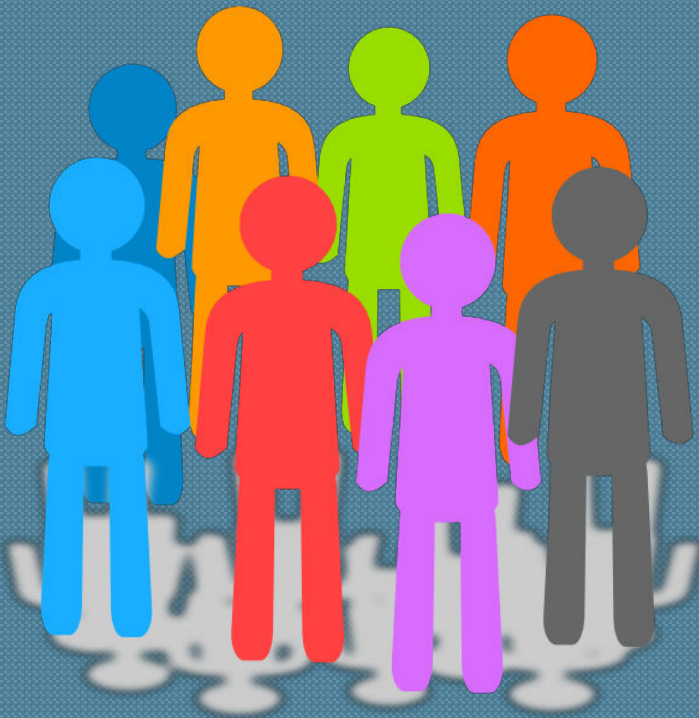


Medical Demography

Fertility & Mortality
Parameters



Objectives:

Student will be able to:

1. Describe different Fertility parameters
2. Differentiate between fertility & Fecundity
3. Explain causes of high population growth
4. Describe Proximate determinants of Fertility
5. Describe different Mortality parameters
6. Describe the causes of high and low fertility and mortality



Fertility

Causes of High Fertility

Crude Birth Rates

General Fertility Rate

Age Specific Fertility Rate

Total Fertility Rate

Fertility Differential

Fertility Control

Proximate Determinants of Fertility



Fertility

Fertility deals with human childbearing or reproduction and is generally confined to women during their reproductive ages (15-49 years). It relates to the number of live births a woman has had i.e. actual reproductive behavior.



Fecundity

Fecundity on the other hand, indicates the physiological ability among women to conceive i.e. to bear children during her reproductive life span.

Woman may bear a maximum of about 42 children in 35 years (if she bears one child every 10 months).

Causes of High Fertility

Since human fertility falls far below fecundity, there must be some explanations to this difference.

The effects of disease and health conditions of women are significant.

However, there are other factors mostly ingrained in the values of the society where a woman has been brought up and is living, which may influence her fertility.

These factors can be broadly grouped into four categories:

1. Psychological

2. Social

3. Economic

4. Demographic

a) Biological

b) Replacement Effects

c) Insurance Effects

Basic Fertility Measures

A rate shows the frequency of a demographic event in a population during a specific time period (usually in a year). These rates may be crude, refined and adjusted.

1. Crude Birth Rate (CBR)
2. General Fertility Rate (GFR)
3. Age-specific Fertility Rate (ASFR)
4. Total Fertility Rate (TFR)

Crude Birth Rate (CBR)

Crude birth rate is the simplest measure of fertility expressed as:

$$\text{CBR} = \frac{\text{No. of live births in a year}}{\text{Population at mid - year}} \times 1000$$

General Fertility Rate(GFR)

General fertility rate is a refined fertility measure over CBR, and only includes in the denominator those women are in their ages, thus:

$$\text{GFR} = \frac{\text{no. of live births in a year}}{\text{no. of women ages 15-49 years}} \times 1000$$

Age-specific Fertility Rate (ASFR)

Age-specific fertility rate is adjusted for age and determines the fertility rate of women in each age-group (usually in 5 years interval), defined as:

$$\text{ASFR} = \frac{\text{Live births in a year to women age group X}}{\text{Number of women of age group X}}$$

Total Fertility Rate (TFR)

ASFR is not a summary measure, but a set of seven numbers, it however helps in determining TFR which expresses fertility in a summary form, calculated as:

$$\text{TFR} = \text{sum of ASFRs} \times 5$$

Since ASFRs are calculated in 5 years age intervals, therefore it is necessary to multiply the summation of ASFR by five

TOTAL FERTILITY RATE

Total Fertility Rate is the average number of children born to a woman during her lifetime.



Asean statistical book

Total Fertility Rate (children per woman), 2014.
(in percent)



Crude Birth Rate & Total Fertility Rates

Year	CBR (Total)	TFR (Total)	CBR (Urban)	TFR (Urban)	CBR (Rural)	TFR (Rural)
1990-1991		5.4 (4.7)		4.9 (3.8)		5.6 (5.1)
2006-2007	30.7	4.1 (3.1)	27.6	3.3 (2.5)	32.3	4.5 (3.4)
2012-2013		3.8 (2.9)		3.2 (2.4)		4.2 (3.1)

Demographic data

Year	Live births per year	Deaths per year	Natural change per year	CBR ¹	CDR ¹	NC ¹	TFR ¹	IMR ¹
1950–1955	1 652 000	937 000	715 000	42.0	23.8	18.2	6.60	176.6
1955–1960	1 873 000	907 000	966 000	43.0	20.9	22.1	6.60	156.3
1960–1965	2 128 000	894 000	1 233 000	43.5	18.3	25.2	6.60	139.5
1965–1970	2 407 000	887 000	1 520 000	43.2	15.9	27.3	6.60	125.7
1970–1975	2 738 000	890 000	1 848 000	42.8	13.9	28.9	6.60	114.8
1975–1980	3 197 000	935 000	2 262 000	42.9	12.6	30.3	6.60	106.6
1980–1985	3 746 000	1 019 000	2 726 000	42.6	11.6	31.0	6.44	101.5
1985–1990	4 367 000	1 120 000	3 247 000	42.1	10.8	31.3	6.30	96.7
1990–1995	4 566 000	1 166 000	3 400 000	38.2	9.7	28.5	5.67	90.1
1995–2000	4 674 000	1 201 000	3 473 000	34.4	8.8	25.6	5.00	83.2
2000–2005	4 387 000	1 213 000	3 175 000	28.9	8.0	20.9	4.00	76.8
2005–2010	4 666 000	1 277 000	3 390 000	28.1	7.7	20.4	3.65	70.9

¹ CBR = crude birth rate (per 1000); CDR = crude death rate (per 1000); NC = natural change (per 1000); TFR = total fertility rate (number of children per woman); IMR = infant mortality rate per 1000 births

Year (beginning).	Population (in thousands)	Live births (in thousands)	Deaths (in thousands)	Natural change (in thousands)	Crude birth rate (per 1.000)	Crude death rate (per 1.000)	Natural change (per 1.000)	Fertility rates
2011	177 100	4 870	1 293	3 577	27,5	7,3	20,2	3.5
2012	180 710	4 915	1 301	3 614	27,2	7,2	20,0	3.4
2013	184 350	4 941	1 291	3 650	26,8	7,0	19,8	3.3
2014	188 020	4 964	1 297	3 667	26,4	6,9	19,5	3.2
2015	191 710	5 003	1 303	3 700	26,1	6,8	19,3	3.2

Fertility Differentials

Since fertility of women is affected by various social, economic and demographic factors, women in various subgroups have different fertility levels. Thus fertility level of women is lower, who have higher level of education and live in urban areas.

