

# Medical Imaging in Developing Countries

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**Picture  
This**

Imaging & Beyond  
by Jankharia

How many of you have worked in or are  
working in developing countries?



# Aims and Goals of Today's MasterClass

Define “developing” vs low  
income

Discuss constraints and  
problems

Discuss potential solutions

# Developing vs low-income

How many active IS3R members are from developing countries?

1. 1

2. 2

3. 5

4. 10

Of the 67 active members and 23  
countries they represent



## Low-Income Economies (\$1,005 GNI per capita in U.S. dollars)

Afghanistan	Eritrea	Madagascar	Sierra Leone
Benin	Ethiopia	Malawi	Somalia
Burkina Faso	Gambia, The	Mali	South Sudan
Burundi	Guinea	Mozambique	Tanzania
Central African Republic	Guinea-Bissau	Nepal	Togo
Chad	Haiti	Niger	Uganda
Comoros	Korea, Dem Rep.	Rwanda	Zimbabwe
Congo, Dem. Rep	Liberia	Senegal	

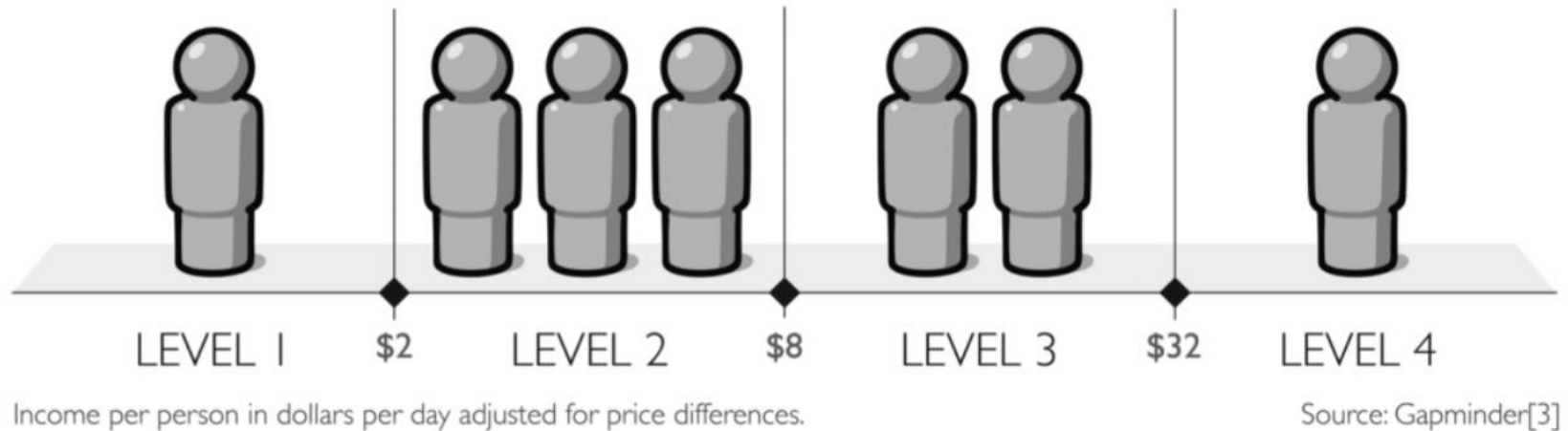
## Lower-Middle-Income Economies (\$1,006-\$3,995 GNI per capita in U.S. dollars)

Angola	Georgia	Micronesia, Fed. Sts.	Sudan
Armenia	Ghana	Moldova	Swaziland
Bangladesh	Guatemala	Mongolia	Syrian Arab Republic
Bhutan	Honduras	Morocco	Tajikistan
Bolivia	India	Myanmar	Timor-Leste
Cabo Verde	Indonesia	Nicaragua	Tunisia
Cambodia	Kenya	Nigeria	Ukraine
Cameroon	Kiribati	Pakistan	Uzbekistan
Congo, Rep.	Kosovo	Papua New Guinea	Vanuatu
Côte d'Ivoire	Kyrgyz Republic	Philippines	Vietnam
Djibouti	Lao PDR	São Tomé and Príncipe	West Bank and Gaza
Egypt, Arab Rep.	Lesotho	Solomon Islands	Yemen, Rep.
El Salvador	Mauritania	Sri Lanka	Zambia

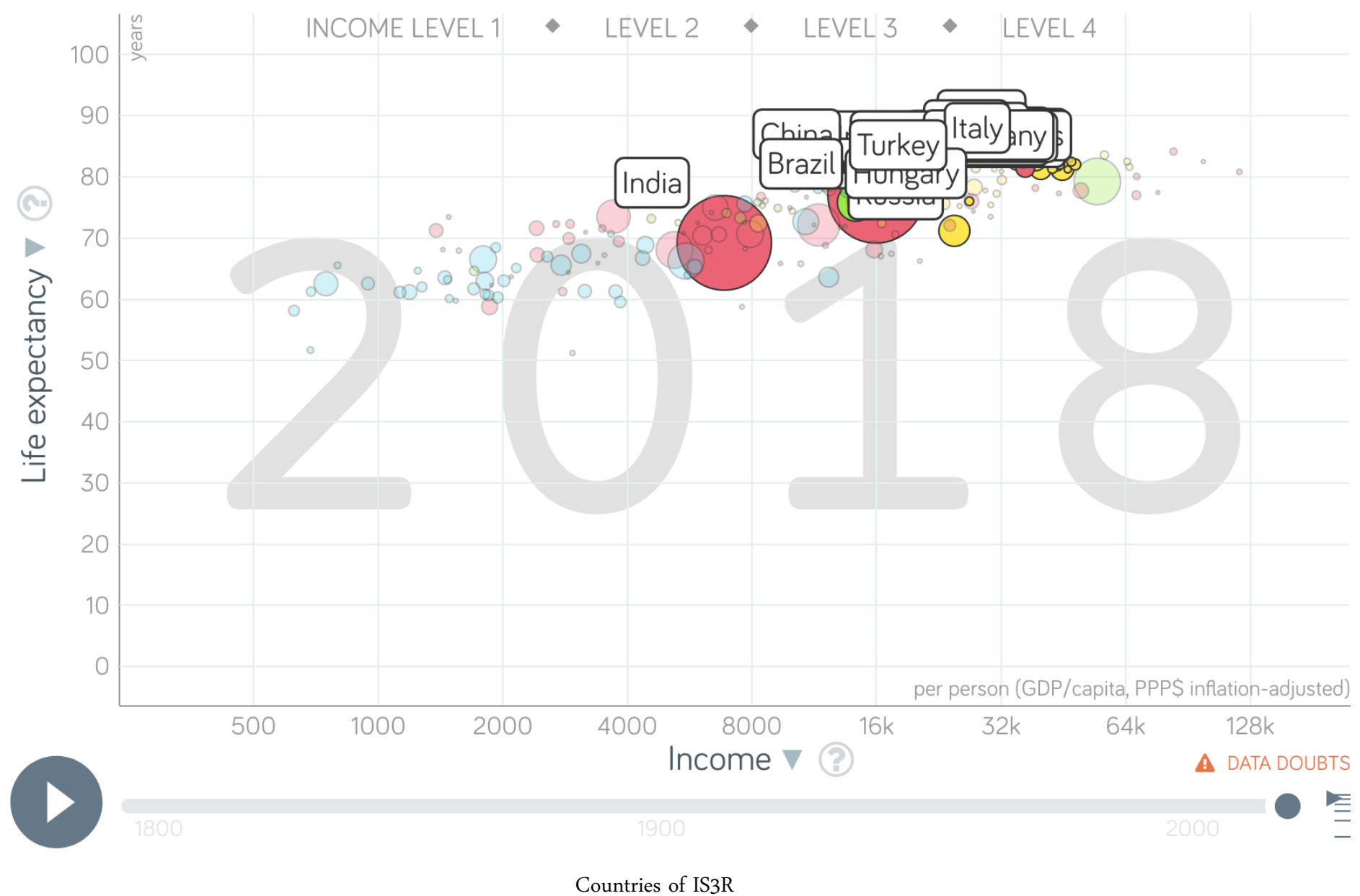
1

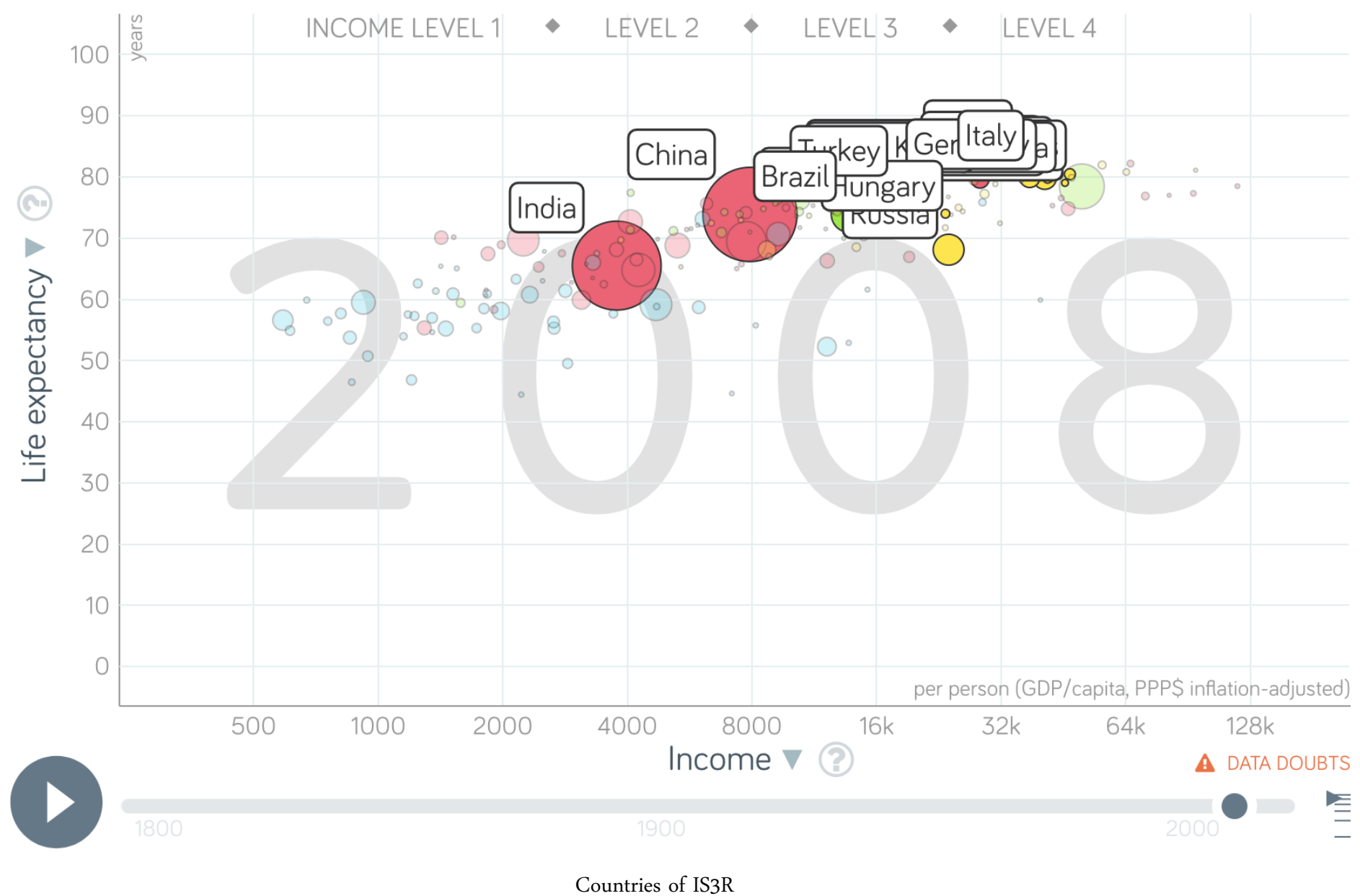
The misconception of the developing / developed concepts

