Assessment and control of nutritional deficiency diseases: generating better data for more coherent programs

Kenneth H Brown

Department of Nutrition, and

Program in International and Community Nutrition

University of California, Davis

"Better Foods for Better Health" Les Pensières Center for Global Health Veyrier-du-Lac, France March 20-22, 2018



The problem of childhood undernutrition

In 2011, ~7 million children died before reaching 5 years of age.

45% of these deaths (3.1 M) were attributable to undernutrition.





Black RE et al. Lancet, 2013.

Deaths of U-5 children attributable to nutritional disorders, by type of nutrition-related problem

Nutritional disorder	No of deaths	% of total U5MR
Fetal growth restriction (<1 mo)	817	12%
Stunting (1-59 mo)	1017	17%
Underweight (1-59 mo)	999	17%
Wasting (1-59 mo)	875	12%
Vitamin A deficiency (6-59 mo)	157	2.3%
Zinc deficiency (12-59 mo)	116	1.7%
Sub-optimal breast feeding (0-23 mo)	804	12%
Joint effects (all nutritional disorders)	3097	45%

Black RE et al. Lancet, 2013.

Number of under-5 deaths attributable to vitamin and mineral deficiencies of children or their mothers

		Series
Maternal and Child Nutrition 1		@` \ @
Maternal and child undernutri	tion and overweight in	
low-income and middle-incom	ne countries	
Robert E Black, Cesar G Victora, Susan P Walker, Zulfiqar A Bhutta", Paru Sally Grantham-McGregor", Joanne Katz", Reynaldo Martorel ", Ricardo	'Christian", Mercedes de Onis", Majid Ezzati", Jauy", and the Matemal and Child Nutrition Study Group!	
Statem and child real-matrices in low increme and multi a graving problem with enversionity and solvers, how hose decided nonswhat in the past two decades but continues are everyfish than has have high reasons mices with the solution of lower graves but children's younger than 3 yous has dee decided and the solution of the solution of the solution like the solution of the solution of the solution of the decided solutions in facil gravit trends in a dis- decided solution of the solution of the solution of discretion of the solution of the solution of the discretion of the solution of the solution of the solution of like. We estimate that understanding the solution manually or dSN of all child doubts in 2011. Maternal area disclutes, and more communicable discretes. The high prev women of reproductive age, pregnancy, and children in the solution of the solution of the solution of the solution discretes and the solution of the solution of the solution discretes and the solution of the solution of the solution women of reproductive age, pregnancy, and children in the indematrition and overweight, are global problems with and charteric denses, heading betweeners, and the	a construction of the standard structure of the standard structure of the standard structure st	Level 2013, 1812- 67-53 patched on the hypothesis of thypothesis of thypothesis of the hypothesis of the
economic productivity of individuality and societars. Mineral and deline uniomativition, individuality, maning, antinerality, was the subject of a periors' in The Loard in 2008, which quantified their providences to thorizon and long atoms consequences, and potential for reductions the crustal period of programs and the first 3 years of the crustal period of programs and the first 3 years of the crustal period of programs and the first 3 years of the crustal period of programs and the first 3 years of clubels. In \$200 Series identified the nucleon tables second clubels for generate rational periody for multition pro- grammers, more integration which health, programmers, and coordination in the global multition period first of multition and coordination in the global multition period first multition and coordination in the global multition were of inter- mution algorizes, donors, academic, exist in scient, and the private nexts 5 years allow that soles, we instand sone with the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the standard sole of the stand	Expression I line and calcular differences controlled in subsecting to multi- Matureal line oblightings is associated with balance with the we Matureal land calculat controlled and the subsection of the sub- controlled in the subsection of the subsection of the subsection terms and an example of their multi-subsection of the subsection of the	strial douths eight (<2500 g) at birth kild environments, productivy in adulthood in morbidity, preterm ture and underweight d at least 165 million at 52 million children ki douthra annually mr braastfeeding e q5% of child douths, younger than Syears

 Table 1. Total Number of Under-5 Child Deaths Attributable to MN Deficiencies Among Children and Pregnant Women.

