## Roadmap to National Benefit Cost Ratio



### **Defining National Economic**

#### **Consequences Micronutrient Deficiencies**

- Scientific literature has established coefficients on <u>Health Risks</u> or <u>Performance Deficits</u> related to specific <u>Nutrition Indicators</u>.
- These Coefficients can be applied to national data and statistics to project magnitude of loss for each of s indicator by indicator.

Size of Population Affected	X	Potential Earning	x	Labor Participation Rate (%)	x	Coefficient Of Risk or Deficit	=	Baseline Annual Loss
National Data: Prevalence & Mortality		National Data		National Data		Global Scientific Literature		\$/yr

## 4 Pathways of "Damage" to Measure Baseline Economic Loss



### Pathway #1: Mortality



### Applying Global Evidence (RR) to National MNM Prevalence & Mortality Rates

Prevalence Indicator Risk Group	x	Relative Risk of Mortality	=	Population Attributable Risk (PAR)	X	Mortality in Risk Group	=	Number Deaths/yr Fraction
From National Statistics		RR From Global Literature		Fraction or % of Risk Group Affected		From National Child Mortality Statistics		Attributed To Indicator*

W/ statistical adjustment for periods of multiple risks

## National Data: Baseline Micronutrient Deficiency and Mortality

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	C24 ▼	5 minus Infant Plus 6-11 m	onths	~
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1	Demographics			
2	Total Population	13,300,410	National Stats	
3	Working Age Adults 15-65	7,615,962	National Stats	1
4	Working Age Male Adults 15-65	3,576,944	National Stats	1
5	Working Age Female Adults 15-65	4,039,018	National Stats	
6	Children < 15 years	5,679,275	National Stats	1
7	Children < 5 years	1,893,092	National Stats	
8	Birth Rate	35.6	UNICEF	
9	Annual Live Births	474,027	Calculated	
10	Population Growth	2.51%	CIA	
11	Birth Rate Growth	2.00%	National Stats	
12	Mortality Rates			
13	Under 5 Mortality/1000	72	DHS URBAN	
14	Infant Mortality/1000	47	DHS URBAN	
15	Neonatal < 1 month/1000	26	UNICEF	
16	Maternal Mortality Rate/100,000	392	UNICEF	
17	Mortality			
18	Maternal Mortality	1,858	Calculated from Mortality & Birth Rates	
19	Under 5 Mortality	34,130	Calculated from Mortality & Birth Rates	
20	Infant Mortality/1000	22,279	Calculated from Mortality & Birth Rates	
21	Neonatal < 1 month	12,325	Calculated from Mortality & Birth Rates	
22	Mortality Months 1-11	9,955	Calculated: Infant Minus Neonatal	
23	Estimated 6-11 months	4,344	Calculated: 6/11ths of 1-11 months x 80% as estimated correction for lower death rate in	
24	Mortality 6-59 months	16,194	Calculated: < 5 minus Infant Plus 6-11 months	
25	Prevalence of Micronutrient Deficiencies			-
14	Econ Demo & Health VAD / FE Neonata	NTD / Maternal Morta	ty ZSUM Mort ZIDA kids ZIDA Adults ZSUM DAR ZCons Cov ZEffect Est ZSUM Mort Ber	
Read	dy		Average: 1746684.997 Count: 66 Sum: 36680384.94 🔟 🔟 102% 🖯	Ð

## Global Sources: Major Medical & Public Health Sources

# THE LANCET

Maternal and child undernutrition and overweight in low-income and middle-income countries

Robert E Black, Cesar GVictora, Susan PWalker, Zulfiqar A Bhutta\*, Parul Christian\*, Mercedes de Onis\*, Majid Ezzati\*, Sally Grantham-McGregor\*, Joanne Katz\*, Reynaldo Martar ell\*, Ricardo Uauy\*, and the Maternal and Child Nutrition Study Group†

#### Relative Risk:

Ratio of risk of death or disease among those exposed to the risk among those not exposed.

