Human Population Dynamics (Part 2)

Total fertility rate (From Wikipedia)

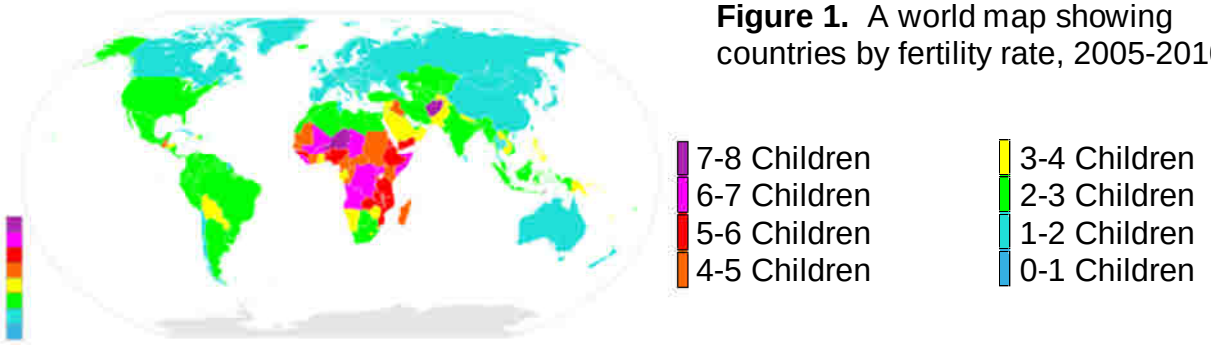

Figure 1. A world map showing countries by fertility rate, 2005-2010.

The **total fertility rate** (**TFR**, sometimes also called the **fertility rate**, **period total fertility rate** (PTFR) or **total period fertility rate** (TPFR)) of a population is the average number of children that would be born to a woman over her lifetime if (1) she were to experience the exact current age-specific fertility (birth) rates (ASFRs) through her lifetime, and (2) she were to survive from birth through the end of her reproductive life.[1] That is, TFR ignores the effect of survivorship on the average number of children born over a woman's lifespan. It is obtained by summing the single-year age-specific fertility rates that prevail for a specific year.

The TFR is a synthetic rate, not based on the fertility of any real group of women, since this would involve waiting until they had completed childbearing. Nor is it based on counting up the total number of children actually born over their lifetime, but instead is based on the age-specific fertility rates of women in their "child-bearing years," which in conventional international statistical usage is ages 15–44 or 15-49.[3]

The TFR is therefore a measure of the fertility of an *imaginary* woman who passes through her reproductive life subject to *all* the age-specific fertility rates for ages 15–49 that were recorded for a given population **in a given year**. The TFR represents the average number of children a woman *would* have were she to fast-forward through all her childbearing years in a single year, under all the age-specific fertility rates for that year. In other words, this rate is the number of children a woman would have if she was subject to prevailing fertility rates at all ages from a single given year, and survives throughout all her childbearing years.

An alternative fertility measure is the net reproduction rate (NRR), which measures the number of *daughters* a woman would have in her lifetime if she were subject to prevailing age-specific fertility ***and mortality* rates** in the given year. When the NRR is exactly **one**, then each generation of women is exactly reproducing itself. The NRR is less widely used than the TFR, and the United Nations stopped reporting NRR data after 1998. But the NRR is particularly relevant where the number of male babies born is very high (due to selective abortion, as practiced in China and India).

The TFR (or TPFR—total period fertility rate) is a better index of fertility than the Crude birth rate (annual number of births per thousand population) because it is independent of the age structure of the population, but it is a poorer estimate of actual completed family size than the total cohort fertility rate, which is obtained by summing the age-specific fertility rates that actually applied to each cohort as they aged through time. In particular, the TFR does not necessarily predict how many children young women now will eventually have, as their fertility rates in years to come may change from those of older women now. However, the TFR is a reasonable summary of current fertility levels.