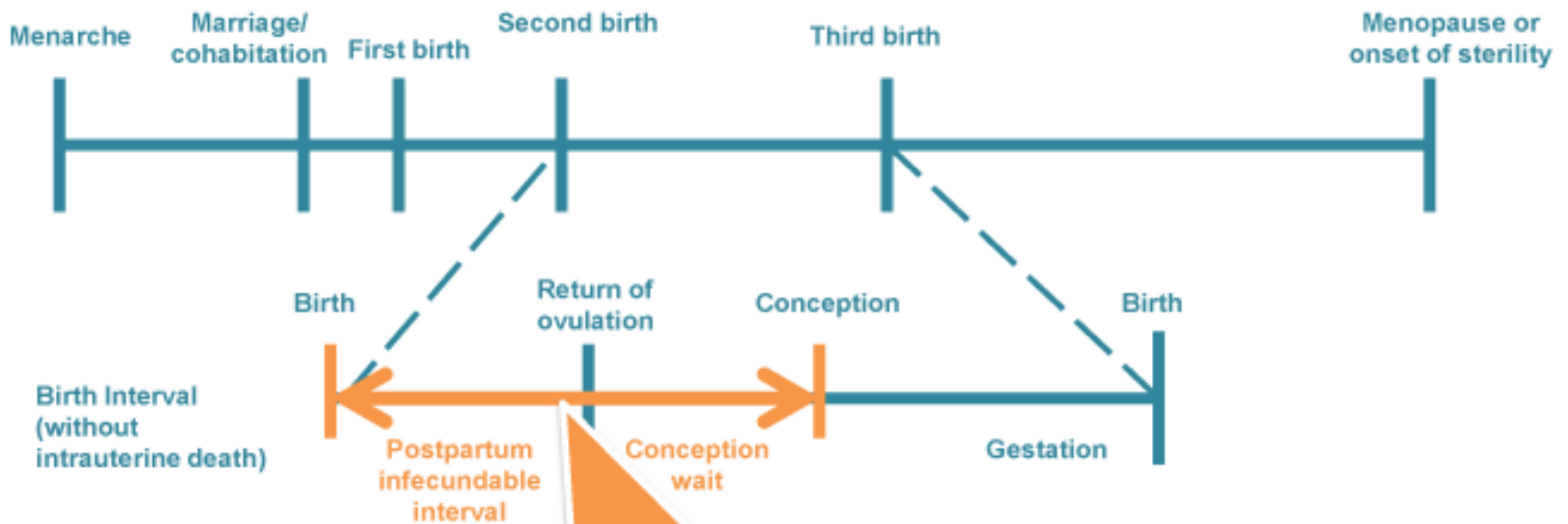
Characteristics of women	TFR
Residence	
Urban	4.2
Rural	5.8
Level of education	
No schooling	5.7
Up to primary	4.8
Up to middle	4.2
Secondary and above	3.2

Fertility Control

During the past 40 years the world population has increased from 2.5 billion in 1950 to 6.3 billion in 2003.

Most of this growth has occurred in the developing world, where improvements in the standard of living during 1950-60 was accompanied by a rapid decrease in death rates.

In many developing countries, fertility has declined at a slower rate. In some cases, especially in Africa and some South Asian countries, fertility rates remain 2-3 times higher than the developed countries.

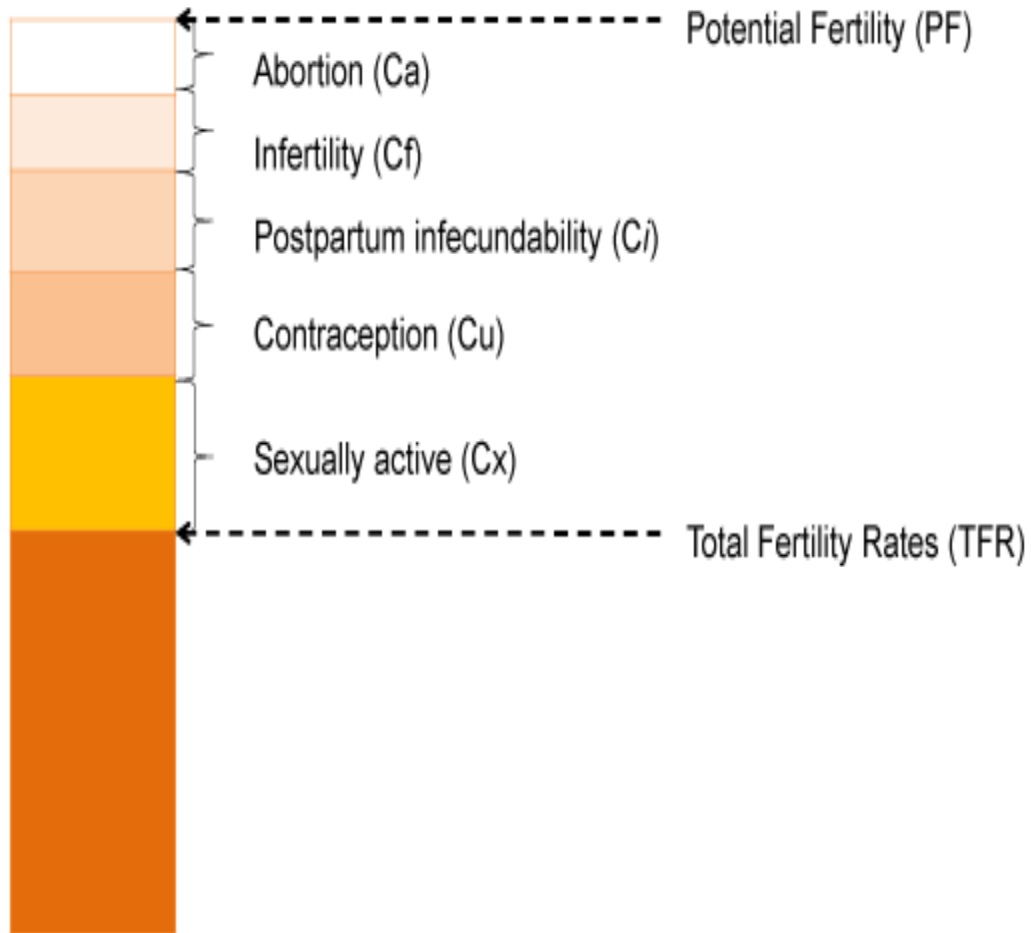


The minimum length of this period is 20 months on average when no breastfeeding or postpartum abstinence is practised. It is usually extended by practice of breastfeeding and postpartum abstinence.

If median duration of postpartum insusceptibility is 20 months, Ci becomes $20/(18.5+20) = 0.52$.

Proximate Determinants of Fertility

Fertility Rate



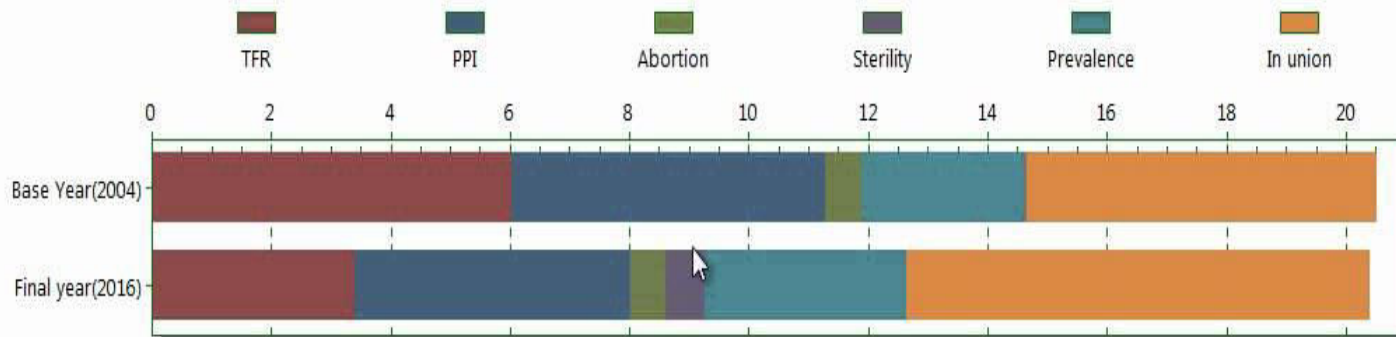
- **John Bongaarts**
- **(Born 1945)**
- **Dutch-
American
Demographer**



Effects of Proximate Determinants on TFR

Effects Method Mix

Effects of Proximate Determinants on TFR



Survey year: 2004

Final year: 2016

In union (15-49)	71 %	<input type="text" value="62"/> %
Prevalence	31 %	<input type="text" value="49"/> %
Sterility	2.1 %	<input type="text" value="8.9"/> %
Total abortion rate	0.8	<input type="text" value="0.8"/>
PPI (months)	13	<input type="text" value="13"/>
TFR	6.02	

Calculated total fecundity: 20.41

Calculated TFR: 3.41

The purpose of this screen is to demonstrate the change in the Total Fertility Rate (TFR) based on fertility factor adjustments in the final year. For example, raise contraceptive prevalence to see how the TFR would decline. Repeat with other factor adjustments and observe the resulting TFR. Note: standard FamPlan results will vary slightly from the results below. This is due to the increased complexity of the FamPlan calculations which include elements in addition to the Proximate Determinants equation modeled here.

