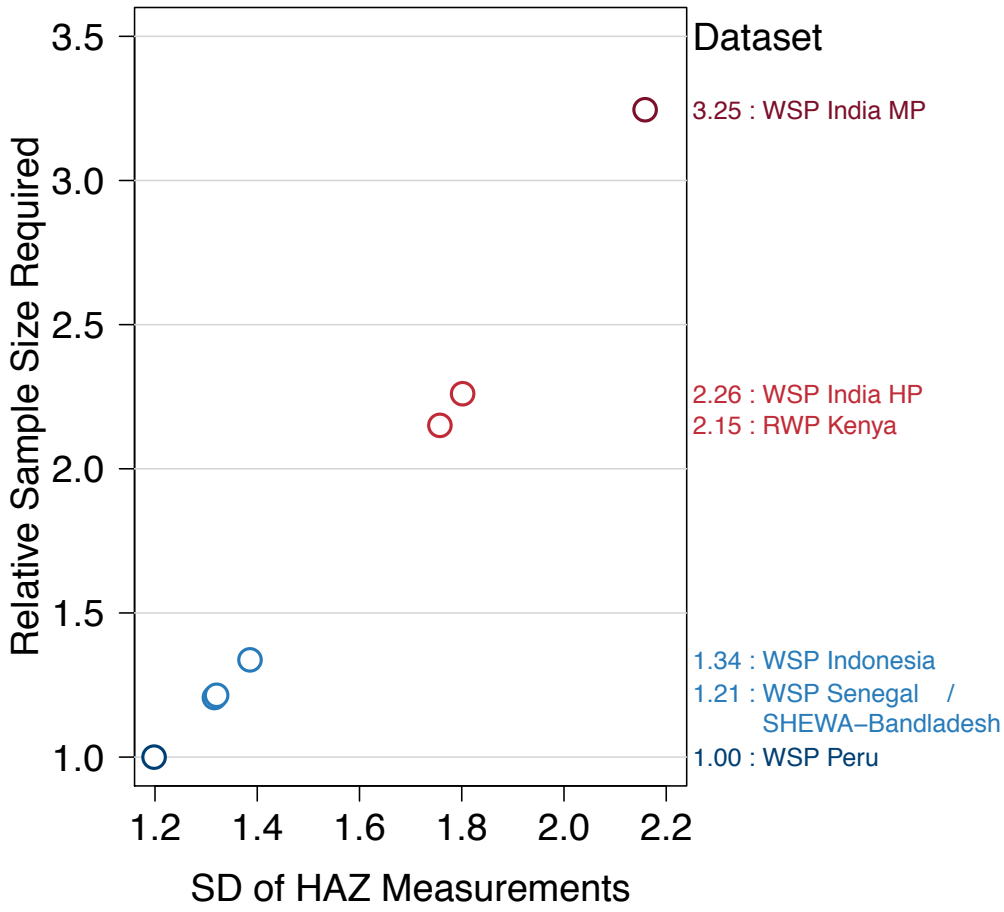


- **How:**
  - Measure age with birth dates.
  - Use vaccination cards to validate when possible.
  - In our Bangladesh EE pilot 58.8% of children ages 10 – 48 months had a vaccination card with a birth date.
  - In Kenya DHS 2008-9, 76.8% of children < 6 mo had a vaccination card in one of our target populations.
- **Why does age measurement need to be so accurate?**
  - Measurement error in age contributes to error in HAZ scores because the scores are standardized by sex and **age** (accurate to <u>days</u>)
  - If age measurement is really inaccurate, can resort to raw length measurements.

# Impact of HAZ measurement error on sample size



Studies with poor measurement in length and/or age must be 2 – 3 times larger to compensate for measurement error:



# When and how often should we measure height to estimate intervention impact?



- **Suggested minimum measurement:**

  **2 measurements**

  - 1 baseline at age < 6 months
  - 1 follow-up at age 24 months or later

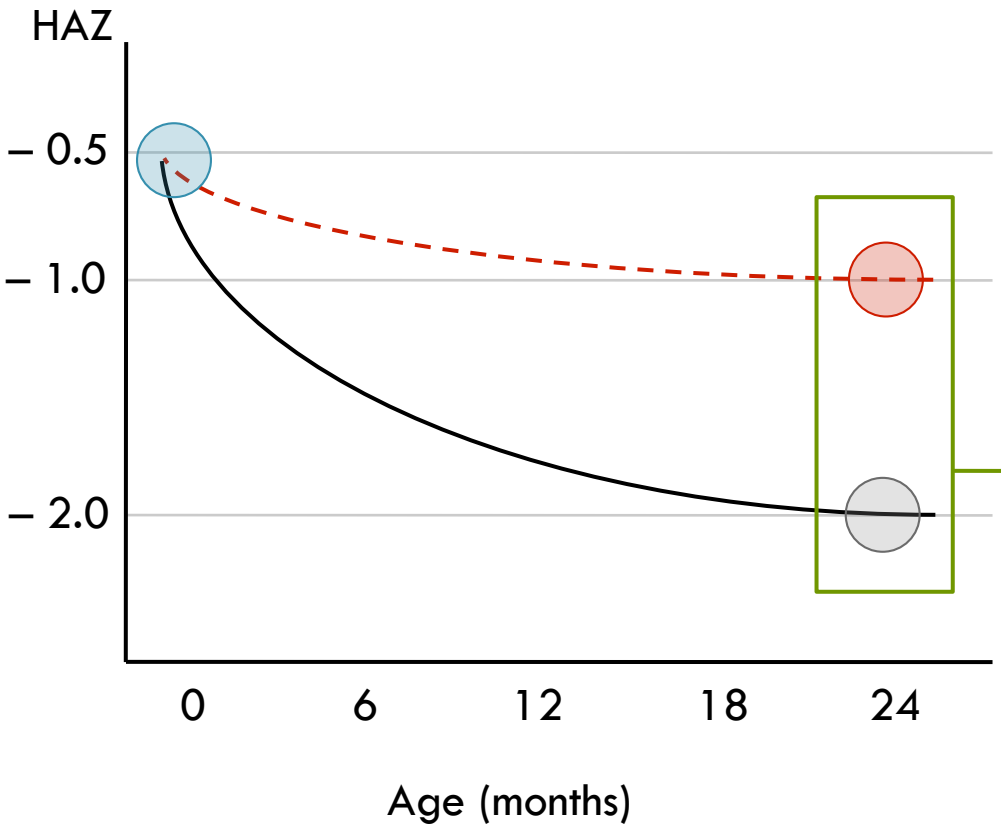
# Why a single measure on either end of the growth faltering window?