	Conservat	tive Scenario ^a	Updated Scenario (see text)			
MN Deficiency	Attributable Deaths	% U5 Deaths (Total n = 6.8 million)	Attributable Deaths	% U5 deaths (Total n = 6.8 million)		
Vitamin A, children	157 000	2.3	157 000 ^b	2.3		
Zinc, children	116 000	1.7	116 000	1.7		
Iron, women	93 860	1.4	247 000 ^c	3.6		
Zinc, women	-	-	144 200 ^d	2.1		
lodine, women	-	-	_e	-		
Folate, women	60 626	0.9	81 220 ^f	1.2		
All ^g	427 486	6.3	745 420	11.0		

Brown KH, et al. Food Nutr Bull, 2015

www.thelancet.com Vol 382 August 3 200

undernutrition, but also to examine the growing problems.

of overweight and obesity for women and children and

intries (LMICs). Many of these countries are said to

r the so-called double burden of malnutrition, wit

nces in low-income and middle-income

Black RE, et al. Lancet 2013

In adulthood

on, communicable diseases in adulthood

Undemutrition during pregnancy, affecting fetal growth, and the first 2 years of life is

a major determinant of both stunting of linear growth and subsequent obesity and

Estimated global birth prevalence of neural tube defects in 2015 and related U-5 mortality

Ann N.Y. Acad. Sci. ISSN 0077-89

ANNALS OF THE NEW YORK ACADEMY OF SCIENCES Income Enlate Status in Warman and Margal Take Defact Disk Dask after ORIGINAL ARTICLE

Estimates of global and regional prevalence of neural tube defects for 2015; a systematic analysis

Hannah Blencowe, 101 Vijava Kancherla,2 Sowmiva Moorthie,3 Matthew W. Darlison,4 and Bernadette Modell⁴

¹Centre for Maternal, Adolescent, Reproductive, and Child Health, London School of Hydiene and Tropical Medicine, London UK. ²Department of Epidemiology. Emory University Bollins School of Public Health. Atlanta. Georgia. ³PHG Foundation. Cambridge, UK. ⁴World Health Organization Collaborating Centre for Community Genetics, UCL Centre for Health Informatics and Multiprofessional Education (CHIME), University College London, London, UK

Address for correspondence: Dr Hannah Blencowe, Centre for Maternal, Adolescent, Reproductive, and Child Health London School of Hygiene and Tranical Medicine London, WC1E 7HT LIK, Hannah Biencowe@lehtm ac uk

Neural tube defects (NTDs) are associated with substantial mortality, morbidity, disability, and psychological and economic costs. Many are preventable with folic acid, and access to appropriate services for those affected can improve survival and quality of life. We used a compartmental model to estimate global and regional birth prevalence of NTDs (live births, stillbirths, and elective terminations of pregnancy) and subsequent under-5 mortality. Data were identified through web-based reviews of birth defect registry databases and systematic literature reviews. Meta-analyses were undertaken where appropriate. For 2015, our model estimated 260,100 (uncertainty interval (UI): 213.800-322.000) NTD-affected birth outcomes worldwide (prevalence 18.6 (15.3-23.0)/10,000 live births). Approximately 50% of cases were elective terminations of pregnancy for fetal anomalies (UI: 59,300 (47,900-74,500)) or stillbirths (57,800 (UI: 35,000-88,600)). Of NTD-affected live births, 117,900 (~75%) (UI: 105,500-186,600) resulted in under-5 deaths. Our systematic review showed a paucity of high-quality data in the regions of the world with the highest burden. Despite knowledge about prevention, NTDs remain highly prevalent worldwide. Lack of surveillance and incomplete ascertainment of affected pregnancies make NTDs invisible to policy makers. Improved surveillance of all adverse outcomes is needed to improve the robustness of total NTD prevalence estimation, evaluate effectiveness of prevention through folic acid fortification, and improve outcomes through care and rehabilitation.

