Economic & Social Affairs

World Fertility Report 2015

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Department of Economic and Social Affairs
Population Division

World Fertility Report 2015

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The Department of Economic and Social Affairs of the United Nations Secretariat is a vital interface between global policies in the economic, social and environmental spheres and national action. The Department works in three main interlinked areas: (i) it compiles, generates and analyses a wide range of economic, social and environmental data and information on which States Members of the United Nations draw to review common problems and take stock of policy options; (ii) it facilitates the negotiations of Member States in many intergovernmental bodies on joint courses of action to address ongoing or emerging global challenges; and (iii) it advises interested Governments on the ways and means of translating policy frameworks developed in United Nations conferences and summits into programmes at the country level and, through technical assistance, helps build national capacities.

The Population Division of the Department of Economic and Social Affairs provides the international community with timely and accessible population data and analysis of population trends and development outcomes for all countries and areas of the world. To this end, the Division undertakes regular studies of population size and characteristics and of all three components of population change (fertility, mortality and migration). Founded in 1946, the Population Division provides substantive support on population and development issues to the United Nations General Assembly, the Economic and Social Council and the Commission on Population and Development. It also leads or participates in various interagency coordination mechanisms of the United Nations system. The work of the Division also contributes to strengthening the capacity of Member States to monitor population trends and to address current and emerging population issues.

Notes

The designations employed in this report and the material presented in it do not imply the expression of any opinions whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This report has been issued without formal editing. It is available in electronic format on the website of the Population Division, at www.unpopulation.org. For further information about this report, please contact the Office of the Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, 10017, USA, by Fax: 1 212 963 2147 or by email at population@un.org.

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PREFACE

The Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat is responsible for providing the international community with up-to-date and impartial information on population and development. The Population Division provides guidance on population and development issues to the United Nations General Assembly, the Economic and Social Council and the Commission on Population and Development, and undertakes regular studies on population estimates and projections, fertility, mortality, migration, reproductive health, population policies and population and development interrelationships.

As part of its work on fertility, the Population Division monitors levels and trends in age and parity patterns of fertility and its proximate determinants, such as marriage and contraceptive use, collects and analyses information on the relationship between fertility and development, and provides substantive support to intergovernmental discussions at the United Nations on the topics of fertility, family planning and development.

The World Fertility Report 2015 is the sixth in a series and focuses on trends in fertility since 1950, fertility projections through 2100, empirical data underlying fertility estimates, and effects of fertility on population growth. The data presented are from *World Population Prospects: The 2015 Revision*, the official United Nations publication of population estimates and projections, *World Fertility Data 2015*, and *Demographic Components of Future Population Growth: 2015 Revision.*

This report was prepared by Mr. Kirill Andreev with substantive inputs from Ms. Cheryl Sawyer and Ms. Karoline Schmid. The concept note for the report was developed by Ms. Ann Biddlecom, and Ms. Petra Nahmias contributed to early drafting. Mr. Kyaw Kyaw Lay provided technical support with maps and data, and Ms. Natalia Devyatkin provided editorial support. Mr. Jorge Bravo reviewed and provided helpful comments on the report.

The World Fertility Report series as well as other population information may be accessed on the Population Division's website at www.unpopulation.org. For further information concerning this publication, please contact the Office of the Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, 10017, USA, telephone (212) 963-3209, fax (212) 963-2147, email: population@un.org.

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[1] Online annex tables and figures are available at http://www.un.org/en/development/desa/population/publications/fertility/world-fertility-2015.shtml

EXPLANATORY NOTES

The following symbols are used in the tables shown in this report:

Two dots (..) indicate that data are not available or are not separately reported.
Three dots (…) indicate that the treaty was not ratified.
An em dash (—) indicates that the amount is nil or negligible.
A hyphen (-) indicates that the item is not applicable.
A minus sign (-) before a figure indicates a decrease.
A full stop (.) is used to indicate decimals.
Use of a hyphen (-) between years, for example, 1990-2000, signifies the full period from 1 July of the first year to 1 July of the second year.

Due to rounding, the numbers and percentages displayed in tables may not add up to the corresponding totals.

The designation "more developed" and "less developed" regions are intended for statistical purposes and do not express a judgment about the stage reached by a particular country, territory or area in the development process. The term "country" as used in this publication also refers, as appropriate, to territories or areas.

More developed regions comprise all sub-regions of Europe plus Northern America, Australia/New Zealand and Japan. Less developed regions comprise all sub-regions of Africa, Asia (excluding Japan), and Latin America and the Caribbean as well as Melanesia, Micronesia and Polynesia. Countries or areas in the more developed regions are designated as "developed countries". Countries or areas in the less developed regions are designated as "developing countries". Following common practice, the more developed regions are also referred to as the "North", while the less developed regions are also referred to as the "South".

The group of least developed countries, as defined by the United Nations General Assembly in its resolutions (59/209, 59/210, 60/33, 62/97, 64/L.55, 67/L.43, 64/295 and 68/18) included 47 countries in June 2017: 33 in Africa, 9 in Asia, 4 in Oceania and one in Latin America and the Caribbean. Those 47 countries are: Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen and Zambia. These countries are also included in the less developed regions.

The designation sub-Saharan Africa refers to all countries in Africa except Algeria, Egypt, Libya, Morocco, Sudan, Tunisia and Western Sahara.

Countries and areas are grouped geographically into six regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America and Oceania. These are further divided into 21 geographical sub-regions.

Country names and the composition of geographical areas follow those of "Standard country or area codes for statistical use", available at: http://unstats.un.org/unsd/methods/ m49/m49.htm.

EXPLANATORY NOTES (*continued*)

The following abbreviations have been used:

DESA	Department of Economic and Social Affairs
DHS	Demographic and Health Survey(s)
DYB	United Nations *Demographic Yearbook*
HIV/AIDS	Human immunodeficiency virus/Acquired immunodeficiency syndrome
ICPD	International Conference on Population and Development
LDCs	Least developed countries
MIS	Malaria Indicators Survey(s)
NSO	National Statistical Office(s)
RHS	Reproductive Health Survey(s)
SAR	Special Administrative Region
SDG	Sustainable Development Goals
UNGIS	United Nations Geospatial Information Section
UNRWA	United Nations Relief and Works Agency
WHO	World Health Organization

Classification of countries or areas by region and sub-region of the world

AFRICA				
Eastern Africa	*Middle Africa*	*Northern Africa*	*Western Africa*	*Southern Africa*
Burundi	Angola	Algeria	Benin	Botswana
Comoros	Cameroon	Egypt	Burkina Faso	Lesotho
Djibouti	Central African Republic	Libya	Cabo Verde	Namibia
Eritrea	Chad	Morocco	Côte d'Ivoire	South Africa
Ethiopia	Congo	Sudan	Gambia	Swaziland
Kenya	Democratic Republic of the Congo	Tunisia	Ghana	
Madagascar	Equatorial Guinea	Western Sahara	Guinea	
Malawi	Gabon		Guinea-Bissau	
Mauritius[2]	Sao Tome and Principe		Liberia	
Mayotte			Mali	
Mozambique			Mauritania	
Réunion			Niger	
Rwanda			Nigeria	
Seychelles			Saint Helena[3]	
Somalia			Senegal	
South Sudan			Sierra Leone	
Uganda			Togo	
United Republic of Tanzania[4]				
Zambia				
Zimbabwe				

ASIA				
Central Asia	*Eastern Asia*	*Southern Asia*	*South-Eastern Asia*	*Western Asia*
Kazakhstan	China[5]	Afghanistan	Brunei Darussalam	Armenia
Kyrgyzstan	China, Hong Kong Special Administrative Region[7]	Bangladesh	Cambodia	Azerbaijan[6]
Tajikistan	China, Macao Special Administrative Region[11]	Bhutan	Indonesia	Bahrain
Turkmenistan	Democratic People's Republic of Korea	India	Lao People's Democratic Republic	Cyprus[8]
Uzbekistan	Japan	Iran (Islamic Republic of)	Malaysia[10]	Georgia[9]
	Mongolia	Maldives	Myanmar	Iraq
	Republic of Korea	Nepal	Philippines	Israel
		Pakistan	Singapore	Jordan
		Sri Lanka	Thailand	Kuwait
			Timor-Leste	Lebanon
			Viet Nam	Oman
				Qatar
				Saudi Arabia
				State of Palestine[12]
				Syrian Arab Republic
				Turkey
				United Arab Emirates
				Yemen

2 Including Agalega, Rodrigues and Saint Brandon.
3 Including Ascension and Tristan da Cunha.
4 Including Zanzibar.
5 For statistical purposes, the data for China do not include Hong Kong and Macao, Special Administrative Regions (SAR) of China.
6 Including Nagorno-Karabakh.
7 As of 1 July 1997, Hong Kong became a Special Administrative Region (SAR) of China.
8 Including Northern-Cyprus.
9 Including Abkhazia and South Ossetia.
10 Including Sabah and Sarawak.
11 As of 20 December 1999, Macao became a Special Administrative Region (SAR) of China.
12 Including East Jerusalem. Refugees under UNRWA's mandate are not counted as part of the migrant stock for the State of Palestine, as almost all of these individuals were born in the territory.

CLASSIFICATION OF COUNTRIES OR AREAS BY REGION AND SUB-REGION OF THE WORLD (*continued*)

EUROPE			
Eastern Europe	*Northern Europe*	*Southern Europe*	*Western Europe*
Belarus	Channel Islands[13]	Albania	Austria
Bulgaria	Denmark	Andorra	Belgium
Czech Republic	Estonia	Bosnia and Herzegovina	France
Hungary	Faeroe Islands	Croatia	Germany
Poland	Finland[14]	Gibraltar	Liechtenstein
Republic of Moldova[15]	Iceland	Greece	Luxembourg
Romania	Ireland	Holy See[16]	Monaco
Russian Federation	Isle of Man	Italy	Netherlands
Slovakia	Latvia	Malta	Switzerland
Ukraine	Lithuania	Montenegro	
	Norway[17]	Portugal	
	Sweden	San Marino	
	United Kingdom of Great Britain and Northern Ireland[19]	Serbia[18]	
		Slovenia	
		Spain[20]	
		The former Yugoslav Republic of Macedonia[21]	

LATIN AMERICA AND THE CARIBBEAN		
Caribbean	*Central America*	*South America*
Anguilla	Belize	Argentina
Antigua and Barbuda	Costa Rica	Bolivia (Plurinational State of)
Aruba	El Salvador	Brazil
Bahamas	Guatemala	Chile
Barbados	Honduras	Colombia
British Virgin Islands	Mexico	Ecuador
Caribbean Netherlands	Nicaragua	Falkland Islands (Malvinas)
Cayman Islands	Panama	French Guiana
Cuba		Guyana
Curaçao		Paraguay
Dominica		Peru
Dominican Republic		Suriname
Grenada		Uruguay
Guadeloupe[22]		Venezuela (Bolivarian Republic of)
Haiti		
Jamaica		
Martinique		
Montserrat		
Puerto Rico		
Saint Kitts and Nevis		
Saint Lucia		
Saint Vincent and the Grenadines		

[13] Refers to Guernsey and Jersey.
[14] Including Åland Islands.
[15] Including Transnistria.
[16] Refers to the Vatican City State.
[17] Including Svalbard and Jan Mayen Islands.
[18] Including Kosovo.
[19] Also referred to as United Kingdom.
[20] Including Canary Islands, Ceuta and Melilla.
[21] Also referred to as TFYR Macedonia.
[22] Including Saint-Barthélemy and Saint-Martin (French part).

CLASSIFICATION OF COUNTRIES OR AREAS BY REGION AND SUB-REGION OF THE WORLD (*continued*)

LATIN AMERICA AND THE CARIBBEAN (*continued*)		
Caribbean	*Central America*	*South America*
Sint Maarten (Dutch part)		
Trinidad and Tobago		
Turks and Caicos Islands		
United States Virgin Islands		

NORTHERN AMERICA
Bermuda
Canada
Greenland
Saint Pierre and Miquelon
United States of America

OCEANIA			
Australia and New Zealand	*Melanesia*	*Micronesia*	*Polynesia*
Australia[23]	Fiji	Guam	American Samoa
New Zealand	New Caledonia	Kiribati	Cook Islands
	Papua New Guinea	Marshall Islands	French Polynesia
	Solomon Islands	Micronesia (Federated States of)	Niue
	Vanuatu	Nauru	Samoa
		Northern Mariana Islands	Tokelau
		Palau	Tonga
			Tuvalu
			Wallis and Futuna Islands

[23] Including Christmas Island, Cocos (Keeling) Islands and Norfolk Island.

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KEY FINDINGS

Worldwide, fertility decline gained momentum starting in the 1970s, reaching historically low levels in 2010-2015. While in the period 1970-1975 half of the countries in the world had levels of total fertility above 5.5 live births per woman, in the period 2010-2015, the median fertility stood at 2.3 births per woman. By 1970, only 22 countries had completed the transition to low fertility, falling below 2.1 births per woman, which is the level required to ensure the replacement of generations in low-mortality populations. By 2013, the number of countries with below-replacement fertility had nearly quadrupled, reaching 83.

Fertility remained at relatively high levels (more than 3.5 births per woman) in 2010-2015 in just 55 countries or areas: 42 in Africa, 8 in Asia, and 5 in Oceania, with two-thirds of them (37) belonging to the group of Least Developed Countries (LDCs). In only 11 of the 48 LDCs, fertility is now less than 3.5 births per woman, and only in Bhutan has it dropped to the replacement level. In 47 of the 55 high-fertility countries, fertility declines were smaller than the world median decline of 3.2 births per women. Thirty-five of these 47 countries are LDCs. Among high-fertility countries, fertility declined only in eight countries at an accelerated pace, namely in Jordan, Kenya, Mayotte, State of Palestine, Rwanda, Tajikistan, Yemen, and Zimbabwe.

More and more people are living in countries with below-replacement fertility. In 2013, the total population of the 83 countries or areas with below-replacement fertility was close to half of the world's population. In 1973, the share of the world's population with below-replacement fertility was only about 15 per cent and in 1953 it was less than half of one per cent.

Sustained low levels of fertility inevitably leads to population ageing. Many middle-income countries that have only recently reached below-replacement fertility levels have undergone far more rapid transitions than was historically the case for countries that completed their fertility transitions earlier. The countries with more recent and more rapid drops in fertility have less time to adapt to the macro socio-economic changes resulting from the rapid changes taking place in the age-structure of their populations.

Contrary to the global trend of declining fertility, several below-replacement fertility countries (32) experienced modest fertility increases over the past 15 years. However, despite these trend reversals, no country with below-replacement fertility has yet returned to the replacement level or above.

The adolescent birth rate (ABR) has declined in most countries but remains higher than 100 live births per 1,000 women aged 15-19 years in 25 countries, all but one in Africa. Eighteen of these 25 countries are LDCs. The highest levels of adolescent childbearing are found in Niger, Mali, Angola, Mozambique and Chad, with adolescent birth rates higher than 150 live births per 1,000 women, and even higher than 200 live births per 1,000 women in the case of Niger. Between 1990-1995 and 2010-2015, adolescent birth rates declined faster than total fertility. The lowest levels of adolescent birth rates, less than 3 live births per 1,000 women, are found in the Democratic People's Republic of Korea and the Republic of Korea.