Close

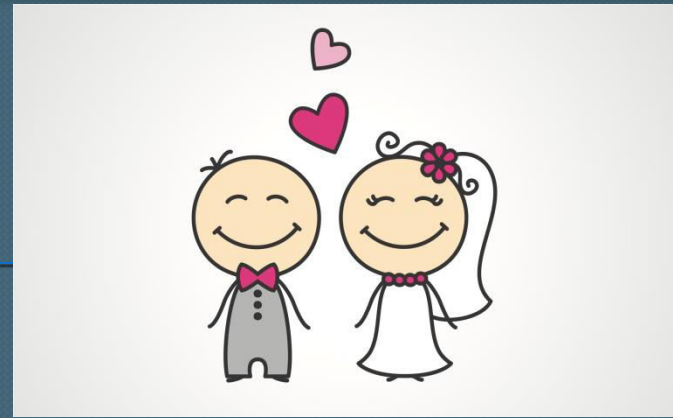
Help

Proximate Determinants of Fertility

John Bongaart has researched and identified seven factors, called the proximate determinants of fertility, as follows: They are also called ***seven proximate variables***.

1. Any change of these determinants will cause a change in fertility (provided the other factors remain constant).
2. Together they determine the level of fertility, generally denoted by (TFR)
3. The first four of these are most important

1. Proportions of married among females



2. Contraceptive use and effectiveness



3. Prevalence of induced abortion



4. Duration of postpartum infecundability

5. Fecundability or frequency of intercourse

6. Spontaneous intra-uterine mortality

7. Prevalence of permanent sterility

Inhibitors of fertility are

- 1. Delayed marriages**
- 2. The use of contraception**
- 3. Induced abortions**
- 4. Post-partum in-fecundability
(induced by breast feeding or
abstinence)**

Comparison of TFR with respect to the four proximate determinants of fertility

Area	TFR (per women)	Mean age at marriage of females	Duration of breast feeding (in months)	Contraceptive prevalence (%)	Total induced abortion rate (per women)
Developing	6.4	21.2	12	14	Not known
Developed	2.1	25.3	9	74	0.5

MORTALITY

Reasons for High Mortality
Causes of Decline
Basic Mortality Measures
Life Expectancy at Birth



Mortality data serve as important indicators of socio-economic and health progress made in one of the areas of most universal concern, namely;

1. The lengthening of life and avoidance of pre-mature death. Besides,
2. They help to identify target groups needing special attention and, are
3. Useful in evaluating the existing health programs.

Reasons For High Mortality In The Past

1. Acute and chronic food shortage causing famine and malnutrition
2. Epidemic Disease
3. Poor Public Health Conditions

Causes of Rapid Mortality Decline

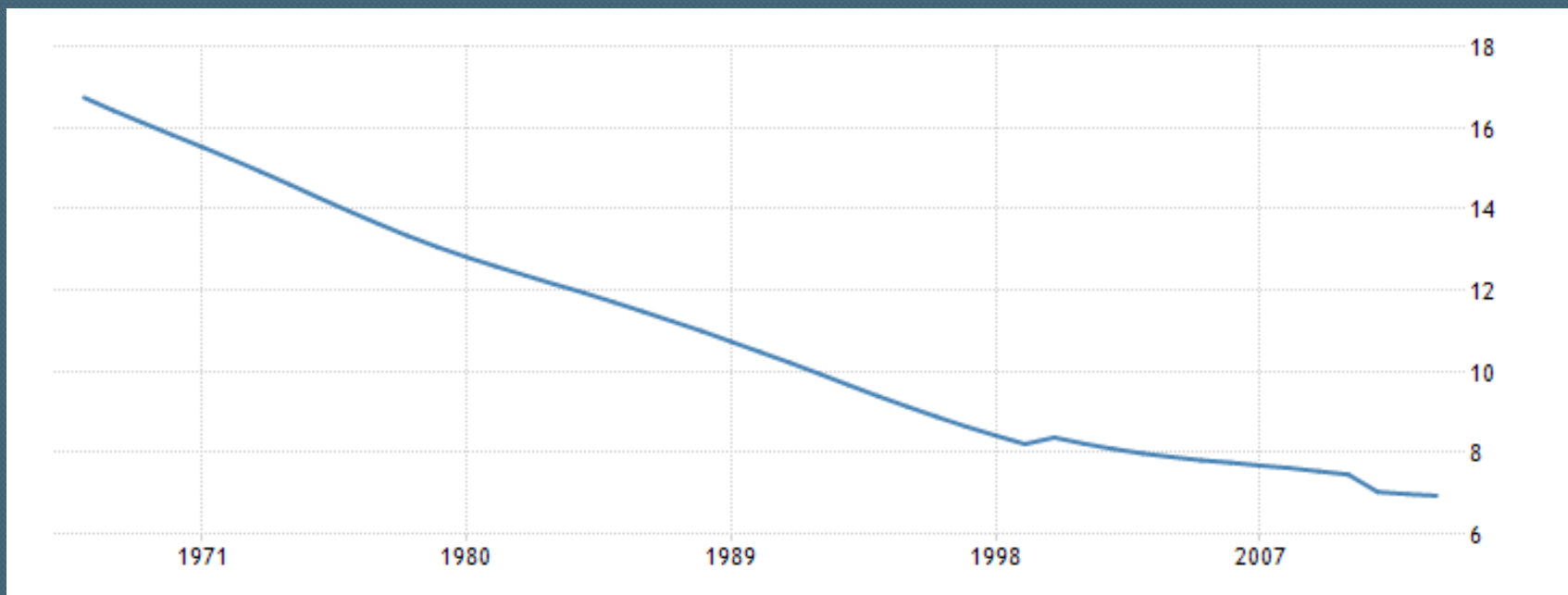
1. Increased Agriculture Production
2. Industrialization
3. Improved Transportation
4. Special Reforms
5. Control of Temperature and Humidity
6. Public Sanitation
7. Improved Personal Hygiene
8. Immunology

Basic Mortality Measure

Crude Death Rate: Similar to *CBR*, Crude Death Rate (CDR) is simply the number of deaths in a year divided by the total population at mid-year and multiplied by 1000

$$\text{CDR} = \frac{\text{Number of Deaths in a Year}}{\text{Population at Mid-Year}} \times 1000$$

Crude Death Rates of Pakistan



Age-Specific Death Rate (ASDR):

CDR covers all ages, a crucial and thus useful measure is the Age-specific Death Rate (ASDR), since everybody is not at the same risk of dying. Thus.

$$\text{ASDR} = \frac{\text{Number of deaths of persons age X in year}}{\text{number of persons age X}} \times 1000$$

Life Expectancy at Birth

Life expectancy by country



Life Expectancy at Birth

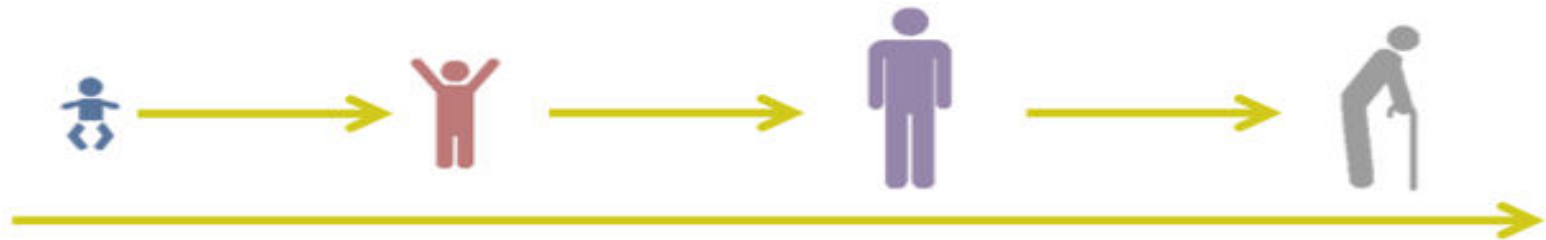
The unprecedented increase in the population is caused by the rapid decline in the mortality. Such declines occurred in all the European countries during the last three centuries and in many less developed countries during this century.

One widely known indicator to measure mortality changes is “life expectancy at birth” which is a

“Summary Index obtained from a Life Table.”