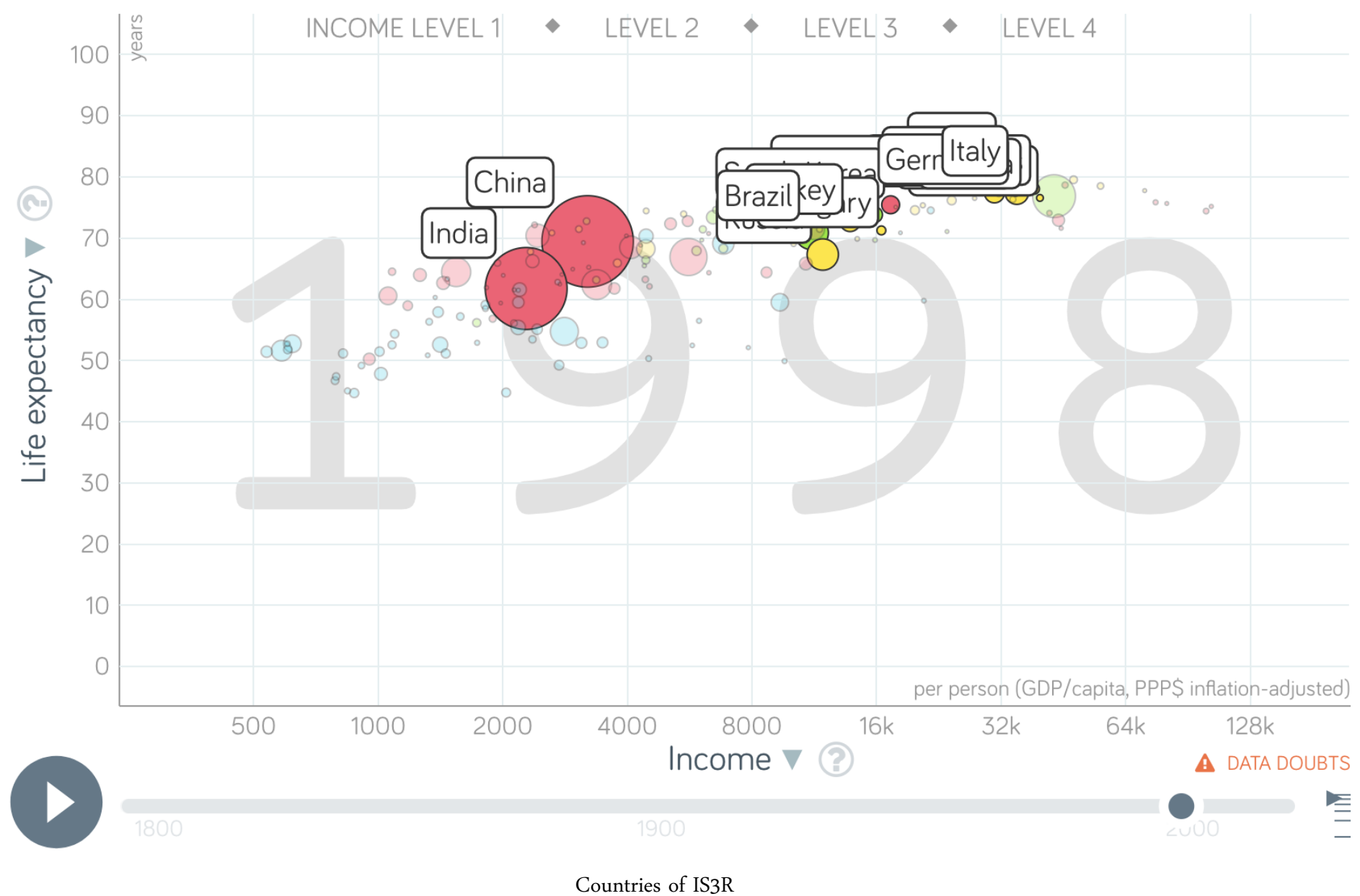
# Four income levels

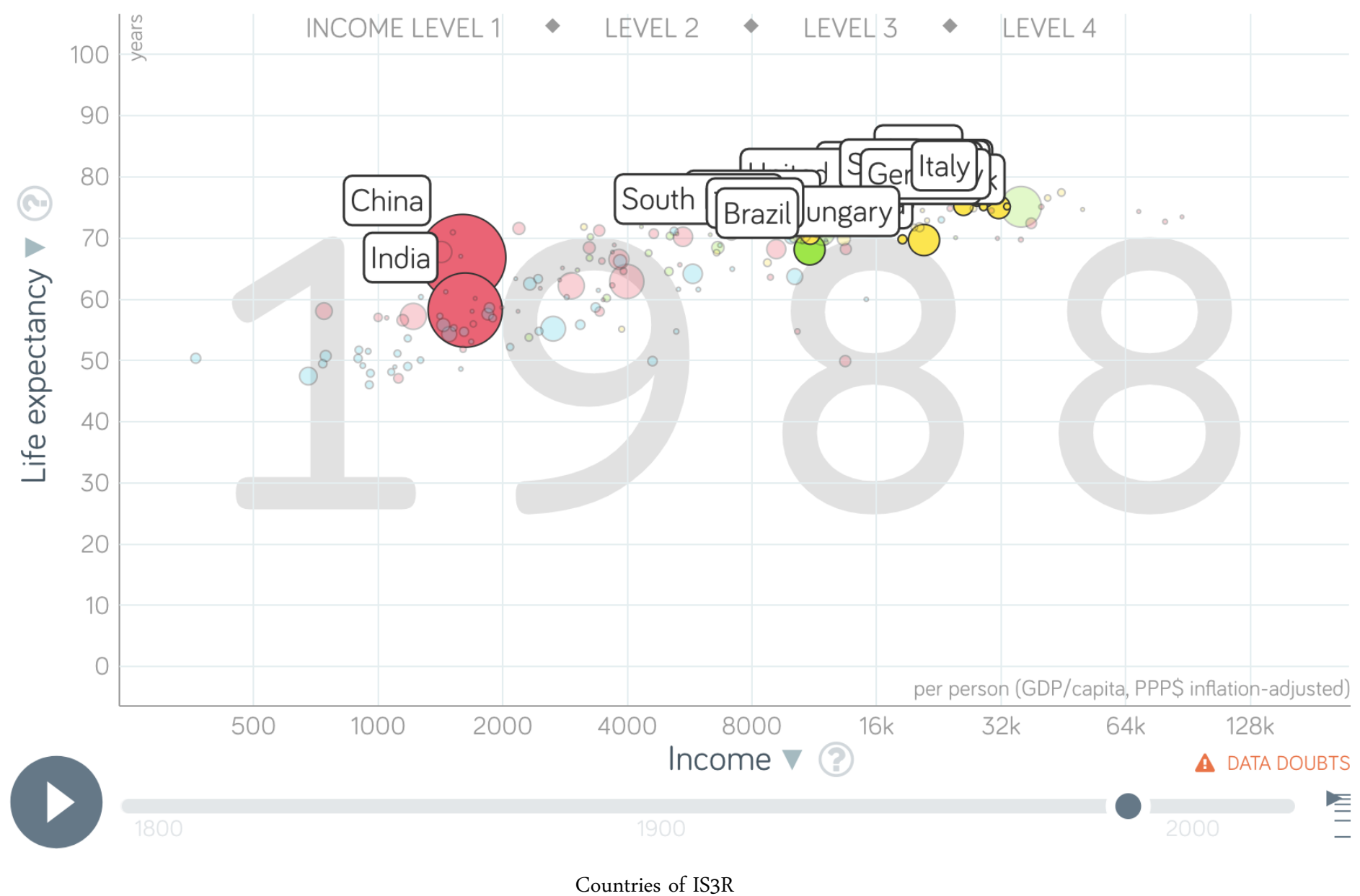


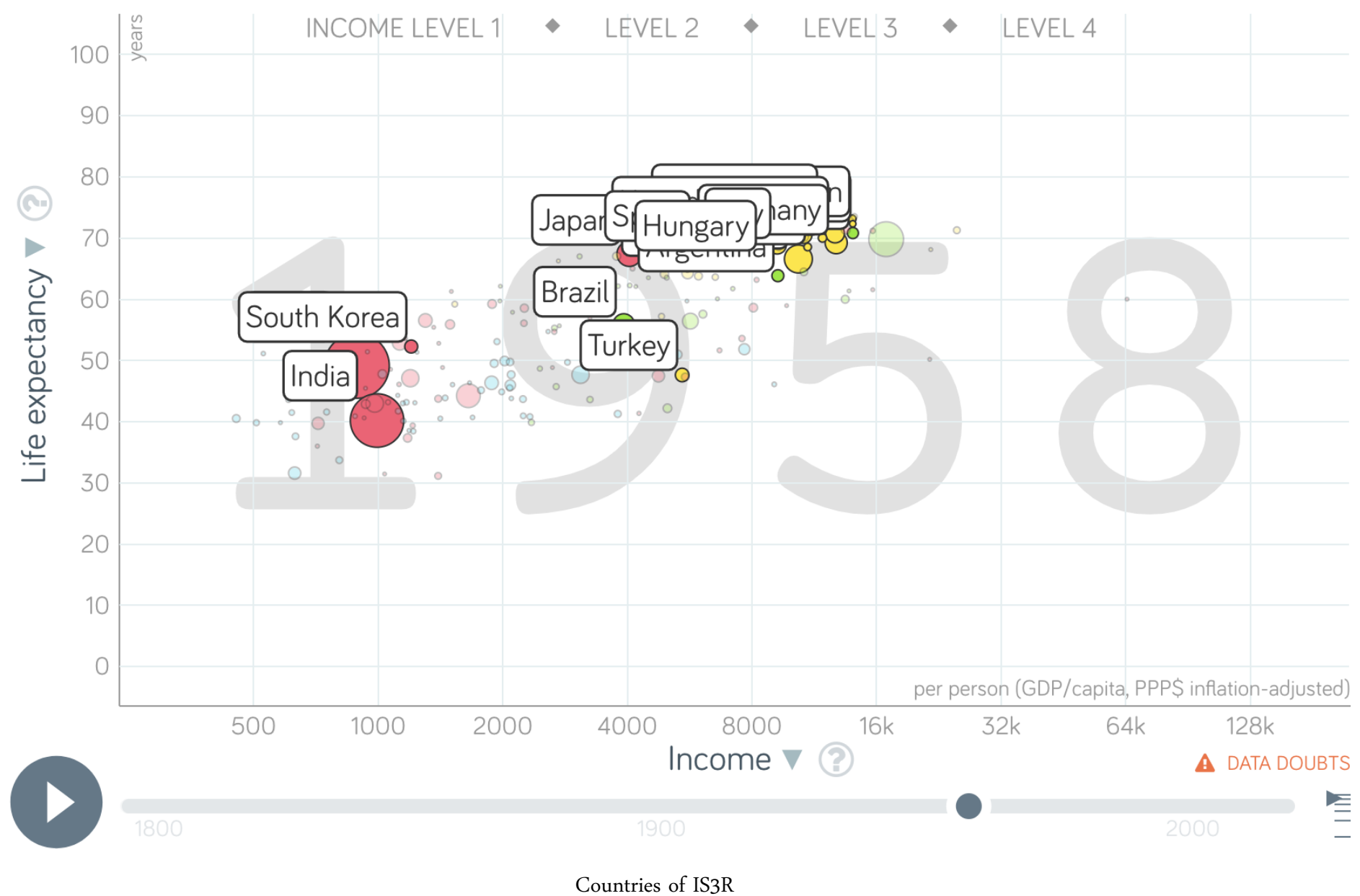
All of us live in one of these 4 income levels













The world is getting better  
and there is constant movement in income levels  
sometimes over just a matter of a decade

Which also means that strategies and goals have often  
change depending on the situation

But within a country as well there can be  
significant disparity