Between 1990-1995 and 2010-2015, the global proportion of births to adolescent mothers declined 1.5 percentage points, from 10.7 to 9.2. Accelerated progress has been made in all regions except Latin America and the Caribbean, especially in Central and South America, where adolescent fertility as a share of all births actually increased from 13.7 to 15.5 per cent between these two period and is currently the highest in the world.

Along with the transition to lower total fertility, the world has witnessed dramatic changes in the age pattern of childbearing. At the global level, the mean age at childbearing (MAC) declined from 29.1 years of age in 1950-1955 to 27.5 years in 1990-1995, and has remained generally at this level through 2015. The evolution of the MAC over this time-period varied across regions and even more so at the country levels. Due to the postponement of first births, the MAC has risen sharply in Europe, North America and in the high-income countries of Asia and Oceania, many of which have low levels of fertility and a MAC above 30 years. Conversely, in countries of Latin America and the Caribbean and in the middle- and low-income countries of

Asia and Oceania, births are taking place now at younger ages than before, a trend caused by declines in high-parity births without significant changes in the spacing between births.

The world's population is projected to increase from 6.9 billion in 2010 to 9.7 billion in 2050, or by 40 per cent. More than half of the projected population growth is due to population momentum (namely, 26 of the 40 percentage points), 8 percentage points of the change are due to above-replacement fertility, and 6 percentage points are credited to anticipated mortality declines. Population momentum alone is projected to account for the addition of 1.8 billion people to the world's population between 2010 and 2050. Above-replacement fertility is by far the largest contributor to population growth in LDCs and is projected to add more than 600 million people from 2010 to 2050. In Africa, above-replacement fertility will account for 87 per cent of the projected population increase, adding more than 900 million people over this period.

In high-fertility countries, total fertility is projected to decline towards the replacement level, from 2.5 births per woman in 2010-2015, to 2.3 in 2045-2050 and further to 2.0 births per woman in 2095-2100. All regions, except for Africa, are expected either to remain below or to reach the replacement level of fertility by the end of this century. The future pace of fertility decline, however, is inherently uncertain, and whether fertility will in fact decline more or less rapidly than in previous periods, particularly in sub-Saharan Africa, is a subject of on-going debate. In the current projections, 21 African countries are expected to complete their transitions only after 2100. Consequently, high-fertility countries will continue to have growing and youthful populations, even if the projected fertility declines materialize. There are opportunities to benefit from changing age structure brought about by continued fertility declines in the form of a "demographic dividend", especially if increased investments in human capital, education, employment and other policies are put in place.

Countries dipping just below the replacement level in 2010-2015 are expected to follow trajectories similar to below-replacement fertility countries, with fertility continuing to decline to levels well below replacement, and then at some low point to bounce back and start to rise gradually towards a level that is still below replacement. Projections suggest that the lower the present level of fertility, the faster their future increase is likely to be. The largest fertility gains would therefore be expected in Taiwan Province of China, Macao SAR (China), and Hong Kong SAR (China): starting from current fertility levels of 1.2 births per women or less, an increase of more than half a birth is expected by 2100 in these areas.

High-quality and timely data are key to making policy decisions and to monitoring progress towards the achievement of the Sustainable Development Goals. A review of empirical data suggests that our knowledge about fertility levels and trends is based on insufficient or otherwise inadequate empirical evidence. In more than half of the countries and areas of the world, recent fertility estimates are not based on complete vital registration data. The greatest challenges are in Africa and Oceania, where timely fertility estimates based on complete vital registration exist for only 12 per cent and 38 per cent of countries or territories, respectively. Special efforts need to be directed toward strengthening civil registration and vital statistics, toward scaling up national statistical capacities, and toward strengthening and modernizing statistical systems so that they can produce and disseminate timely and reliable demographic data on fertility and births. These improvements should also support national efforts to meet the SDG target of achieving legal identity for all, including through birth registration, by 2030.

INTRODUCTION

The demographic transition that began about two centuries ago in Europe has ushered major changes in fertility levels and patterns around the world. Globally, total fertility has declined at unprecedented rates and to unprecedented levels, reaching a median level of 2.5 births per woman in 2010-2015, down from almost five births per woman in 1950-1955. More than 83 countries,[1] with close to half of the world's population, are now experiencing below-replacement fertility levels. However, total and adolescent fertility levels remain high in many countries, particularly those in sub-Saharan Africa and in the group of the Least Developed Countries (LDCs). Also, low fertility in Europe, Northern America, Eastern Asia, and parts of Oceania and Latin America is a cause of concern due to population ageing and, in some cases, population decline.

High and sustained levels of fertility in the majority of the LDCs have led to continued and steady population growth there, posing almost insurmountable challenges to already strained Governments striving to meet the Sustainable Development Goals between now and 2030 by eliminating extreme poverty providing access to sustainable livelihoods, education, jobs, food, health care and housing, and addressing other socio-economic challenges. Population ageing, an inevitable consequence of low levels of fertility and increased longevity, presents another set of issues for the achievement of the 2030 Agenda for Sustainable Development, including insufficient coverage or adequacy of social protection schemes for the rapidly increasing number of older persons in the world.

This report provides a detailed overview of existing estimates and projections of fertility[2] levels and trends, with a particular focus on changes observed between 1970-1975 and 2010-2015 and on changes that are projected to occur between 2010-2015 and 2045-2050. An additional focus is given to the analysis of fertility transitions. Estimates of some parameters of the fertility transitions, including the level and pace of fertility decline at different stages of the fertility transition, are provided for all countries of the world, including for countries that commenced their fertility transitions prior to 1950. The discussion of changes in fertility levels and age patterns of childbearing at the regional level[3] and for individual countries is supplemented with an extensive set of annex plots.

The 2030 Sustainable Development Agenda includes the SDG indicator 3.7.2, "Adolescent birth rate", which is the annual number of births to females aged 10-14 or 15-19 years per 1,000 females in the respective age group[4]. This report presents an in-depth analysis of past, present and projected levels and trends of adolescent fertility at the global, regional as well as national levels.

The report further extends previous publications by quantifying the effect of fertility on population growth over the period from 2010 to 2050, with a focus on those countries where fertility is the driving factor behind population growth or decline.

The report also includes a chapter on empirical data sources and methods for fertility estimation to address the call of the 2030 Sustainable Development Agenda for strengthening data production and the use of better data in policymaking and monitoring. Drawing on a recently established database of empirical fertility data, the 2015 World Fertility Data (United Nations, 2015c), this report provides estimates of gaps and timeliness in the empirical fertility data used as a basis for producing estimates of fertility levels and trends.

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[1] The term "country" as used in this publication refers, as appropriate, to countries, territories or areas.
[2] United Nations (2015a).
[3] In previous editions of the *World Fertility Report*, analysis was also conducted by development group where countries were categorized as part of developed regions or developing regions. These development group categories were not used in the present report. Many countries classified as part of developing regions now have very low fertility (e.g., China) as well as high per capita income (e.g., the Republic of Korea and Singapore).
[4] Due to lack of empirical evidence on adolescent fertility for the 10-14-year age group, the present analysis focuses only on fertility of adolescents aged 15-19 years.

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I. DATA SOURCES FOR THE ESTIMATION OF FERTILITY

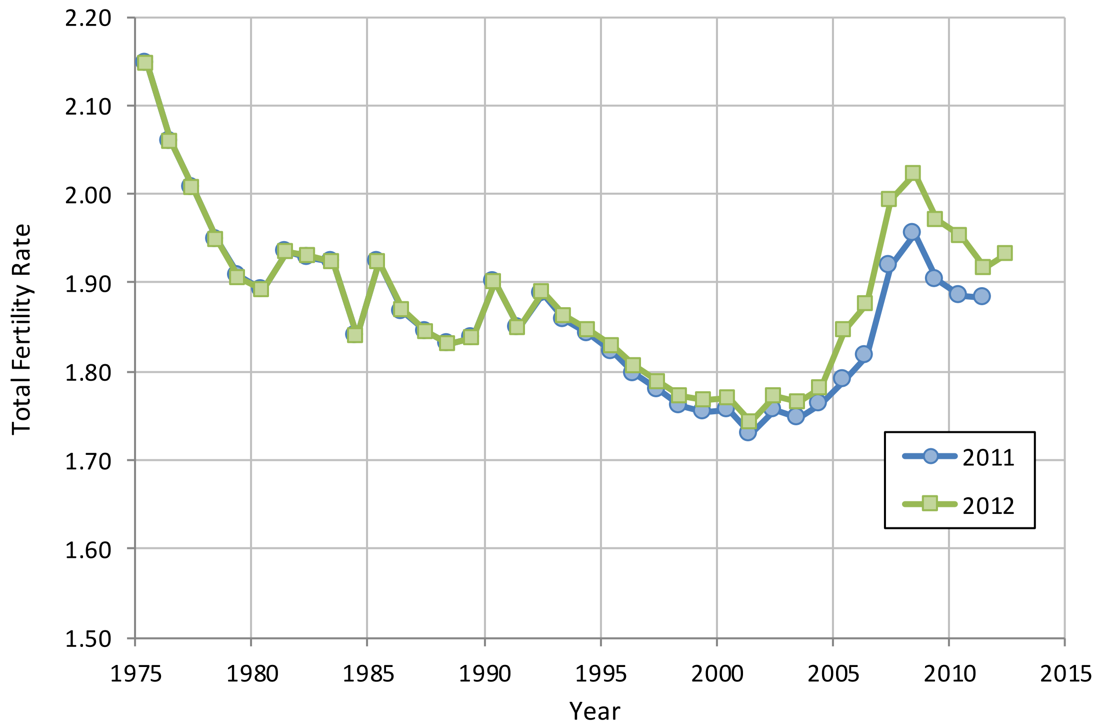
The primary information required for estimating fertility is the number of live births by age of mother during a specified time interval and estimates of the population exposed to the risk of giving birth over the same interval. The best estimates of fertility are obtained from a universal and well-functioning civil registration and vital statistics system (United Nations, 2014). In such a system, all births are registered shortly after occurrence and a birth certificate is issued for every child born. The information from the birth certificates is then used for the production of vital statistics. The population exposures needed for computations of fertility rates are based on annual population estimates, which are derived from the population by age and sex enumerated in population censuses, and births, deaths, and migration for intercensal or postcensal periods. In countries with operating population registers population censuses are not regularly conducted, since statistics in such countries are based on the continuous collection of information on both population and vital events. In these countries, annual population estimates are based on the data recorded in the population registers.

For countries with a reliable civil registration and vital statistics system, as is the case in most developed countries and in some developing countries, age-specific fertility rates and derived indicators (e.g., the total fertility rate, the mean age at childbearing) are computed from births by age of mother and population estimates, using standard demographic methods (Preston and others, 2001). Such estimates are commonly known as direct estimates based on vital registration or “VR-based estimates” for short. They are based almost entirely on complete data collected on births and population estimates in a country, with minimal assumptions required. The term "direct" is used to qualify a broader class of estimation methods that rely mostly on the reporting of demographic events, rather on information only indirectly related to an estimate or obtained based on a statistical model. VR-based estimates are usually published by single calendar years and updated annually.

The quality of VR-based estimates depends on the accuracy of the information collected on births and on the accuracy of population estimates. One of the main sources of error or bias in VR-based estimates is incomplete coverage of birth registration or population statistics. Even in countries with accurate and complete birth registration, population estimates used as denominators for computing fertility rates are frequently revised. For example, in 2012 the Australian Bureau of Statistics revised population estimates back to 1990, which in turn led to retrospective revisions of fertility rates back to that year. Figure I.1 illustrates the effect of this revision on the estimates of the total fertility rate for Australia. The series “2012” is the estimates of the total fertility rate based on the latest revision of population and the series “2011” is the estimates based on the previous population estimates. The updated estimates of fertility are higher than previously estimated, due to the downward revision of the population figures.

Population registers tend to produce population data of better quality than censuses. Nevertheless, population estimates based on registers might still be affected by inaccurate data on international migration. Citizens who have left the country for an extended period or permanently may have no incentive to report their departure if it would entail losing advantages associated with the registration, and they remain included in the population register as “temporary” emigrants. Similarly, foreigners living habitually in the country and who are included in the population register, will still be included erroneously if they return to their home countries without notifying the authorities. It is not unusual to find coverage rates of international emigration below 50 per cent (Poulain and Herm, 2013). Additional sources of errors in population registers may include incorrect records of age or other demographic characteristics of foreign-born persons.

Figure I.1 Effect of revision of population estimates on total fertility rate for Australia



Source: Computations by the Population Division/DESA of the United Nations based on vital registration and Australian population estimates released by Australian Bureau of Statistics in 2011 (series "2011") and in 2012 (series "2011").

When vital registration systems fail to record all births that take place during a given period of time or population censuses fail to enumerate every individual, their coverage is said to be incomplete. Using incomplete data to produce fertility estimates requires adjustments to births and population estimates. In the case of population censuses, adjusted population estimates are usually produced by conducting a post-enumeration survey. The coverage and completeness of civil registration is often assessed by a dual registration approach or by using alternative sources of information on vital events. In countries with incomplete civil registration systems, data from incomplete vital statistics are frequently supplemented by data from household surveys to derive final estimates of fertility. More detailed accounts of methods for assessing the quality of population and vital statistics are given in Preston and others (2001), Bogue and others (1993), Shryock, Siegel, and Associates (1980). Moriyama (1990) describes an array of methods historically used to evaluate the quality of population and vital statistics in the United States.

Yet many countries still face difficulties in establishing a well-functioning civil registration and vital statistics system. Only 53 per cent of countries or areas globally reported basic data on births by age of mother from complete civil registration and vital statistics systems (i.e., 90 per cent or more of births were registered) for the period 2010-2014 to the Statistics Division /DESA of the United Nations (Skenderi, 2015). In some countries, vital registration is incomplete for a variety of reasons: many births go unregistered if they take place at home; newborns who die shortly after birth may not be registered; registration fees may provide a disincentive for individuals to register births; local registration offices may fail to transfer birth records to the national statistical office; the national office may lack resources to process transferred records and produce vital statistics. In addition, there could be long delays between the occurrence of a birth and its registration. For example, birth registration could be delayed by parents until the child reaches school age. In countries with incomplete vital registration, the main sources of information on fertility levels and trends are population censuses and nationally-representative household surveys.

Because population censuses aim to enumerate all individuals in a country and to record information on various topics, normally only a very limited set of questions about fertility is included. Typical questions asked in a population census are about a) lifetime or cumulated fertility (children ever born), and b) recent fertility (i.e., births in the last year, or another period of time before the census). The data on recent births collected in censuses are used to derive estimates of current fertility, but these estimates are often implausibly low due to errors resulting from omissions of births, recall problems, misinterpretation of the reference period before the census, and significant non-response rates, amongst other problems (United Nations, 1983). These challenges led to the development of demographic methods for estimating fertility by incorporating information that indirectly relates to the quantity in question, commonly known as methods for indirect estimation (United Nations, 1983, Moultrie and others, 2013). Two independent questions on fertility included in population censuses, a question on lifetime fertility and a question on recent births, make consistency checks between current and cumulative fertility possible. Under fairly general assumptions about fertility trends and typical errors, direct estimates based on recent births can be adjusted by incorporating information on lifetime fertility. This was the original idea behind the P/F (parity/fertility) ratio method (Brass, 1964). This idea was further developed in several other methods that utilize information on both cumulative and recent fertility, adapted to the information available from a census or survey, including Arriaga's technique and the relational Gompertz model (United Nations, 1983; Arriaga, 1983; and Moultrie and others, 2013).