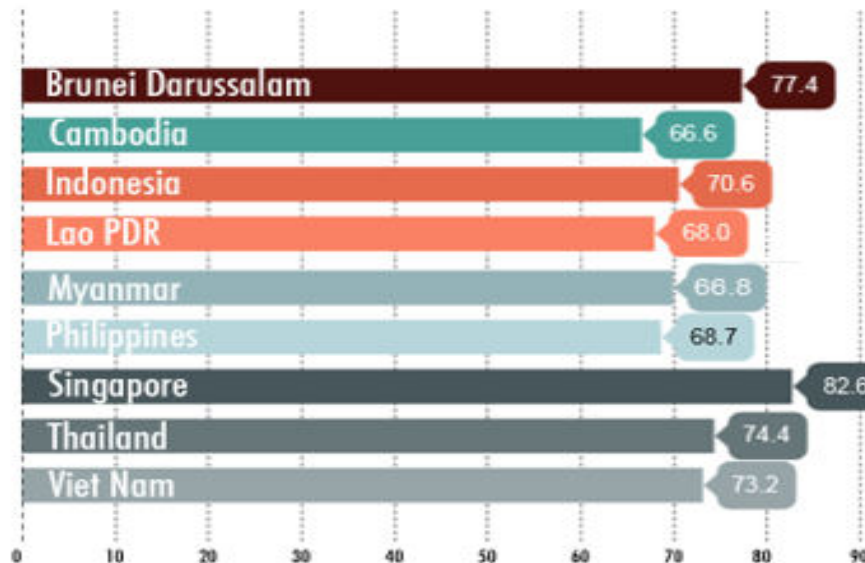
LIFE EXPECTANCY AT BIRTH

Life Expectancy at Birth refers to the number of years a newborn will live if prevailing patterns of mortality at the time of the child's birth were to stay the same throughout his or her lifetime.



x Years (based on prevailing patterns of mortality)

Life Expectancy at Birth (Years), 2014
(in percent)



Importance:

- **Life expectancy at birth** is based upon age specific rates, it is independent of the age structure of a population and
- Therefore, provides a more reliable basis than the **crude death rate** for international comparisons of the level of mortality.

What is a life table?

It shows, for each age, what is the probability that a person of that age will die before his or her next birthday.

In other words, it represents the survivorship of people from a certain population.

Types of life table:

There are two types of life tables:

Period or static life tables

1. show the current probability of death (for people of different ages, in the current year)

Cohort life tables

1. show the probability of death of people from a given cohort (especially birth year) over the course of their lifetime.

Table 1. Life table for the total population: United States, 2003

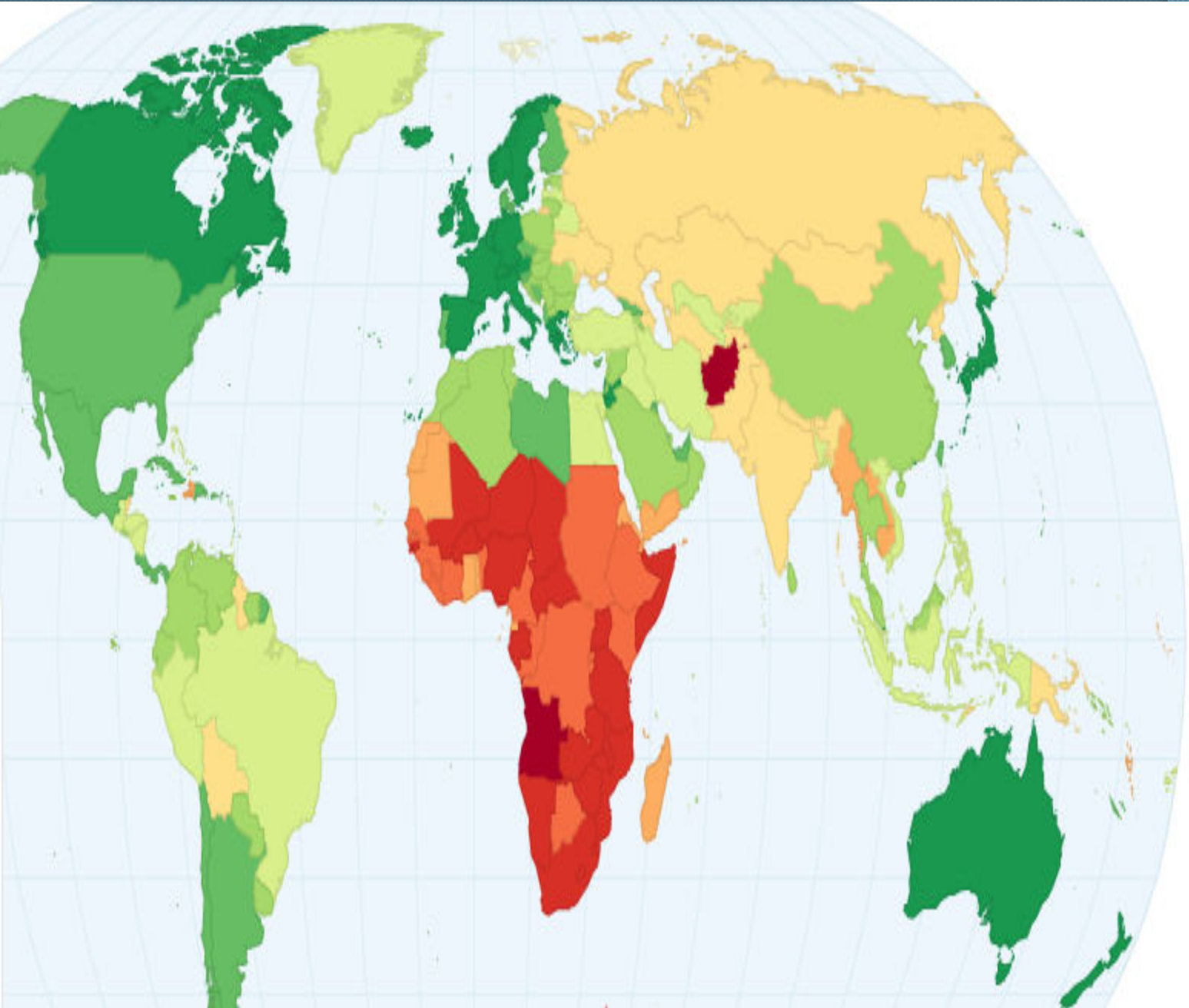
[Click here for spreadsheet version](#)

Age	Probability of dying between ages x to $x+1$	Number surviving to age x	Number dying between ages x to $x+1$	Person-years lived between ages x to $x+1$	Total number of person-years lived above age x	Expectation of life at age x
	$q(x)$	$l(x)$	$d(x)$	$L(x)$	$T(x)$	$e(x)$
0-1	0.006865	100,000	687	99,394	7,743,016	77.4
1-2	0.000469	99,313	47	99,290	7,643,622	77.0
2-3	0.000337	99,267	33	99,250	7,544,332	76.0
3-4	0.000254	99,233	25	99,221	7,445,082	75.0
4-5	0.000194	99,208	19	99,199	7,345,861	74.0
5-6	0.000177	99,189	18	99,180	7,246,663	73.1
6-7	0.000160	99,171	16	99,163	7,147,482	72.1
7-8	0.000147	99,156	15	99,148	7,048,319	71.1
8-9	0.000132	99,141	13	99,134	6,949,171	70.1
9-10	0.000117	99,128	12	99,122	6,850,036	69.1
10-11	0.000109	99,116	11	99,111	6,750,914	68.1
11-12	0.000118	99,105	12	99,100	6,651,803	67.1
12-13	0.000157	99,094	16	99,086	6,552,704	66.1
13-14	0.000233	99,078	23	99,067	6,453,618	65.1
14-15	0.000339	99,055	34	99,038	6,354,551	64.2
15-16	0.000460	99,022	46	98,999	6,255,513	63.2

FACTOR	DEFINITION OF DAILY EXPOSURE	MALES OVER 35		FEMALES OVER 35	
		ESTIMATED CHANGE IN LIFE EXPECTANCY (YEARS)	MICROLIVES PER DAY	ESTIMATED CHANGE IN LIFE EXPECTANCY (YEARS)	MICROLIVES PER DAY
Smoking	Smoking 15–24 cigarettes (a)	- 7.7	- 10	- 7.3	- 9
Alcohol	First drink (10 g alcohol) (b)	1.1	1	0.9	1
	Each subsequent drink (up to 6)	- 0.7	- ½	- 0.6	- ½
Obesity	BMI: per 5 kg above 22.5 (c)	- 2.5	- 3	- 2.4	- 3
	Per 5kg above optimum weight for average height	- 0.8	- 1	- 0.9	- 1
Sedentary Behavior	2 hours watching television (d)	- 0.7	- 1	- 0.8	- 1
Red Meat	One Portion (85 g, 3 oz) (e)	-1.2	- 1	- 1.2	- 1
Fruit and Vegetable Intake	Five Servings or more (blood vitamin C > 50 nmol/l) (f)	4.3	4	3.8	4
Coffee	2–3 cups (g)	1.1	1	0.9	1
Physical Activity	First 20 minutes of moderate exercise (h)	2.2	2	1.9	2
	Subsequent 40 minutes of moderate exercise	0.7	1	0.5	½
Statins	Taking a statin (j)	1	1	0.8	1
Air Pollution	Living in Mexico City rather than London (k)	0.6	- ½	0.6	-½
Gender	Being male rather than female (l)	- 3.7	- 4	-	-
Geography	Resident of Sweden vs. Russia (m)	- 14.1	- 21	- 7.6	- 9
Era	Living in 2010 vs. 1910 (n)	13.5	15	15.2	15
	Living in 2010 vs. 1980	7.5	8	5.2	5
Single Dose of Ionizing Radiation	0.07 MSV (e.g., single transatlantic flight)	30 mins	-1	30 mins	-1