World historical and predicted total fertility rates (TFR) for 1950–2050

Years	TFR	Years	TFR
1950–1955	4.92	2000–2005	2.67
1955–1960	4.81	2005–2010	2.56
1960–1965	4.91	2010–2015	2.49
1965–1970	4.78	2015–2020	2.40
1970–1975	4.32	2020–2025	2.30
1975–1980	3.83	2025–2030	2.21
1980–1985	3.61	2030–2035	2.15
1985–1990	3.43	2035–2040	2.1
1990–1995	3.08	2040–2045	2.15
1995–2000	2.82	2045–2050	2.02

Replacement Fertility Rates

Replacement fertility is the total fertility rate at which newborn girls would have an average of exactly one daughter over their lifetimes. In more familiar terms, women have just enough babies to replace themselves.

If there were no mortality in the female population until the end of the childbearing years (generally taken as 44 or 49, though some exceptions exist) then the replacement level of TFR would be very close to 2.0, indicating 1 daughter and 1 son (actually slightly higher because of the excess of boy over girl births in human populations). However, the replacement level is also affected by mortality, especially childhood mortality. The replacement fertility rate is roughly 2.1 births per woman for most industrialized countries (2.075 in the UK for example), but ranges from 2.5 to 3.3 in developing countries because of higher mortality rates.[4] Taken globally, the total fertility rate at replacement is 2.33 children per woman (see Figure 2). At this rate, global population growth would trend towards zero.

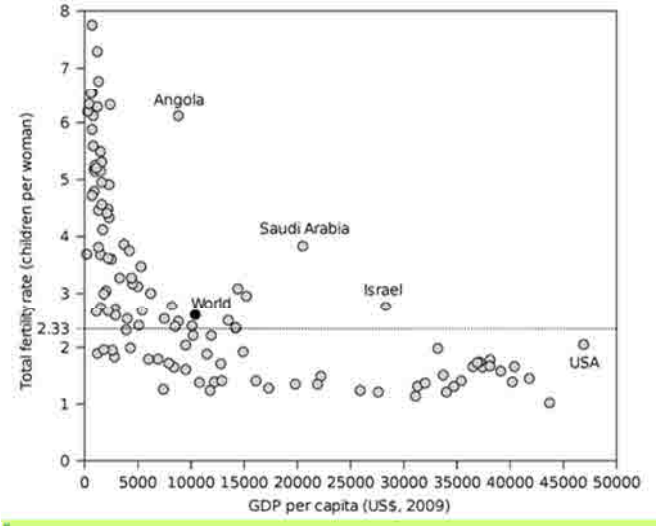

Figure 2. Total Fertility Rates vs. Economic Development (GDP per capita) of the corresponding country, 2009. (Replacement fertility rate for the world population indicated by horizontal line at TFR = 2.33. Only countries with over 5 million population were plotted to reduce outliers. Source: *CIA World Fact Book*)

The total fertility rate in the United States after World War II peaked at about 3.8 children per woman in the late 1950s and by 1999 was at 2 children (see table on next page). This means that an imaginary woman who fast-forwarded through her life in the late 1950s would have been expected to have about four children, whereas an imaginary woman who fast-forwarded through her life in 1999 would have been expected to have only about two children in her lifetime. The fertility rate of the total U.S. population is at around the replacement level of about 2.1 children per woman. However, the fertility of the population of the United States is below replacement among those native born, and above replacement among immigrant families, most of who come to the U.S. from countries with higher fertility than that of the U.S. However, the fertility rate of immigrants to the U.S. has been found to decrease sharply in the second generation, correlating with improved education and income.[7]

Period	U.S. Total Fertility Rate[6]
1930–34	2.1
1935–39	2.0
1940–44	2.5
1945–49	3.0 (Baby Boom begins)
1950–54	3.3
1955–59	3.7
1960–64	3.4 (Baby Boom ends)
1965–69	2.6
1970–74	2.1
1975–79	1.8

A population that maintained a TFR of 3.8 over an extended period of time without a correspondingly high death or emigration rate would increase rapidly, whereas a population that maintained a TFR of 2.0 over a long time would decline (unless it had a large enough immigration). However, it may take several generations for a change in the total fertility rate to be reflected in birth rate (number births per 1000 people). For example, a population that has only recently dropped below replacement-level fertility will continue to grow, because the high fertility in the recent past resulted in a large proportion of the population being in the reproductive age-classes (relatively young **median age:** age for which 50% of population is equal to or younger). Even if these reproductive individuals have only replacement fertility, they will still produce a large absolute number of children and add to the population size. This large number of children will do the same when they reach reproductive age, again even if they have only replacement fertility. This phenomenon carries forward for several generations and is called population momentum or *population-lag effect*. This population momentum continues over several generations until the population age distribution reaches equilibrium, with equal numbers of individuals entering and exiting the reproductive age-classes. This time-lag effect is of great importance to the growth rates of human populations. Given that many developing countries have a very large proportion of individuals under the age of 30 (most with median age < 25 yrs), the human population will continue to grow for decades even if everyone chose replacement fertility today. Depending on how quickly all countries attain replacement fertility in the coming years, projections are that the world human population will stabilize at 9 – 10 billion people sometime around the year 2050; that is 50% higher than the population today.