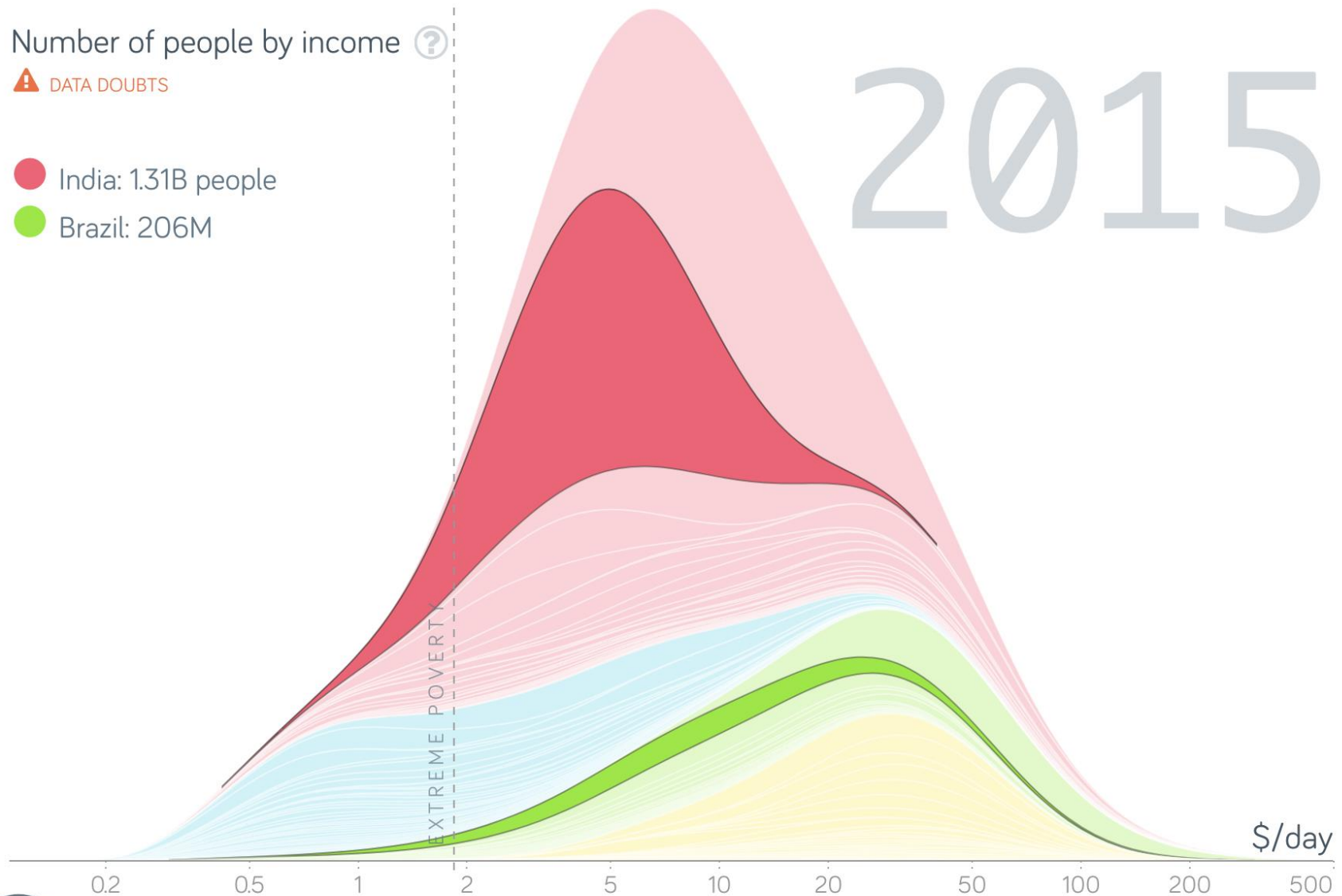
Number of people by income ?

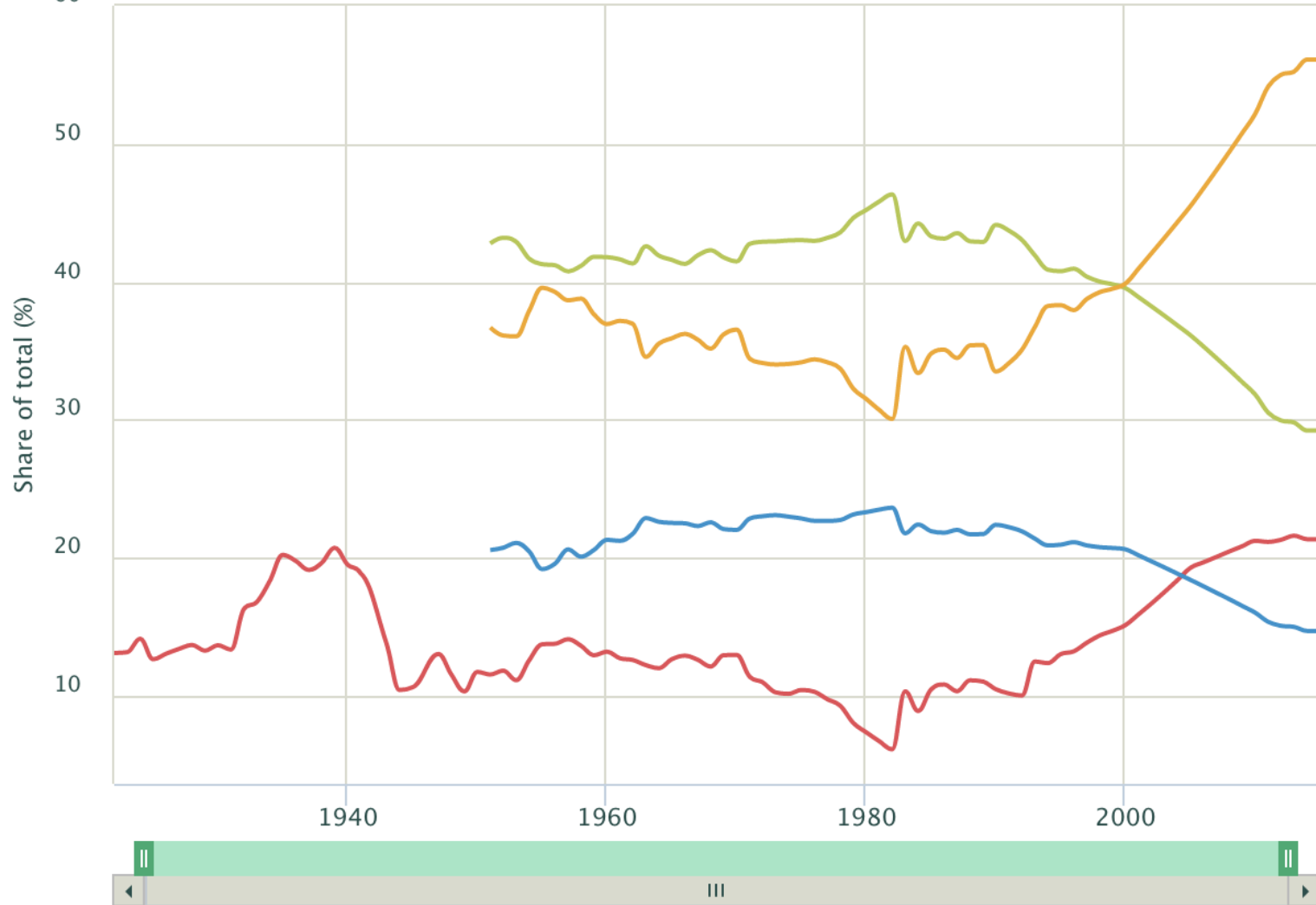
⚠ DATA DOUBTS

● India: 1.31B people

● Brazil: 206M

2015





- Pre-tax national income | Top 1% | share | ADULTS | EQUAL SPLIT ✕
- Pre-tax national income | Bottom 50% | share | ADULTS | EQUAL SPLIT ✕
- Pre-tax national income | Middle 40% | share | ADULTS | EQUAL SPLIT ✕
- Pre-tax national income | Top 10% | share | ADULTS | EQUAL SPLIT ✕

So the actual title of the MasterClass should be...