Life Expectancy at Birth

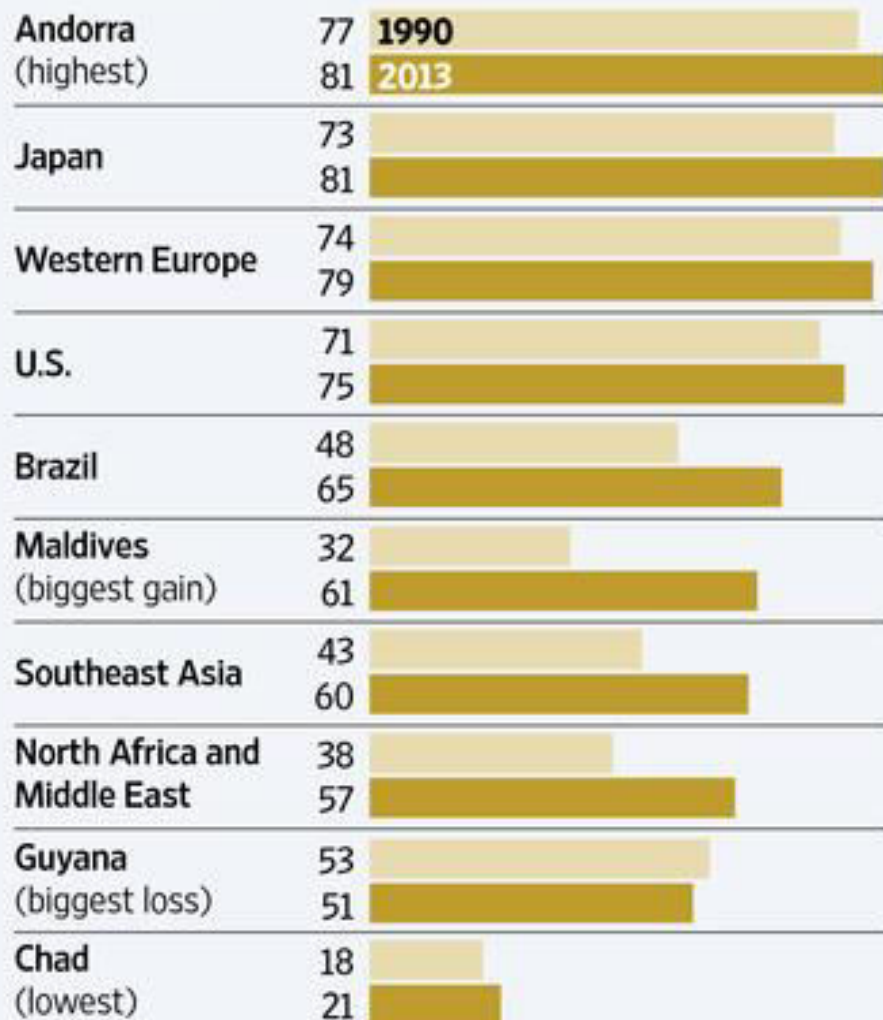
- Less than 45.0
- 45.0 – 53.7
- 53.7 – 59.84
- 59.84 – 64.88
- 64.88 – 68.89
- 68.89 – 73.0
- 73.0 – 76.21
- 76.21 – 79.88



Greater Expectations

A new analysis found that global life expectancy increased by about six years from 1990 to 2013.

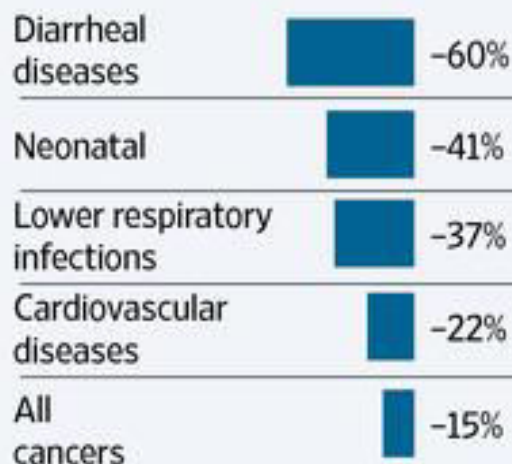
AVERAGE AGE AT DEATH



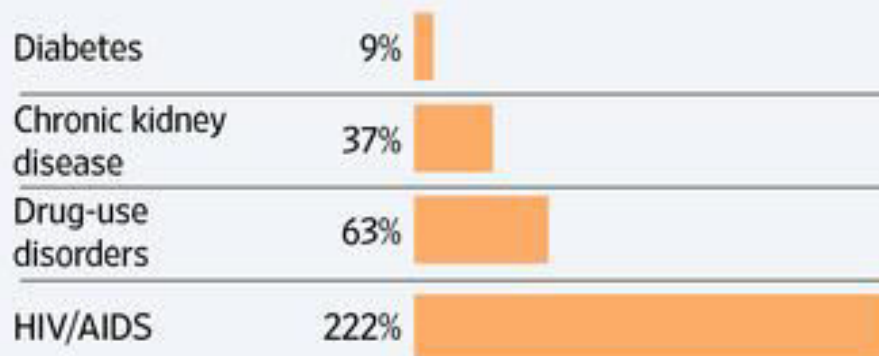
Source: The Lancet
The Wall Street Journal

The gain was driven by drops in the death rates for several major diseases...

MEDIAN CHANGE, 1990-2013



...though some conditions are taking a greater toll, such as HIV/AIDS in Sub-Saharan Africa



71 years

was the average
life expectancy at birth
of the global population
in 2013



Life expectancy at birth, total (years)

2013

66 years

Pakistan



Other Measures of Mortality

1. Infant Mortality Rate (IMR)
2. Neonatal Mortality Rates
3. Peri-natal Mortality Rate
4. Maternal Mortality Ratio (MMR)

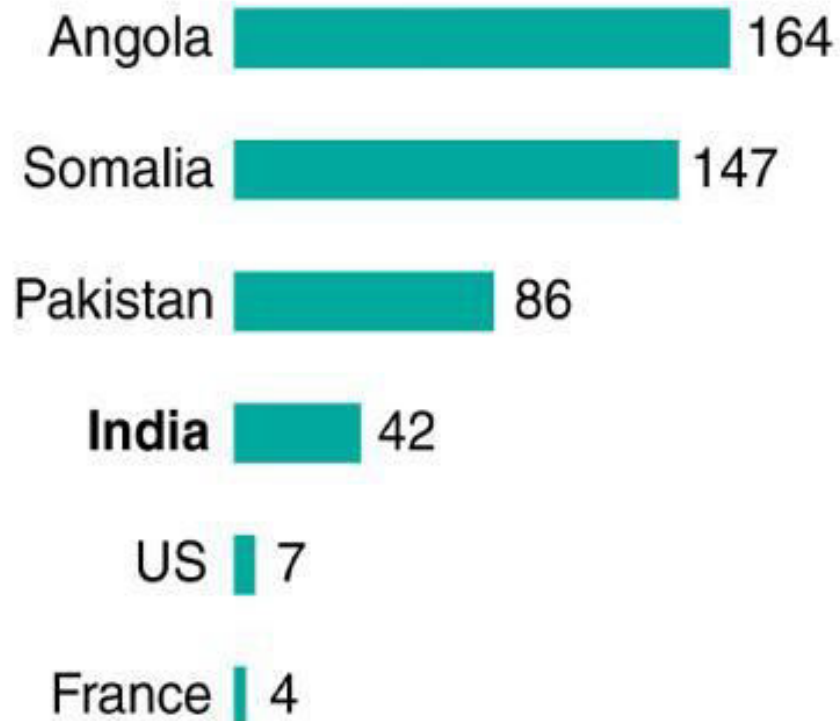
Infant Mortality Rate (IMR)

Since children during the first year of life (under 1 year) are at a high risk of dying, therefore, it is customary to relate the number of deaths of persons below age 1 during a year. The latter figure is a reasonable estimate of the population at risk and is used in the denominator. The rate thus calculated, is known as:

$$\text{IMR} = \frac{\text{Number of deaths of infants (below 1 year) in a year}}{\text{Number of live births in a year}} * 1000$$

Infant mortality

Infants dying before reaching age 5
(per 1,000 live births in 2012)