Fertility and Economic Development

Developed countries usually have a much lower fertility rate due to greater wealth, education, and urbanization. Infant mortality rates are low, birth control is understood and easily accessible, and costs associated with having children are often deemed very high because of education, clothing, feeding, and social amenities. With wealth, contraception becomes affordable. However, in countries like Iran where contraception was made artificially affordable before the economy accelerated, birth rate also rapidly declined. Further, longer periods of time spent getting higher education often mean women have children later in life (longer generation time T). The result is the demographic-economic paradox (see text box later in this document). Female employment outside of the home (salaried, non-agricultural work) also has substantial negative impact on fertility as children are a greater burden for working mothers.

In developing countries on the other hand, rural families desire children who begin working at an early age and contribute to the family's economic well-being, and because grown children are the primary caregivers for their parents in old age (no Social Security). Fertility rates are also higher due to the lack of access to contraceptives and the lower status of women, generally manifested as lower levels of female education (Control-click on this hyperlink to see more information about female education around the world), earlier age of marriage (http://en.wikipedia.org/wiki/Age_at_first_marriage), and lower rate of female employment outside the home.

The Demographic – Economic Paradox (edited version of Wikipedia entry)

The demographic-economic paradox is the inverse correlation found between wealth and fertility within and between nations. The higher the degree of education and GDP per capita of a human population, sub-population or social stratum, the fewer children are born per woman in any industrialized country. In a 1974 UN population conference in Bucharest, Karan Singh, a former minister of population in India, stated "Development is the best contraceptive."

The term "paradox" comes from the notion that greater economic means could be expected to allow for the production of **more** offspring, as described by the original human population researcher Thomas Malthus. Roughly speaking, nations or sub-populations with higher GDP per capita are observed to have fewer children, even though a richer population can support more children. Malthus held that in order to prevent widespread suffering from famine and other resource limitations caused by over-population “moral restraint" (which included abstinence) was required. The demographic-economic paradox suggests that reproductive restraint arises naturally as a consequence of economic progress, without the need for coercive governmental or social regulation.

It is hypothesized that the trend of declining fertility with increasing economic development has come about as a response to increased life expectancy, reduced childhood mortality, improved female literacy and independence, and urbanization that all result from increased GDP per capita, consistent with the **demographic transition model**.

Current information suggests that the demographic-economic paradox only holds up to a point though. Recent data suggests that once a country reaches a certain level of human development and economic prosperity the fertility rate stabilizes and then recovers slightly to replacement rates.

Child Mortality (edited from article by Hannah Doherty, September 3, 2008)

In 2006, the latest year with data available, the world's child mortality rate-the number of children who die before the age of five per 1,000 live births-dropped to 72 (7.2%), a 20-percent decline since 1990, when 93 children died for every 1,000 live births. For the first time since recordkeeping began in 1960, child mortality fell below 10 million, to 9.7 million, which was less than half the number who died before reaching five in 1960. Despite the steady decline in global under-five deaths disparities between and within regions continue to grow.

Under-five mortality decreases as per capita income increases. In the poorest households in developing countries, 107 children under the age of five die for every 1,000 live births (10.7%). This is nearly 40 percent higher than in the richest households in those same developing nations, where the rate is 67 deaths for every 1,000 live births (6.7%). The disparity is even greater when compared with the rate in industrial nations-6 deaths per 1,000 live births (0.6%).