Keywords: estimates: mortality; neural tube defects; prevalence; spina bifida

Introduction

Neural tube defects (NTDs) are a group of severe congenital disorders associated with substantial mortality, morbidity, long-term disability, and psychological and economic costs.1 Many NTDs are preventable with folic acid,2-4 and long-term survival and quality of life among those living with NTDs can be improved through access to appro-priate clinical care and rehabilitative services.⁵⁻⁷ However, efforts for primary prevention and for NTDs, with uncertainty intervals (UIs), for the addressing the needs of those living with NTD have been hampered by a lack of transparent prevalence estimates to quantify the burden, especially in resource-poor settings. The Modell Database of Congenital Disorders (MGDb) was developed

recently to estimate the birth prevalence of congenital disorders globally.8,9 Previous global estimates using this method were published in the March of Dimes Global Report on Birth Defects. 10 These provided an estimate of 323,900 live births with NTDs in 2001; however, neither detailed methodology nor uncertainty estimates were provided.10 Here, we build on the Modell methodology to generate

Data to inform the prevalence of NTD are available from a number of sources, including population- and hospital-based birth defect surveillance registries; multicenter birth defects monitoring networks, such as the European

doi: 10.1111/nvas.13548

Ann. N.Y. Acad. Sci. xxxx (2018) 1–16 ⊕ 2018 The Authors. Annals of the New York Academy of Sciences sublideed by Weier Periodicals (sc. on behalf of The New York Academy of Sciences This is an open access article under the terms of the Creative Commons Altitution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

Blencowe H et al. Annals NYAS, 2017.

- 260,100 NTD-affected birth outcomes (prevalence = • 18.6 /10,000 live births)
 - 59,300 elective terminations of pregnancy
 - 57,800 stillbirths
 - 143,000 NTD-affected live births
 - 117,900 under-five deaths of affected live births



Bailey LB et al. Annals NYAS, 2017.

Thiamine deficiency in Myanmar

REPORT OF THE SURVEY ON VITAMIN B₁ STATUS OF PREGNANT WOMEN AND LACTATING MOTHERS IN MYANMA



National Nutrition Centre/UNICEF

February

2009

- 5.6% of pregnant and lactating women had elevated ETKAC
- Infantile beriberi is listed as fifth leading cause of infant mortality (7.1% of infant deaths)

Changes in U5 deaths from 2004 to 2011

	2004		2011	
U5 deaths	~10,000,000		~7,000,000	
Nutrition-attributable deaths	3.5 M		3.1 M	
% nutrition-	35%		45%	
	Why have more ra		e infectious diseases declined idly than under-nutrition? esources flobal coordination ocused interventions etter data	ned

Development assistance (ODA) disbursements to nutrition, as % of health ODA and total ODA, 2004-2015



Programs directed at Infectious Diseases and Nutrition at WHO & BMGF

WHO

Infectious disease	Nutrition
HIV/AIDS	Nutr for Health & Devl
ТВ	Prevention of NCDs
Malaria	(MNCH)
Polio eradication	
Neglected Tropical Diseases	
Food safety/Zoonoses	
Immunization/Vaccines	
(MNCH)	

BMGF

Infectious disease	Nutrition
HIV	Nutrition
Enteric & Diarrheal Diseases	
Pneumonia	
Malaria	
ТВ	
Neglected Tropical Diseases	
Vaccine Develop/Delivery	
Polio	

Global coordination for control of infectious diseases

- In 2013, there were 528,000 malaria deaths, ~412,000 in children <5
- Roll back malaria partnership
 - WHO, UNICEF, UNDP, World Bank
 - Achieve consensus, coordinate action, mobilize resources
 - Global Malaria Action Plan, Action and Investment to defeat Malaria





- In 2015, there were 1.1 million AIDSrelated deaths, ~190,000 in children <15
- UNAIDS
 - Leadership/partnerships
 - Advocacy
 - Monitoring
 - Resource mobilization





Prevalence of Falciparum malaria in sub-Saharan Africa in 2000 and 2015, and attributable effects of malaria control programs*



*5 km² spatial resolution

Bhatt S et al. Nature, 2015.

Prevalence of stunting (2000-2015) in children <5 years and progress toward 2025*



*5 km² spatial resolution

Osgood-Zimmerman et al. Nature, 2018.