Medical Imaging in Low Income (LINC) and Low-Middle  
Income (LMINC) Countries and LINC and LMINC Areas  
Within HINC Countries

# Constraints in LINC Countries

# Constraints

Govt spending

Equipment

Personnel

Research

Training

Regulatory

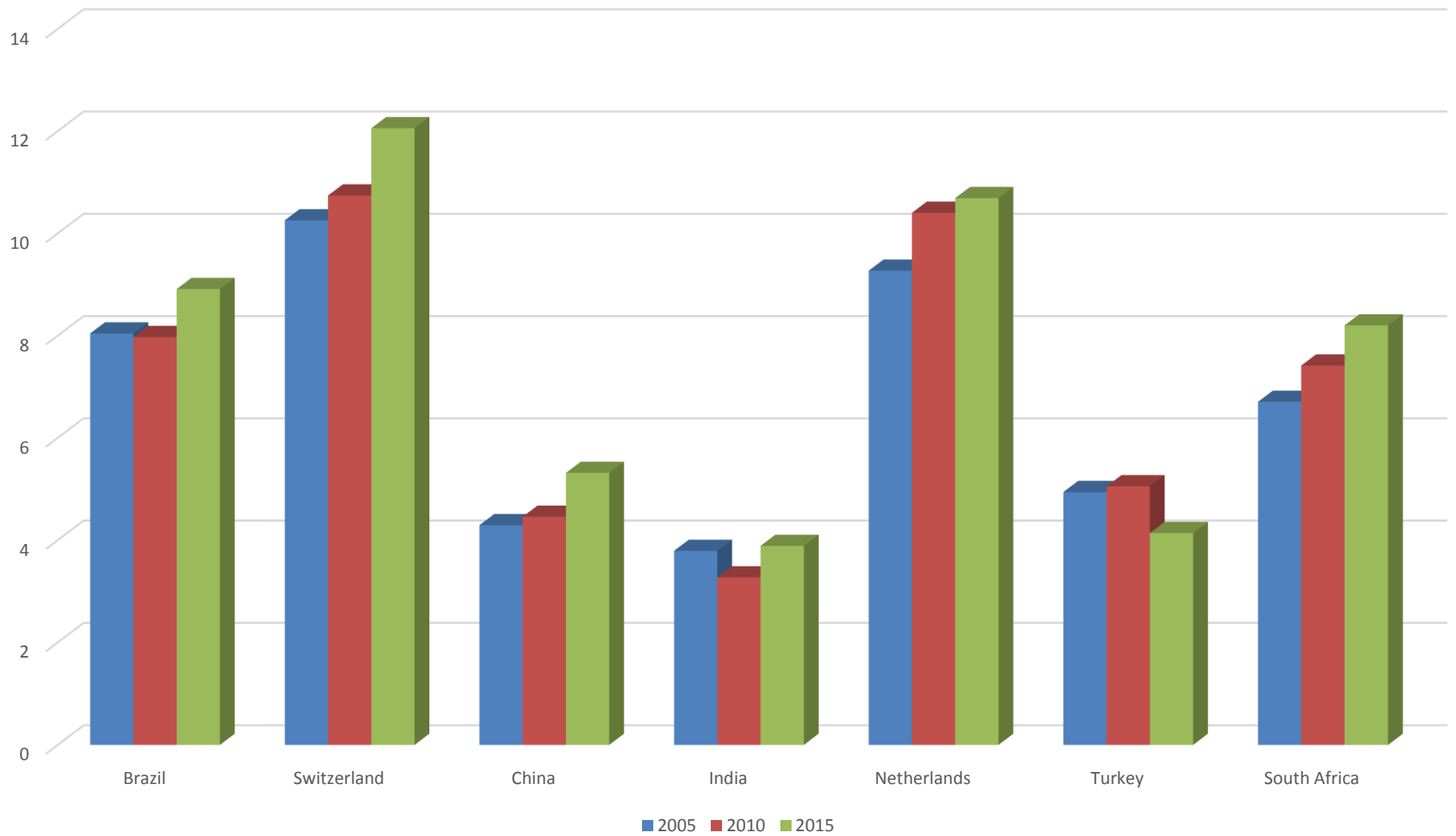
Adherence to SOPs

Disease specific issues



# Spending

Diagrammtitel



When Govt spending is low, overall  
healthcare delivery including medical  
imaging suffers

# Equipment

What proportion of the world's population of 7 billion has no access to basic X-rays?

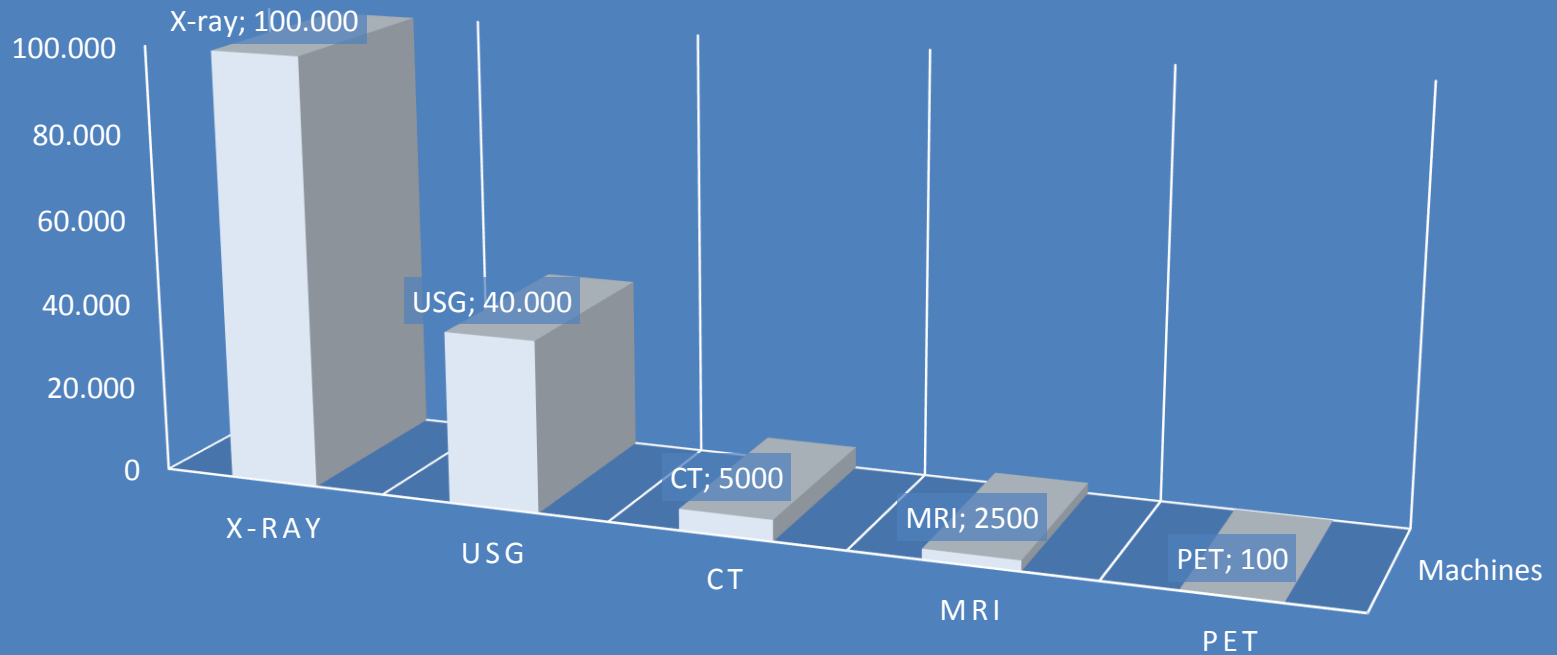
1.  $1/4$
2.  $1/2$
3.  $2/3$
4.  $3/4$

What proportion of the world's population of 7 billion has no access to basic X-rays?

- 1.  $1/4$
- 2.  $1/2$
- 3.  $2/3$
- 4.  $3/4$

## MACHINES IN INDIA – AS OF 2017

■ Machines



All clustered in high income areas and urban environments

What can be done?



# How does one best equip low income areas

- A. Donate used equipment
- B. Encourage entrepreneurship
- C. Develop low cost equipment adaptable to the area

# Low Income Areas

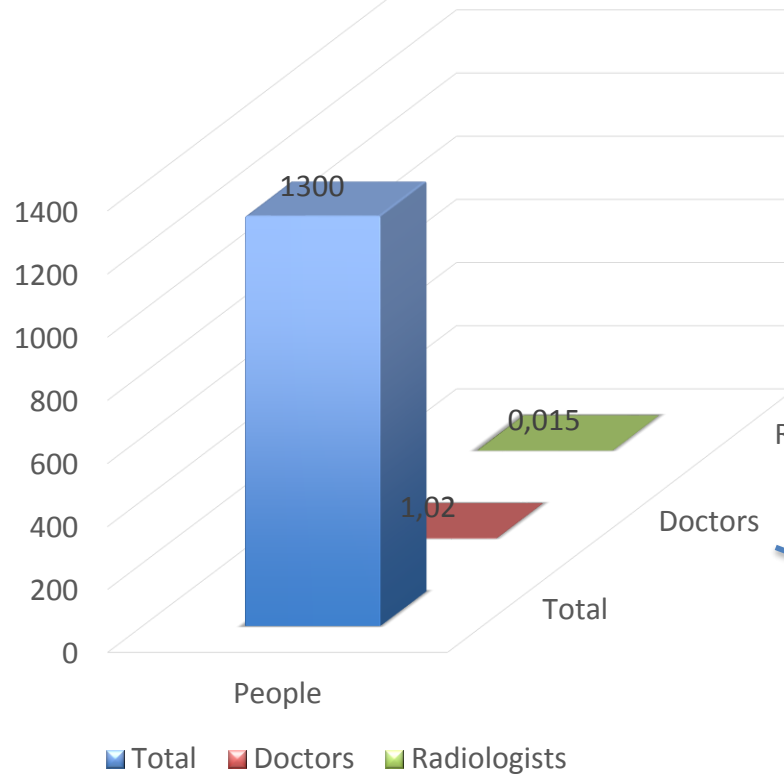
## Infrastructural issues

- Poor roads
- Variable electricity
- Minimal service support
- No trained manpower

It would help to have machines developed to work in these circumstances

# Manpower

## Doctors / POPULATION



15000 radiologists  
 1 per 87333 people or 11 / million  
 (Sweden – 150, UK – 30, Japan – 36)

Radiologists

Doctors

1.02 million doctors  
 1 doc / 1313 people or 0.76 / 1000

700 rads in Mumbai (18.4 m) – 1 per 26,285 people – 38 / million

500 rads / year passing out

Kenya has 200 radiologists for 50 million i.e. 1 radiologist for  
200000 or 5 radiologists per million  
10-12 radiologists passing out per year

Liberia has 2 radiologists for 4 million, i.e. 1 radiologists for 2  
million or half a radiologist per million

**Table 2.** Medical school, internship, and residency questions and responses

Country	a. Length of Medical School (Excluding Internship)	b. Internship Requirement	c. Length of Radiology Residency (Internship Included)	d. Number of Radiology Residency Programs
Algeria	≥7	No	4	6-10
Egypt	5	Yes	4	6-10
Ethiopia	6	Yes	4	1-5
Ghana	6	Yes	5	1-5
Kenya	6	Yes	6	1-5
Nigeria	6	Yes	5-6	11-20
Rwanda	6	Yes	—	0*
Senegal	≥7	Yes	≥7	6-10
Seychelles	—	Yes	—	—
South Africa	5	Yes	6	6-10
Tanzania	5	Yes	4	1-5
Uganda	5	Yes	3	1-5
Zambia	≥7	Yes	—	1-5

\*Rwanda is developing its first radiology residency program, which was scheduled to begin in September 2016.