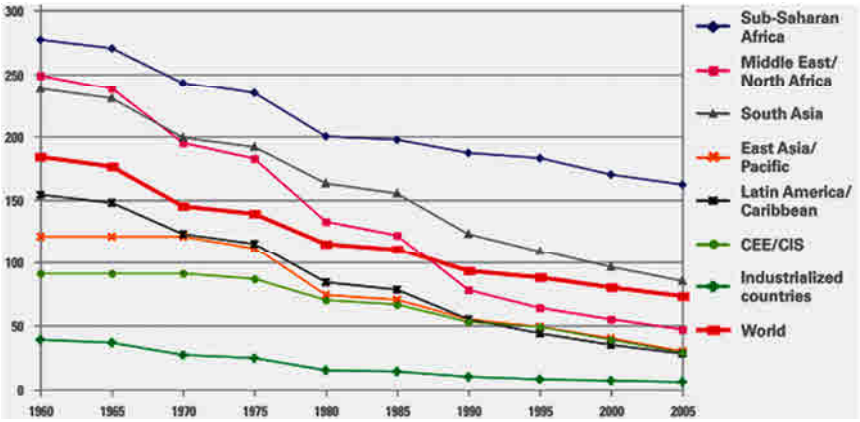

Figure 3. Child (under 5 yr old) Mortality Rate (global & by region) 1960 - 2005.

Y-axis is crude mortality rate (number of children who die before age 5 per 1000 children born). Dividing Y-axis values by 10 yields % infant mortality.

For the average child living in rural areas and isolated from basic health services and adequate sanitation, the under-five mortality rate is 105 (10.5%) - far greater than in urban areas, where the rate is 69 deaths per 1,000 live births (6.9%).

East Asia and the Pacific, Central and Eastern Europe, and Latin America and the Caribbean have reduced regional child mortality rates by half since 1990. In 2006, the mortality rate for each of these regions was below 30 per 1,000 live births (3%).

A number of countries in Latin America, such as Cuba and Chile, have lowered their child mortality rates by more than 50 percent since 1990. Despite these positive trends, the averages mask wide disparities between and within Latin America. The mortality rates of Haiti and Bolivia are more than twice the regional average, and indigenous children living in both urban and rural areas in Latin America face a greater risk of dying before their first birthday than non-indigenous children.

South Asia has shown improvement, reducing its regional under-five mortality rate from 123 child deaths per 1,000 live births (12.3%) in 1990 to 83 in 2006 (8.3%). Even with

the improvements, however, in 2006 this region had the second highest number of deaths among children under the age of five-roughly 3.1 million-accounting for 32 percent of the global total.

Afghanistan, Pakistan, and India account for half the world's undernourished children, despite having just 29 percent of the developing world's under-five population. Afghanistan's child mortality rate was 252 (25.2%) for the 2002-05 period, three times South Asia's average rate and the third highest in the world. Compared with the regional average of 1 child death for every 12 children**, in Afghanistan 1 in 5 children die before reaching their 5th birthday.**

Sub-Saharan Africa has made the least progress in reducing regional child mortality rates, with 1 in every 6 children dying before the age of five. On average, its under-five mortality rate was 160 deaths for every 1,000 live births (16%) in 2006, only a modest improvement from its 1990 rate of 187 (18.7%). Some countries in West and Central Africa, however, have made no progress, and some nations actually reported increases in under-five mortality rates, such as Côte d'Ivoire. Only 22 percent of the world's children are born in sub-Saharan Africa, yet this region accounts for 49 percent of the world's under-five deaths.

Lack of safe water and sanitation along with inadequate hygiene are largely responsible for breeding the leading killers of children under five: diarrheal diseases, pneumonia, neonatal disorders, and under-nutrition (see Figure 4). Some 88 percent of diarrheal diseases, the second most common direct cause of under-five deaths, are attributed to poor water management. These illnesses take nearly 2 million children a year and account for 17 percent of children deaths.

Access to adequate health care is also a leading contributor. Pneumonia, the single leading cause of child mortality, kills 2 million children and 1 million infants worldwide each year, accounting for 19 percent of children's deaths and nearly a quarter of neonatal deaths. Sadly, only 56 percent of the world's children with pneumonia are taken to appropriate health care providers.

Life is most vulnerable in the first 28 days of life, when most of the world's child deaths occur, taking 4 million infants each year. Collectively, neonatal causes contribute to 37 percent of under-five deaths. The disparity between neonatal deaths in rich and poor nations has been growing. Newborns in developing countries are eight times more likely than newborns in industrial countries to die, largely because mothers there receive inadequate or no care during pregnancy, childbirth, and the postpartum period. The World Health Organization reports that nearly three quarters of all neonatal deaths could be prevented if women were adequately nourished and received appropriate care.[31] Skilled help at birth can prevent the leading causes of newborn deaths-severe infections and asphyxia, which together account for 49 percent of neonatal deaths.