Problems with manual anthropometry

- Portability
- Personnel training & standardization
- Accuracy & precision





Accuracy and precision of manual anthropometry



- 52 DHS Surveys that included height, weight, HAZ, WAZ, WHZ children under 5
- Wide range of data quality between surveys
- High variability in length measures for children under 2

Using body imaging to simplify and improve manual anthropometry*









*Photos provided by Gene Alexander, Body Surface Translations.

Using body imaging to obtain anthropometric data*



*Figures provided by Gene Alexander, Body Surface Translations.

Estimated prevalence of vitamin A deficiency in 2013, and number of countries providing data



N = 134 data sources from 83 countries since 1990 55 countries had no data; 54 had just one data source

Stevens GA et al. Lancet 2015

Countries with representative data on zinc or thiamine status

Zinc status (n = 20)



Hess SY. Food Nutr Bull, 2017.

Thiamine status (n = 2)



Whitfield KC et al. Annals NYAS, in press.

Data needs for nutrition programming

2014 GLOBAL ACTIONS AND ACCOUNTABILITY TO ACCELERATE THE WORLD'S PROGRESS **ON NUTRITION**

"There are many gaps in data on nutrition outcomes, programs and resources... for the 4 WHA indicators where rules exist to classify countries as on course, only 60% of 193 UN member countries have data"

Data gaps

Low birth weight (SGA)

Food access/Dietary intake

MN status/anemia

Program coverage

Program costs

Issues of data quality, frequency, sub-national disaggregation

Approaches and challenges to assessing population micronutrient status

Type of information	Data source	Advantages	Challenges
Food availability	Natl food balance sheets	Routinely collected	Natl level data only
Individual dietary intake	Dietary recall surveys	Estimates of % of individuals with inadequate intake	Cumbersome data collection and processing; variable accuracy

Approaches and challenges to assessing population micronutrient status

Type of information	Data source	Advantages	Challenges
Food availability	Natl food balance sheets	Routinely collected	Natl level data only
Individual dietary intake	Dietary recall surveys	Estimates of % of individuals with inadequate intake	Cumbersome data collection and processing; variable accuracy
Clinical exam (e.g., xerophthalmia, rickets)	Surveys, surveillance	Functional indicator	Not pathognomonic; low prevalence (large sample sizes)

Approaches and challenges to assessing population micronutrient status

Type of information	Data source	Advantages	Challenges
Food availability	Natl food balance sheets	Routinely collected	Natl level data only
Individual dietary intake	Dietary recall surveys	Estimates of % of individuals with inadequate intake	Cumbersome data collection and processing; variable accuracy
Clinical exam (e.g., xerophthalmia, rickets)	Surveys, surveillance	Functional indicator	Not pathognomonic; low prevalence (large sample sizes)
Biochemical assessment	Surveys with clinical specimen collection	Direct information on MN status	Cost, complexity, acceptability

Per capita availability of selected nutrients in national food supplies of two countries

Improving nutrition security through agriculture: an analytical framework based on national food balance sheets to estimate nutritional adequacy of food supplies	Country	Avail- ability	Energy (kcal)	Vit A (ug RE)	Vit C (mg)	Ribofl (mg)	Folate (ug)	Zinc (mg
Joanne E. Arsenault, Robert J. Hijmans & Kenneth H. Brown	Bangladesh	Amount	2429	121	31	0.68	132	8.7
Food Security		% req		25	58	78	47	96
The Science, Sociology and Economics of Food Photocicum and Access to Food ISSN 1876-4517 Food Sec. Doi 10.1007/1/3277-015-0452y		% adeq		<1	8	18	<1	44
And Encounties of the Andrew State of the Andr								
🖄 Springer								

Per capita availability of selected nutrients in national food supplies of two countries