The infrequency with which censuses are conducted (typically every 10 years) is one of their main limitations—it is often inadequate for the management and monitoring of population and development programmes. A more flexible mechanism for collecting fertility data are sample household surveys. Due to their smaller sample sizes, data on fertility can be collected more frequently and questions can be more detailed and targeted than in population censuses. Starting with the World Fertility Survey in the late 1970s, household surveys have routinely collected full "birth histories" of the mothers interviewed. A birth history records every live-born child a woman has had, the child's sex, date of birth and, if the child died, the date of death. Questions on key demographic characteristics such as education characteristics of the mother are commonly included in the questionnaires making it possible to study fertility differentials by socio-economic factors.

Full birth histories have become the dominant source for producing estimates of fertility levels and trends for countries without well-functioning civil registration and vital statistics systems. Birth histories are usually collected from a random sample of women of reproductive age, commonly defined as ages 15 to 49. Typically, data are collected from all women in this age group, but in some countries the collection of data has been restricted to married women only. Figure I.2 illustrates birth histories collected in a hypothetical survey conducted in 2010. Green squares on the vertical line in 2010 designate mothers interviewed in this survey; the position of a square corresponds to the age of the mother. The green diagonal lines show the mothers' life lines, starting at the year of birth and ending with the interview date. For example, the oldest mother interviewed in this survey was aged 48 as shown by the highest green square in 2010. She was born in 1962 as illustrated by the diagonal green line going from age 48 in 2010 to age 0 in 1962. Births recorded in this survey are shown as red circles on the life lines of their mothers. The oldest mother in this figure, for example, gave birth three times, at ages 25, 29 and 32.

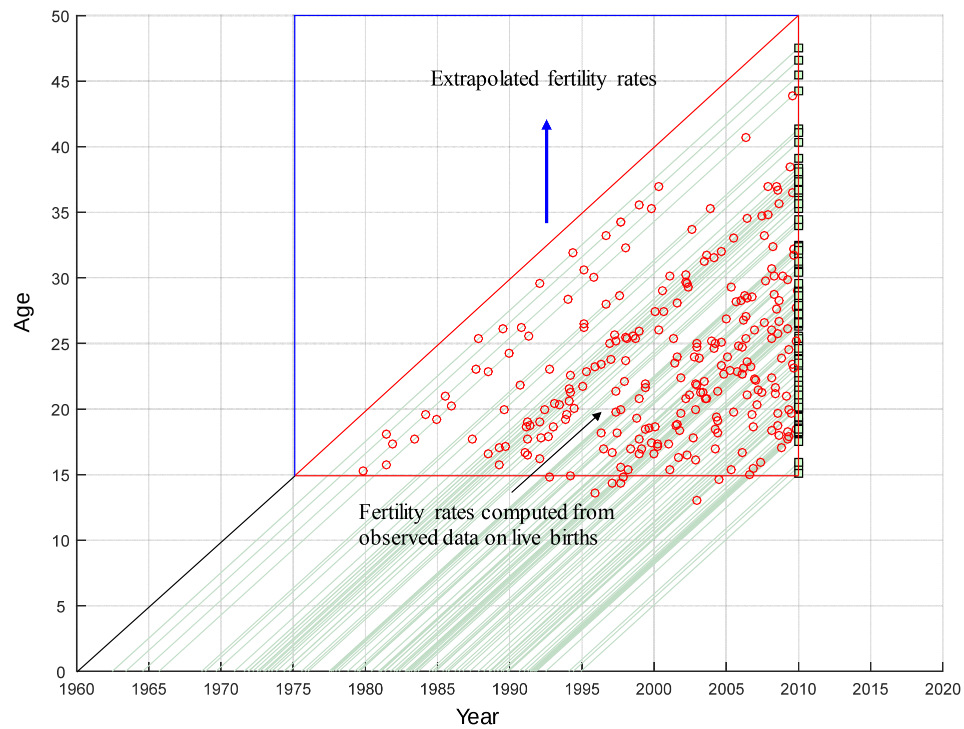
Direct computation of fertility rates from birth histories is fairly straightforward and well-documented (Croft, 1991; Rutstein and Rojas, 2006). To compute an age-specific fertility rate for a defined period of time and age group one needs to compute the number of births and time lived by all mothers in the age group (population exposure). Total fertility is then computed by summing age-specific fertility rates over age. As illustrated by figure I.2, births covering almost the entire reproductive age interval are available only for a short period before a survey, three or five years. For this period, the estimate of the total fertility rate is based virtually entirely on empirical data. As one moves back in time from the date of the survey, empirical fertility rates are available only for progressively lower age groups (red triangle in figure I.2) and total fertility cannot be computed without further assumptions about fertility rates in the older age groups (blue triangle in figure I.2). A common assumption for deriving fertility estimates for age groups with no data, and, consequently, estimates of trends in total fertility, is that the age pattern of fertility is unchanged before the survey. Under this assumption, the age pattern of fertility is borrowed from the age pattern estimated for the period of three or five years before the survey, and fertility levels for the truncated age groups are obtained by extrapolation from the empirical fertility rates for younger ages with available data. This can be carried out either by manual computations or by applying Poisson regression (Schoumaker, 2013).

Household surveys tend to collect more reliable fertility data than population censuses due to the smaller field operations involved and better-trained field staff to conduct face-to-face interviews. Sampling variability, however, may prevent estimation of fertility differentials by small geographical areas or across population groups, which would be possible with census data.

Surveys are also subject to certain non-sampling errors in data collection. Typical errors in household surveys include age misreporting among women, misreporting of dates of births, and displacing or omitting births in birth histories, among others. For example, interviewers may reallocate or omit births in the birth history tables of the Demographic and Health Surveys (DHS) to avoid completing a lengthy child health section for recent births in the DHS questionnaire (Marckwardt and Rutstein, 1996; Schoumaker, 2014). Such displacement or omission can cause a downward bias in fertility estimates for the most recent period.

Another problem inherent to household surveys is the representativeness of the sampling frame and sampling design. Sampling frames for surveys are commonly based on the last census, with an implicit assumption that the population distribution is unchanged between the date of the last census and the date of a survey. This assumption becomes increasingly questionable the more years are between the last census and the field work of a survey. For example, the sampling frame of the 2013 DHS of the Democratic Republic of Congo is based, by and large, on the sampling frame of the 1984 census, updated partially several times by administrative censuses (Ministère du Plan et Suivi de la Mise en oeuvre de la Révolution de la Modernité, Ministère de la Santé Publique et ICF International, 2014). If a household survey is designed to sample from a specific population (e.g., ever-married women only) or oversample specific population groups or areas of interest (e.g., rural or malaria-affected areas), additional information or additional assumptions are needed to extend the results to the general population. Unintentional oversampling or undersampling could also affect fertility estimates. For example, there is some evidence that 2002-2003 and 2007 DHS surveys in Indonesia undersampled mobile and childless women, thus introducing upwards bias into fertility estimates (Hull and Hartanto, 2009). It is not yet common practice, but this research suggests that comparing population distribution by marital status in household surveys and population censuses could be both suggestive and revealing.

Figure I.2 Illustration of birth history data on a Lexis diagram



NOTE: The green squares designate mothers interviewed in a survey. They are placed according to the age of each mother at the time when the survey was conducted (in 2010). The green diagonal lines show life lines of the mothers. Children are designated by red circles and shown on the life lines of the mothers at the ages when the birth took place. The lower red triangle shows age and time periods where birth rates can be computed from empirical data on births and population exposure. The upper blue triangle shows age and time periods with missing data that needs to be modelled to compute trends in total fertility before the survey.

Another class of methods for indirect estimation of fertility relies on the observed age structure of a population. If migration and mortality rates are known for recent periods before a census or survey, the method of estimation is to compute, by reverse survival of the population under age 10 or 15 years, the corresponding births that took place during the past 10 or 15 years, and to infer fertility from the reconstructed births (United Nations, 1967). If children enumerated in a census are linked to their mothers, the reverse-survival method can be further extended to exploit this information. This extension, known as the “own children” method, can also produce estimates of the age pattern of fertility for a time period preceding a census or survey (United Nations, 1983, Grabill and Cho, 1965). Results of the application of methods based on reverse survival depend crucially on the quality of data on the population age structure. If the quality is poor because of age heaping or differential completeness of the enumeration, the results of these indirect estimation methods may be unusable. For example, the underenumeration of young children in population censuses, which is fairly common, results in a spurious drop of fertility during the two or three years immediately preceding a census. Severe age heaping could also produce spurious annual variations in the estimated total fertility rates. For example, the application of the reverse-survival method to data from the 2005 Afghanistan National Risk and Vulnerability Assessment survey produced implausible estimates of total fertility in a range from 6 children per woman to 14 children per woman because of age heaping in this survey[1]. The own-children method applied to the data from the same survey returned only marginally better results.

[1] See online plot: http://www.un.org/en/development/desa/population/publications/dataset/fertility/wfd2015/4_tfr.png

Assumptions made about migration and mortality needed for the application of methods based on reverse survival introduce an additional source of uncertainty into the fertility estimates. For countries with incomplete vital registration systems, where such indirect methods are usually applied, estimates of migration and mortality can be even more uncertain than estimates of fertility. To some degree, the requirement of accurate mortality estimates is alleviated by the age range for which the survival rates are needed. Since survival rates are required for adult ages only to carry out reverse projection, and death rates in this age range are typically low, the sensitivity of the results produced by the methods based on reverse survival to mortality assumptions is relatively small. Nevertheless, in the populations highly affected by HIV/AIDS epidemics, with steep increases in adult mortality, applications of these indirect methods could be problematic. In populations where age reporting is accurate, migration is negligible and mortality changes are gradual, the methods perform reasonably well, producing results consistent with fertility estimates derived by other methods (United Nations, 1983; Avery, 2013; Spoorenberg, 2013). The last limiting factor of application of the own-children method is access to population census microdata, which is restricted in many cases.

A. ALL AVAILABLE DATA SOURCES MUST BE CONSIDERED FOR DERIVING FERTILITY ESTIMATES

Deriving estimates of fertility levels and trends requires considering simultaneously all available data sources and fertility estimates based on them. This approach provides a consistency and quality check of various data sources and estimation procedures. This approach also provides information about data gaps and the reliability and uncertainty of the fertility estimates derived. To illustrate this approach, two examples are discussed below based on fertility estimates for Georgia and Uganda. Georgia was selected as a country reporting 90 per cent or more of all births covered by their civil registration and vital statistics system and where estimates based on surveys are also available. Uganda was selected as a typical country where a majority of births are not registered and where fertility estimates are based mainly on data from surveys and censuses. Figure I.3 shows all available fertility estimates for Georgia, either based on vital registration or derived from household surveys. The series "Direct_DYB" are direct estimates based on population estimates and births from vital registration data reported to the United Nations Statistical Division by the National Statistical Office (NSO) of Georgia. The series "Eurostat.20150811" are official estimates of fertility submitted by the NSO to Eurostat[2]. Both series are largely consistent, suggesting that the National Statistics Office of Georgia uses data from vital registration and population estimates to derive official fertility estimates. The series "RHS1999", "RHS2005", "RHS2010", and "RHS2010 (OCM)" are estimates of fertility derived by various methods based on data collected in the 1999, 2005, and 2010 Reproductive Health Surveys[3]. Series "WPP" are estimates produced by the Population Division/DESA of the United Nations and published in United Nations (2015a).

Until the early 1990s, the estimates from the United Nations ("WPP" series)[4] follow closely the direct VR-based estimates. After independence from the Soviet Union in 1991 followed by armed conflict, separatist movements, unaccounted large-scale emigration and the introduction of fees for vital registration (Badurashvili and others, 2001), the quality of vital statistics and population estimates deteriorated significantly, rendering fertility estimates based on vital registration unreliable. Therefore, for the period 1990-2010, the estimates derived from data from the Reproductive Health Surveys were considered to be more reliable than those based on vital records. After 2010, the quality of VR-based estimates is regarded to have improved to the point that estimates from the United Nations could be based again on the data from vital statistics only. Due to inconsistencies between the VR and survey sources, the data do not provide firm evidence of recovery toward replacement-level fertility in Georgia after 1995.

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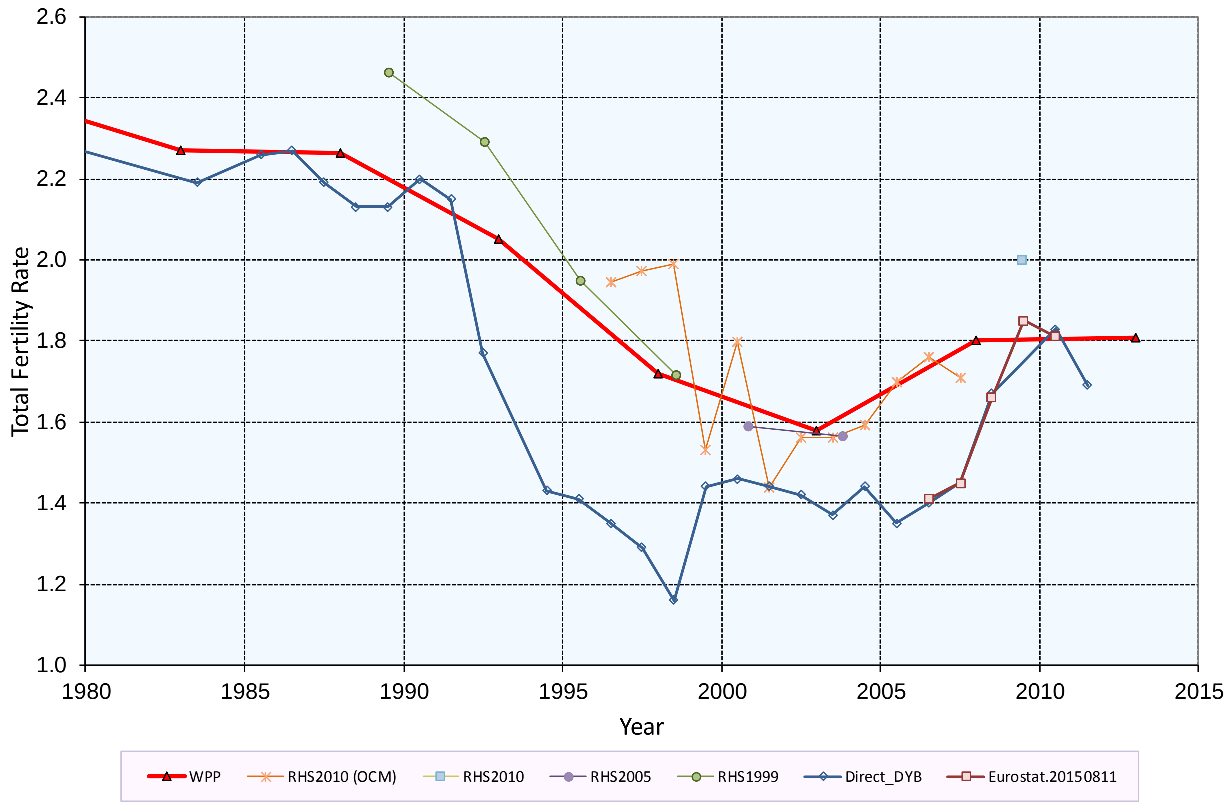
[2] Suffix 20150811 is a timestamp of download from Eurostat website, August 11th, 2015, yyyymmdd format.

