Anthropometric criteria for best identifying children at high risk of mortality:

work of the Wasting & Stunting Technical Interest Group (WaSt TIG)

Tanya Khara: ENN

The status quo

Is this justified? Is it effective?

Wasting and Stunting Technical Interest Group (WaSt TIG)

Abigail Perry (WFP), **André Briend** (Independent), **Andrew Hall** (Independent), **Andrew Mertens** (Berkeley), **Anne Walsh** (Power of Nutrition), **Bernadette Cichon** (No Wasted Lives/ACF), **Carlos Grijalva-Eternod** (IGH/UCL*), **Carmel Dolan** (N4D), **Caroline Wilkinson** (ICRC), **Casie Tesfaye** (IRC), **Cécile Cazes** (ALIMA), **Christine McDonald** (UCSF), **Dominique Robenfroid** (Institute of Tropical Medicine, Antwerp), **Erin Boyd** (BHA), **Gloria Odei** (Independent) **Heather Stobaugh** (ACF), **Hedwig Deconinck** (Independent). **Jay Berkely** (KEMRI/Wellcome Trust research programme, Kenya), **Jeanette Bailey** (IRC), **Jonathan Wells** (GOS-ICH-UCL^), **Kay Dewey** (University of California Davis), **Ken Maleta** (University of Malawi), **Kevin Phelan** (ALIMA), **Kieran O'Brien** (University of San Francisco), **Leisel Tally/Mija Ververs** (CDC), **Mark Manary** (University of St Louis), **Mark Myatt** (Brixton Health), **Marko Kerac** (LSHTM), **Martha Mwangome** (KEMRI/Wellcome Trust research programme, Kenya), **Michel Garenne** (Independent), **Mutsa Bwakura** (Zvitambo Institute for Maternal & Child Health Research), **Natasha Lelijveld** (ENN), **Paluku Bahwere** (Independent), **Patrick Webb** (Friedman School of Nutrition Science and Policy, TUFTS), **Robert Black** (Johns Hopkins Bloomberg School of Public Health), **Saul Guerrero** (UNICEF), **Sheila Isanaka** (T.H Chan School of Public Health, Harvard). **Silke Pietzsch** (Independent), **Sophie Moore** (Kings College London, MRC Cambridge), **Stephanie Richards** (Bloomberg School of Public Health, Johns Hopkins University), **Susan Thurstans** (LSHTM), **William Checkley** (Bloomberg School of Public Health, Johns Hopkins University), **Zita Weise Prinzo** (WHO), **Zulfiqar Bhutta** (Aga Khan University, Sick Kids).

Coordinators: **Tanya Khara & Natalie Sessions**

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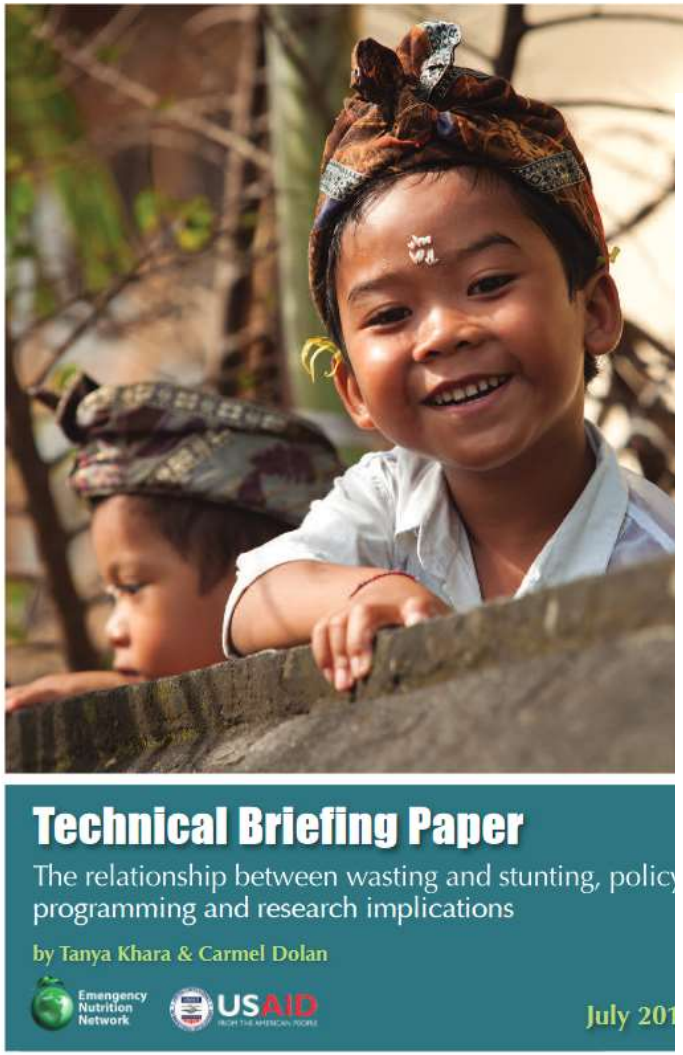
Review of existing evidence and prioritisation of research gaps



PLOS ONE

RESEARCH ARTICLE

Research Priorities on the Relationship between Wasting and Stunting

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¶ Complete membership of the WaSt Technical Interest Group is listed in the Acknowledgments.
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Abstract

Background

Wasting and stunting are global public health problems that frequently co-exist. However, they are usually separated in terms of policy, guidance, programming and financing. Though both wasting and stunting are manifestations of undernutrition caused by disease and poor diet, there are critical gaps in our understanding of the physiological relationship between them, and how interventions for one may affect the other. The aim of this exercise was to establish research priorities in the relationships between wasting and stunting to guide future research investments.