# Radiologists

No one wants to read plain radiographs or do X-ray procedures

The vast majority want to do cross-sectional imaging

No one wants to do night calls

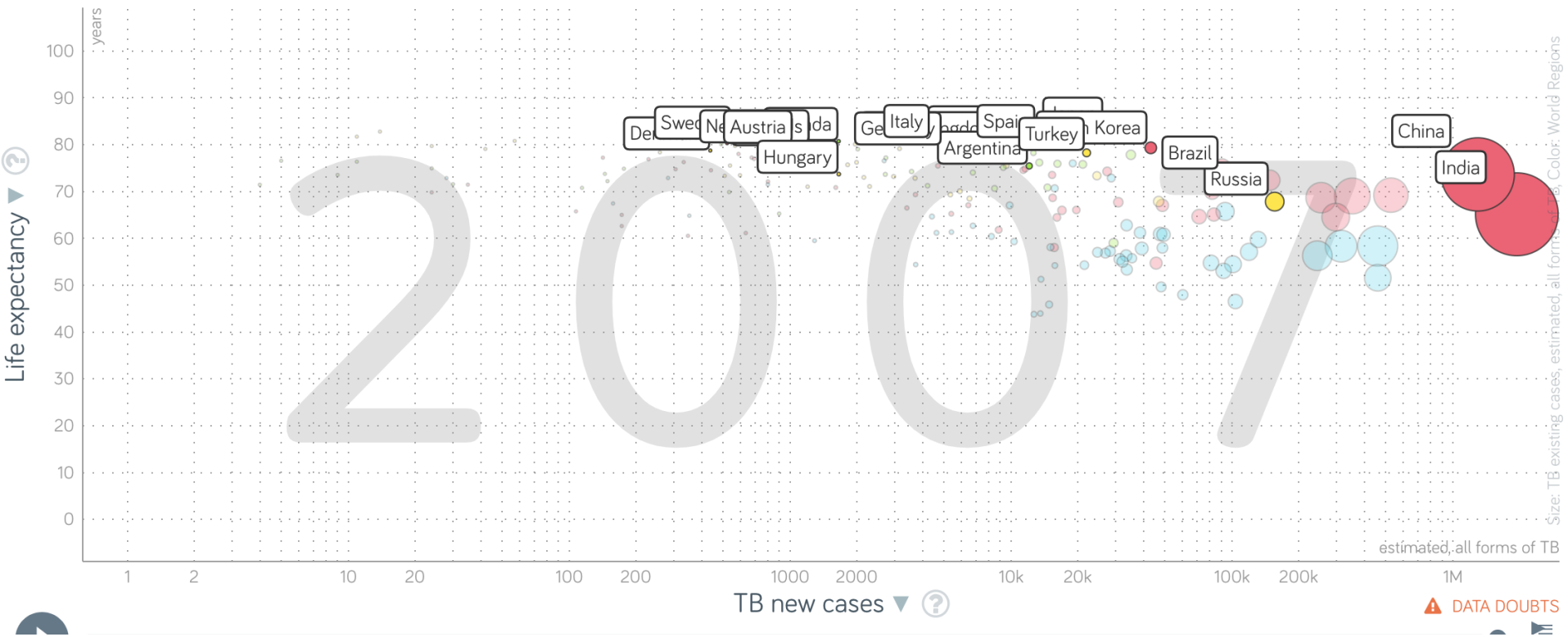
Very few want to do USG because of the PC-PNDT Act & its draconian implementation

Life-style matters – clustered in large cities

Disease Spectrums are Different and the  
Overall Burden Higher



# Tuberculosis





# CHINA

POPULATION: 1 410 MILLION

World Health Organization  
WHO GLOBAL TB REPORT 2018

2017

## 889 000 FELL ILL WITH TB

600 000 males 289 000 females 99 000 children

773 150 TB cases notified



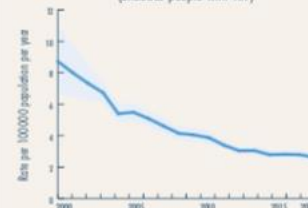
115 850 people not notified or not diagnosed

## 39 000 TB DEATHS



including 1 800 deaths among people with HIV

## TB MORTALITY 2000-2017 (Excludes people with HIV)



## TREATMENT

### TB treatment coverage

87%

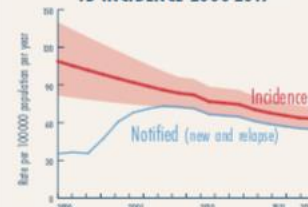
2025

90%  
End TB  
operational  
targets

### Treatment success rate

93%

## TB INCIDENCE 2000-2017



## DRUG-RESISTANT TB

73 000 people fell ill with drug-resistant TB

13 069 notified



5 943 notified and started on treatment

## TB/HIV

12 000 people living with HIV fell ill with TB

4 246 notified

Not reported notified and on antiretroviral treatment

## TB PREVENTIVE TREATMENT



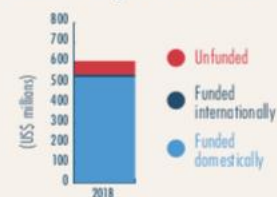
Not reported HIV-positive people (newly enrolled in care) on TB preventive treatment



Not reported Children (aged <5 years) household contacts of bacteriologically-confirmed TB cases on TB preventive treatment

## TB FINANCING 2018

National TB budget USD 609 million



2018 WHO report on TB



# BRAZIL

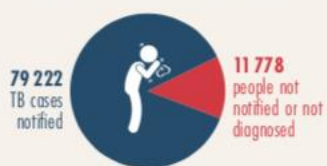
POPULATION: 209 MILLION



## 2017

### 91 000 FELL ILL WITH TB

62 000 males 29 000 females 11 000 children

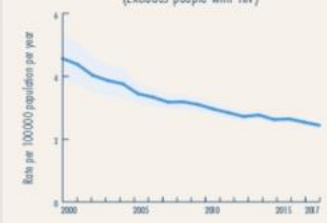


### 7 000 TB DEATHS



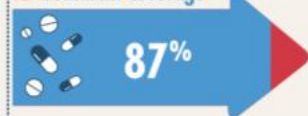
including 1 900 deaths among people with HIV

### TB MORTALITY 2000-2017 (Excludes people with HIV)



## TREATMENT

### TB treatment coverage



2025

90%  
End TB  
operational  
targets

### Treatment success rate

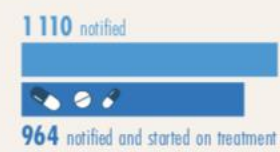


### TB INCIDENCE 2000-2017



## DRUG-RESISTANT TB

2 400  
people fell ill with  
drug-resistant TB



## TB/HIV

11 000  
people living with  
HIV fell ill with TB



## TB PREVENTIVE TREATMENT



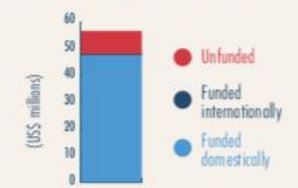
Not reported  
HIV-positive people  
(newly enrolled  
in care) on TB  
preventive treatment



Not reported  
Children (aged <5 years)  
household contacts of  
bacteriologically-confirmed TB  
cases on TB preventive treatment

## TB FINANCING 2018

National TB budget USD 57 million



2018 WHO report on TB



# INDIA

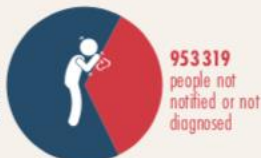
POPULATION: 1 339 MILLION

2017

## 2 740 000 FELL ILL WITH TB

1 780 000 males 954 000 females 224 000 children

1 786 681  
TB cases notified



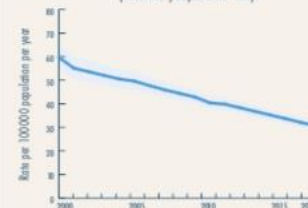
## 421 000 TB DEATHS



including 11 000 deaths among people with HIV

## TB MORTALITY 2000-2017

(Excludes people with HIV)



## TREATMENT

### TB treatment coverage

65%

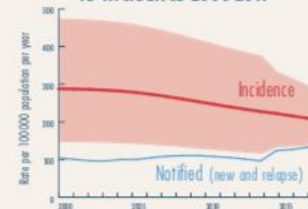
2025

90%  
End TB operational targets

### Treatment success rate

69%

## TB INCIDENCE 2000-2017



## DRUG-RESISTANT TB

135 000 people fell ill with drug-resistant TB

39 009 notified

35 950 notified and started on treatment

## TB/HIV

86 000 people living with HIV fell ill with TB

36 440 notified

28 651 notified and on antiretroviral treatment

## TB PREVENTIVE TREATMENT



10%

HIV-positive people (newly enrolled in care) on TB preventive treatment



11%

Children (aged <5 years) household contacts of bacteriologically-confirmed TB cases on TB preventive treatment