[3] OCM stands for the own-children method.

[4] The series "WPP" (WPP stands for World Population Prospects) are the estimates produced by the Population Division, DESA, United Nations and published in United Nations (2015a).

Figure I.3 Estimates of total fertility for Georgia



NOTE: The series "WPP" are the estimates published in United Nations (2015a), the series "RHS2010 (OCM)" are the estimates based on the 2010 Reproductive Health Survey produced by the own-children method, the series "RHS2005" and "RHS1999" are the direct estimates from the 2005 and 2009 Reproductive Health Surveys, the series "Direct_DYB" are VR-based estimates produced from the births and population estimates reported by the National Statistics Office of Georgia to the Statistics Division /DESA of the United Nations, and "Eurostat.20150811" are the estimates reported the National Statistics Office of Georgia to Eurostat and downloaded from the Eurostat's online database on 11 August 2015.

Figure I.4 presents all available fertility estimates for Uganda based on censuses and household surveys as well as the estimated fertility trend produced by the United Nations Population Division (United Nations, 2015a). Data on recent births and lifetime fertility were collected in 1959, 1969, 1991, and 2002 censuses, and the estimates produced by direct methods are shown in the series "1959 Census Report"[5], "1969 Census,D-RB", "1991 Census,D-RB", and "2002 Census,D-RB". The indirect estimates are given in the series "1959 Census,A-RB", "1969 Census,A-RB", "1991 Census,A-RB", and "2002 Census,A-RB". The methods used for deriving indirect estimates from the Ugandan censuses are variants of the Brass P/F ratio method, but the variants and the parameters used (e.g., age groups selected for adjusting current fertility) vary from one census report to another. The Ugandan indirect estimates are significantly higher than the direct estimates[6]: in the 2002 census, for example, the indirect estimate of total fertility was 7.03 children per woman, while the direct estimate was 6.3 children per woman.

The estimates from household surveys—the 1988-1989, 1995, 2000-2001, 2006, and 2011 DHS and the 2009 MIS—are all derived from data on full birth histories. Direct estimates of current fertility based on the full birth histories are plotted in the series "1988-1989 DHS,D-BH", "1995 DHS,D-BH", "2000-2001 DHS,D-BH", "2006 DHS,D-BH", "2011 DHS,D-BH", and "2009 MIS,D-BH". Direct

[5] This estimate is published in the 1959 census report. Presumably, it is a direct estimate but no exact information how this estimate has been derived was found.

[6] Except for the 1991 census. For this census both direct and indirect estimates are close.

estimates of fertility trends from the same surveys that are significantly affected by the extrapolation procedure discussed earlier are distinguished by the suffix "X-BH". For example, the current fertility estimates based on full birth histories from the 2011 DHS appear in the plot as "2011 DHS,D-BH" and the extrapolated estimates of fertility trends based on the same data source are labelled as "2011 DHS,X-BH".

From figure I.4, it is evident that until approximately the year 2000, the indirect estimates based on population censuses, the official estimates of fertility (the series "NSO") and the estimates from the Population Division/DESA ("WPP") are consistent. The direct estimates from the household surveys are considerably higher than the indirect estimates from the population censuses for this period and the WPP time series. Recent fertility estimates from the 2006 DHS, 2009 MIS, and 2011 DHS surveys mark an onset of fertility decline in Uganda, and the WPP time series more closely aligns with these direct estimates since 2000.

Figure I.4 Estimates of total fertility rate for Uganda

NOTE: The series "WPP" are the estimates published in United Nations (2015a), the series "NSO" are the fertility estimates reported by National Statistical Office, the series "2009 MIS" are the estimates from the 2009 Malaria Indicators Survey, the series "1988-1989 DHS", "1995 DHS", "2000-2001 DHS", "2006 DHS", and "2011 DHS" are the estimates from the 1988-1989, 1995, 2000-2001, 2006 DHS, and 2011 Demographic and Health Surveys, the series "1959 Census", "1969 Census", "1991 Census", and "2002 Census" are the estimates from 1959, 1969, 1991, and 2002 censuses, and the estimate "1959 Census Report" are the estimates published in the 1959 census report. The suffix "D-RB" refers to the direct estimates based on recent births, the suffix "A-RB" to the adjusted estimates based on recent births, the suffix "D-BH" refers to the direct estimates based on birth histories, and the suffix "X-BH" refers to the direct estimates based on birth histories obtained by extrapolation from the empirical fertility rates for younger ages.

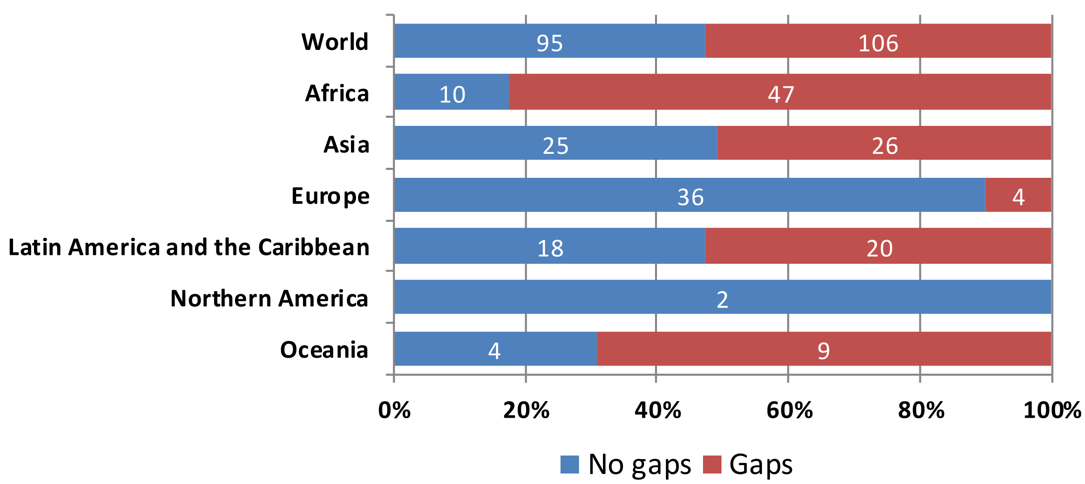
Source: United Nations (2015a) and United Nations (2015c).

B. DATA GAPS

In order to help assess the quality, empirical basis and uncertainty of fertility estimates for all countries in the world, for the first time in 2015, the Population Division collected, organized, documented and published all available empirical fertility data used as inputs for fertility estimation (United Nations, 2015c). This online data set includes plots of these fertility estimates as well as, for illustrative purposes, the latest estimates of fertility levels and trends published in *World Population Prospects: The 2015 Revision*. The plots have been produced for total fertility rates, age-specific fertility rates for age groups 15-19 through 45-49, and for the mean age at childbearing. The data set and the plots of the empirical data facilitate exploration of the empirical basis for fertility estimation, the differences across primary data sources, and the data gaps for each country.

The analysis of the empirical data published in *World Fertility Data 2015* (United Nations, 2015c) reveals significant gaps in fertility data for the period 1950-2015 (I.5). A country is classified as a country with "gaps in fertility data" if there are no empirical data for at least for one decade since 1950 or for the period 2010 and later[7]. At the world level, gaps in fertility data exist in 106 out of 201 countries or areas with population of 90,000 or greater in 2015, or in more than 50 per cent of countries or areas. The largest data gaps are found in Africa, where 47 out of 57 countries (i.e., more than 80 per cent) lack data for at least some portion of the period from 1950 to 2015. In Oceania, data gaps are found in 9 out of 13 countries, or in about 70 per cent of all countries. In Asia and in Latin America and the Caribbean, data gaps are comparable to the world level: about half of the countries in each of these regions suffer from data gaps. The situation is much better in Europe, where only four countries, or about 10 per cent, lack adequate coverage by fertility data. In Northern America, both Canada and the United States have fertility statistics for the full-time period.

Figure I.5 Distribution of countries by significant gaps in fertility data

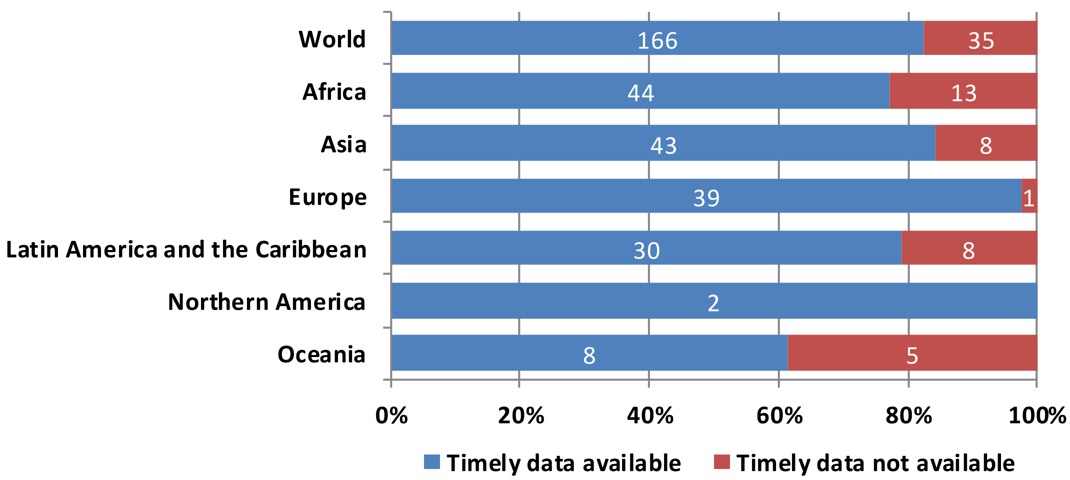


NOTE: Based on tabulations from United Nations (2015c). A country is classified as a country with "gaps in fertility data" if there are no empirical data for at least for one decade since 1950 or for the period 2010 and later (see footnote 7).

[7] Computations are based on the 2015 World Fertility Data (United Nations, 2015c). Outliers and unadjusted empirical estimates of total fertility rates have been excluded. Data on coverage of birth registration systems are provided by the member states of the United Nations to the Statistics Division /DESA of the United Nations and published online at http://unstats.un.org/unsd/demographic/CRVS/CR_coverage.htm (the webpage was accessed in May 2016).

The timeliness of data for monitoring fertility levels and trends has greatly improved over the past few decades. A country is classified as a country with “timely data available” if the latest empirical data point is available for the period 2010 or later[7]. At the world level, only 33 countries (17 per cent) have no fertility estimates since 2010, although the geographic distribution of these countries in unequal. There is a lack of recent fertility data for about 40 per cent of the countries in Oceania, 23 per cent in Africa and 21 per cent in Latin America and the Caribbean. In Asia, about 16 per cent of all countries lack timely fertility data, while in Europe and Northern America the problem of timeliness is virtually non-existent, with fertility statistics typically available with a delay of only one or two years.

Figure I.6 Distribution of countries by timeliness of fertility data



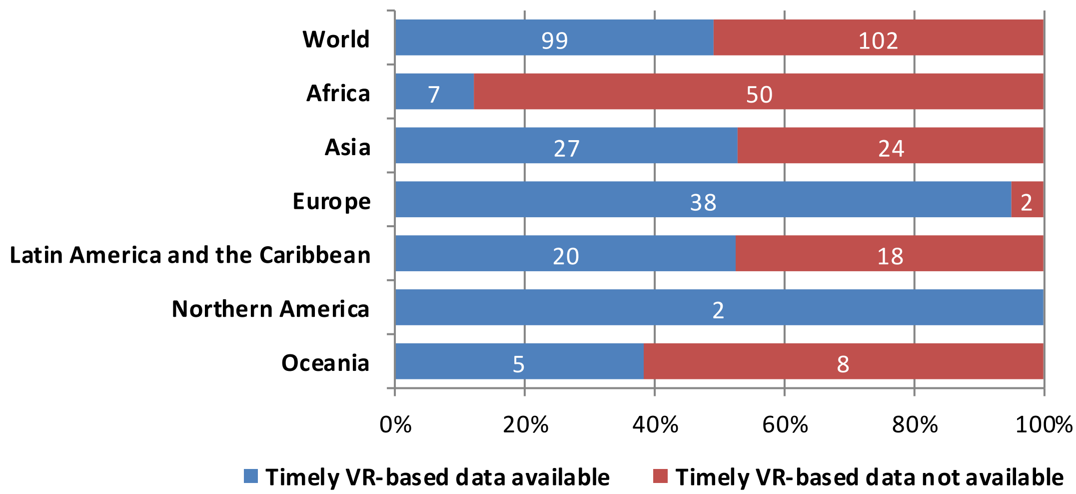
Source: Based on tabulations from United Nations (2015c).

NOTE: A country is classified as a country with “timely data available” if the latest empirical data point is available for the period 2010 or later.

Ensuring complete coverage of birth registration is one of the targets of the 2030 Agenda for Sustainable Development: “By 2030, provide legal identity for all, including birth registration” (target 16.9)[8] . Most of the recent fertility data, however, are not produced by complete civil registration and vital statistics systems. As discussed earlier, most of the data available is from either (infrequently conducted) population censuses or from sample household surveys. While figure I.6 showed that only 35 countries lacked timely data from any source, a more stark contrast is observed in figure I.7, which presents estimates of the timeliness of fertility data that are based on birth registration with high coverage. A country is classified as a country with “timely VR-based data available” if the latest empirical point is available for the period 2010 or later and the coverage of birth registration is at least 90 per cent7. As illustrated by this figure, more than half of the countries or areas in the world lack recent fertility estimates that are based on complete VR data. Asia and Latin America and the Caribbean show an extent of timeliness of VR-based data close to the global level. In Africa and Oceania, however, the situation is considerably worse: for 88 per cent of the countries or territories in Africa and 62 per cent in Oceania, there are no timely VR-based fertility estimates. The opposite is observed in Europe and Northern America: less than 5 per cent of the countries in these regions lack timely VR-based fertility data.

[8] https://sustainabledevelopment.un.org/sdg16

Figure I.7 Distribution of countries by timeliness of fertility data based on vital registration.



Source: Based on tabulations from United Nations (2015c).

NOTE: A country is classified as a country with "timely VR-based data available" if the latest empirical data point is available for the period 2010 or later and the coverage of birth registration is at least 90 per cent.

The analysis in this chapter of available data sources on fertility, the availability of empirical fertility estimates and timeliness of fertility data indicates that achieving Target 16.9 of the 2030 Agenda for Sustainable Development, "By 2030, provide legal identity for all, including birth registration", will be challenging. Special efforts will need to be directed towards strengthening civil registration and vital statistics, and to developing the capacity of national institutions to generate and disseminate timely and reliable demographic data on fertility and births. In addition to highlighting the need for legal identity for all in a stand-along indicator, the development agenda also stresses the need for necessary statistical capacity building as critical to achieve the Goals outlined in the 2030 Development Agenda as part of Sustainable Development Goal 17, target 17.19: "By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries"[9].