Source: World Bank

AFP



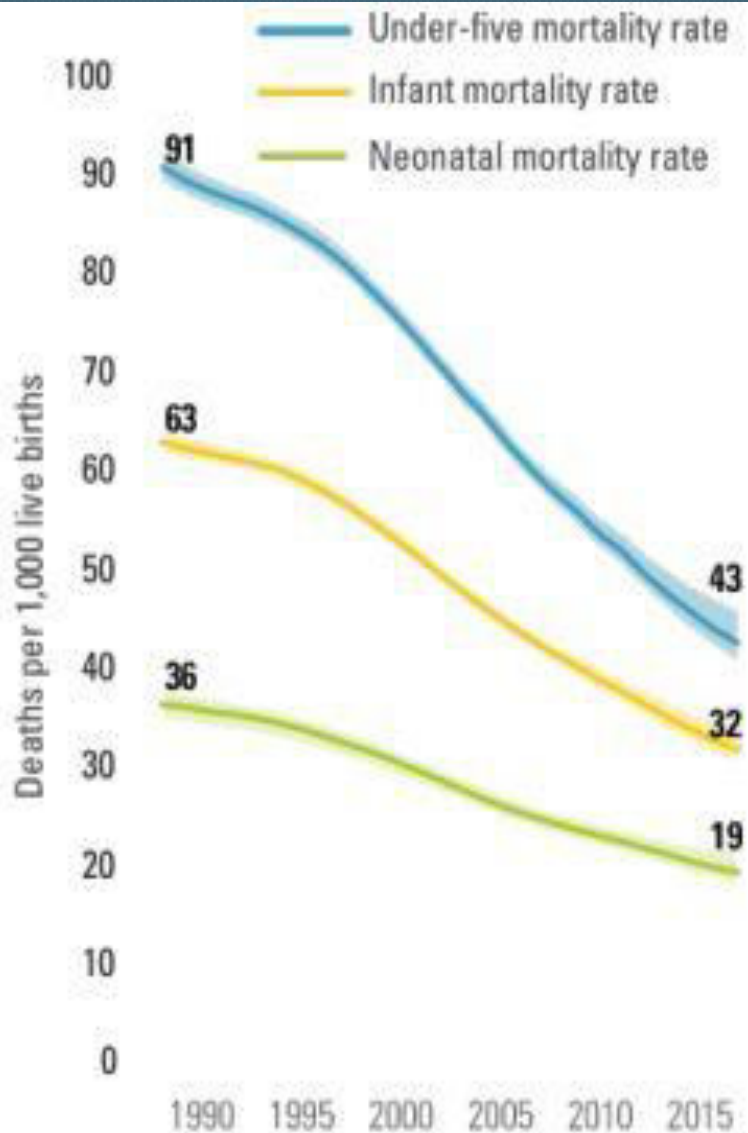
Neonatal Mortality Rates

The social and biological factors influencing infant mortality vary during the first year of life. Deaths during the first year of life (known as neonatal mortality) is generally due to events occurring pregnancy while those which occur during 1 month and 11 months of life (known as post-neonatal mortality) are generally due to socio-economic and environmental conditions. Neonatal mortality is further classified into Early Neonatal mortality and Late neonatal Mortality Rates.

Early Neonatal M.R=Death under 1week X1000
Live Births in a year

Late Neonatal M.R=Death during 1-4weeksX1000
Live Births in a year

Post Neonatal M.R= death during 4-52weeksX1000
Live Births in a year



Peri-natal Mortality Rate

This widely used rate avoids the problems of defining a live birth and classifies stillbirths (including miscarriages and spontaneous abortions) together as they are thought to be determined by similar causes. It is defined as:

$$\text{Perinatal M.R} = \frac{\text{stillbirth} + \text{Deaths under 1 week} \times 1000}{\text{Stillbirth} + \text{Live births in a year}}$$

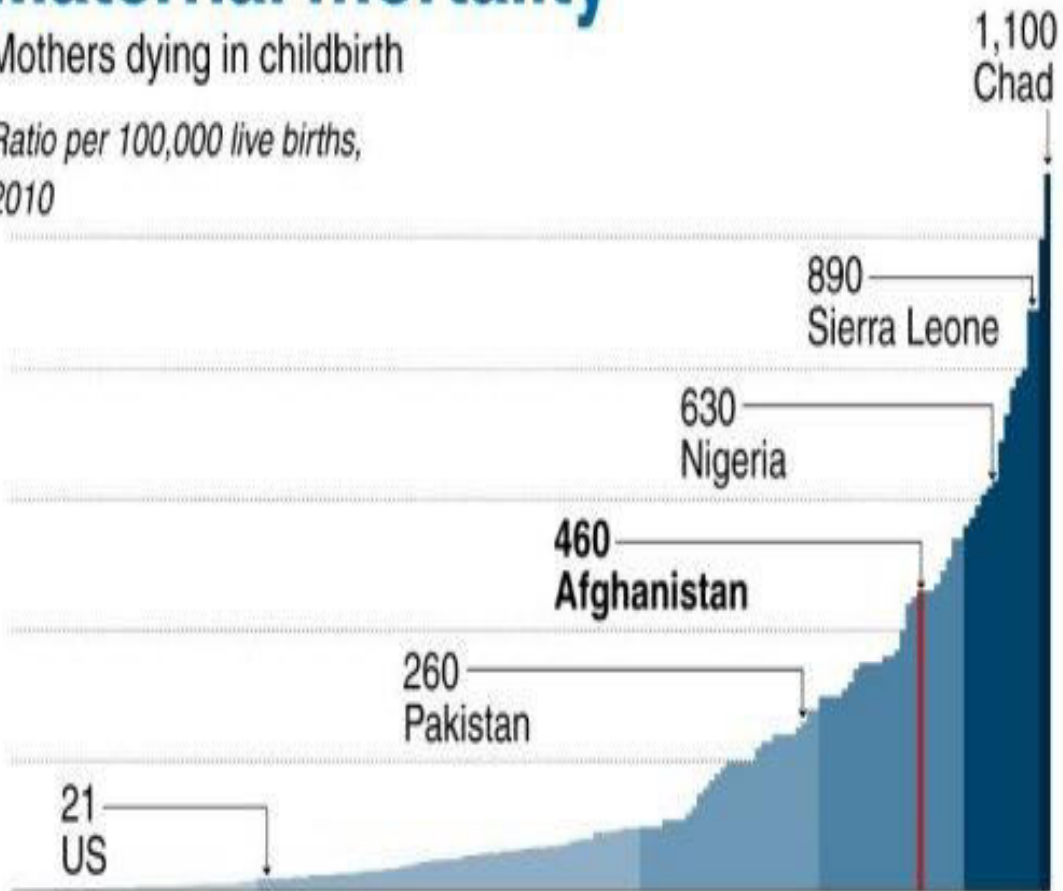
Maternal Mortality Ratio (MMR)

MMR= Deaths of women due to pregnancy complications or after child birth(within 42days after delivery)X1000
Live births in a year

Maternal mortality

Mothers dying in childbirth

Ratio per 100,000 live births,
2010



Source: World Health Organization

AFP



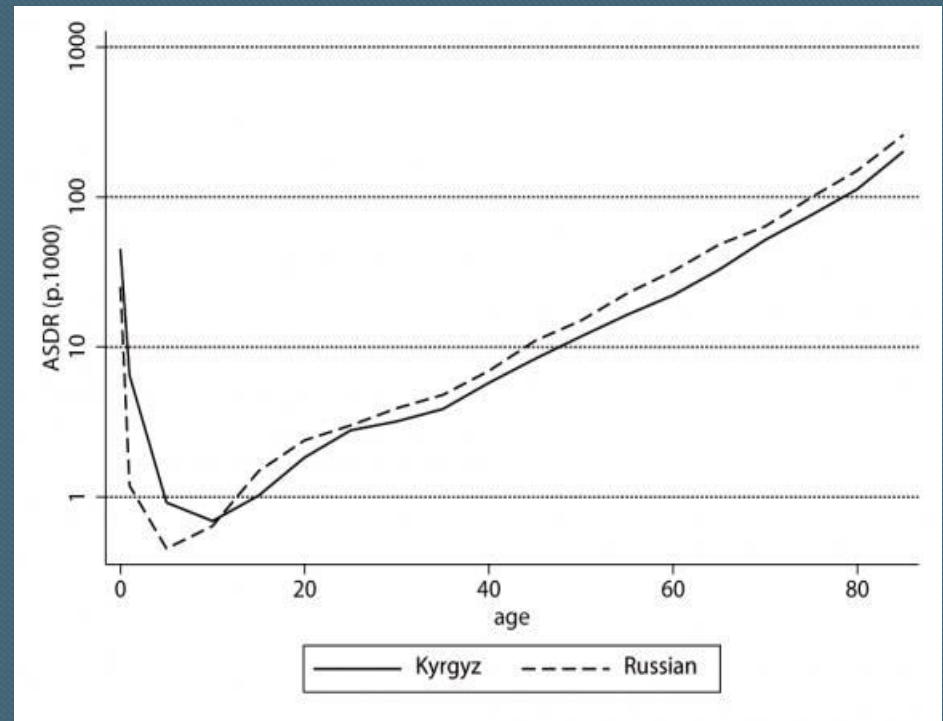
Mortality in Pakistan

Like many European countries, overall crude death rate in Pakistan has declined substantially. Thus, while it took over three centuries in most European countries to experience the mortality decline, in Pakistan such a decline occurred only during the second half of 20th century. The crude death rate in Pakistan, which continued to be above 45 per 1000 till the beginning of the 20th century, has now reached about 8 per 1000 population. Thus the crude death rate in Pakistan today is one fourth of what it was only 60 years ago.