>1 = Threat

< 1 = Protection</p>

#### Evidence of Elevated Risk Relative Risk for 4 Indicators

	Risk*	Source
Maternal Anemia: Neonatal Mortality	RR 1.45	In Black et al Lancet, 2013
Maternal Anemia: Maternal Mortality /per 1 g/dL Hb increase	RR 1.41	In Black et al Lancet, 2008/2013
Maternal Folic Acid Deficiency: Neural Tube Defect (NTD)	RR 1.38	Cochrane Review, 2012
<b>Child Vitamin A Deficiency</b> Mortality 6-59 Months	RR 1.32	In Black et al Lancet, 2013

Converted from protective as inverse/

### **Population Attributable Risk:**

#### Population Attributable Risk

- Proportion of cases that can be attributed to a specific exposure.
- Proportion of mortality that can be attributed to current rates of anemia, folic acid or vitamin A deficiency?
- PAR in a population depends on:
  - National Data: Prevalence of the risk factor
  - Global Evidence strength of association (RR) with disease.

The formula: (PREV\*(RR-1))/(1+(PREV\*(RR-1))

#### **Deaths from Vitamin A Deficiency**



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1	VAD Associated Deaths of Children 6-59 months		
2	Deaths of Children 6-59 months	16,194	
3	Prevalence of vitamin A deficiency	30%	≣
4	Coefficient of Loss		
5	Relative risk of death due to vitamin A deficiency	1.32	Calculated f
6	Population attributable risk	8.7%	
7	The number of deaths due to vitamin a deficiency	1,401	
8	Loss of Productive Potential		
9	Annual wage	\$1,489	
10	National Labor Participation Rate	77.3%	
11	NPV Economic Loss (13 years to workforce entry)	\$19,622,856	•
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## Summary Projections for 4 Mortality Indicators (Blue Tab)

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1	Mortality Summary	2014	10 Year	
2	Maternal Mortality	288	3149	≡
3	Neo Natal Mortality	654	7162	
4	Birth Defect	418	4574	
5	Vitamin A Def	1,401	15345	
6	Total Deaths	2,761	30231	
7	Under 5 year Deaths	2,473	27,081	
8		7%		
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## **Converting Lives to Currency: A Cold Banker's Approach**

Net Present Value of Work Lost to Childhood Mortality Discount over 45 Year Projected Work-life @ 3%

Size of Population Affected	X	Average Earning	X	Labor Participation Rate (%)	X	NPV Lifetime Earning:*	=	Baseline Annual Loss
Nutrition Attributed Deaths		\$/y National Data		% National Data		45 years 15y Delay 3% Rate		\$/yr

## Net Present Value (NPV): Converting Units to Value Future Benefits

- Human perceptions of value change over time.
  - People value current money more than future money.
  - Value diminishes with added "waiting time" for benefits.
- FF Costs current. FF benefits extend far into future
   Period of No Returns. Earnings 2028-2073
- What's the value or discount of waiting for the Benefit?
  - NPV converts future into present value using a discount rate.
  - Discount Rate charges for waiting:
- NPV % Discount Rate makes big difference in assessing value of interventions that yield long term benefits.
  - Higher % rates diminish the value of future benefits.
    - Model Default: 3% World Bank from World Development Report

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7	The number of Child deaths attributed to IDA in Mother	654	Calculated	
8	Loss of Productive Potential			
9	Annual wage	\$1,489		
10	National Labor Participation Rate	77.3%		
11	NPV Economic Loss (15 years to workforce entry)	\$ 8,177,876	Calculated	
12				
13	45 Years @ \$1489		Status Quo Deaths	
14		\$8,177,876	654	
15		\$8,341,434	667.1	
16	> \$60 thousand/Child	\$8,508,262	680.5	
17		\$8.678,427	694.1	≡
18		\$8.851.996	708.0	
19	NPV over 60 years with no	\$9,029,036	722.1	
20	earnings for first 15 years	\$9,209,617	736.6	
21		\$9,393,809	751.3	
22		\$9,581,685	766.3	
23	~\$12 thousand/child	\$9,773,319	781.7	
24		\$89,545,461	7,162	
14 4		Mort / IDA kids / ID	A Aduits / SUM DAR / Cons Cov / Effect Est / SUM I	Mort Ber
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## Pathway #2: Anemia Lost Future Earnings Potential Children