Improving nutrition security through agriculture: an analytical framework based on national food balance sheets to estimate nutritional adequacy of food supplies	Country	Avail- ability	Energy (kcal)	Vit A (ug RE)	Vit C (mg)	Ribofl (mg)	Folate (ug)	Zinc (mg)
Joanne E. Arsenault, Robert J. Hijmans & Kenneth H. Brown	Bangladesh	Amount	2429	121	31	0.68	132	8.7
Food Security		% req		25	58	78	47	96
In Solving Socially and Coloning of Coloni		% adeq		<1	8	18	<1	44
Information on nutrient content of food								
supply can be used to prompt decisions on: - Agricultural policy		n:	461	118	1.24	444	8.9	
- Food importation				102	241	152	168	108
- Large-so	- Large-scale food fortification			<u>52</u>	99	87	91	62

Use of national food balance sheets to assess national-level risk of zinc deficiency

Estimated prevalence of inadequate zinc intake



Wessells KR, Brown KH. PLoS ONE, 2012.

Countries with an elevated risk of zinc deficiency based on FBS data, stunting prevalence, or both



Obstacles to obtaining more/better information on biomarkers of population MN status

- Perceived high cost of data collection
- Lack of agreement on which assessment methods to use and how to interpret them.
- Logistical challenges in specimen collection, processing and transport
- Lack of laboratory capacity and trained personnel







FONDATION MÉRIEUX

- Increasing access to diagnosis
 - Developing infrastructure
 - Strengthening skills and processes
 - Building laboratory networks
 - Improving lab management & efficiency
- Supporting public health initiatives
- Enhancing research capabilities
- Improving conditions for mothers and children

Achieving consensus on use and interpretation of MN status biomarkers

• BOND/NIH

- Iodine
- Iron
- Zinc
- Folate
- Vitamin A
- Vitamin B12
- Inflammation
- NYAS committees
 - Thiamine
 - Vitamin D

The Journal of Nutrition
Supplement: Biomarkers of Nutrition for Development (BOND) Expert Panel Reviews, Part 1

Biomarkers of Nutrition for Development—lodine Review¹⁻⁴

Fabian Rohner,^{5,6,15} Michael Zimmermann,^{7,8,15} Pieter Jooste,^{9,10,15} Chandrakant Pandav,^{11,12,15} Kathleen Caldwell,^{13,15} Ramkripa Raghavan,¹⁴ and Daniel J. Raiten¹⁴*

¹Groundwork LLC, Cranspretz-Gägns, Swarzenhard, "Gabda Allance for Improved Narrisen (GAN), Geneva, Switzerhard, "Imattane of Tood, Narrison and Heahs, Swits Forder Intunies of Tochnology (TFL), Zarck, Switzerhard, "The International Cossal for the Coarter of Isolato Heckinsy, Biosedire JL, CZDD) Golda Network, "Geneva, South Africa," Switzerhard, "Genera of Exaltbase for Narrisen, Faculty of Health Stersey, Oster, Weither March, "Switzerhard, "The International," The International Cossal for the Coarter of Isolato Heckins, Biosedire JL, Carlon, Switzerhard, "La Guerence, Suita, Heckins, Background, Switzerhard, "La Guerence, Suita, Heckins, Background, Switzerhard, "La Guerence, Suita, Heckins, Background, Switzerhard, Switzerhard

The Journal of Nutrition Supplement: Biomarkers of Nutrition for Development (BOND) Expert Panel Reviews, Part 3

Biomarkers of Nutrition for Development (BOND)—Zinc Review¹⁻⁵

Janet C King,^{6,7} Kenneth H Brown,^{7,8} Rosalind S Gibson,⁹ Nancy F Krebs,¹⁰ Nicola M Lowe,¹¹ Jonathan H Siekmann,⁶ and Daniel J Raiten^{12,*}

⁶Children's Hospital Oakland Research Institute, Oakland, CA; ²University of California, Davis, Davis, CA; ⁸Bil & Melinda Gates Foundation, Scattle, WA; ²University of Otago, Damedin, New Zealand; ¹⁰University of Colorado School of Medicine, Aurora, CO; ¹¹University of Central Lancashire, Pretoro, United Kingdom; and ¹¹SHI, Bethesda, MD