Mortality Differentials

Mortality varies quite substantially with various characteristics of the population. Two such major characteristics are *age* *and sex*

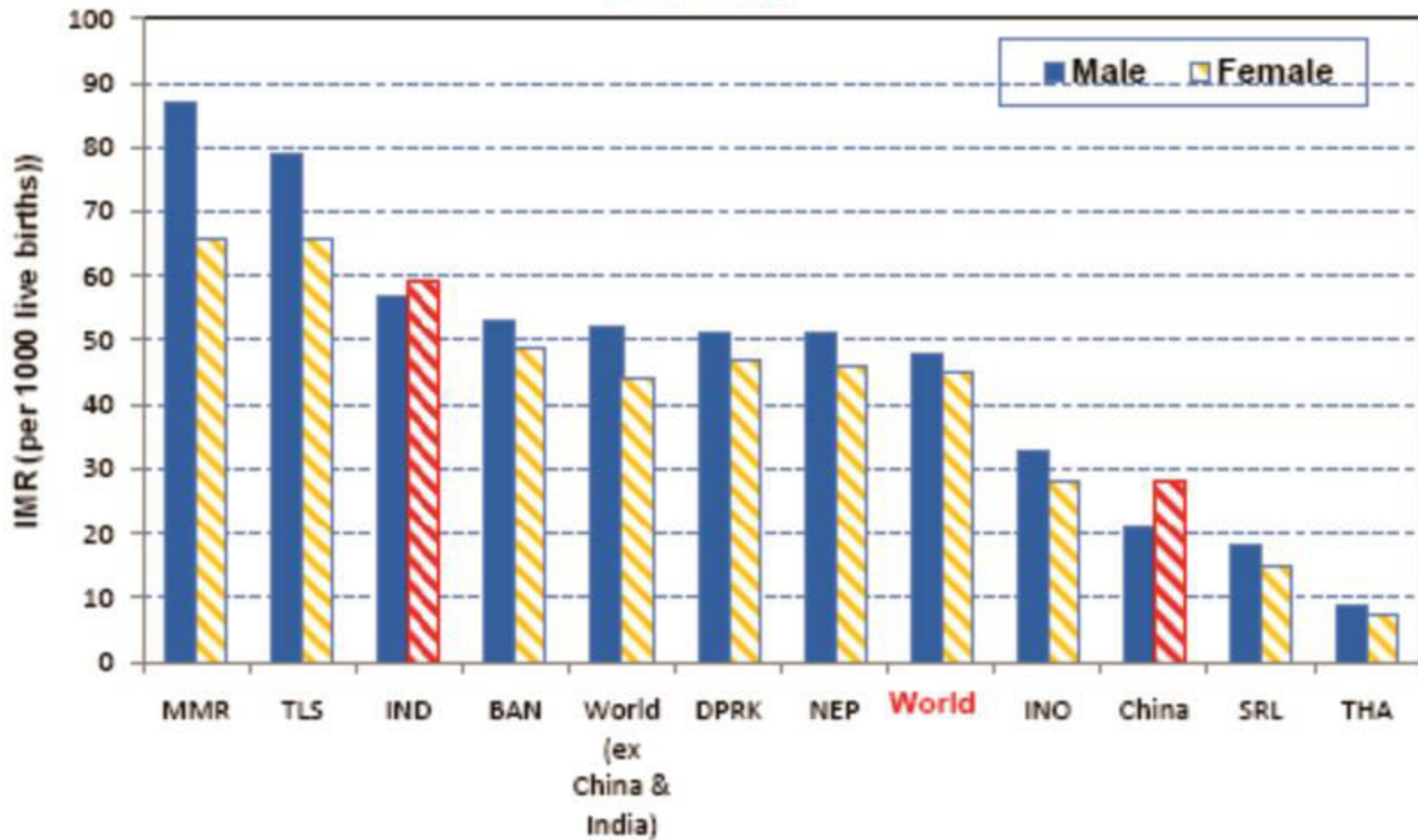
A person is at the highest risk of dying during the first year of life while the risk of dying during the first year of life declines gradually and again increases during the older ages. Thus, the age-specific mortality follows a U-shaped curve.



Males and females show similar age-specific curves, however, females show lower mortality rates than males

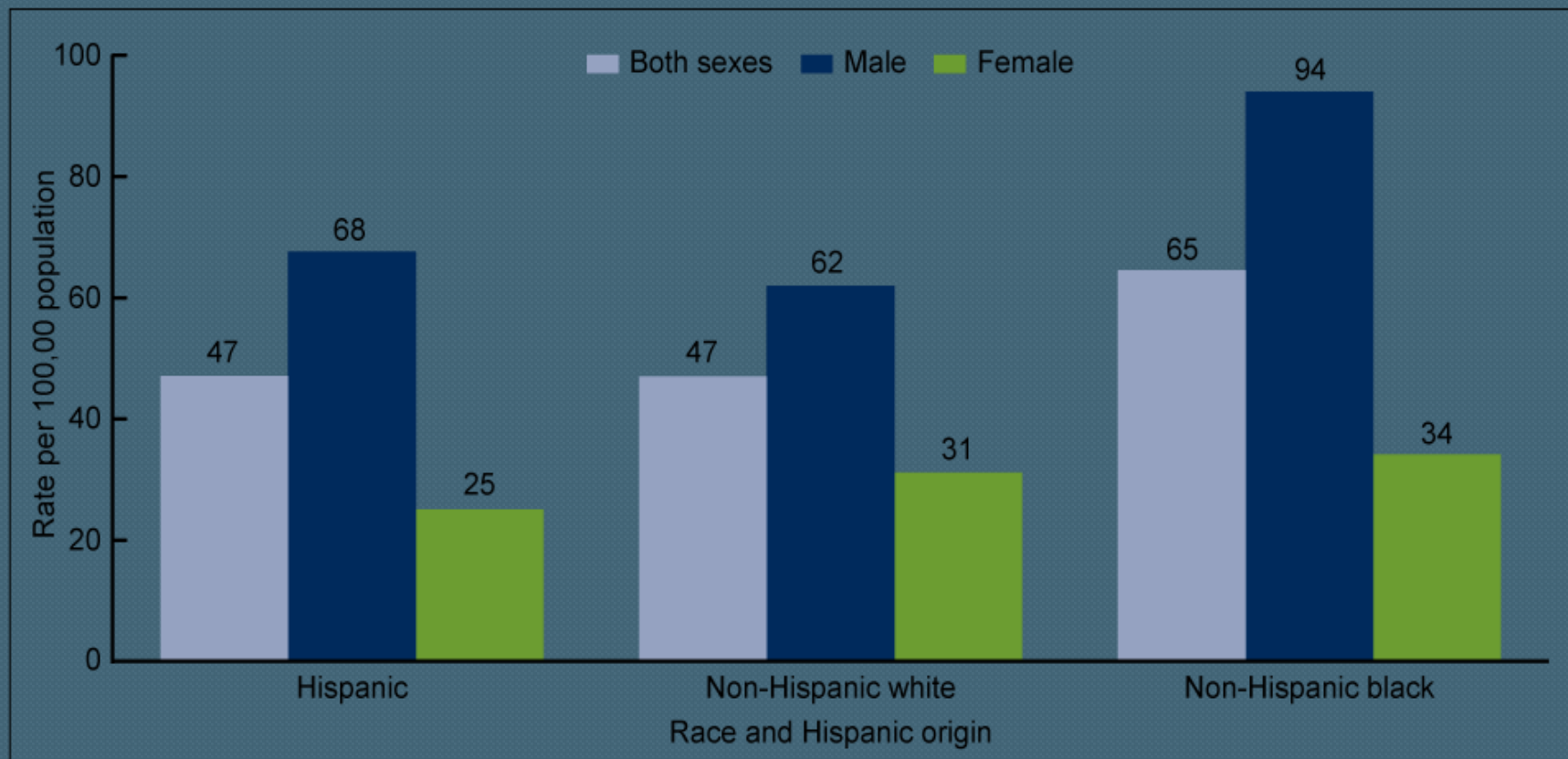
These differences are generally attributed to inherent biological superiority of females and occupational hazards faced by men