### Childhood Anemia and Iron Deficiency: Future Productivity and Earnings

#### Nutrition Literature:\*

- Iron deficiency in childhood causes cognitive deficit.\*
- Iron interventions improve cognition 0.5 to 1 SD.\*\*
- **Economic Literature:** 
  - 0.5 SD increase in IQ = increase in wages 5-10%\*\*
- Future earnings deficit in anemic children 2.5%.\*\*\*





2014: Current Child Status Mental Development & Schooling 2029-2074: Future Productivity

## NPV Annual Losses to National Economy



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1	Child Productivity Loss from ID			
2	Health Data Background			
3	Population <5 yrs	1,893,092		
4	Children with IDA	8.08%		
5	Children with Anemia	152,993	Calculated	≡
6	Project proportion/ratio children with ID but without IDA	1.00		
7	Children with ID/IDA Cognitive Deficit	305,985		
8	Demographic and Labor Background Data			
9	Average Annual Wage in All Sectors	\$1,489		
10	National Labor Participation Rate	77.3%		
11	Economic Productivity Loss Projections			
12	Reduction in future productivity in all sectors due to anemia	2.50%	Horton & Ross, 2003	
13	NPV Economic Loss (12.5 years to workforce entry)	\$22,016,574	Calculated	
15	10 Year Status Quo Losses at Current Population Growth			
16	2014	\$22,016,574		
17	2015	\$22,456,905		_
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#### Pathway #3:

#### **Anemia Impact on Adult Productivity**

#### Health Impact

- Weakness & fatigue
- Work Impact:
  - Lower performance or output

#### Consensus Estimates

- Copenhagen Consensus, PROFILES/USAID, ADB/CIPs
- 5% in Manual Labor
  - 17% Heavy Manual Labor
- White-Collar, Parenting & Voluntary work not calculated

#### Controlled Studies: Improved Productivity From Correction of Anemia



## Adult Female Workers Productivity Deficits from Anemia

## Annual Losses to National Economy

Female Deficit: \$/yr

Male Deficit: \$/yr

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1	Current Adult Productivity Loss from IDA	Women	Men	Totals	
2	Health Data Background				
3	Iron Deficiency Anemia	10.3%	2.6%		Calculated
4	Demographic and Labor Data Background				
5	Working Age Adults	2,669,791	3,162,018	5,831,809	National Data and Assumption
6	Labor Participation Rate (Male and Female)	66.1%	88.4%		National Data and Assumption
7	Employed Population	1,764,732	2,795,224	4,559,956	Calculated
8	Manual Labor Share	88.5%	88.5%		National Data and Assumption
9	Working in Manual Labor	1,561,788	2,473,774	4,035,561	Calculated
10	Heavy Manual Labor Share of Overall Manual Labo	15%	15%		Assumption used in Horton et al, 2
11	Workers in Heavy Manual Labor	234,268	371,066	605,334	Calculated
12	Average Wage Sector	\$1,005	\$1,117		Calculated
13	Economic Productivity Loss Projections				
14	Workers with IDA in Manual Labor	160,519	63,563	224,083	Calculated
15	Productivity Deficit	5%	5%		From Horton et al 2003
16	Manual Labor Loss Subtotal	\$8,066,446	\$3,549,096	\$11,615,542	Calculated
17	Workers with IDA in Heavy Manual Labor	24,077.92	9,534.48	33,612	Calculated
18	Additional Deficit	12%	12%		From Horton et al 2003
19	Additional Loss for Heavy Manual Labor Subtotal	\$2,903,921	\$1,277,674	\$4,181,595	Calculated
20	Grand Total	\$10,970,367	\$4,826,770	\$15,797,137	Calculated
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#### Pathway #4: Excess Health Care Costs