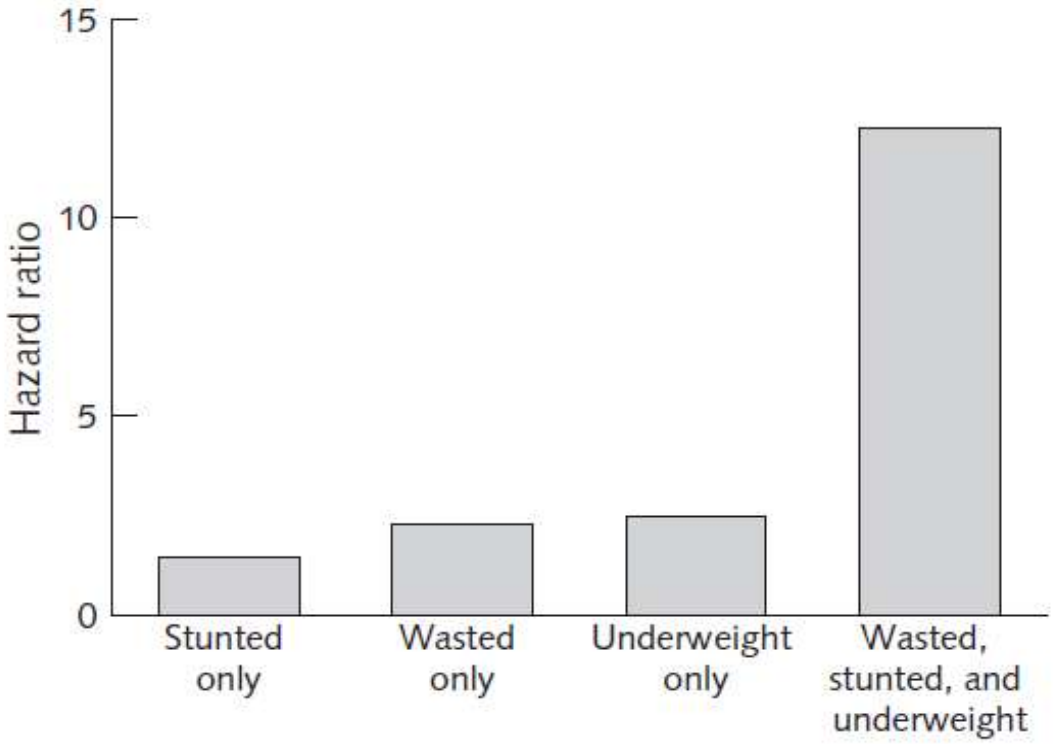
Methods and Findings

We used the CHNRI (Child Health and Nutrition Research Initiative) methodology for setting research priorities in health. We utilised a group of experts in nutrition, growth and child health to prioritise 30 research questions against three criteria (answerability, usefulness and impact) using an online survey. Eighteen of 25 (72%) experts took part and prioritised research directly related to programming, particularly at the public health level. The highest-rated questions were: "Can interventions outside of the 1000 days, e.g. pre-school, school age and adolescence, lead to catch-up in height and in other developmental markers?"; "What timely interventions work to mitigate seasonal peaks in both wasting and stunting?"; and "What is the optimal formulation of ready-to-use foods to promote optimal ponderal growth and also support linear growth during and after recovery from severe acute malnutrition?" There was a high level of agreement between experts, particularly for the highest ranking questions.

Conclusions

Increased commitment to rigorous evaluations of treatment and prevention interventions at the public health level, addressing questions of the timing of intervention, and the extent to

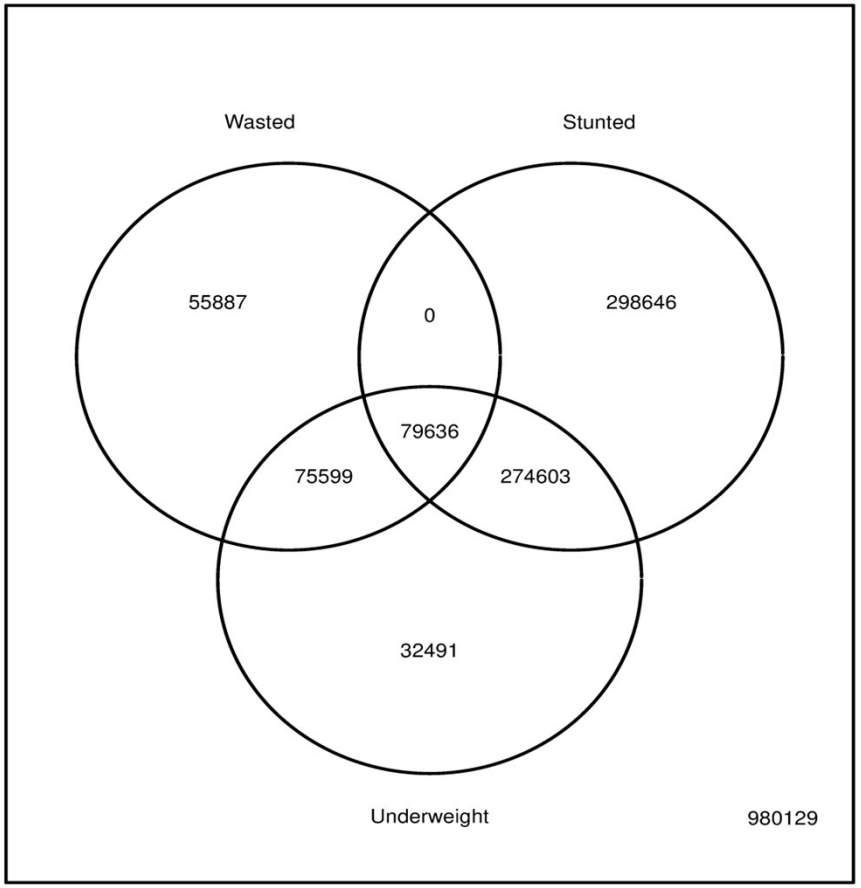
Being wasted & stunted is particularly risky



(McDonald, Olofin et al. 2013)

Children wasted, stunted and underweight are **12 times** more likely to die than non-wasted or stunted children - similar risk of death to those severely wasted

What is the role of underweight?