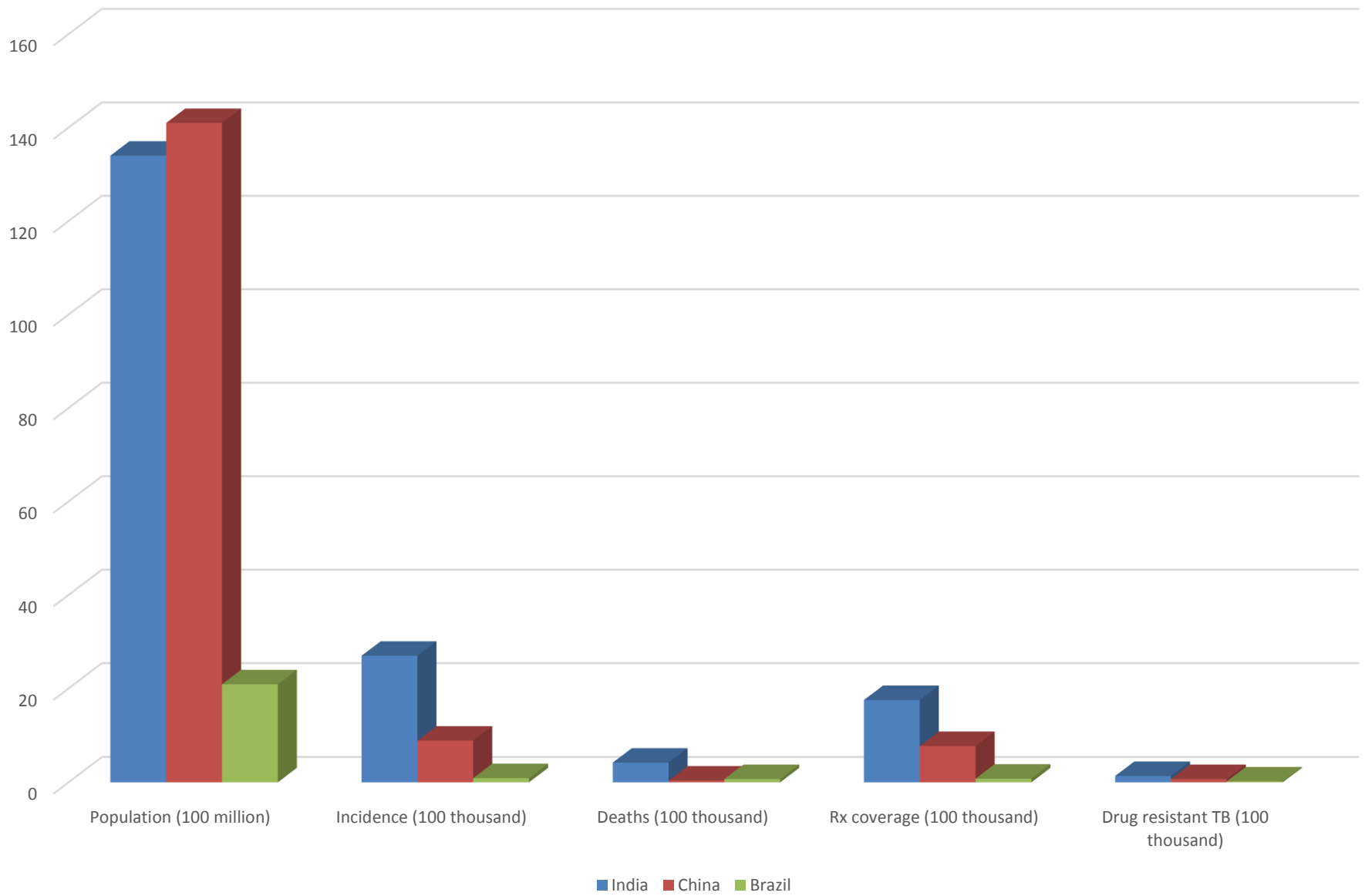
## TB FINANCING 2018

National TB budget USD 580 million



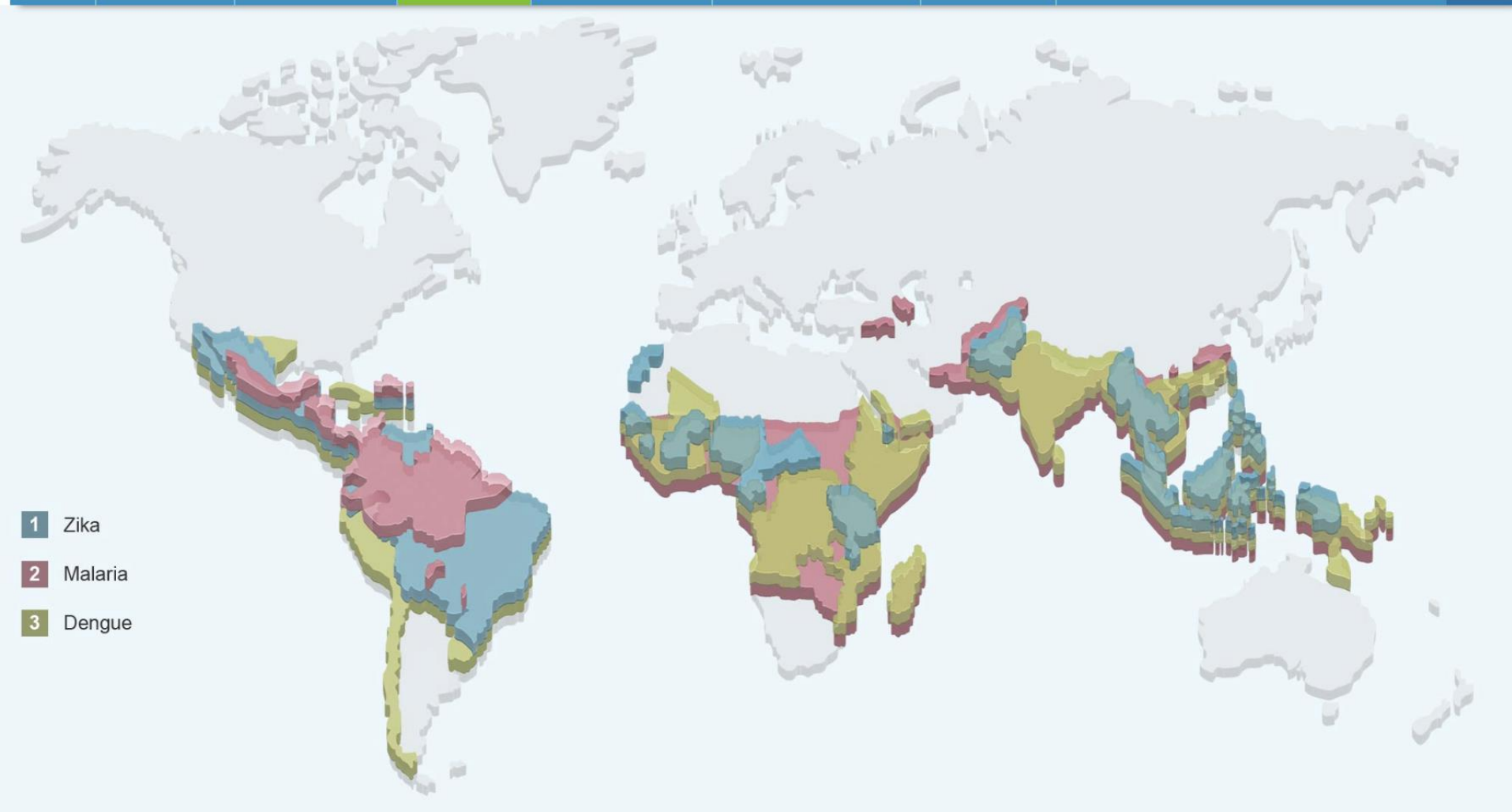
2018 WHO report on TB

## TB 2017



# Other infections



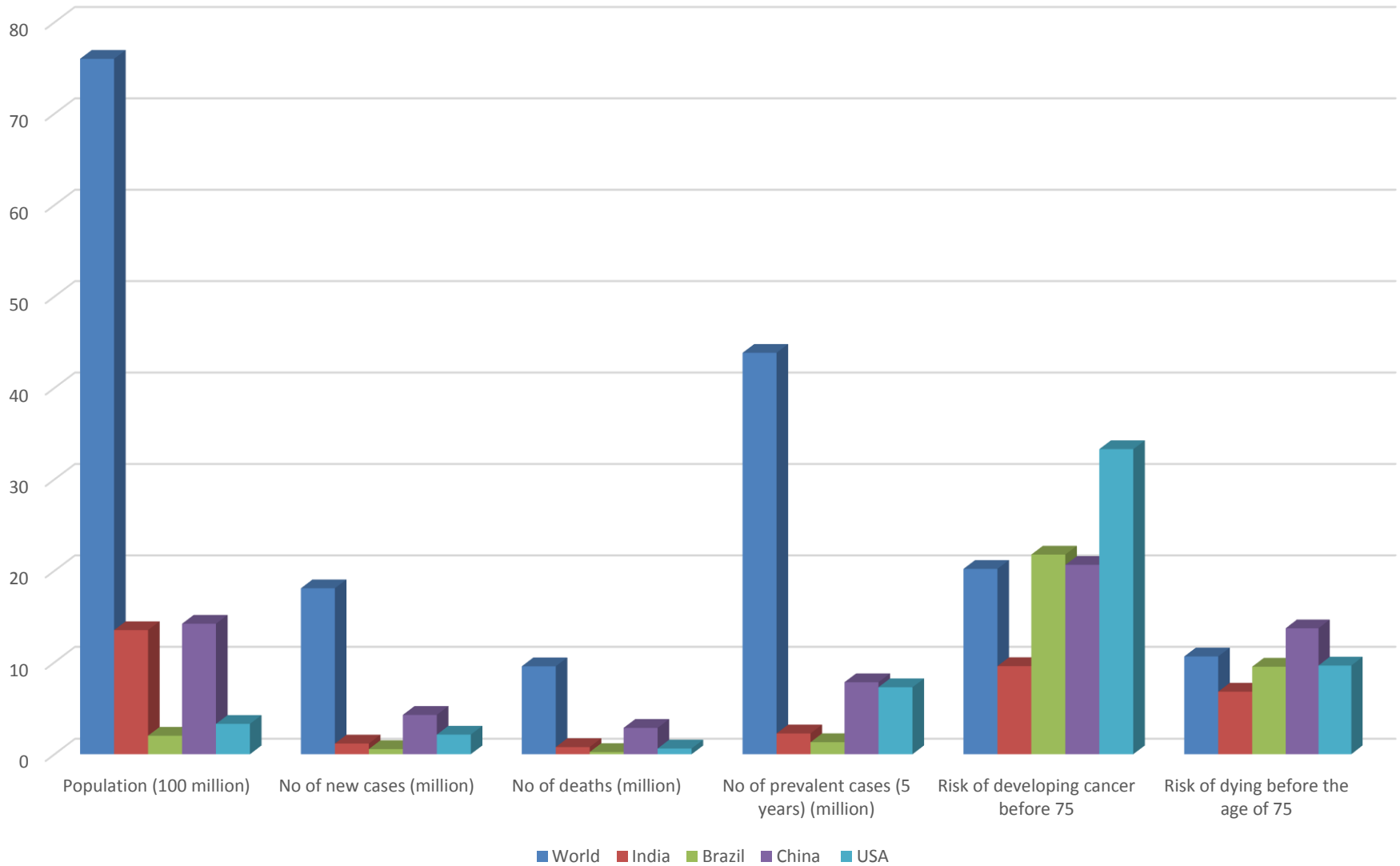


<https://www.research.bayer.com/en/mosquitoes-zika-malaria-dengue.aspx>



# Cancer

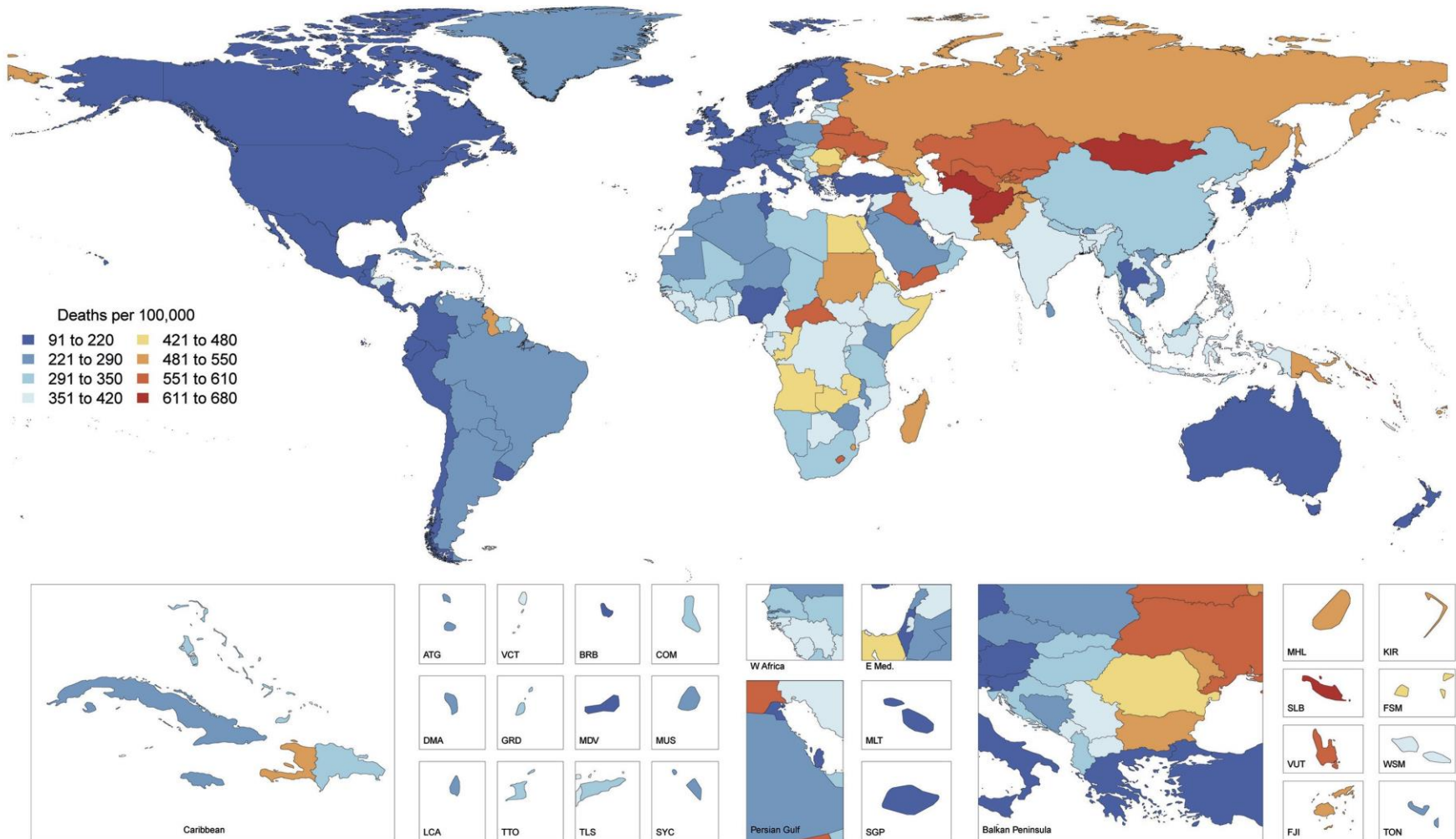
## 2018 Cancer Statistics



Data culled from the 2018 WHO report

The same is true of cardiovascular risk

# CENTRAL ILLUSTRATION: Global Map, Age-Standardized Death Rate of CVD in 2015



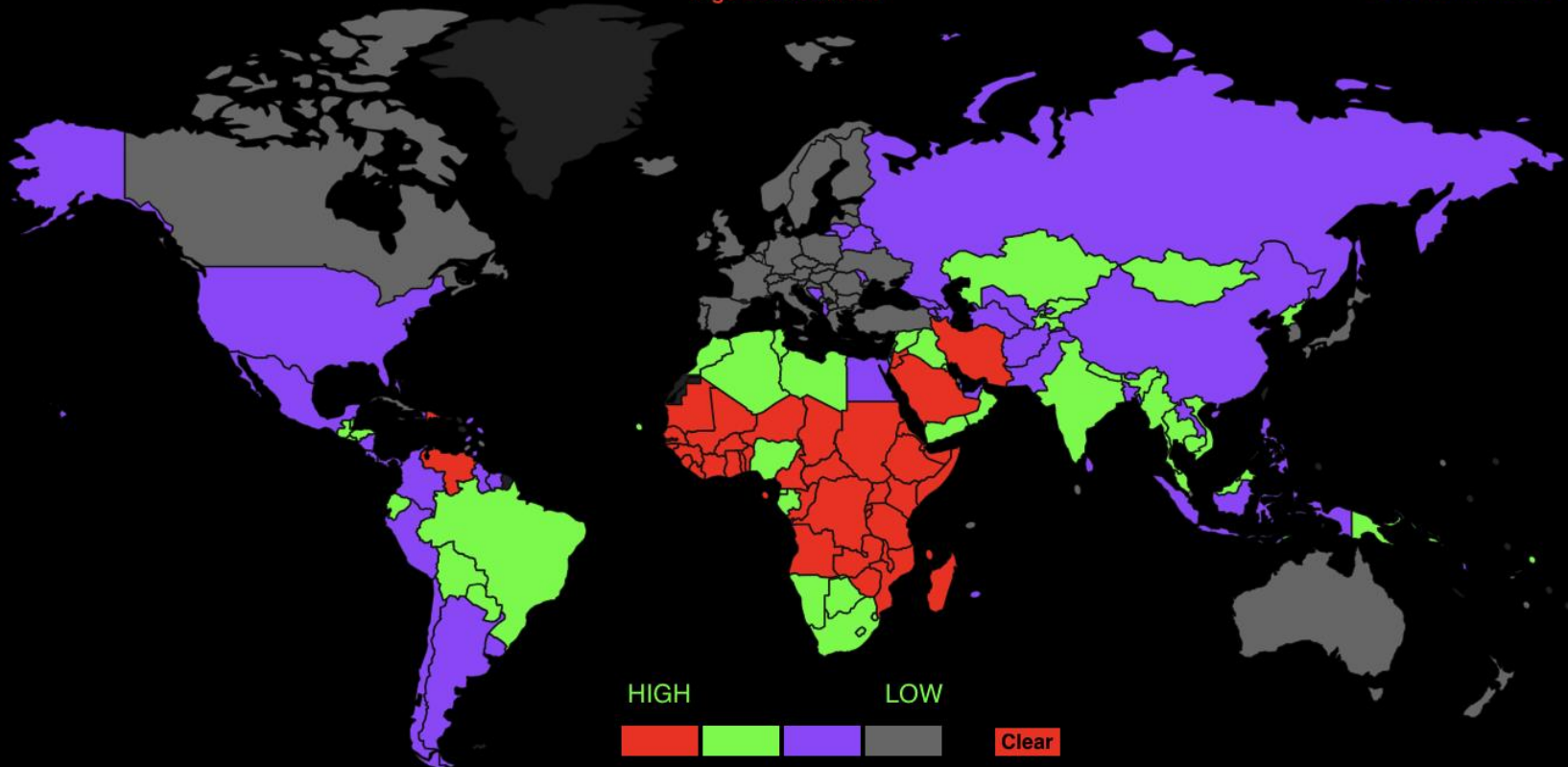
Roth, G.A. et al. J Am Coll Cardiol. 2017;70(1):1-25.

# ROAD TRAFFIC ACCIDENTS

Death Rate Per 100,000  
Age Standardized

Road Traffic Accident: 

SELECT CAUSE



Low income countries even have a higher rate of deaths due to RTAs