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21	Cost Estimates for Care of Survivors	U	Î	
22	% Births with Access to Special Care or Pediatric Surgery for NTD	10%		
23	Estimate of Annual Cost per Case for Pediatric Surgey for NTD Cases	\$1,000		
24	Estimated Annual Cost per Case of Ongoing Rehabilitation and Care for Severely Disabiled	\$250		
25	Estimated Annual Cost per Case of Ongoing Rehabilitation and Care for Moderately Disabled	\$100		
26	Annual Social Security, Welfare or Other Special Programs	\$200		
27	Surgery Cost Per Year	\$51,195		
28	Ongoing Medical Care and Rehab Costs per Year	\$16,626		
29	Annual cost of Social Security, Welfare and Other Special Programs	\$15,358		
30	Total Recurring Costs for Care of Survivors	\$83,179	=	
31				
32	10 Year Status Quo Losses at Current Population Growth			
33	2014	\$4,475,852		
34	2015	\$4,565,369		
35	2016	\$4,656,677		
36	2017	\$4,749,810		
37	2018	\$4,844,806	Ŧ	
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1		Summa	ary Economic Co	nsequences f	or All Indicator	s	
		Lost	Lost Future	Lost	Current		
2		Workforce	Productivity	Current	Healthcare	Tot	tal
3		000,000/yr	000,000/yr	000,000/yr	000,000/yr	000,000/yr	
4	Maternal Mortality	\$5.3				5.29	
5	Neo Natal Mortality	\$8.2				8.18	
6	Birth Defect NTD	\$3.9	\$0.5		\$0.08	4.48	
7	Childhood IDA		\$16.5			16.51	
8	Vitamin A Def	\$19.6				19.62	
9	IDA in Adults			\$15.8		15.80	
10	Total	\$37.0	\$17.0	\$15.8		69.88	
11		<b>53%</b>	24%	23%		% of GDP	
12							
13							
14							
	Mat Mort / SUM Mort / IDA kids / I	DA Adults , SUM DAR	Cons Cov / Effect Est /	SUM Mort Ben 🖌 SUN	1 Fin Ben 🖌 Premix 🖌 Mi	Govt / SUM Cost / BCR /	Ś
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#### **Team Work Session 1: 3-4 Hours**

- 1A: Review National Data Inputs (Yellow)
- □ 1B: Review Mortality Projections (Red)
- Review Lost Productivity Projections (Green)
- Consider Results:
  - Discuss work to be done as follow-up
  - How to use in communications and advocacy.

## Session 1A: Yellow Worksheets Background Information 30 Minutes

- Demo-Health and Econ Data Sheet
  - Discuss and Fill In Data
  - If no data: discuss & agree on educated assumption
    - A placeholder until you get better data
  - Review assumption cells and calculations (no highlight)
- IDA Issues
  - Review Lancet Table Link (DEMO Lines 44-51)
  - Review " region" from web table.
- Average Over-all Wage Earnings (ECON Line 19)
  - Fill in you best estimate for line 19 OR
  - Review logic of Model's Assumption (lines 16-19)

## Flour Fortification Protection for Iron Deficiency & Iron Deficiency Anemia



Courtesy of H. Pachon, FFI Zimmermann 2008; Gleason 2007; Scott 2007; West 2007; Cameron 2011

## Lancet Web Table: Anemia and Iron Deficiency Anemia in Africa Regions

Web Table 3: Prevalence of total and severe iron deficiency anemia (IDA) in children under 5 years of age and pregnant women

	Anemia prevalence in pregnant women (%)				
UN regions and Total IDA total Severe IDA severe Total IDA total Severe sub-regions anemia anemia anemia anemia anemia anemia anemia anemia anemia (95% CI) (95\% CI) (95\% CI) (95\% CI)	IDA severe anemia () (95% CI)				
Africa 60-2 20-2 3-3 1-9 44-6 30-3 1-4 (0-9, 1-8 (0-9, 1	0-8 ) (0-5, 1-2)				
Eastern Africa 54-3 20-6 1-2 (0-9, 1-5 (0-9, 1	0-7 ) (0-5, 0-9)				
Middle Africa 64-9 21-0 1-6 (0-7, 2-5) (17-8, 2-4) (17-8, 2-4) (0-7, 2-5)	1-0 ) (0-5, 1-6)				
Northern Africa 44-7 19-2 Arrennia 70 0-5 (0-0, 1-0) (12-3, 2 (0-0, 1-0) (0-0	0-3				
Southern Africa 41.6 20.3 (23.2, 61.1) (9.7, 32 0/ 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0-3 ) (0-0, 0-6)				
Western Africa         73.5         19.8         70 Anemia from IDA         1.8           (69.8, 76.9)         (17.6, 22.0)         (4.1, 7.1)         (2.3, 3.9)         (48.1, 0.7.6)         (19.8, 28.6)         (0.4, 3.1)	1·2 (0·3, 2·1)				