Infant mortality (deaths under age 1 per 1000 live births (2001-2010))



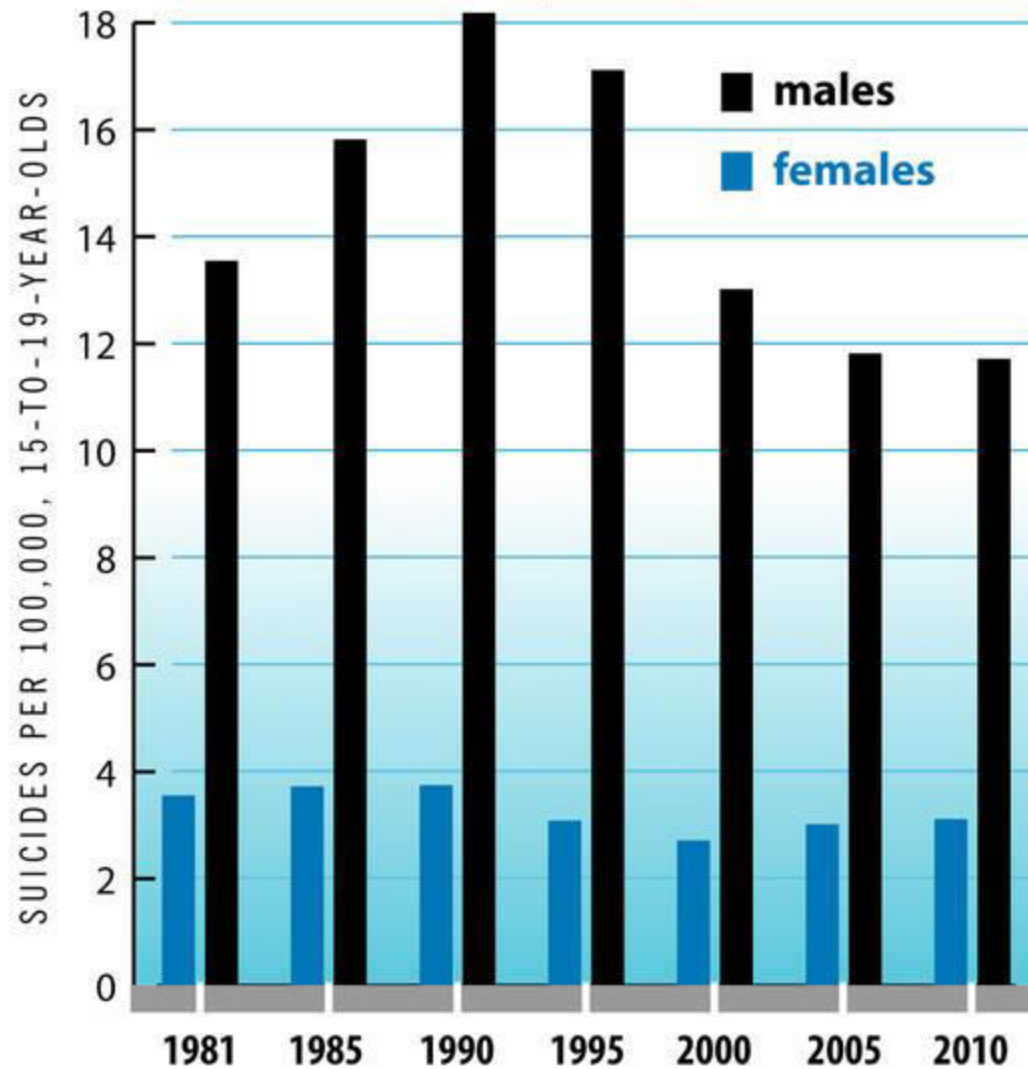
Source : UN/DESA, Population Division, "Sex differentials in childhood mortality 2011"

Figure 3. Death rates for teenagers 12–19 years, by race, Hispanic origin, and sex: United States, 1999–2006



SOURCE: National Vital Statistics System, Mortality.

Suicide rates: boys vs. girls



SOURCE: Centers for Disease Control and Prevention



1 Coronary heart disease (I20–I25)

11,016

8,750

2 Dementia and Alzheimer disease (F01, F03, G30)

3,656

7,277

3 Cerebrovascular disease (I60–I69)

4,181

6,368

4 Lung cancer (C33, C34)

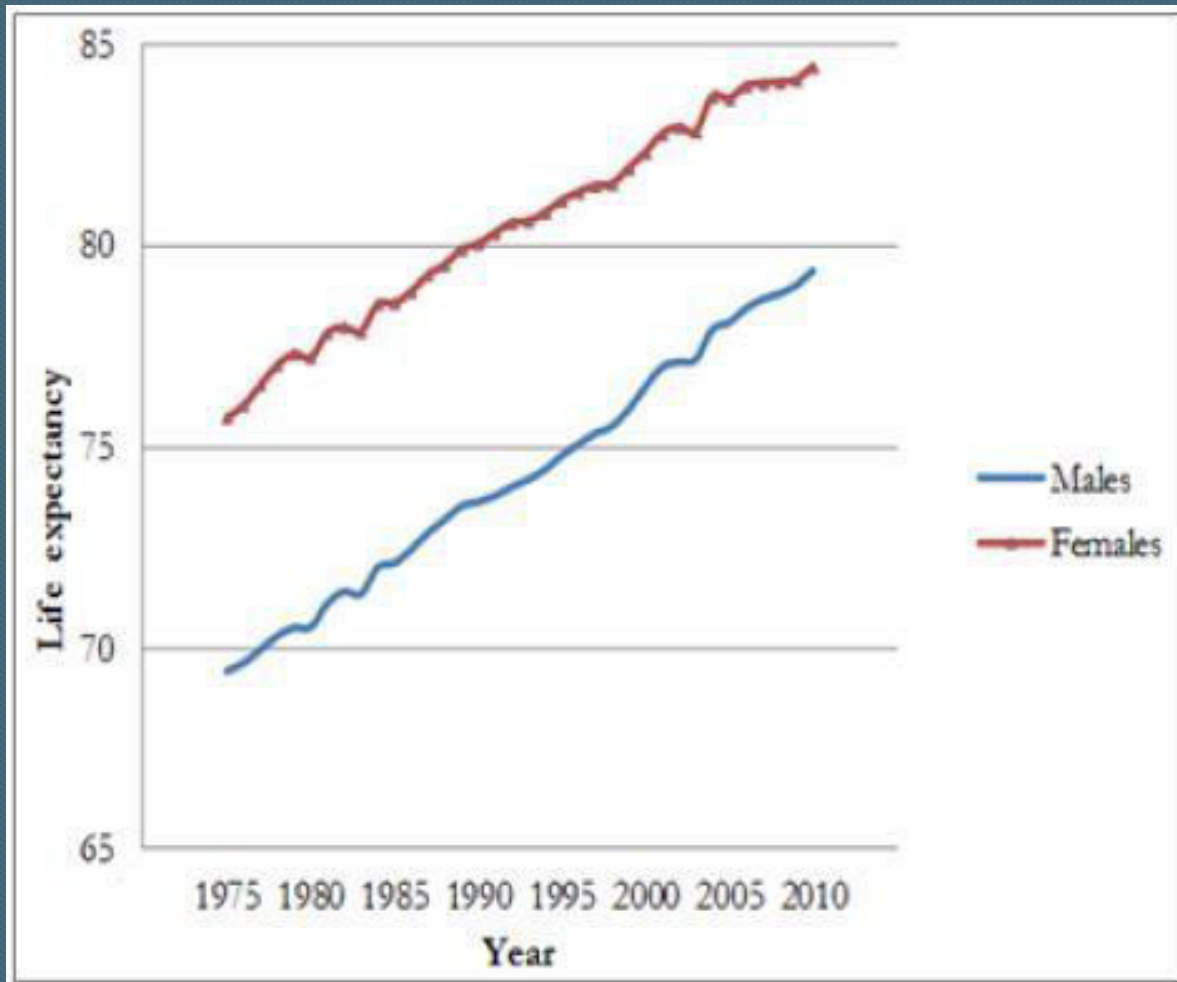
4,995

3,222

5 Chronic obstructive pulmonary disease (COPD) (J40–J44)

3,572

2,890



References:

- https://en.wikipedia.org/wiki/Life_table

Thank You