[9] https://sustainabledevelopment.un.org/sdg16

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II. FERTILITY ESTIMATES (1950-2015)

A. TOTAL FERTILITY

The world has experienced significant fertility declines over the past six decades. Total fertility fell from an average of almost five live births per woman in 1950-1955 to 2.5 births per woman in 2010-2015 (table II.1). The level of total fertility for a given period reflects the average number of children women would bear if current fertility rates remained unchanged during their reproductive lifespans (15-49 years of age). Africa remained the region with the highest fertility (4.7 births per woman in 2010-2015) with particularly high levels in sub-Saharan Africa (5.1 births per woman in 2010-2015). Fertility was also high (4.3 births per woman) for the group of countries designated by the United Nations as the least developed countries (LDCs)[1]. Both Asia and Latin America and the Caribbean had fertility levels of 2.2 births per woman, closely followed by Oceania with 2.4 births per woman in 2010-2015. In Northern America and Europe, fertility is now below the threshold required for replacement of the population over time[2] (that is, total fertility below about 2.1 births per woman for low-mortality countries). Fertility is lowest in Europe (1.6 births per woman) and somewhat higher in Northern America (1.9 births per woman).

TABLE II.1. TOTAL FERTILITY FOR THE WORLD, DEVELOPMENT GROUPS AND REGIONS, SELECTED TIME PERIODS

	Total fertility (average number of births per woman)			
Development group or region	*1950-1955*	*1970-1975*	*1990-1995*	*2010-2015*
World	5.0	4.5	3.0	2.5
Least developed countries	6.6	6.7	5.8	4.3
Africa	6.6	6.7	5.7	4.7
Sub-Saharan Africa	6.6	6.8	6.2	5.1
Asia	5.8	5.1	3.0	2.2
Europe	2.7	2.2	1.6	1.6
Latin America and the Caribbean	5.9	5.0	3.0	2.2
Northern America	3.4	2.0	2.0	1.9
Oceania	3.8	3.2	2.5	2.4

Source: United Nations (2015a).

1. FROM THE 1950S TO THE 1970S, THE WORLD EXPERIENCED MODEST DECLINES IN FERTILITY

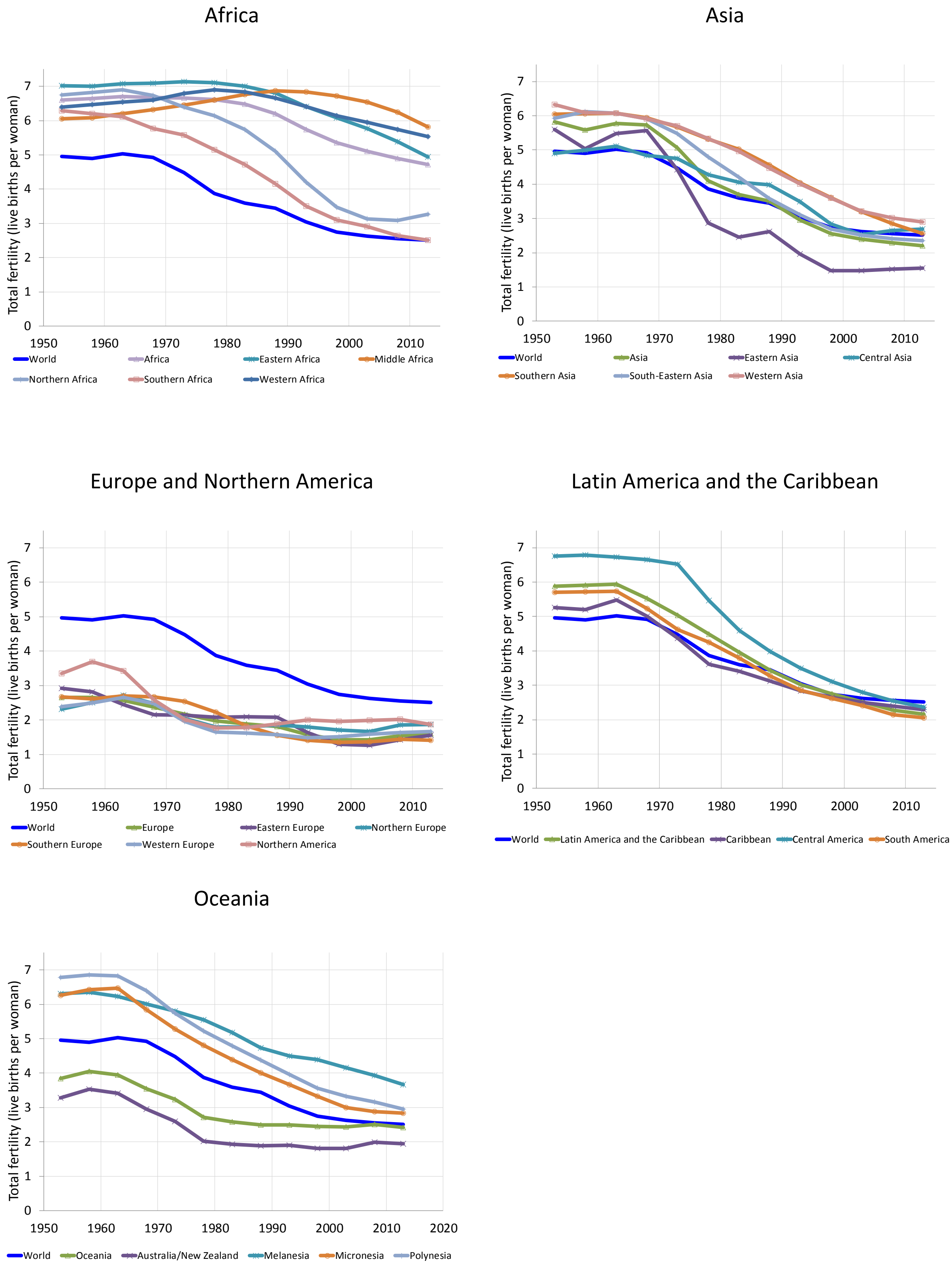
The timing and pace of fertility decline have varied considerably both across regions and across sub-regions (figure II.1). Between 1950-1955 and 1970-1975, the world's level of total fertility declined by just under half a child from 5.0 births per woman to 4.5 births per woman. Declining fertility characterized most regions and countries in the world outside Africa over this period. In some cases, this decline was substantial and rapid. In Northern America, Eastern Asia, South America and Polynesia, fertility declined

[1] The group of least developed countries, as defined by the United Nations General Assembly in its resolutions (most recently, 68/18) included 48 countries in 2015: 34 in Africa, 9 in Asia, 4 in Oceania and one in Latin America and the Caribbean.

[2] Replacement fertility represents the level at which each generation just replaces the previous one, thus leading to zero population growth for given level of mortality and absence of migration, or to the net reproduction rate equal one. Replacement fertility varies with level of mortality, the higher is mortality the higher is replacement fertility. For low-mortality populations, replacement fertility is just above two births per women, often approximated by a level of 2.1 births per woman. Below-replacement fertility results eventually in the negative population growth and extinction of population in a long term.

by more than one child per woman, more than double the world's average decline over this period. In some sub-regions, such as Central America, Central Asia, and Southern Europe, fertility declines were small, less than 0.25 births per woman. Many countries in Europe and Northern America that had experienced a post-war "baby-boom" during the 1950s and 1960s, saw their fertility fall by 1970-1975. The number of countries with below-replacement fertility increased from four in 1950-1955 to thirteen in 1970-1975. All of those countries were in Europe and Northern America, with the exception of Macao SAR (China). More than two-thirds of all countries in the world in 1970-1975 still had fertility over four births per woman. In contrast to the declines experienced in most countries all over the world in the years between 1950-1955 and 1970-1975, fertility increased in Eastern, Middle and Western Africa, regions that historically had relatively high levels of primary sterility (Larsen, 1994). One of the main factors behind the increase was the successful treatment of sexually transmitted infections, a major cause of infertility in this region in the past (United Nations, 1963; Romaniuk, 1980). Altogether, there were 67 countries where fertility increased between 1950-1955 and 1970-1975, and in two countries—Gabon and Mongolia—fertility increased by more than 30 per cent during this period.

Figure II.1. Total fertility for the world, regions and sub-regions, 1950-2015



Source: United Nations (2015a).

2. The pace of global fertility decline accelerated in the 1970s

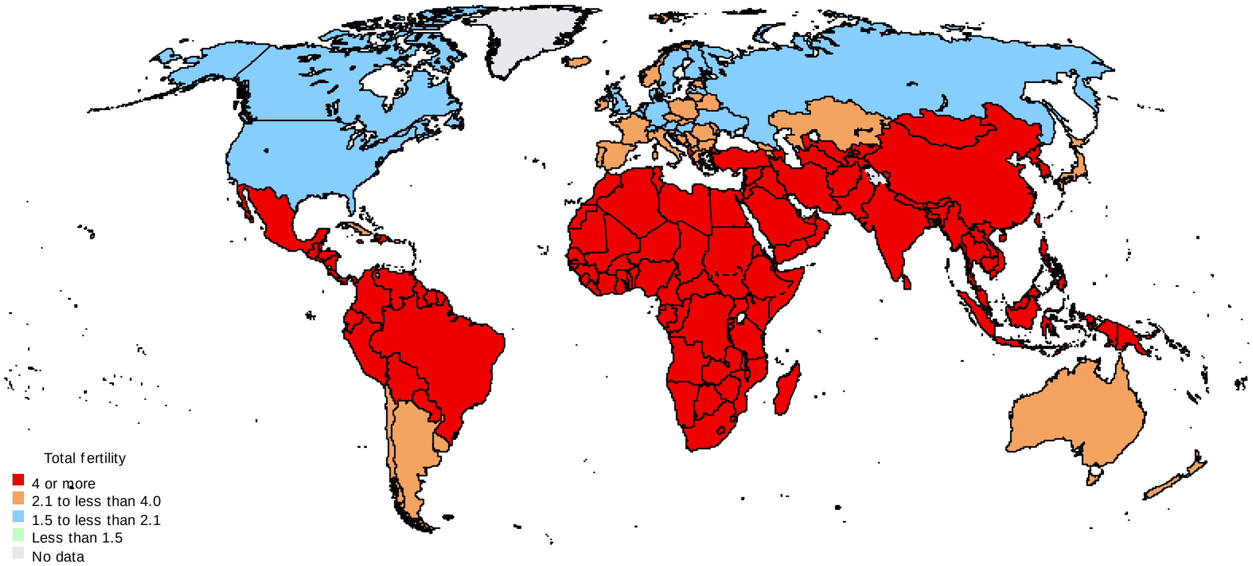
Fertility decline gained momentum starting in the 1970s (figure II.1). Unlike the earlier reductions in fertility, this decline was universal, including every region and sub-region. At the world level, total fertility fell from an average of 4.5 births per woman in 1970-1975 to 2.5 births per woman in 2010-2015—a decline of 2.0 births per woman. Most of this change, more than eighty per cent, is attributable to the dramatic fertility reductions that took place in Asia. Another fifteen per cent of this change is due to fertility decline in Latin America and the Caribbean, and the rest, about five per cent, due to decline in Africa, Europe, Northern America and Oceania.Fertility in Asia declined from 5.1 births per woman in 1970-1975 to 2.2 in 2010-2015, led by the reductions in Eastern, South-Eastern and Southern Asia—in these regions total fertility dropped on average by 3.0 births per woman. An equally pronounced decline took place in Latin America and the Caribbean where fertility declined from 5.0 in 1970-1975 to 2.2 births per woman in 2010-2015. Central America experienced a rather rapid decline, with a reduction of 4.1 births per woman, from 6.5 to 2.4 births per woman. In the case of Africa, fertility fell from 6.7 to 4.7 births per women, with the largest declines, 3.1 births per women on average, observed in the Northern and Southern regions. Western and Eastern Africa saw significantly smaller declines: 2.2 and 1.3 births per woman, respectively. In Middle Africa, the decline was only slightly more than half a child. Middle Africa stands out as the sub-region with the highest fertility in 2010-2015, at 5.8 births per woman. Large reductions in fertility were observed in high-fertility regions in Oceania—Melanesia, Micronesia, Polynesia—where total fertility fell on average by 2.4 births per woman, from 5.6 to 3.2 births per women. Given that in Australia and New Zealand total fertility was already low and approaching replacement levels in the 1970s, the experienced decline was relatively small, only 0.7 births per woman. Similarly, in Europe and North America, total fertility had already dropped to replacement level by 1970-1975 and further declines between 1970-1975 and 2010-2015 were small compared to other regions in the world.

3. The slower pace of fertility decline for sub-Saharan Africa is reflected in the trends for individual countries

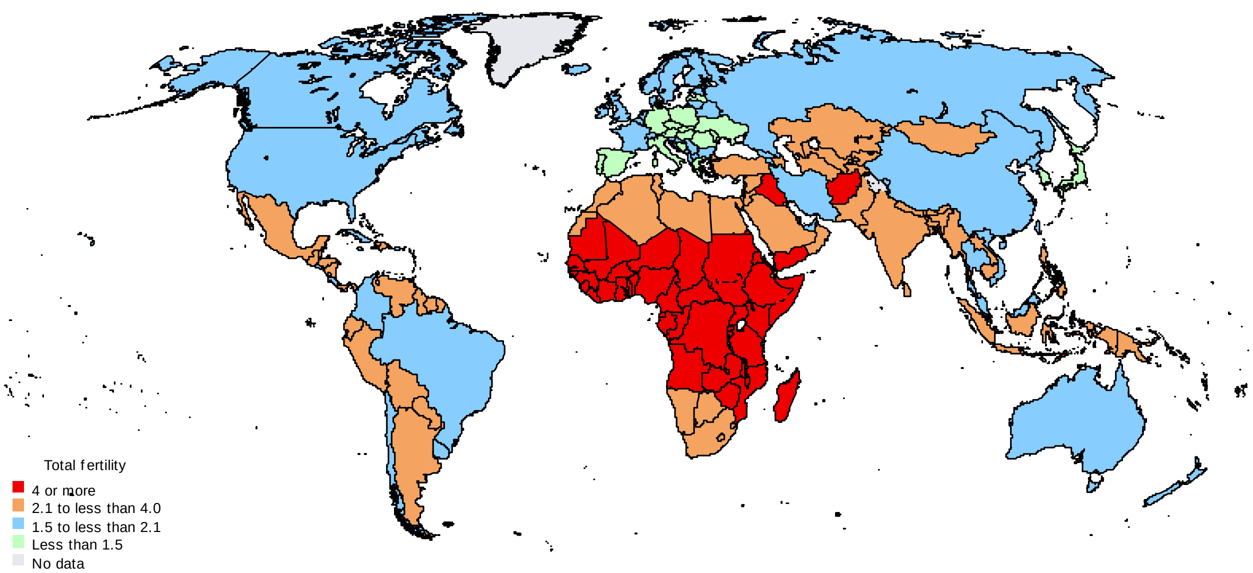
The following map (figure II.2) represents the total fertility for individual countries or areas for 1970-1975 and 2010-2015. As can be seen, in 1970-1975, Africa, Asia, Latin America and the Caribbean, and Oceania (except for Australia and New Zealand) had high fertility levels, more than 4 births per woman. In Europe and Northern America, fertility is low: close to or below replacement level. By 2010-2015, due to global fertility decline, high fertility remains concentrated in sub-Saharan Africa (except for Southern Africa with notably lower fertility), and in select countries of Asia.

Figure II.2 Total fertility, 1970-1975 and 2010-2015

Period 1970-1975



Period 2010-2015



Map data source: UNGIS.