Myatt et al. Archives of Public Health (2018) 76:28
https://doi.org/10.1186/s13690-018-0277-1

Archives of Public Health

RESEARCH Open Access

Children who are both wasted and stunted are also underweight and have a high risk of death: a descriptive epidemiology of multiple anthropometric deficits using data from 51 countries

Mark Myatt[1*], Tanya Khara[2], Simon Schoenbuchner[3], Silke Pietzsch[4], Carmel Dolan[2], Natasha Lelijveld[5,6] and André Briend[7,8]

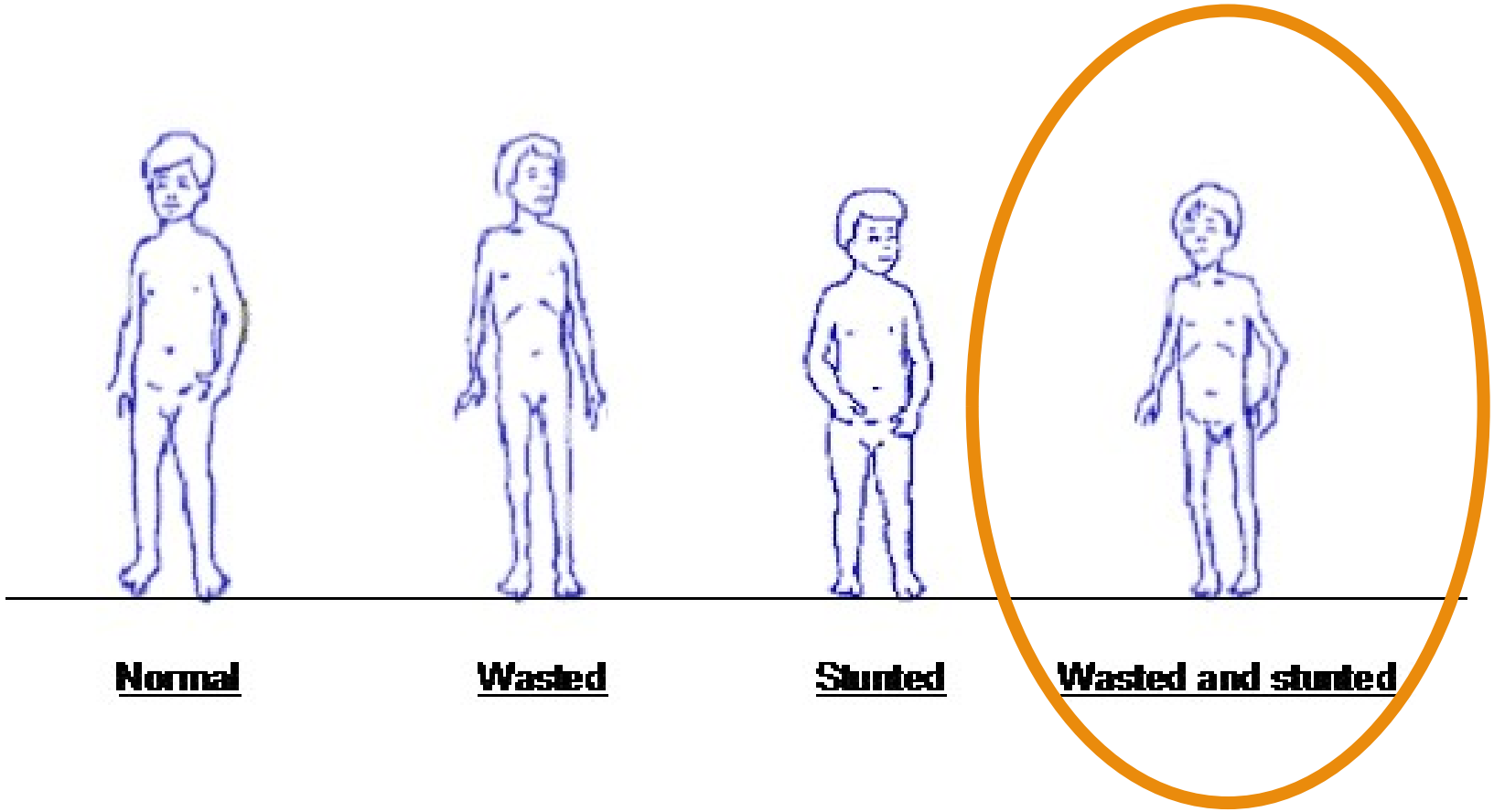
All children who are wasted and stunted are underweight

Multiple anthropometric deficit category is the same as WaSt.

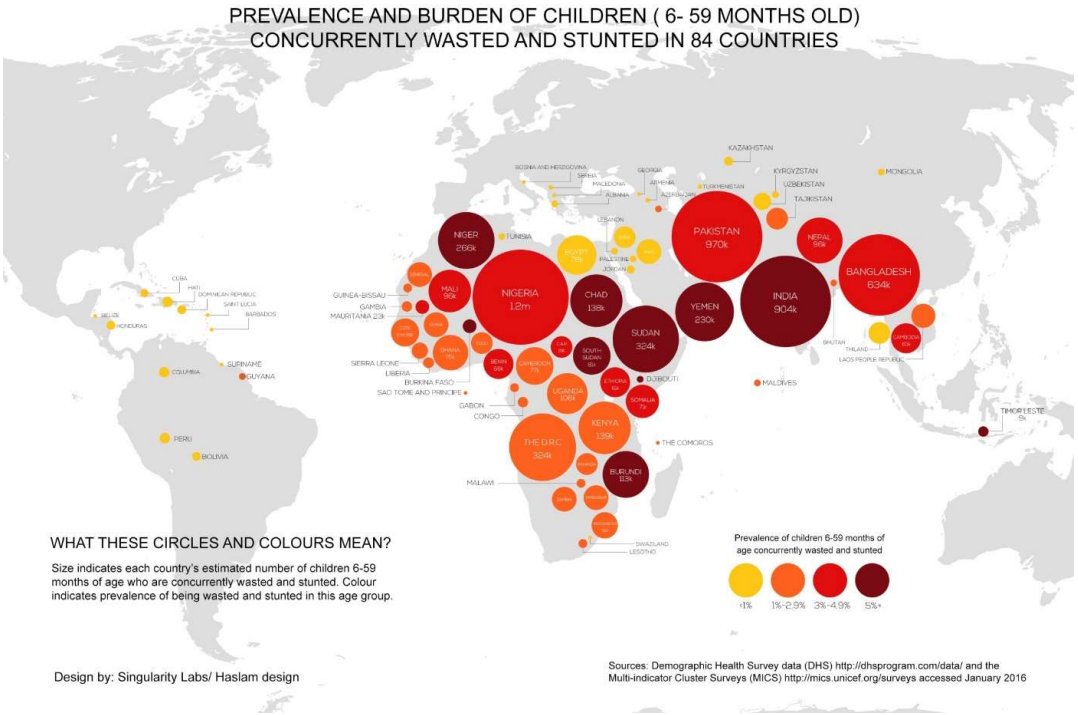
WaSt cases are more stunted and more wasted than those with single deficits but severity **doesn't** explain the level of mortality risk

2,515 survey/SMART datasets (1992-2015), 51 countries, >1.7 million children

Myatt et al; AoPH 2018


Normal
Wasted
Stunted
Wasted and stunted

How many are there?