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27	Anemia in Children					
28	Anemia in Children 6-59 months	30%	National Data			
29	Iron Deficiency Anemia Proportion	27%	National Data or Caculated % from From Black et a			
30	Estimated IDA in Children 6-59 months	8.1%	Calculated			
31	Anemia in Pregnant Women					
32	Anemia in Pregnant Women	30%	National Data			
33	Proportion IDA in Pregnant Women	42%	National Data or Caculated % from From Black et a			
34	Estimated IDA in Pregnant Women	12%	Calculated			
35	Anemia in Adult Women					
36	Anemia Adult Women	30%	National Stats			
37	Proportion IDA in WRA	34%	National Data or Average Children & Pregnant Wor			
38	Estimated IDA in WRA	10.3%	Calculated			
44	Regional Statistic for IDA From Black et al in La	ncet				
45	Pregnant Women Regional Anemia	58.20%				
46	Pregnant Women Regional IDA	24.20%				
47	Pregnant Women Proportion IDA	41.6%	Linked to B 34			
48	Child Regional Anemia	73.50%				
49	Child Regional IDA	19.80%				
50	Child Proportion IDA	26.9%	Linked to B 34			
	Cons Cov / Effect Est / SUM Mort / SUM Mort / IDA kids / IDA Adults / SUM DAR / Cons Cov / Effect Est / SUM Mort Ben / SUM Fin B					
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	A16 • f <sub>x</sub> GDP (current US\$)		-	*		
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	A	В	C			
4	Female Labor Participation rate	66.1%	http://data.un.org/CountryProfile.aspx?crName=SENEGAL#Economic			
5	Economically Active Adults	5,883,331	Caclulated from B2 and Demo & Health B3			
6	Economically Active Male Adults	3,162,018	Calculated			
7	Economically Active Female Adults	2.669.791	Calculated			
8	Healthy Life Expectancy		(GDP			
9	Healthy Life Expectancy, Male			≡		
10	Healthy Life Expectancy, Female					
11	Average Maternal Age at Birth	Economically Active Adults)				
12	Work Force Entry	v v				
13	Women's Worklife					
14	Male Worklife	60% Wage Share of GDP				
15	Work Life Average	59	Calculated			
16	GDP (current US\$)	\$14,600,000,000				
17	GDP/Working Person	\$2,482	Calculated from line 5 and 16			
18	Individual Wage/Labor Share	60%	ILO from 16 Developing Countries			
19	Average Over-all Wage/Earnings/Income	\$1,489	From National Statistics or Calculated from line 17 and 18			
20	Manual Earnings % Overall Earnings	75% National Data or Assumption				
21	Adjustment for Manual Wage	\$1,117 Calculated from National Stat or Assumption				
22	Female % Male Manual Wage	90% National Data or Assumption				
23	Discount Rate	3%	Judgement Based on World Bank 1993			
24				Ŧ		
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## Session 1B: Mortality: (4 Red Worksheets) 1 hour

- For Each Red Worksheet: Consider & Explore Results:
  - Review logic in the sequence of cells:
    - Reasonable? Credible?
    - Sensitivity Analysis: Consider impact of light blue cells:
  - Issue: NTD Worksheet
    - Review and correct assumptions made in yellow cells
    - □ If no data, use a placeholder until you get better data
    - Issue: Maternal Mortality Worksheet
      - RR Based on Hb distribution not simple prevalence
- Review Blue Worksheet: SUM Mort
- Consider & Discuss:
  - How would you communicate these results?
    - Balance of mortality and economics