- The window between 3 and 24 months is when most of the faltering occurs
- The within-child correlation of HAZ is high
  - Example: Southern India measurements separated by 1 year: correlation of HAZ within child is 0.64 (Arnold 2010)
- There are two implications from the high correlation:
  - Repeated observations close in time provide relatively little new information for HAZ
  - A treatment contrast within a child (i.e. both baseline + follow-up) adds a large amount of statistical power relative to follow-up only (Frison 1992)

# Note: Two measures not needed for validity
# A single post-treatment measure is unbiased






(– 0.5) = Baseline HAZ

(– 1.0) = Intervention at 24 mo

(– 2.0) = Control at 24 mo

Post-treatment difference:
(-1.0) – (-2.0) **= 1.0**

Difference in change from baseline
(Difference in Differences):

[(-1.0) – (-0.5)] – [(-2.0) – (-0.5)] **= 1.0**

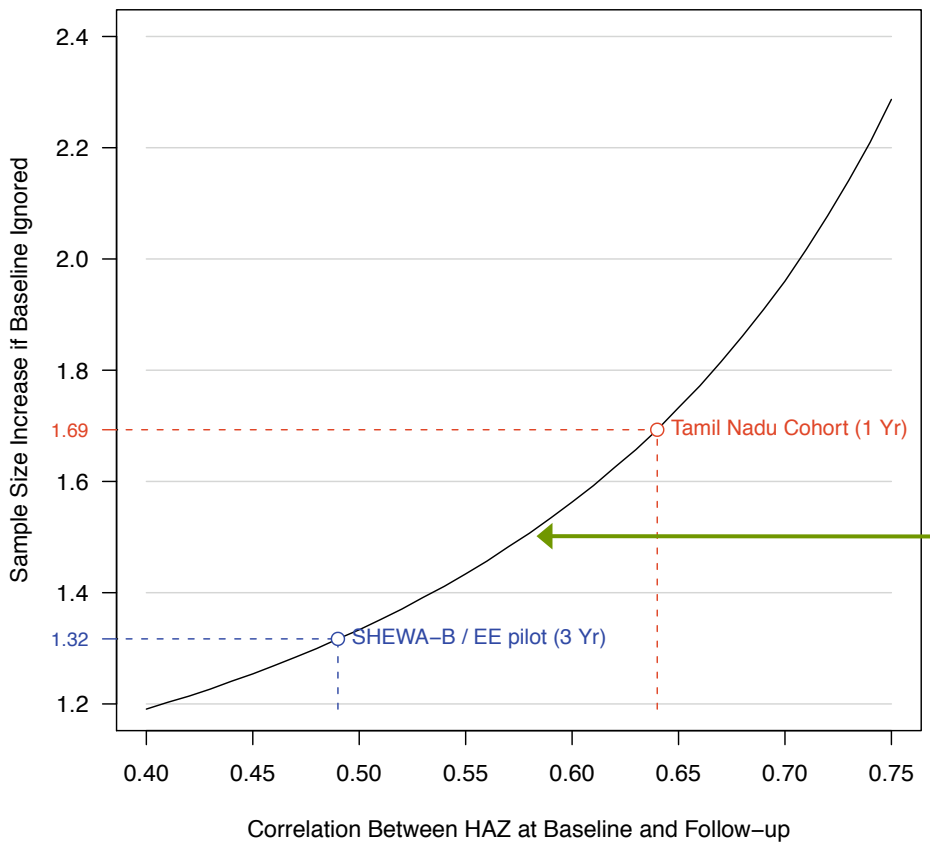
# Ignoring Baseline HAZ Harms Power: Required Sample Size Increase ~1.3 – 1.7x



Sample Size Increase Required by Ignoring Baseline

vs.

HAZ Correlation Between Baseline + Follow-up




Correlation = 0.64, 1 year between measures

Expect WASH Benefits to be in the middle with 2 years between measures

Correlation = 0.49, 3 years between measures

# More frequent length measurement is required if estimating growth curves



- Two measurements for a child will allow us to estimate a difference in mean HAZ change between groups.
- This is a useful parameter of interest for average cumulative impacts of WASH interventions over the growth faltering window.
- 2 measurements will not provide a growth curve for individual children

# More frequent length measurement is required if estimating growth curves



- If patterns of growth are important, then you must collect more frequent measurements (every 3 – 6 months) at uniform ages to estimate:
  - Size: absolute level of height at time $t$
  - Velocity: change in height from $t$-$1$ to $t$
  - Tempo: timing of growth (when does it start and end?)

(Cole 2010)

# References



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