NOTE: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

The change in total fertility for countries between these two periods is summarized in figure II.3. The net change in fertility between these two periods was negative in 197 of the 201 countries or areas, indicated by the data points below the diagonal line (countries would fall along the diagonal if fertility in 2010-2015 were equal to that in 1970-1975)[3]. In 1970-1975, total fertility levels were at a median of 5.5 births per woman. In other words, half the countries in the world had total fertility below this level and half of countries were above this level. By 2010-2015, the median fertility felt to 2.3, a decline of 3.2 births per woman[4]. Countries where changes in total fertility, both initial level and magnitude of decline, were close to the changes in the median fertility are located mostly in Asia and in Latin America and the Caribbean. In figure II.3, such countries are located close to the large green square showing the change of the world's median fertility level. Examples of countries with magnitudes of changes similar to the median include Dominican Republic, Myanmar, Paraguay, and Turkey. Only four countries experienced net increases in total fertility over this period: among high-fertility countries, fertility increased in Niger and Timor-Leste, and among low-fertility countries it increased in Finland and Sweden.

Fertility declined at a more rapid pace than the median decline in about one quarter of all countries. Out of the 51 countries with accelerated fertility decline, 26 were in Asia, 13 in Africa, 10 in Latin America and the Caribbean, and 2 in Oceania. Exceptionally rapid declines occurred in Libya, Maldives, Mongolia, and Kuwait, where total fertility fell by more than 4.8 births per woman. Among the countries that reached below-replacement levels in 2010-2015, total fertility had declined particularly fast in Iran, Qatar, Viet Nam, and the United Arab Emirates, countries that had fertility levels of above six births per woman in 1970-1975.

Out of the countries with fertility above the median in the 1970s, 52 countries experienced slower fertility declines than the median fertility decline of 3.2 births per woman[5]. A majority (37) of these countries were in in sub-Saharan Africa, and most of them belonged to the group of least developed countries. Among the remaining countries, 2 countries were in Northern Africa, 6 in Asia, 3 in Latin America and the Caribbean, and 4 in Oceania.

The examination of country trends reveals that the fertility decline for the African region as a whole, about 2.0 births per woman between 1970-1975 to 2010-2015, conceals widely varying trends among African countries. About 50 per cent of the fertility decline in the region is attributed to the declines in total fertility in Northern Africa (e.g., Egypt, Algeria, Morocco), another 30 per cent is due to fertility reductions in Eastern Africa (e.g., Ethiopia, Kenya), another 15 per cent due to fertility reductions in Southern Africa. The decline in Southern Africa is attributed largely to a single country, South Africa. In Western and Middle Africa, fertility changes were marginal, and fertility remained high overall.

The aggregate fertility decline for sub-Saharan Africa over the same period was 1.7 births per woman, and was due, by and large, to declines that took place in Eastern Africa (accounting for 50 per cent of the total change in sub-Saharan Africa), and Southern Africa (25 per cent of the total change). South Africa, Ethiopia, Kenya, and the United Republic of Tanzania together accounted for more than 50 per cent of the decline in sub-Saharan Africa between 1970-1975 and 2010-2015[6].

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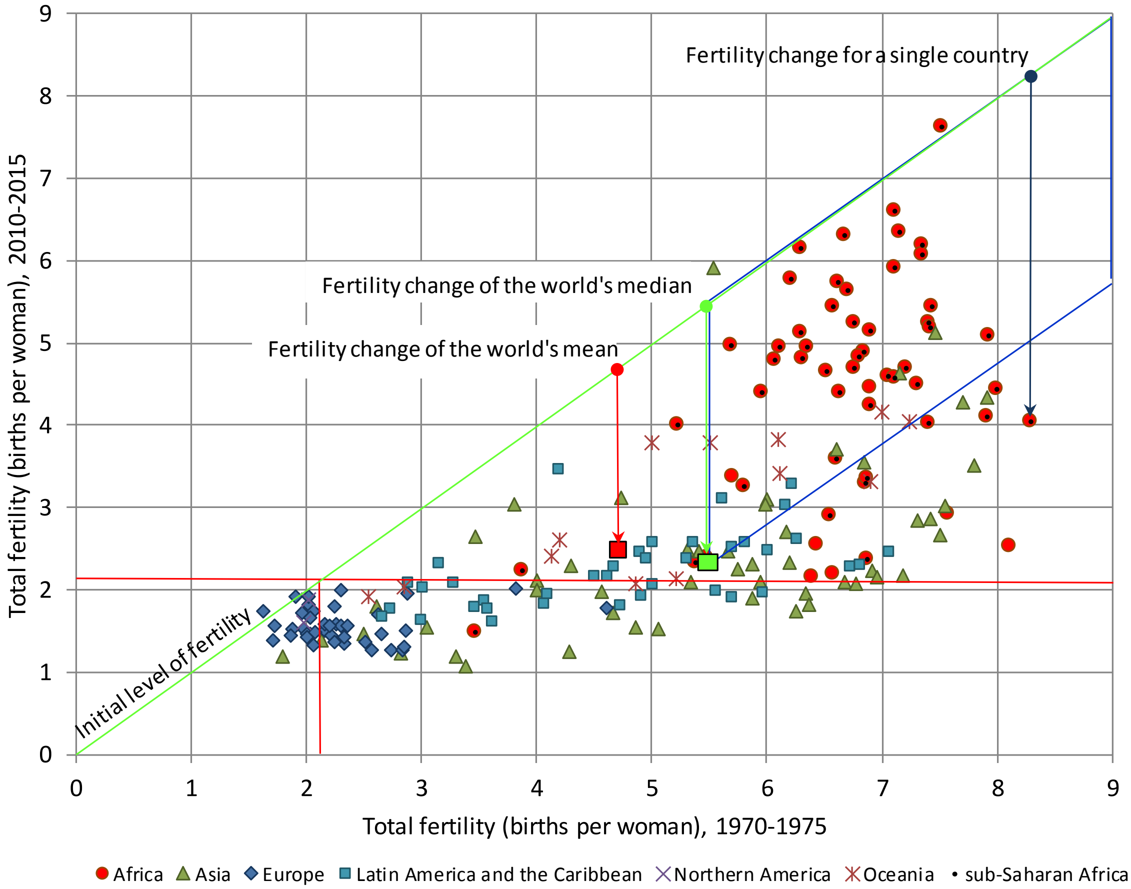
[3] Comparing total fertility at two points in time masks the heterogeneity of fertility trends among individual countries. For many countries fertility trends were far from uniform. Fertility trends for individual countries can be explored in annex figure 3.
[4] See the large square green marker in figure II.3
[5] These countries are inside the blue parallelogram, figure II.3
[6] The percentage of the decline attributed to a group of countries incorporates both the magnitude of the fertility decline and the total population of the countries.

Continued reductions in fertility led to a growing number of countries that had reached below-replacement levels of fertility in 2010-2015, indicated by their position below the red horizontal line in figure II.3. In the early 1970s, 19 out of 20 countries with below-replacement fertility were in Europe or Northern America, whereas the 83 countries with below-replacement fertility in 2010-2015 comprised all 42 countries of Europe and Northern America, 20 countries in Asia, 17 countries in Latin America and the Caribbean, 3 in Oceania and 1 in Africa[7]. In 25 countries, total fertility fell to extremely low levels, below 1.5 births per woman, in 2010-2015. Seventeen of these 25 countries were in Europe, 7 in Asia and 1 in Africa.

Figure II.3 Total fertility in 1970-1975 and 2010-2015



NOTES: The distance between the diagonal labelled "Initial level of fertility" and location of a particular data point shows the change in total fertility between 1970-1975 and 2010-2015. The fertility change of the world's median (large green square) shows position of the world's median in the period 1970-1975 and 2010-2015: 5.5 and 2.3, respectively. In 1970-1975, half the countries in the world had total fertility below 5.5 and half of countries were above this level. In 2010-2015, due to fertility declines that took place over this period, half the countries in the world had total fertility below 2.3 and half of countries were above this level. The fertility change of the world's mean (large red square) shows position of the world's mean in the period 1970-1975 and 2010-2015: 4.7 and 2.5, respectively. The blue parallelogram in the upper right corner highlights the countries with delayed fertility transitions—with total fertility higher than the median level in 1970-1975 and a decline from 1970-1975 to 2010-2015 slower than the decline in median fertility during that same time period.

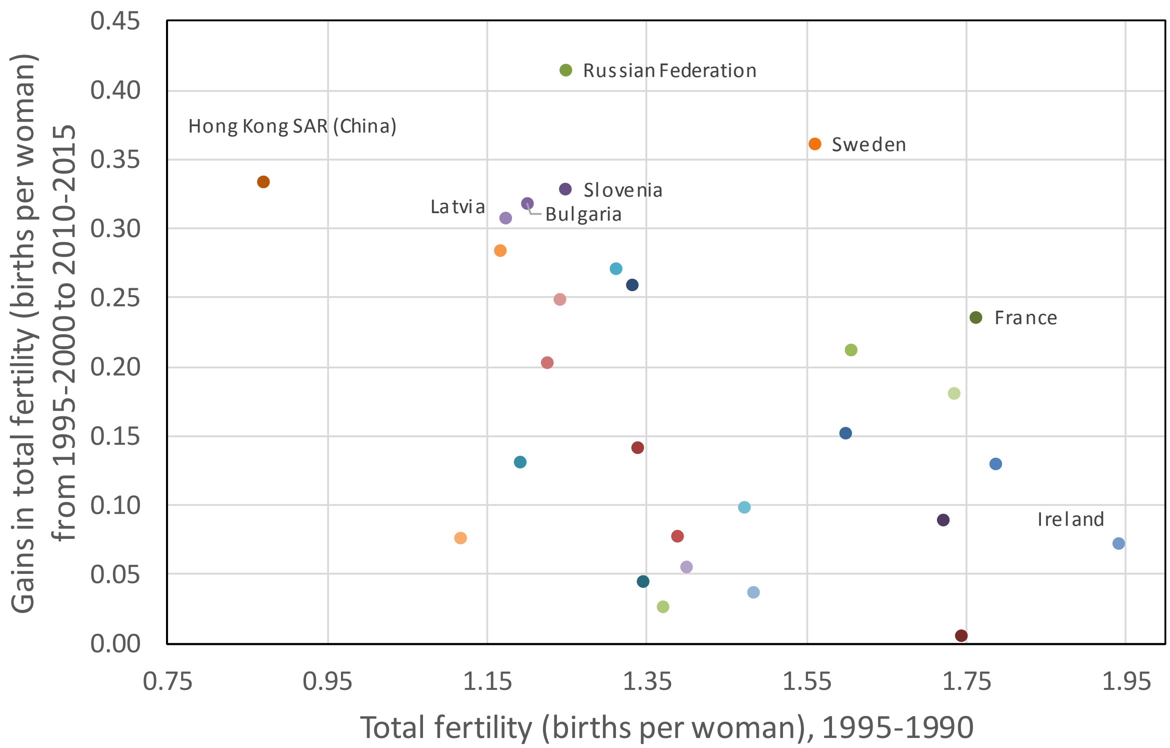
[7] Mauritius

4. FERTILITY REVERSES IN MANY COUNTRIES WITH BELOW-REPLACEMENT FERTILITY

An important trend not captured in figure II.3 is that in recent years, declining fertility trends reversed in many countries with below-replacement fertility. Between 1995-2000 and 2010-2015, total fertility was on average increasing in 28 “below-replacement” countries. The largest gains in this group of countries over the recent period were observed in Russian Federation, Sweden, Hong Kong SAR (China), Slovenia, Bulgaria, and Latvia, all of which experienced increases of total fertility larger than 0.3 births per woman (figure II.4). However, in countries and areas with extremely low fertility, less than 1.5 births per woman, at current paces of fertility recovery, total fertility will not reach replacement level until about 2030 in Russian Federation, 2040 in Bulgaria and Latvia, and 2055 in Hong Kong SAR (China).

Changes in total fertility between 1970-1975 and 2010-2015 for the regions, individual countries and areas can be further explored in annex figure 1.

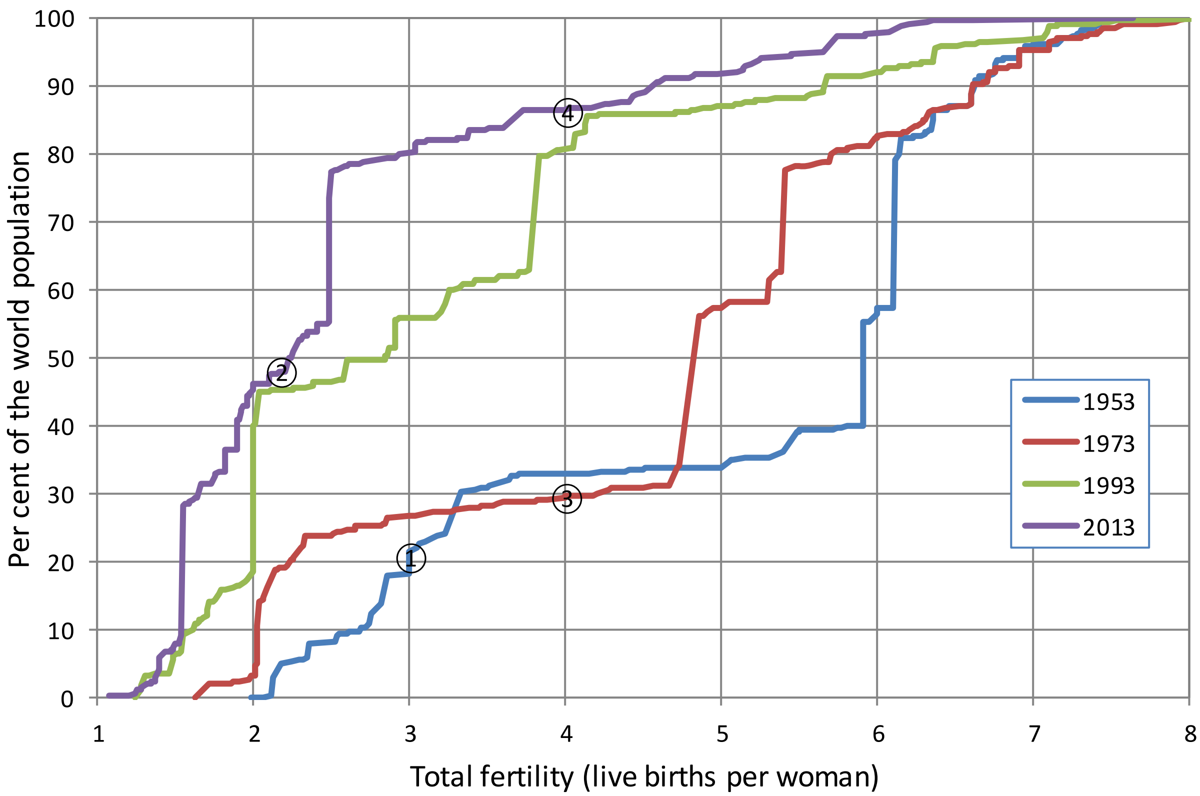
Figure II.4 Gains in total fertility between 1995-2000 and 2010-2015 in countries and areas with below-replacement fertility in 2010-2015



5. THE PROPORTION OF THE WORLD’S POPULATION LIVING IN HIGH-FERTILITY COUNTRIES HAS DIMINISHED

In the early 1950s, only about one in five people worldwide lived in a country with fertility levels below three births per woman (figure II.5, marker ①) and a very small proportion (0.1 per cent) of the world’s population lived in countries with below-replacement fertility. Today, almost half of the world’s population lives in countries with below-replacement fertility (figure II.5, marker ②), a shift that occurred by the early 1990s when China’s total fertility fell below the replacement level. Large families have become much less common than they were in the past. Whereas about 70 per cent of the world’s population until the 1970s lived in countries where women had four or more births on average (figure II.5, marker ③), just 14 per cent of the world's population did so in 2010-2015 (figure II.5, marker ④). The number of countries with very high fertility, more than 5.5 births per woman, dropped remarkably from 1970-1975 to 1990-1995, from 100 to 47, and further declined to 12 in 2010-2015 (table II.2). The 83 countries or areas where fertility was below the replacement level in 2010-2015 accounted for approximately 46.4 per cent of the world's population. By contrast, only 5.4 per cent of the world's population lived in countries with a fertility level at 5.5 or more births per woman in 2010-2015 (table II.2).