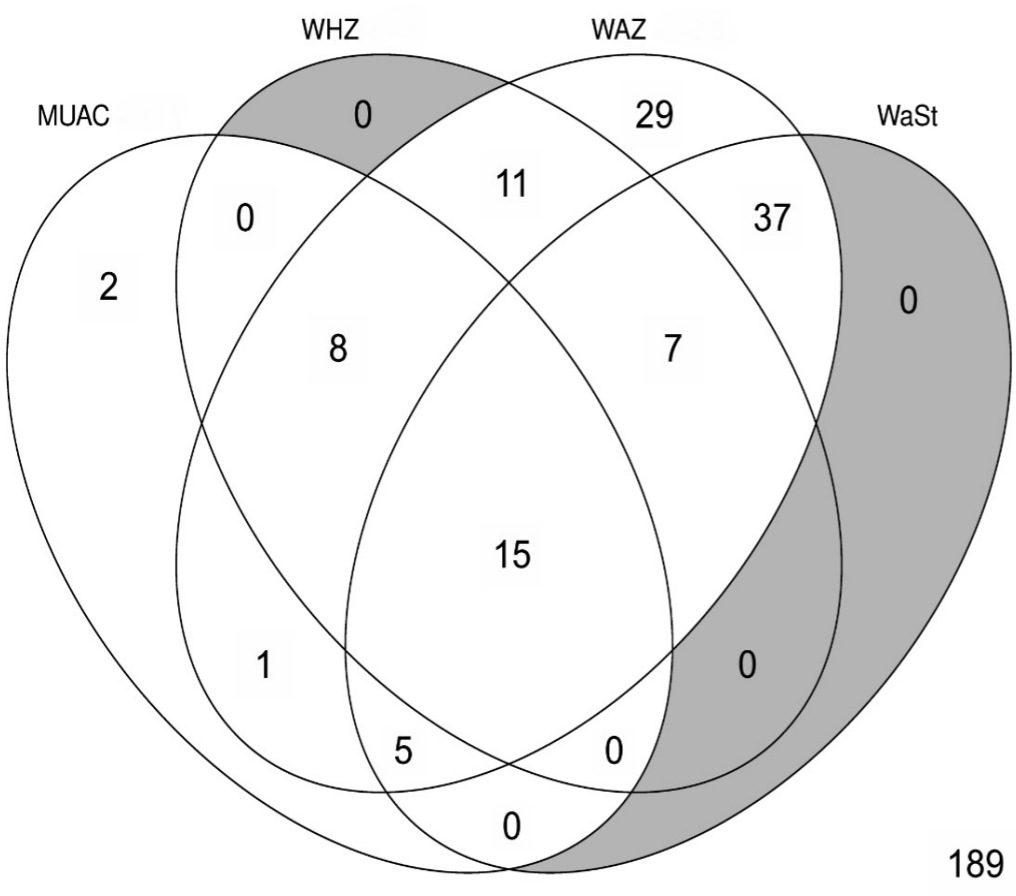
- Ranging from 0% to 8%
- 9 countries >5%
- Pooled prevalence 3.0% (95% CI 2.97 to 3.06)
- Burden ~ 6 million children (6-59m) – update from GNR 16 million

Call for concurrence to be routinely reported in GNR/Joint estimates

Are these children being reached?

Khara et al; 2017, Maternal and Child Nutrition

How to best identify the most at risk children?



Niakhar (Senegal) 1980

- 5,751 children
- Every 6m for 2yrs
- WAZ<-2.8 together with MUAC<115mm identify all deaths associated with WHZ and WaSt

Myatt et al; 2018, Public Health Nutrition

Are we reaching the most at risk? Could we? And how?

Public Health Nutrition: page 1 of 17 doi:10.1017/S136898002300023X

Systematic Review and Meta-Analysis

Anthropometric criteria for best-identifying children at high risk of mortality: a pooled analysis of twelve cohorts

Tanya Khara[1,*], Mark Myatt[2], Kate Sadler[1], Paluku Bahwere[3], James A Berkley[4,5], Robert E Black[6], Erin Boyd[7], Michel Garenne[8,9,10,11], Sheila Isanaka[12,13], Natasha Lelijveld[1], Christine McDonald[14,15], Andrew Mertens[16], Martha Mwangome[5], Kieran O'Brien[17], Heather Stobaugh[18,19], Sunita Taneja[20], Keith P West[21] and André Briend[22,23]

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Abstract

Objective: To understand which anthropometric diagnostic criteria best discriminate higher from lower risk of death in children and explore programme implications.
Design: A multiple cohort individual data meta-analysis of mortality risk (within 6 months of measurement) by anthropometric case definitions. Sensitivity, specificity, informedness and inclusivity in predicting mortality, face validity and compatibility with current standards and practice were assessed and operational consequences were modelled.
Setting: Community-based cohort studies in twelve low-income countries between 1977 and 2013 in settings where treatment of wasting was not widespread.
Participants: Children aged 6 to 59 months.
Results: Of the twelve anthropometric case definitions examined, four (weight-for-age *Z*-score (WAZ) <−2), (mid-upper arm circumference (MUAC) <125 mm), (MUAC < 115 mm or WAZ < −3) and (WAZ < −3) had the highest informedness in predicting mortality. A combined case definition (MUAC < 115 mm or WAZ < −3) was better at predicting deaths associated with weight-for-height *Z*-score <−3 and concurrent wasting and stunting (WaSt) than the single WAZ < −3 case definition. After the assessment of all criteria, the combined case definition