Biomarkers of Nutrition for Development— Folate Review^{1–5}

Lynn B Bailey,⁴⁺ Patrick J Stover,² Helene McNulty,⁴ Michael F Fenesh,² Jesse F Gregory III,¹⁰ Jame L Mills,¹⁰ Christine M Pferffer,¹² Zia Fazili,²¹ Mindy Zhang²² Per M Ulenhal¹³ Ane M Molloy,¹⁴ Marie A Caudill,² Barry Shane,¹⁴ Robert J Berry,¹⁶ Regan L Bailey,¹⁵ Dorothy B Hausman,⁶ Ramkripa Raghavan,¹¹ and Daniel J Raiten¹¹⁴

¹Department of Foods and Natritism, University of Georgia, Advers, CA, 'Division of Natritional Sciences, Carell University, Baues, NY, Nordern Heinda Cone for Food and Heah, Banocidad Sciences, Bearch, Marninu, Nuevriny of Ulter, Landouerty, Baine Klaud, Tennen Heinh Natrignonnia, Lanerary, Food, Natrition, and Bropockaer Banghi, Cammorrandi, Scientik, and Harit and Boarch Spinor. Natriana Instance of Cald Heah and Hannan Development, NR, Behnda, MM, "Prisonal Carent for Environmental Health, CRG, Adams, Clarker and Hannan Development, NR, Behnda, MM, "Prisonal Carent for Environmental Health, CRG, Adams, CA, "Dynaminet of Cald Heah and Hannan Development, NR, Behnda, MM, "Prisonal Carent for Environmental Health, CRG, Adams, CA, "Dynaminet of Cald Heah and Hannan Development, PRI, Behnda, MM, Storger, "Instance Carent for Horney College Beth Prisonal Society College Calence and Hannan Development, PRI, Behnda, MM, Storger, "Instance Carent for Heah Carent, Calence and Heah Carent, Behndard, Calence and Hean Development, Panghima, Bergin, Panghi, Panghi, Panghi, Cran, Calence, Calence, Alan, Behndard, Calence Calence, Clarker, Clarker, Cale, Carent, Cale, Calence, Calence, Calence, Calence, Calence, Calence, Alan, Behndard, Calence Calence, Clarker, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Alan, Behndard, Calence, Clarker, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Alan, Behndard, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Marker, Calence, Alan, Behndard, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Marker, Calence, MD, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, MD, Calence, MD, Calence, Calence, Calence, Calence, Calence, Calence, Calence, Calence, MD, Calence, MD, Ca

> The Journal of Nutrition Supplement: Biomarkers of Nutrition for Development (BOND) Expert Panel Reviews, Part 4

Biomarkers of Nutrition for Development (BOND)—Vitamin A Review¹⁻⁴

Sherry A Tanumihardjo,⁵ Robert M Russell,⁶ Charles B Stephensen,⁷ Bryan M Gannon,⁵ Neal E Craft,⁸ Marjorie J Haskell,⁹ Georg Lietz,¹⁰ Kerry Schulze,¹¹ and Daniel J Raiten¹²*

¹Intendepartmental Graduate Program in Nutritional Sciences, Department of Nutritional Sciences, University of Wisconsin-Madiono, Madiono, Wit, ¹Tufu University, Boston, MA, ¹²ISDA Weetern Human Nutrition Research Centre, Davis, CA, ¹Craft Technologies, Rez. Molton, NC, ¹University of California, Davis, Davis, CA, ¹¹Newcarde University, Neucarde, United Kangon, ¹³Boomberg School of Paklic Hehrl, Johns Hopkus University, Balimores, MD; and ¹³Eutore Kennedy Shriter National Institute of Child Health and Human Development, NH, Henelash, MD

Methodologic approach for the Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) project

Sorrel ML Namaste,^{1,2} Grant J Aaron,³ Ravi Varadhan,⁴ Janet M Peerson,⁵ and Parminder S Suchdev^{6,7} on behalf of the BRINDA Working Group