Figure II.5. Proportion of the world's population living in countries with total fertility below a specific level, selected time periods



Source: United Nations (2015a).

TABLE II.2. DISTRIBUTION OF COUNTRIES AND AREAS AND OF THE WORLD'S POPULATION ACCORDING TO THE LEVEL OF TOTAL FERTILITY IN 1950-1955, 1970-1975, 1995-2000, AND 2010-2015

	Percentage of the world's population[a]			
Total fertility	*1950-1955*	*1970-1975*	*1990-1995*	*2010-2015*
Greater or equal to 5.5	60.7	21.7	12.0	5.4
Between 4 and less than 5.5	6.5	49.2	7.4	8.1
Between 3 and less 4	11.4	2.4	24.8	6.6
Between 2.1 and less than 3	21.3	10.6	10.8	33.5
Between 1.5 and less than 2.1	0.1	16.1	38.9	38.4
Less than 1.5	0	0	6.1	8.0
Total (all fertility levels)	100	100	100	100

	Number of countries or areas			
Total fertility	*1950-1955*	*1970-1975*	*1990-1995*	*2010-2015*
Greater or equal to 5.5	125	100	47	12
Between 4 and less than 5.5	30	35	37	36
Between 3 and less than 4	18	15	28	22
Between 2.1 and less than 3	24	31	35	48
Between 1.5 and less than 2.1	4	20	43	58
Less than 1.5	0	0	11	25
Total (all fertility levels)	201	201	201	201

[a] The population percentage is given at the midpoint of the respective periods (e.g. January 1st, 1953 for 1950-1955).

Source: United Nations (2015a).

NOTE: Only countries or areas with 90,000 persons or more in 2015 are considered.

B. Adolescent birth rate

Reducing adolescent pregnancies and adolescent birth rates (ABR), measured as the number of births per 1,000 women aged 15-19, is an important priority for many Governments (United Nations, 1994; United Nations, 2013)[8]. The ABR was included in the global indicator framework adopted by the United Nations for monitoring the progress towards achievement of the Sustainable Development Goals[9]. Adolescent childbearing is associated with a wide range of risks for young mothers. Women who become pregnant and give birth very early in their lives as well as their newborns are subject to elevated health risks (Nove and others, 2014; WHO, 2014). Particularly in low- and middle-income countries, the risk of deaths of infants born to teenage mothers is about 50 per cent higher than the risk of death of newborns of mothers aged 20-29 (WHO, 2014).

Maternal deaths and lingering health problems are often caused by unsafe abortions. Young women are particularly vulnerable as they are more likely than older women to undergo late abortions (Lim and others, 2012) and to have repeat abortions (Collier, 2009). It is estimated that globally about three million teenage girls undergo unsafe abortions every year (Shah and Ahman, 2012; WHO, 2012). Apart from health risks for mother and child, adolescent pregnancy curtails opportunities for socio-economic development of young girls, forcing young girls to discontinue or interrupt their education, depriving them of advanced education, secure job opportunities, in many cases leading to lower future earnings, perpetuation of poverty cycles and social and political exclusion (United Nations, 2013). In 2010-2015, the world's ABR was 46 births per 1,000 women aged 15-19 (figure II.6). Africa had the highest ABR (98 per 1,000) among the world's regions, followed by Latin America and the Caribbean with an ABR of 67 births per 1,000 women. At the sub-regional level, the highest ABRs were observed in Middle Africa (133 per 1,000), Western Africa (120 per 1,000) and Eastern Africa (99 per 1,000). Other sub-regions with ABRs above the world's average were Central America (69 per 1,000), South America (66 per 1,000), and the Caribbean (60 per 1,000).

For the purpose of the present analysis, an ABR of 100 or more per 1,000 is considered high adolescent fertility. Twenty-five countries had high adolescent fertility in 2010-2015, all but one of which (Dominican Republic) were in Africa. The African countries with high ABR were evenly distributed between Middle, Western and Eastern Africa. The five countries with the highest ABR in 2010-2015 were Niger (208 per 1,000), Mali (179 per 1,000), Angola (176 per 1,000), Mozambique (154 per 1,000), and Chad (152 per 1,000).

The regional average ABRs for Asia, Oceania, and Northern America stood at about 30 births per 1,000 women aged 15-19. Europe had the lowest ABR (16 per 1,000) among all regions. Eastern Asia, Southern Europe and Western Europe were the sub-regions with particularly low adolescent birth rates in 2010-2015: less than 10 births per 1,000 women aged 15-19, often after substantial declines since 1990-1995. The countries with the lowest ABR were the Democratic People's Republic of Korea (1 per 1,000), Republic of Korea (2), Switzerland (3), Hong Kong SAR (China) (4), and Macao SAR (China) (4).

At the International Conference on Population and Development (ICPD) in 1994, 179 governments agreed to "substantially reduce all adolescent pregnancies". Since then, over the last 20 years, from 1990-1995 to 2010-2015, the world's average ABR declined by nearly 30 per cent, from 65 to 46 per 1,000 women aged 15-19 or by 19 births per 1,000 women (figure II.6). Out of these 19 births per 1,000 women

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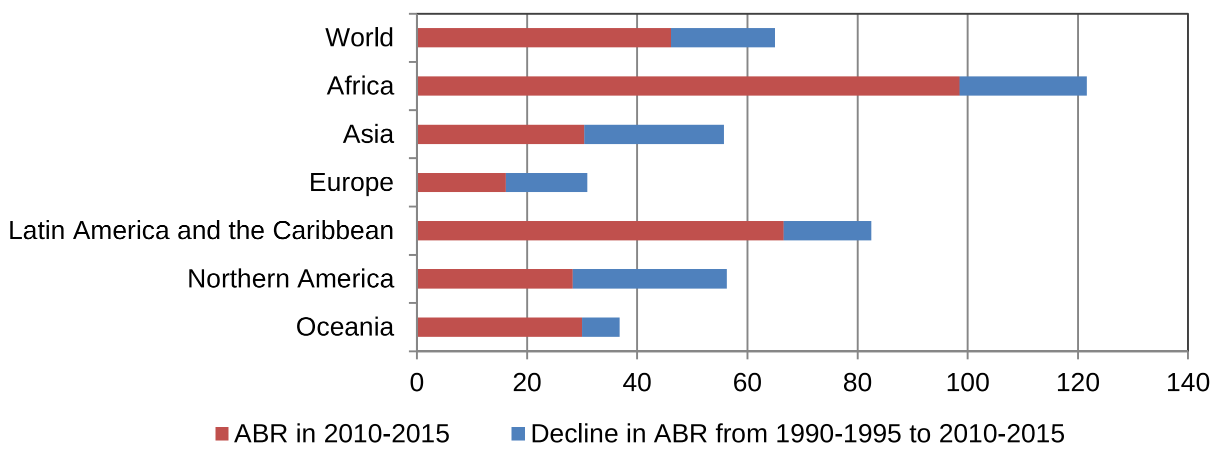
[8] Fertility rates in the age group 10-14 are not discussed in this report due to the current lack of empirical data and estimates.

[9] http://www.un.org/sustainabledevelopment/sustainable-development-goals/

of the global decline in the ABR, eighty-five per cent was attributable to reductions in adolescent fertility in Asia. Another 13 per cent to this decline was contributed by Latin America and the Caribbean and Northern America. Contributions of other regions were comparatively much smaller. Northern America, Europe and Asia had the largest percentage declines in ABR between 1990-1995 and 2010-2015; in these regions, the ABR declined by 50, 48 and 46 per cent, respectively. In Africa, Latin America and the Caribbean, and Oceania the percentage declines were more modest, about 19 per cent in each of these regions.

Figure II.6. Adolescent birth rate for the world and regions in 2010-2015 and decline since 1990-1995



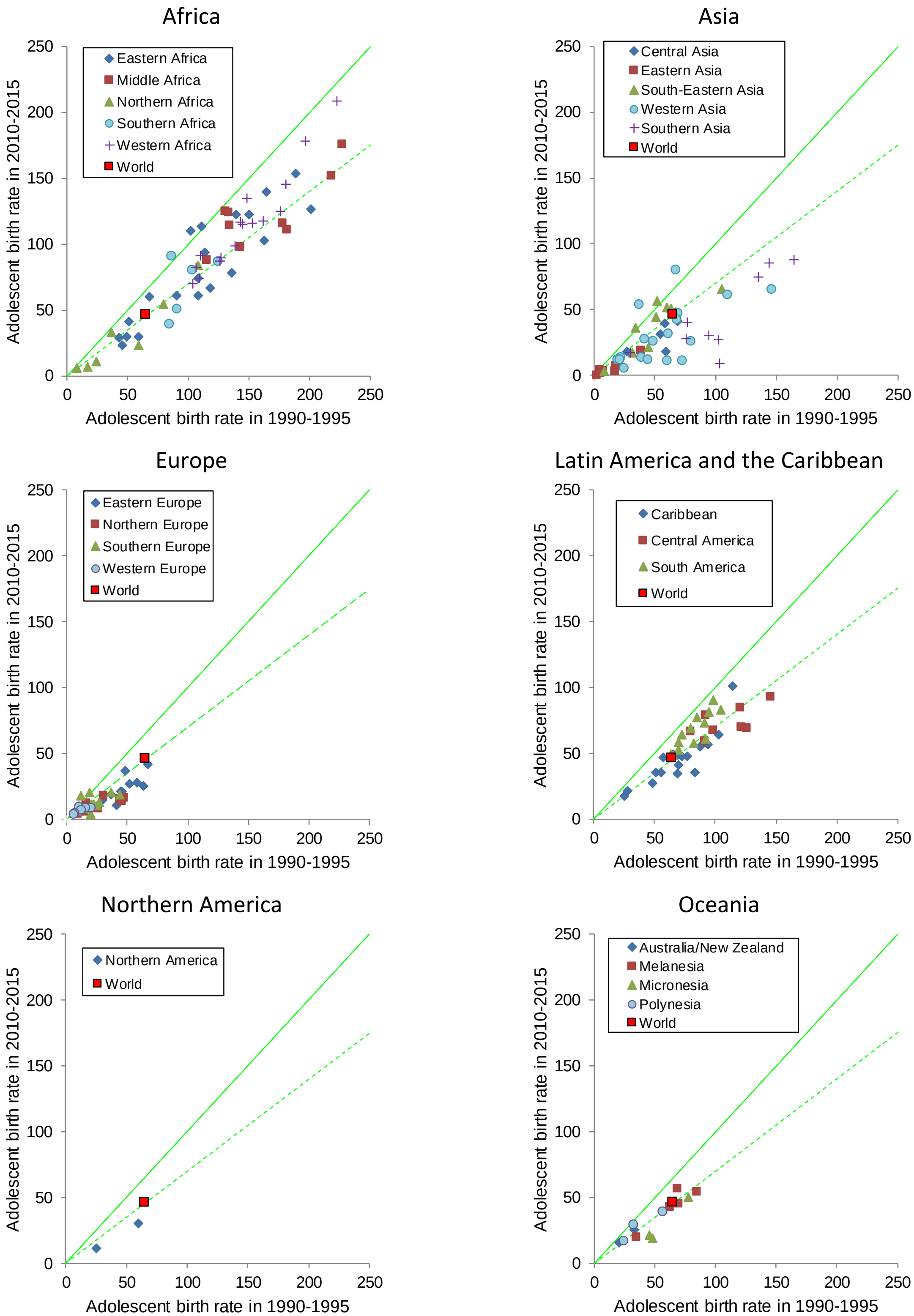
Among individual countries or areas, adolescent fertility fell in all but 10 of the 201 countries or areas (Fig. II.7) between 1990-1995 and 2010-2015. The number of countries with high adolescent birth rates (ABR higher than 100) declined by more than half.

In 1990-1995, the ABR was high in 56 countries: 41 in Africa, 8 in Asia, and 7 in Latin America and the Caribbean. In 2010-2015, only 25 countries, all but one in Africa, were characterised by high adolescent fertility. Although the average ABR remains relatively high in Africa, important progress has been made since the early 1990s. In 2010-2015 the ABR had fallen below 100 per 1,000 in 17 African countries. Rapid declines in ABRs, more than 50 per 1,000, were recorded in 21 countries, 9 of which are in Africa, 9 in Asia, and 3 in Latin America and the Caribbean. Particularly fast declines occurred in Afghanistan, Bhutan, Gabon, Maldives, Uganda, and Yemen—where adolescent fertility fell by more than 70 births per 1,000 over the period considered.

In 79 countries, declines in their respective ABRs over the last 20 years were less rapid but still substantial: less than 50 but more than 20 births per 1,000 women aged 15-19. Out of these 79 countries, 29 were in Africa, 15 in Asia, 12 in Europe and North America, 17 in Latin America and the Caribbean, and 6 in Oceania. In about half of the countries, in 91, ABR declines were moderate, less than 20 per 1,000. The distribution of countries by region in this group is as follows: 16 in Africa, 22 in Asia, 28 in Europe and North America, 18 in Latin America and the Caribbean, and 7 in Oceania.

Among the 10 countries where the ABR *increased* since the ICPD, the largest increases took place in Azerbaijan, from 38 to 54 births per 1,000 women aged 15-19, in Iraq, from 67 to 80 per 1,000, and in Somalia, from 102 to 110 per 1,000. It is important to note that these increases took place notwithstanding that total fertility substantially declined over the same period. In the rest of the countries, increases were less than 8 births per 1,000 women aged 15-19.

Figure II.7: Adolescent birth rate in 1990-1995 and 2010-2015



Source: United Nations (2015a).
NOTE: The solid line is the bisecting (45° angle) line and represents a zero per cent decline in the ABR between the two periods; the dashed line represents a 30 per cent decline.

C. Fertility Transition and Pace of Fertility Decline

1. Current state of fertility transitions worldwide

The demographic transition comprises three stages: (a) a pre-transitional stage, when mortality and fertility are high and population growth is close to zero; (b) a transitional stage, when mortality and fertility are declining, with mortality declines typically preceding fertility declines, resulting in rapid population growth; and (c) a post-transitional stage, with low mortality and fertility, leading to older population age structures. The demographic transition began about two centuries ago with declining mortality in Europe, followed by Northern America and has spread since to all regions of the world. The demographic transitions in Africa, Asia and Latin America started much later and are still underway. The present section will present the basic concepts of fertility transition and provide an in-depth analysis of the timing and trajectories of this transition in various parts of the world. It will further discuss the pace of this transition against the background of the stage of the transition.