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	A	В	С	D	E	F	
1	IDA Associated Neonatal Deaths						
2	Deaths of < 1 month	12,325					
3	Prevalence of IDA in Pregnant Women	12%					
4	Coefficient of Loss						
5	Relative risk of Neonatal Death due IDA in Mother	1.45	Dibley et al in Black et al Lancet 2013				
6	Population attributable risk	5.3%	Calculated				
7	The number of deaths attribued to IDA in Mother	654	Calculated				_
8	Loss of Productive Potential						=
9	Annual wage	\$1,489					
10	National Labor Participation Rate	77.3%					
11	NPV Economic Loss (15 years to workforce entry)	\$ 8,177,876	Calculated				
12							
13	10 Year Status Qquo Losses at Current Population G	rowth	Status Quo Deaths				
14	2014	\$8,177,876	654				
15	2015	\$8,341,434	667.1				
16	2016	\$8,508,262	680.5				
17	2017	\$8,678,427	694.1				
18	2018	\$8,851,996	708.0				
19	2019	\$9,029.036	722.1				
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#### **Incidence of Neural Tube Defects**

Neural Tube Defects per 10,000 live births



March of Dimes estimates for all countries except South Africa. South Africa data from 2008 literature.

## Session 1C: Future and Current Productivity (2 Green Tabs) 1 hour

#### Worksheet: IDA Kids

Discuss and agree on Yellow Cells

Case Iron Deficiency as well as IDA

Review logic in the sequence of cells:

Reasonable? Credible? Agree?

Worksheet: IDA Adults

Discuss and agree on Yellow Cells

Line 8, Manual Labor Share: (% Agriculture + %Industry)

Line 9, Heavy Manual Labor: Make credible estimate

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	$c_{17} \sim f_x$				
	А	В	С		
1	Child Productivity Loss from ID				
2	Health Data Background				
3	Population <5 yrs	1,893,092			
4	Children with IDA	8.08%			
5	Children with IDA	152,993	Calculated		
6	Project proportion/ratio children with ID but without IDA	0.50		≣	
7	Children with ID/IDA Cognitive Deficit	229,489			
8	Demographic and Labor Background Data				
9	Average Annual Wage in All Sectors	\$1,489			
10	National Labor Participation Rate	77.3%			
11	Economic Productivity Loss Projections				
12	Reduction in future productivity in all sectors due to anemia	2.50%	Horton & Ross, 2003		
13	NPV Economic Loss (12.5 years to workforce entry)	\$16,512,430	Calculated		
15	10 Year Status Quo Losses at Current Population Growth				
16	2014	\$16,512,430			
17	2015	\$16,842,679		_	
4 ▲ ▶	Econ / Demo & Health / VAD / Neonatal / NTD / Mat Mort / SUM Mort / IDA kids / ID	A Adults / SUM DAR / Cons Co	V 🖌 Effect Est 🖌 SUM Mort Ben 🖌 SUM Fir	n B	
Ready			<b>Ⅲ Ⅲ</b> 146% ─────↓	-+	

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	A5 • In the Astronomy International Mortality							
				-		_	-	
	A	В	C	D	E	F	G	
1		Summa	ary Economic Col	nsequences fo	or All Indicators	5		
		Lost	Lost Future	Lost	Current			
2		Workforce	Productivity	Current	Healthcare	Tota	al	
3		000,000/yr	000,000/yr	000,000/yr	000,000/yr	000,000/yr	%	
4	Maternal Mortality	\$5.3				5.29	7%	
5	Neo Natal Mortality	\$8.2				8.18	11%	
6	Birth Defect NTD	\$5.2	\$0.6		\$0.11	5.97	8%	
7	Childhood IDA		\$22.0			22.02	29%	≡
8	Vitamin A Def	\$19.6				19.62	26%	
9	IDA in Adults			\$15.8		15.80	21%	
10	Total	\$38.3	\$22.7	\$15.8		76.87	100%	
11		50%	29%	21%		% of GDP	0.53%	
12								
13								
14								
15								
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	Econ / Demo & Health / VAD	FE Neonatal NTD	🖌 Maternal Mortality 🏒	SUM Mort / IDA k	ids / IDA Adults / SU	JM DAR Cons Cov Effec	t Est / SUM Mort Ber	
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### Session 1D: Consider & Discuss 1 hour

- How would you communicate these results?
  - Balance of mortality, human impacts and economics
- Will policymakers and colleagues consider the outputs credible?
  - What can you do to make them more credible?
- How would you frame & present these results?
  - First part of Thursday's Presentation .
- Continue to consider these projections during the week.