¹Strengthening Pannenhips, Results, and Innovations in Natrition Globally, Arlington, VA: ¹Helen Keller International, Washington, DC: ¹Global Alliance for Improved Nutrition, Geneva, Switzerland, ¹Department of Omsology, Johns Hopkins University, Baltimore, MD, ¹Department of Nutrition, University of California, Devis, Davis, CA.¹Switten Brach, CDC, Matsan, GA, and Poparamont of Poliatissis and Global Health, Ennory University, Mattara, GA

ABSTRACT

Background: The Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRNDA) project is a multiagency and multicountry collaboration that was formed to improve micromutrient assessment and to better characterize anemia. INTRODUCTION Global and country-level decision makers frequently make policy and program decisions with the use of uncertain data. Improving methods to accurately estimate priority global health indicators facilitates the reduction of such uncertainty and assists

ASN

Biomarkers of population MN status recommended by BOND and NYAS

Nutrient	Biomarkers
Vitamin A	p RBP, retinol
Zinc	s/p zinc
lodine	s/p TSH, thyroglobulin; u Iodine
Iron	s/p ferritin, sTfr
Folate	RBC folate; s/p folate, Hcy
Vitamin B12	s/p total B12, transcobalamin, MMA
Thiamine	p ThDP; RBC ETKAC
Vitamin D	p 25(OH)D
Inflammation	s/p CRP, AGP

Centrifugation and hood for separating plasma







Portable, battery-operated cooler and liquid nitrogen storage







Approaches to expand information on global MN status

Simplify and reduce costs of specimen collection, processing, transport

- Dried matrix spots
- Field separation of plasma and cells



Simplify and reduce costs of laboratory analyses

- Low specimen volume, multiplexed lab assays
- Regional resource laboratories
- Point of collection analysis?



Separation of dried blood spot specimens for analysis of MN status biomarkers



* = Assays in development

Additional requirements for expanded laboratory analyses of MN status biomarkers

- Network of well-equipped (regional) resource laboratories
 - National buy-in
 - Respected management organization
- Standardized, consensus laboratory methods
- Initial and refresher training of laboratory personnel
- Global reference laboratory and quality control system
- Certified reference material

Consequences of data limitations on population nutritional status



- Failure to recognize existing nutritional problems
- Missing those at risk, or providing insufficient amounts of nutrients
- Unnecessary/redundant coverage
 - Unnecessary costs
 - Risk of excessive intake

Alain Mérieux: "Without diagnostics, medicine is [public health programs are] blind."

Options for vitamin A deficiency control programs



.....

Food fortification

High potency capsules



Dietary diversification





Breast feeding promotion



Biofortification



Low dose supplements (MNP, LNS)

Options for vitamin A deficiency control programs



An example based on control of vitamin A deficiency (Cameroon – Target group: children 6-59 months)



Survey of 1002 HHs; children 1-4 y & WRA; 3 strata

Engle-Stone R *et al.* J Nutr, 2012, 2013, 2014; Brown KH *et al.* Food Nutr Bull, 2015.

Conclusions from optimization analyses

	Y1	Y2	Y3	Y4	Y5	Y6	¥7	Y8	Y9	Y10	All yrs
VAS	All										
DW	All	Busines									
Oil fort	All										
Total Effectively Covered ('000s)	1,193	1,212	1,233	1,254	1,275	1,296	1,316	1,336	1,356	1,376	12,846
Total cost per year ('000s)	\$3,549	\$3,553	\$3,560	\$3,566	\$3,571	\$3,576	\$3,582	\$3,586	\$3,591	\$3,596	\$35,531

Conclusions from optimization analyses



Take-away messages

- Nutrition-attributable child mortality remains high in LMICs and represents an increasing proportion of child deaths
- There are multiple different nutrition-related diseases that need unique forms of intervention; lessons from infectious disease control should be applied for nutrition (better data, focused interventions)
- To improve the quantity and quality of data on population nutritional status, novel methods are being developed for anthropometry, dietary, and biochemical assessment
- There is growing consensus on the best biomarkers for assessing population MN status and there are increasing efforts to resolve logistical challenges in collecting and analyzing clinical specimens
- Nutrition interventions can be more coherent with better data for program planning, costeffectiveness

THANK YOU