Under-nutrition, the result of insufficient food intake and repeated infectious diseases, decreases a child's resistance to infection and is the underlying cause in up to half of all under-five deaths. With 42 percent of South Asia's under-five population underweight,

the region has the highest rate of under-nutrition worldwide. Maternal under-nutrition is also a significant contributing factor to child mortality, leading to children who are severely underweight with stunted physical and intellectual growth.

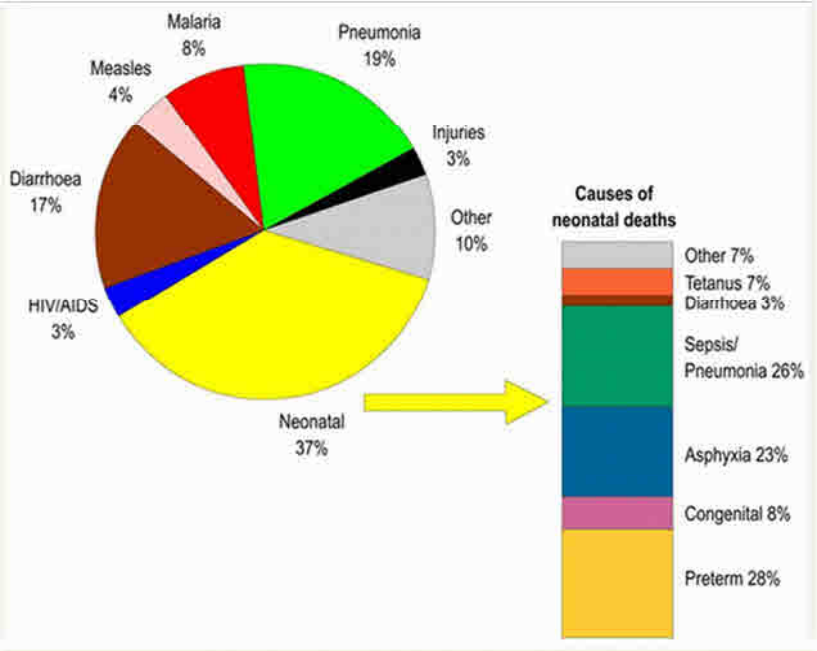

Figure 4. Causes of Infant (under 5 yr old) Mortality
Source: Bryce, J. et al. (2005) Lancet.

Note: Neonatal mortality occurs during the period that begins with labor and delivery through the first 28 days after birth.

The low status of women presents serious challenges in reducing child mortality, especially in South Asia and sub-Saharan Africa. In India, for example, girls are up to 50 percent more likely than boys to die between their first and fifth birthdays. Exclusion of girls from health care is often most severe in rural areas and in urban slums, where women are largely illiterate and suffer from sociocultural barriers to services, compromising the health of all family members. Poverty, race, language, and culture are other factors excluding women and their children from public health services.

Armed conflicts and AIDS also affect a young child's prospects for survival. More than half of the 11 countries where 20 percent or more of children die before age five suffered a major armed conflict since 1989. In the war-torn Democratic Republic of Congo, for example, the child mortality rate was 211 per 1,000 live births (21.1%) in 2000-05. AIDS has also destabilized sub-Saharan Africa, leaving 12 million children without parents. A motherless child is more likely than an infant with a surviving mother to die before reaching age two. And the children themselves are dying of AIDS: sub-Saharan Africa accounts for almost 90 percent of pediatric HIV infections.

The Millennium Development Goals campaign has encouraged basic health interventions, such as early and exclusive breastfeeding, measles immunization, and Vitamin A supplementation, which have decreased child mortality rates. In Latin America, timely measles immunization since 2000 has reached 93 percent of the region's population, nearly eliminating this disease that still kills at least 1 million people a year, 80 percent of whom are children under the age of five.

Reducing child mortality to less than 5% (Millennium Development Goal of United Nations) will rely heavily on reducing poverty and hunger, improving maternal health, increasing the use of cleaner water and sanitation, and providing affordable essential drugs on a sustainable basis.