High income populations and the places they live in, in low income countries, behave in ways similar to high income countries

# Doubly Whammy

Not only do you still have to deal with infectious diseases such as tuberculosis, malaria, dengue, etc, you also have to deal with cancers, cardiovascular diseases, etc

This places an undue burden on already compromised health services

What can be done?



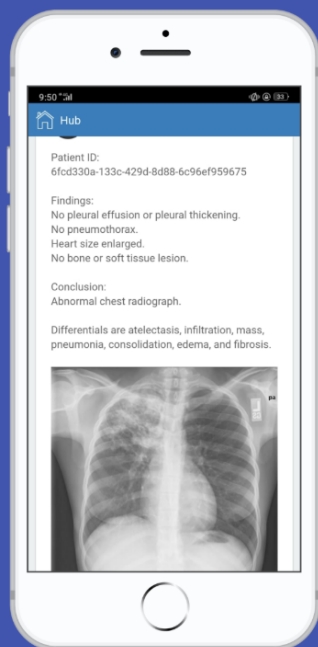
More radiologists

Empower non-radiologists to read

Use of AI to empower referring doctors

# Radiographers can read chest x-rays as well as radiologists

Woznitza, N., Piper, K., Burke, S., & Bothamley, G. (2018). Chest X-ray Interpretation by Radiographers Is Not Inferior to Radiologists. *Academic Radiology*. doi:10.1016/j.acra.2018.03.026



## Solution\*\*

We developed AI for TB to improve the quality and efficiency of chest X-ray screening programs.