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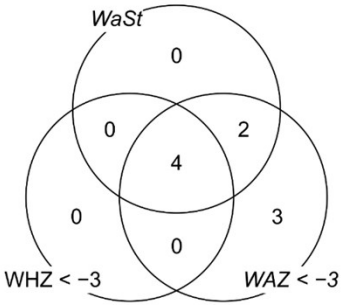
Pooled analysis of 12 cohorts, untreated children

Country	Study	Recruitment years	Children aged 6-59 months [1]	
Bangladesh	Arifeen (2001)	1993-1995	1,317	
DRC	Van den Broek (1993)	1989-1993	4,584	★
Ghana	WHO/CHD (1998)	1995-1997	2,615	
Guinea-Bissau	Molbak (1992)	1987-1990	985	
India	WHO/CHD (1998)	1995-1996	3,613	
Indonesia	Katz (1989)	1977-78	3,806	
Nepal	West (1991)	1989-91	5,883	★
Niger	O'Brien (2019)	2011-2013	970	★
Peru	WHO/CHD (1998)	1995-1996	2,289	
Philippines	Adair (1993)	1982-1983	2,823	
Senegal	Garenne (1987)	1983	5,142	★
Sudan	Fawzi (1997)	1988	22,532	
All	**All**	**1977-2013**	**56,559**	

Prediction of mortality: Pooled sensitivity, specificity and informedness

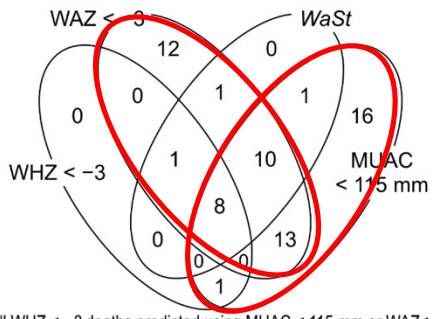
Case-definition	Sensitivity (%)[1]	95% CI[2]	Specificity (%)[1]	95% CI[2]	Youden's Index (%)[1]	95% CI[2]
HAZ <-3	32.63	[23.57;41.69]	79.30	[72.30;86.29]	13.49	[9.96;17.02]
HAZ <-2	58.28	[48.96;67.60]	54.26	[43.75;64.78]	12.77	[7.93;17.60]
WAZ <-3	**30.81**	[24.09;37.52]	**88.62**	[85.07;92.17]	**20.38**	[15.10;25.66]
WAZ <-2	**57.86**	[49.71;66.00]	**66.28**	[56.91;75.65]	**24.94**	[19.87;30.02]
WHZ <-3	11.12	[6.94;15.30]	97.96	[97.43;98.49]	9.01	[5.26;12.76]
WHZ <-2	28.45	[19.73;37.16]	90.06	[87.34;92.79]	18.47	[12.20;24.75]
MUAC <115 mm	17.56	[7.60;27.53]	96.52	[94.14;98.90]	13.46	[6.49;20.44]
MUAC <120 mm	25.11	[10.03;40.18]	92.64	[87.72;97.55]	17.23	[7.62;26.83]
MUAC <125 mm	**37.22**	[20.30;54.13]	**85.89**	[77.02;94.76]	**23.00**	[13.77;32.23]
WHZ <-2 and HAZ <-2	19.33	[9.96;28.70]	93.55	[90.25;96.86]	13.36	[6.69;20.02]
MUAC <115 mm or WHZ <-3	20.38	[13.58;27.18]	95.31	[93.24;97.38]	15.00	[10.12;19.89]
MUAC <115mm or WAZ <-3	**36.29**	[26.13;46.45]	**83.56**	[79.10;98.02]	**22.55**	[16.13;28.97]

Bangladesh



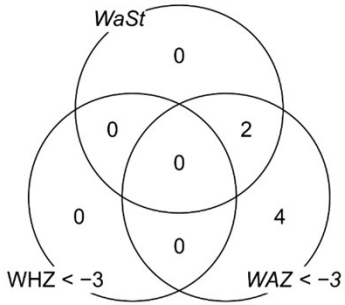
All WHZ < −3 deaths predicted using WAZ < -3
All *WaSt* deaths predicted using WAZ< -3
11 deaths were not predicted using any criteria

DRC



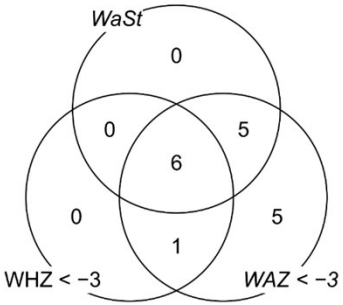
All WHZ < −3 deaths predicted using MUAC < 115 mm or WAZ< -3
All *WaSt* deaths predicted using MUAC < 115 mm or WAZ< -3
133 deaths were not predicted using any criteria

Ghana



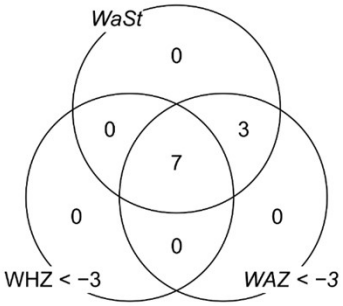
No WHZ < −3 deaths to predict
All *WaSt* deaths predicted using WAZ< -3
25 deaths were not predicted using any criteria

Guinea-Bissau



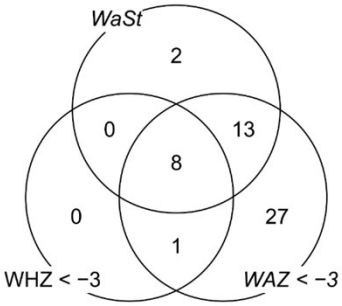
All WHZ < −3 deaths predicted using WAZ< -3
All *WaSt* deaths predicted using WAZ< -3
101 deaths were not predicted using any criteria

India



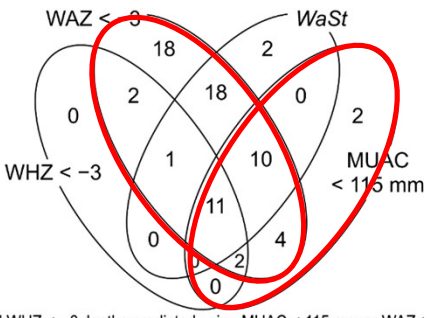
All WHZ < −3 deaths predicted using WAZ< -3
All *WaSt* deaths predicted using WAZ< -3
17 deaths were not predicted using any criteria

Indonesia



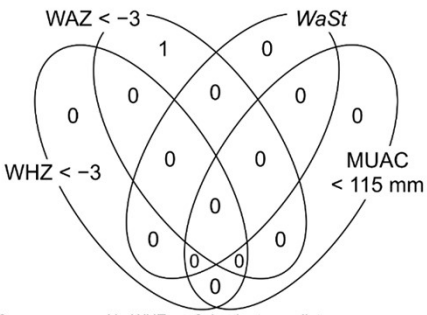
All WHZ < −3 deaths predicted using WAZ< -3
91% of *WaSt* deaths predicted using WAZ< -3
163 deaths were not predicted using any criteria

Nepal



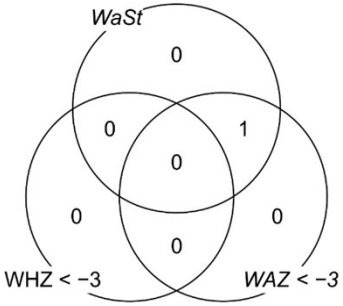
All WHZ < −3 deaths predicted using MUAC < 115 mm or WAZ< -3
95% of *WaSt* deaths predicted using MUAC < 115 mm or WAZ< -3
62 deaths were not predicted using any criteria

Niger



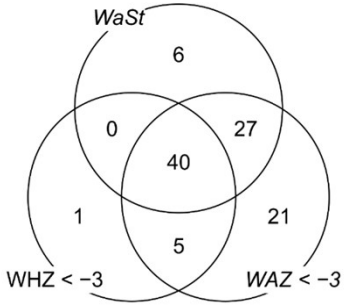
No WHZ < −3 deaths to predict
No *WaSt* deaths to predict
3 deaths were not predicted using any criteria

Peru



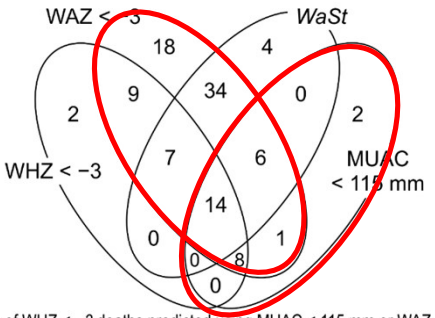
No WHZ < −3 deaths to predict
All *WaSt* deaths predicted using WAZ < -3
4 deaths were not predicted using any criteria

Philippines



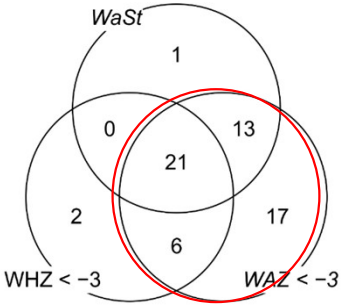
98% of WHZ < −3 deaths predicted using WAZ< -3
92% of *WaSt* deaths predicted using WAZ< -3
133 deaths were not predicted using any criteria

Senegal



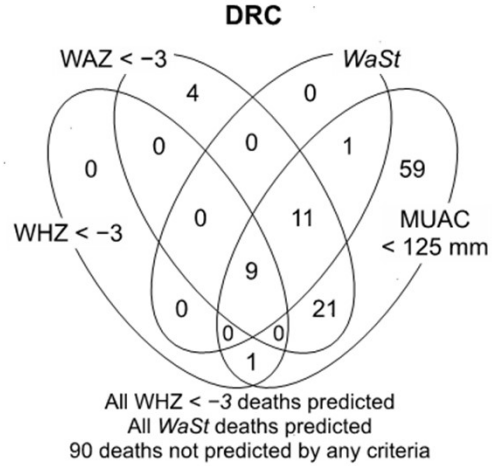
95% of WHZ < −3 deaths predicted using MUAC < 115 mm or WAZ< -3
94% of *WaSt* deaths predicted using MUAC < 115 mm or WAZ< -3
222 deaths were not predicted by any criteria

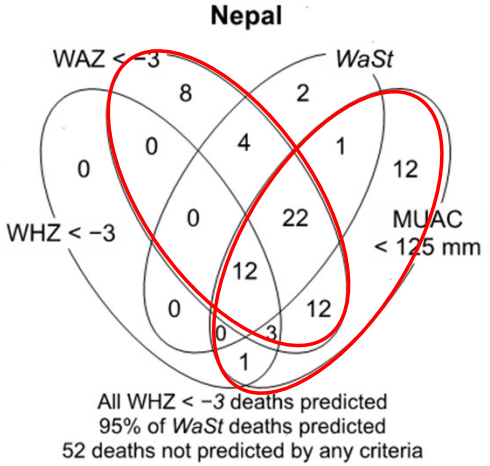
Sudan

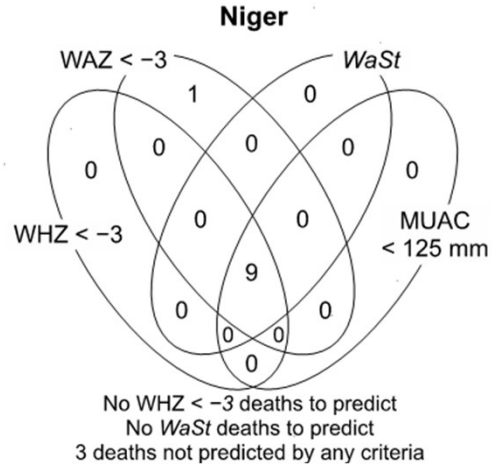


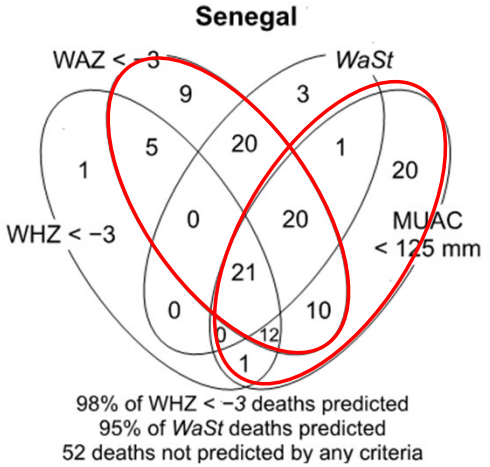
93% of WHZ < −3 deaths predicted using WAZ< -3
97% of *WaSt* deaths predicted using WAZ< -3
75 deaths were not predicted using any criteria