Benefits of SemanticMD AI include:

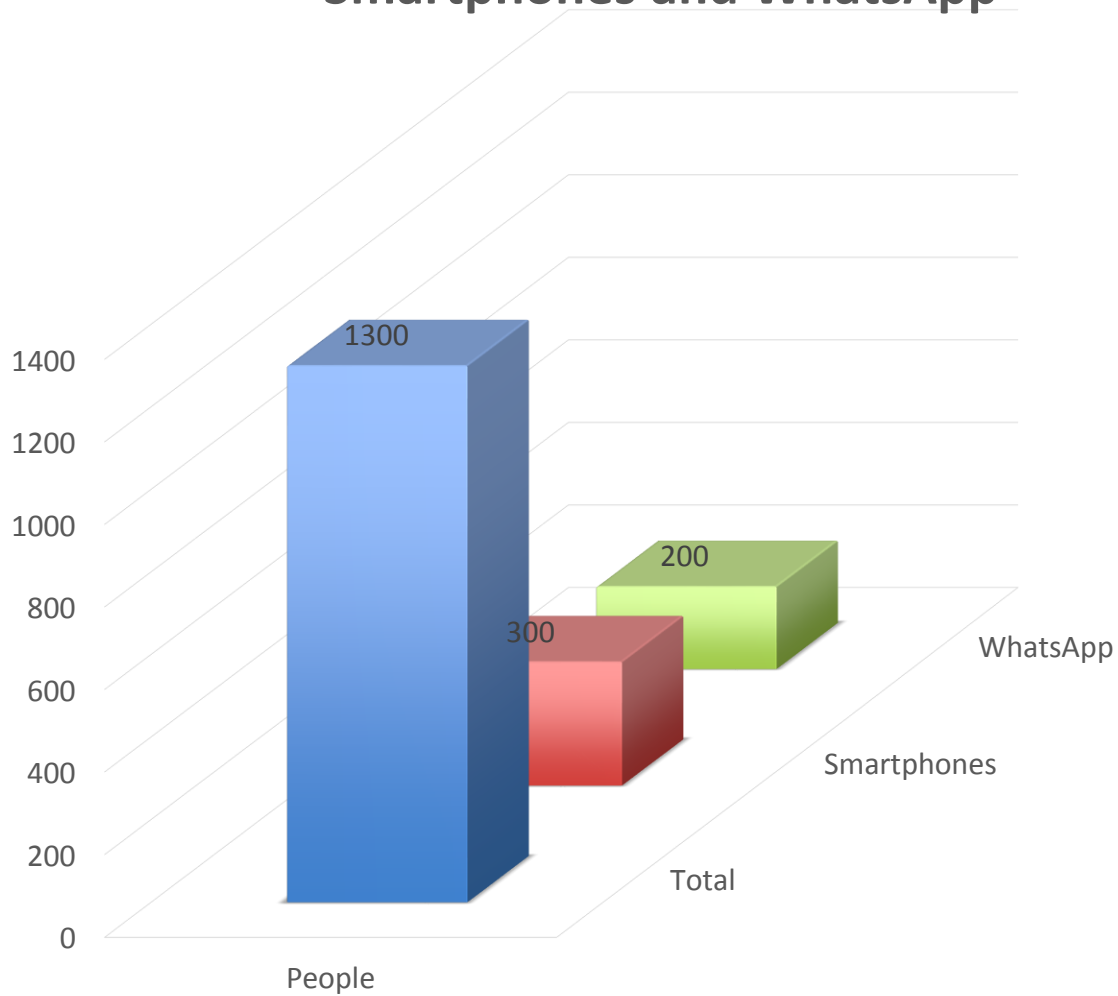
- AI is fine-tuned to be specific to local patient populations
- Cost-efficient compared to teleradiology
- Rapid reading and reporting (<1 second per scan)
- Useful for screening and triage of patients with multiple symptoms
- Sensitivity and specificity equivalent to an expert radiologist
- Can be used offline in remote, low-power areas

\*\*Not available for diagnostic use in the U.S.

An AI solution for chest radiographs for TB already out in the market

# Use of Innovative Low-Cost Solutions

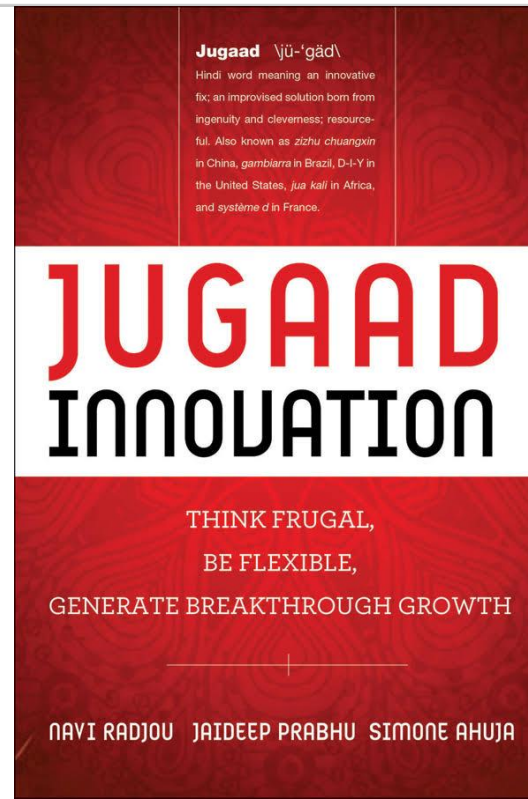
# Smartphones and WhatsApp



**Jugaad** (a word taken from Hindi which captures the meaning of finding a low-cost solution to any problem in an intelligent way) is a new way to think constructively and differently about innovation and strategy.



**Jugaad Innovation Definition from Financial Times Lexicon**  
[lexicon.ft.com/Term?term=jugaad-innovation](http://lexicon.ft.com/Term?term=jugaad-innovation)











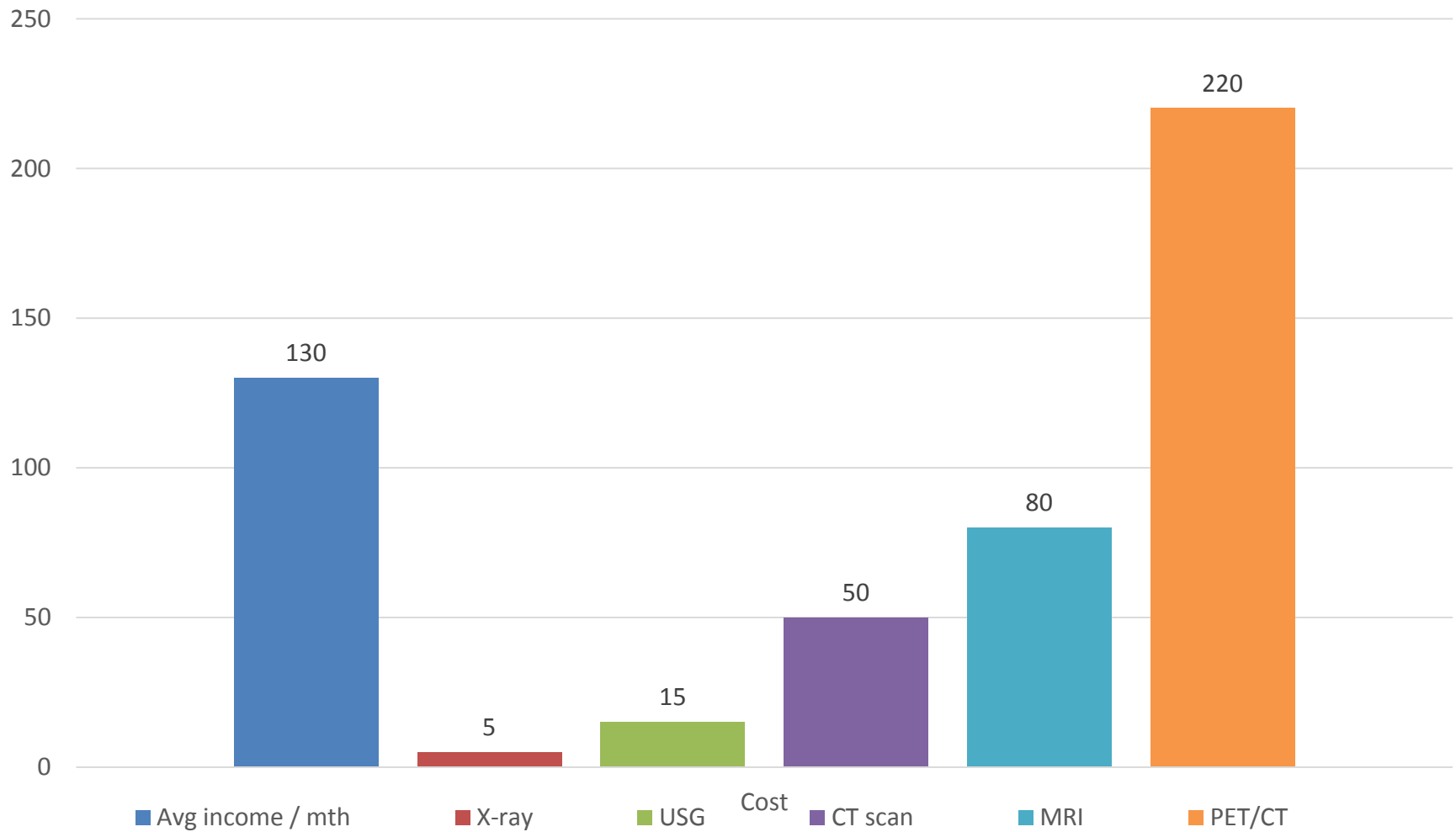
# Affordability

# Poor National Health Schemes

Poor or absent insurance

Out of pocket

## Cost of Test versus Monthly Average Income



In many countries, the cost of an MRI may be equal to the monthly salary or more

Screening programs get short-thrift

# Regulatory Issues and Patient Data

In the absence of national guidelines

Safety norms become quite irrelevant

Difficult to implement SOPs

# What Can Be Done?

# What is not in our hands

Government policies

Spending allocations

Training – colleges, residencies

Infrastructure – roads, electricity



# What Is Possible...

Equipment, training, locally

Resources to radiologists –  
education, articles, sponsorship to  
conferences

Access to solutions like AI that can  
be game-changers

# RAD-AID



53 US academic centres

23 underserved countries

5750 radiology professionals

19855 volunteer hours in 2016

Mollura DJ. JACR 2017;14:841

# What Can IS3R Do?

More representation from LINC  
countries

Invitations to radiologists from LINC and LMINC to attend  
these meetings as guests

Providing access to learning  
resources



**Thank you**



**Picture  
This**  
Imaging & Beyond  
by Jankharia