Inclusivity: MUAC <125mm





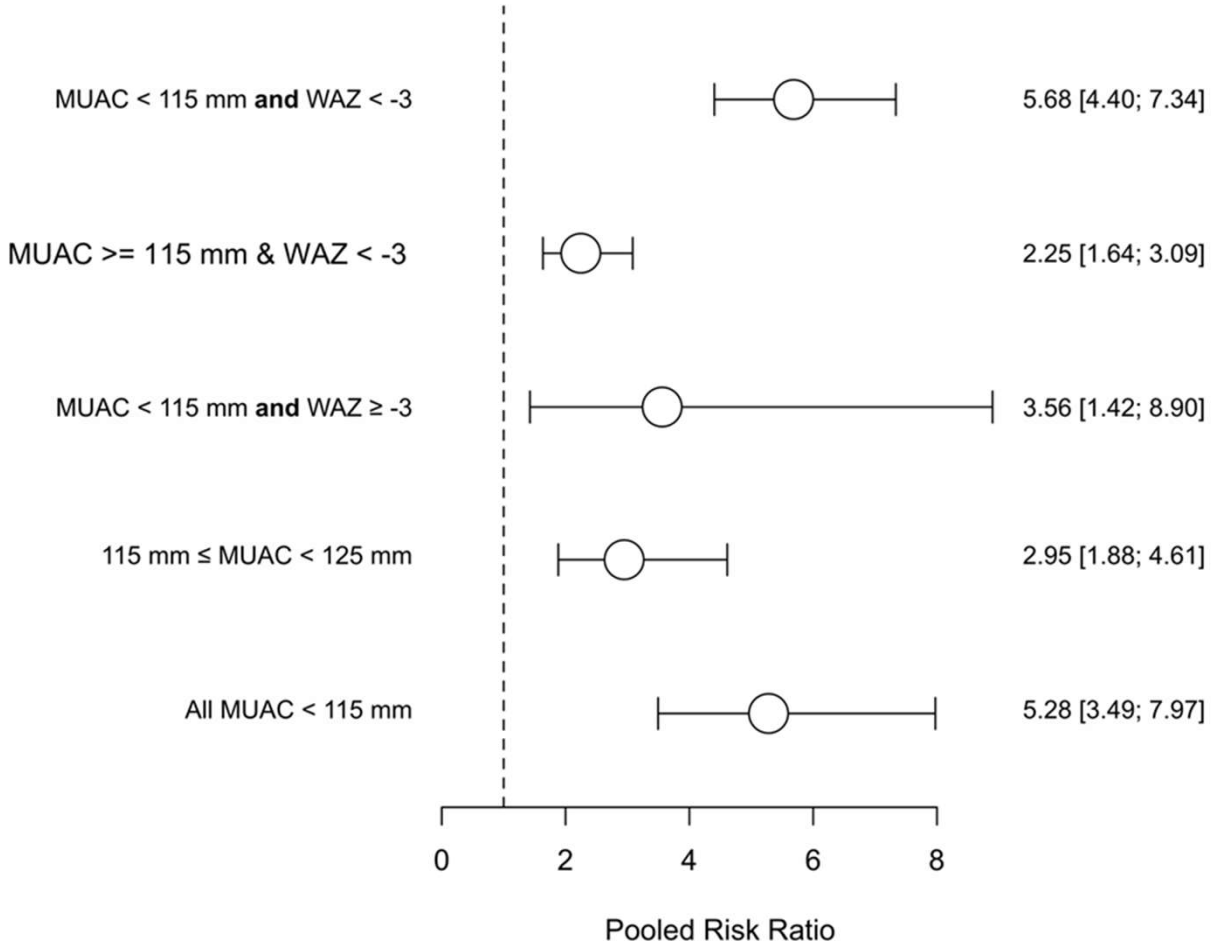




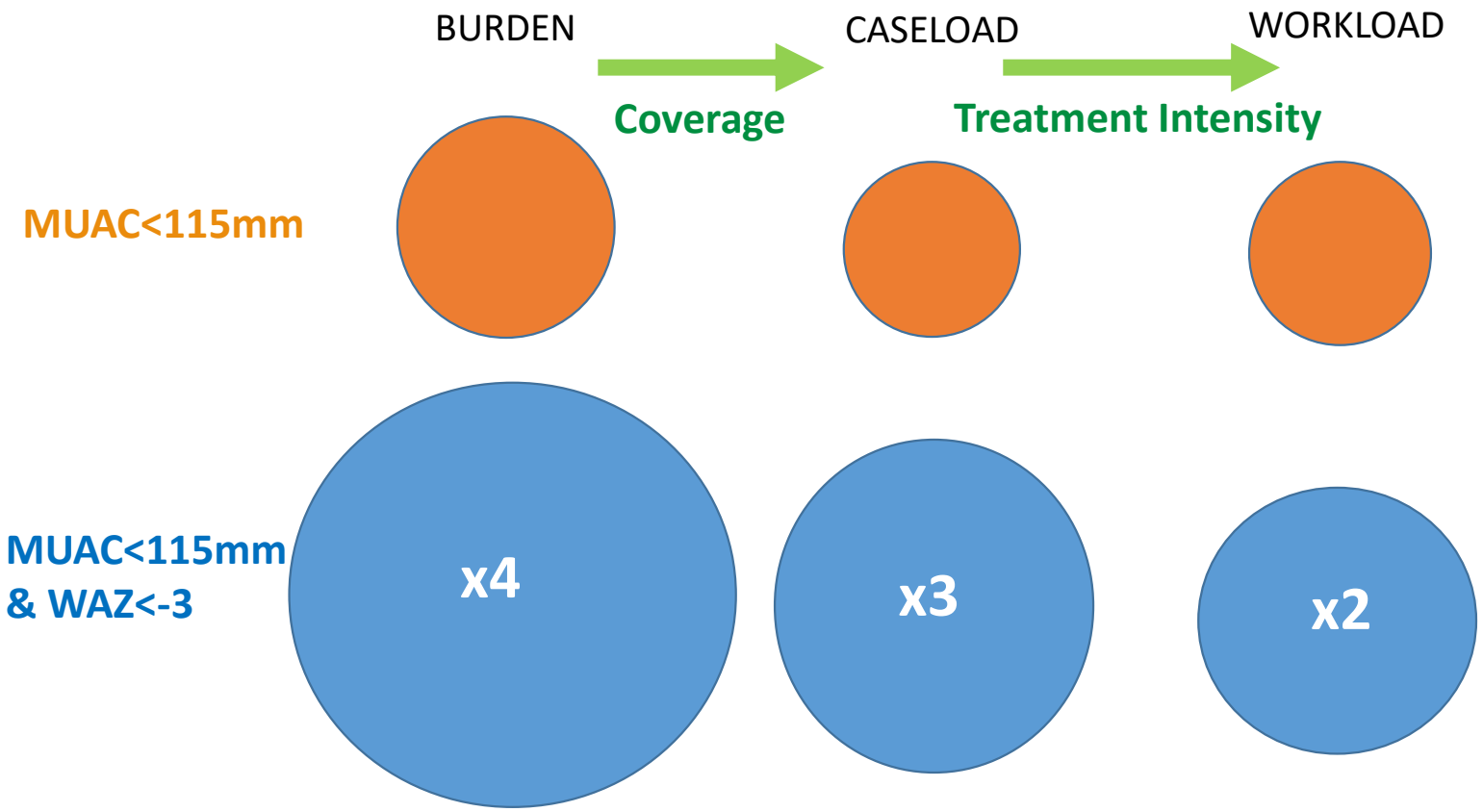
Summary of assessment of criteria

Criteria	Sensitivity	Specificity	Youden's Index	Face Validity	Inclusivity	Compatibility
HAZ <-3	●	○	○	●	?	○
HAZ <-2	●	○	○	○	?	○
WAZ <-3	●	●	●	●	●	●
WAZ <-2	●	○	●	○	●	●
WHZ <-3	○	●	○	●	○	○
WHZ <-2	○	●	●	○	○	○
MUAC <115 mm	○	●	○	●	○	●
MUAC <120 mm	○	●	●	?	?	○
MUAC <125 mm	●	●	●	○	●	●
WHZ <-2 and HAZ <-2 (WaSt)	○	●	○	●	○	○
MUAC <115 mm or WHZ < -3 (WHO)	○	●	○	●	○	○
MUAC <115 mm or WAZ < -3	●	●	●	●	●	●

Risk and intensity of treatment



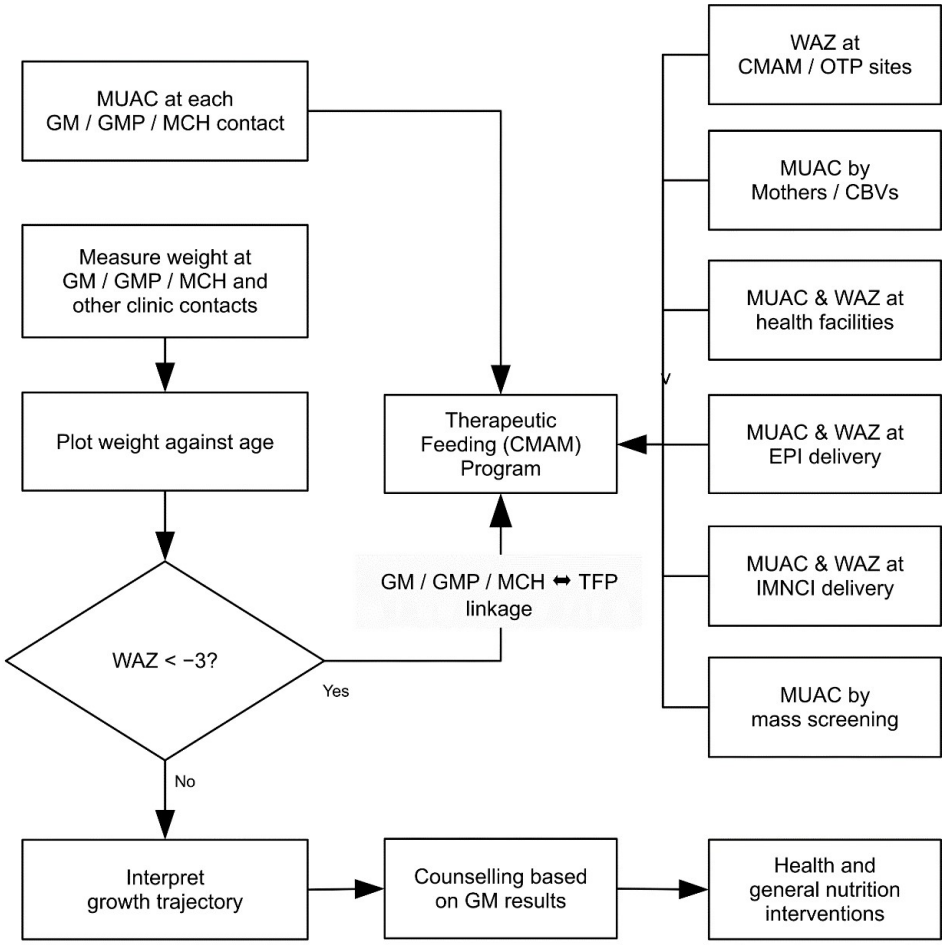
Potential caseload implications



Caseload = population x prevalence x coverage

Workload = caseload x treatment intensity

Potential programme model



Further work.

- Protocol for WaSt cohort study developed and collaboration and funding being sought for implementation
- *Anthropometric deficits and the associated risk of death by age and sex in children aged 6–59 months: A meta-analysis* (Thurstans et al 2022)
- *How do children with severe underweight and wasting respond to treatment? A pooled secondary data analysis to inform future intervention studies* (Odei et al 2022)
- Related analysis of the implications of frequency of measurement (over to André)

Thank you.

https://www.ennonline.net/ourwork/reviews/wastingstunting

Khara, Myatt, Sadler et al 2023. Anthropometric Criteria for best-identifying children at high risk of mortality: a pooled analysis of twelve cohorts.

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