The onset of fertility transition is defined as the first year in which fertility started sustained and irreversible decline. Historically, considerable variation in the timing, initial fertility level, level of development and trajectory of the decline taken by the different countries could be observed. While there are differing definitions of when a fertility transition has commenced (Coale and Treadway, 1986; Casterline, 2001; Bongaarts, 2002; Alkema and others, 2011), for the purposes of this report, a fertility transition was considered to have begun when total fertility had declined by 10 per cent from the most recent peak level of total fertility. Fertility transition was assumed to be completed when total fertility reached the replacement level. The analysis of the fertility transition worldwide was carried out using annual interpolated fertility series[10] augmented by historical data whenever possible.

For the purpose of the present analysis, fertility transition was divided into three stages: early-transition, mid-transition, and late-transition. Countries in transition were categorized as (a) early-transition when fertility was above 4.5 births per woman, (b) mid-transition when fertility was between 3.0 and 4.5, and (c) late-transition when fertility was below 3.0 but still above replacement-level. Countries where peak fertility since 1950 was below 4.5 births per woman were assumed to have commenced their fertility transition prior to 1950[11]. Further, countries where fertility had not declined by 10 per cent from the most recent peak level were considered to be pre-transitional. For all countries and areas in the world, annex table 1 provides estimates of the onset and, the completion of fertility transitions as well as estimates of the transition stages reached by countries in 2010-2015[12]. As needed and available, the estimates considered historical events such as famines or baby booms that had a temporary effect on fertility rates but did not necessarily change long-term fertility trends. In some countries, for example, in Bulgaria, Greece, Ireland, Netherlands, Poland, Romania, and the United States, fertility fluctuated around the replacement level for extended periods of time. In such cases, the completion of the fertility transition was set to the year in which fertility reached a plateau.

Most countries in Europe and Northern America had commenced their fertility transitions prior to 1950 (figure II.8). Only a small number of countries in Asia, Latin America and the Caribbean, and Oceania

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[10] Interpolated fertility data are available online at: http://esa.un.org/unpd/wpp/DVD/Files/1_Indicators%20(Standard)/EXCEL_FILES/5_Interpolated/WPP2015_INT_F01_ANNUAL_DEMOGRAPHIC_INDICATORS.XLS

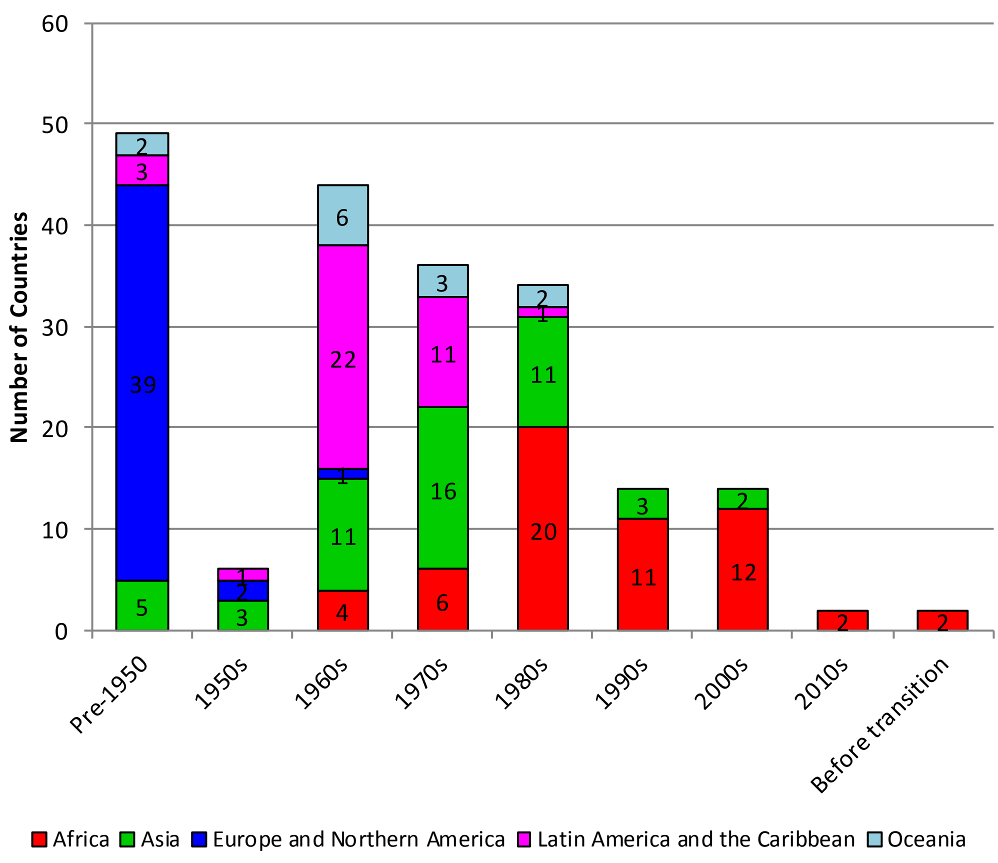
[11] The data prior to 1950 were not generally considered in this report as the historical data were available only for a few countries as published in *World Fertility Data 2015* (United Nations, 2015c)

[12] In addition, onsets and completions of fertility transitions for each country and area are plotted in annex figure 3.

had experienced the onset of their fertility decline that early. In Asia, early fertility declines occurred in Japan, in some successor States of the former USSR (Armenia, Azerbaijan, and Georgia), and in Cyprus; among countries in Latin America and the Caribbean, fertility had started to decline in Argentina, Cuba, and Uruguay and in Oceania, declines had commenced in Australia and New Zealand. In the majority of countries in Asia, in Latin America and the Caribbean, as well as in Oceania fertility transition commenced in the 1960s and 1970s.

The beginning of a fertility transition occurred at a comparatively late stage in countries in Africa. By 1970, only four countries had begun their fertility transitions: Egypt, Mauritius, Réunion and South Africa, and by 1980, another seven countries joined, all but one from Northern Africa. Over next thirty years, from 1980 to 2010, the remaining countries in Asia and Oceania as well as most countries in Africa have entered this transition. By the year 2010, only four countries, the Democratic Republic of the Congo, Gambia, Mali, and Niger—had fertility levels that remained high and stable, with the Democratic Republic of the Congo and Mali showing early signs of fertility decline since then leaving Gambia and Niger the only two countries in the world to be classified as pre-transitional.

Figure II.8 Distribution of countries by onset of the fertility transition

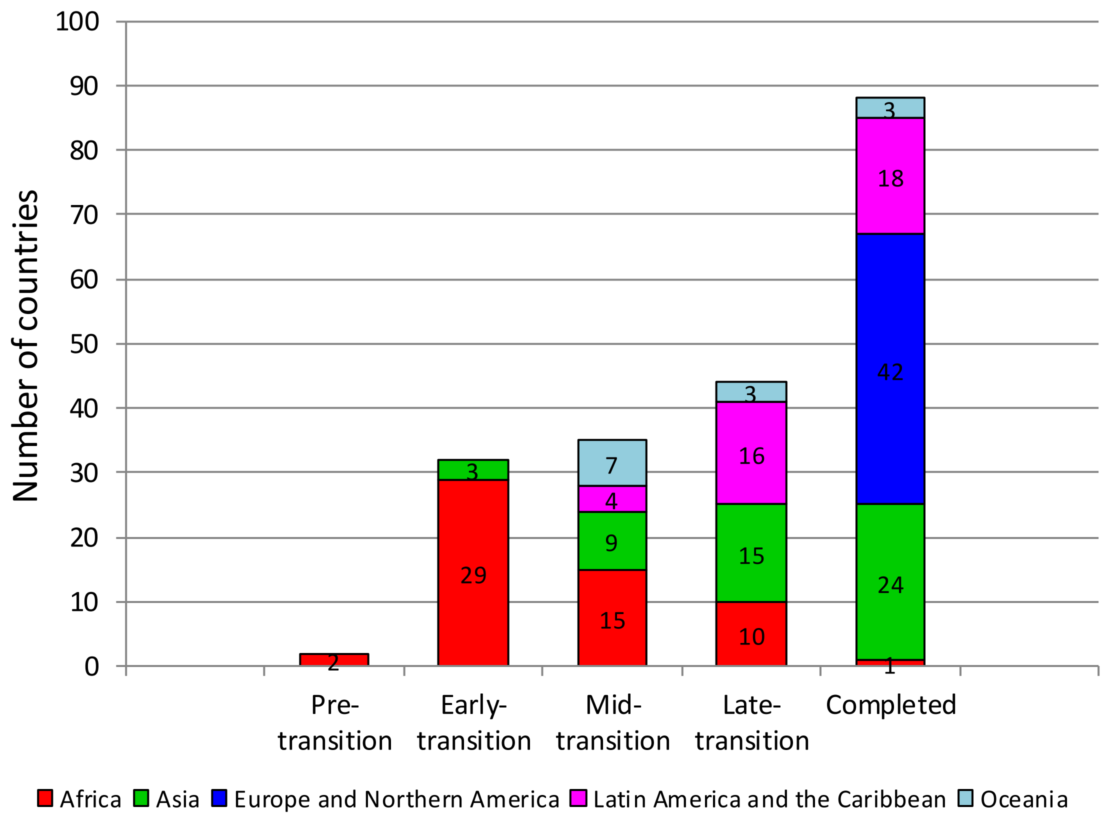


Source: United Nations (2015a).

Figure II.9 shows distribution of countries by the stage of the fertility transition reached by 2010-2015. Out of 201 countries, 88 countries had completed the fertility transition, and another 44 countries were in the last stage of transition. The remaining countries were split evenly, between mid-transition (35 countries) and early- or pre-transition stages (34 countries). The countries that reached below-replacement fertility included all countries in Europe and Northern America (42); 24 countries in Asia, largely from

Eastern Asia; 18 countries in Latin America and the Caribbean; 3 countries in Oceania; and 1 country in Africa (Mauritius). The countries in the late-transition stage were predominantly in in Latin America and the Caribbean (16) and Asia (15). Only 10 countries in Africa, largely from Northern Africa, and 3 countries in Oceania, had reached that stage. The countries in the middle stage of this transition were split between Africa (15 countries), most of them in Eastern Africa, and the rest of the world (9 in Asia, 4 in Latin America and the Caribbean, 7 in Oceania). Pre-transitional and early-transitional countries were located almost entirely in sub-Saharan Africa. Out of the 34 countries still at earlier stages of their fertility transition, 31 countries were in Eastern, Middle and Western Africa and the remaining three countries were in Asia (Afghanistan, Iraq, and Timor-Leste). Africa was the only region where less than one-fifth of the total number of countries had reached the late-transition stage. For other regions, the proportion of countries that had reached either the last stage or even below replacement fertility levels by 2010-2015 amounted to close to half of all countries in Oceania, three-quarters of the countries in Asia, nearly 90 per cent in Latin America and the Caribbean, and all countries in Europe and Northern America.

Figure II.9 Distribution of countries by stage of the fertility transition in the period 2010-2015



NOTES: Countries in transition were categorized as (a) early-transition when fertility was above 4.5 births per woman, (b) mid-transition when fertility was between 3 and 4.5, and (c) late-transition when fertility was below 3 but still above replacement-level. Countries where peak fertility since 1950 was below five births per woman were assumed to have commenced their fertility transition prior to 1950. Further, countries where fertility had not declined by 10 per cent from the most recent peak level were considered to be pre-transitional.

Source: United Nations (2015a).

2. Pace of fertility decline slows down towards the end of the fertility transition

The pace of fertility decline varies by the stage of the transition reached (figure II.10). At earlier stages fertility decline is often much faster than at later stages—many countries at the early-stages of the fertility transition, when fertility is declining to three births per woman, have a pace of fertility decline exceeding one child per decade, averaging 1.2 births per woman per decade at the world's level. Among countries in mid-transition, the pace of fertility decline is generally undoubtedly slower, with the average pace about 0.8 births less per woman per decade. In the late-transition stage, the pace of fertility decline further drops to about 0.3 births per woman per decade.

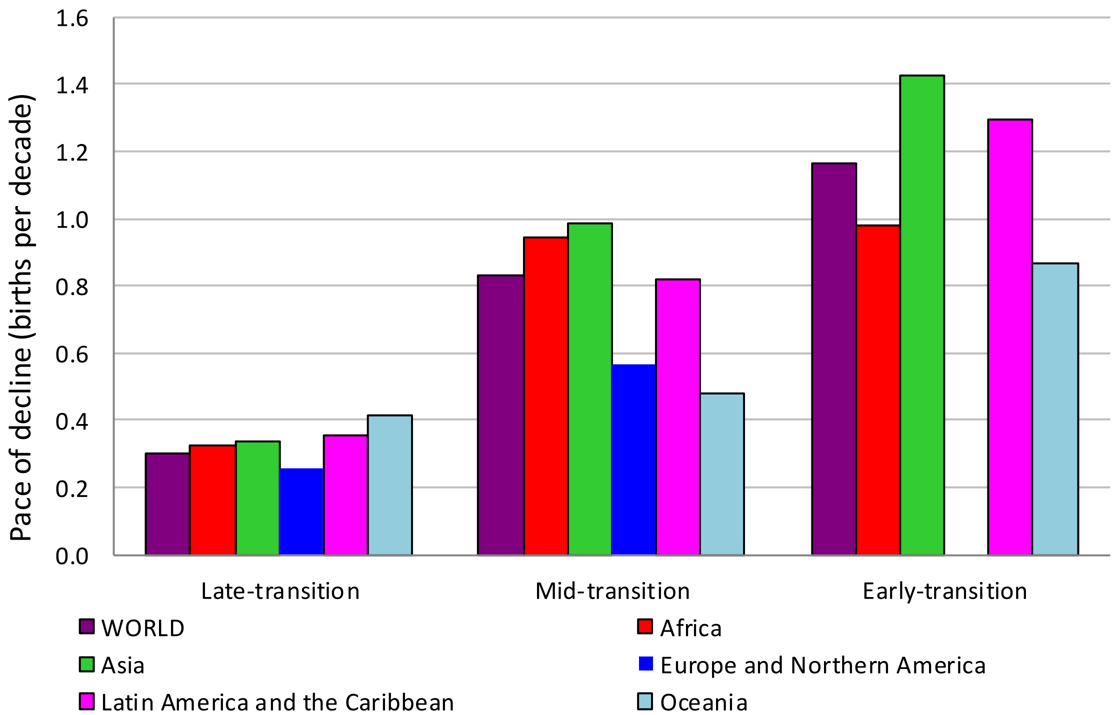
There is considerable variation between regions, countries and areas in the pace of their respective fertility declines. In the early-transition stage the pace of the decline was highest in Asia, more than 1.4 births per woman per decade, followed by Latin America and the Caribbean with 1.3 births per woman per decade. The pace of the decline was lower than the world's average in Africa, where it was estimated to be close to 1.0 births per woman per decade, and the lowest in Oceania, 0.9 births per woman per decade. In sub-Saharan Africa, the pace of this decline was on average 8 per cent lower than in Africa, close to that in Oceania.

In the mid-transition stage, the pace of decline is roughly the same in Asia, Africa, and in Latin America and the Caribbean, about 0.9 births per woman per decade, while it is significantly slower in Europe and Northern America and Oceania, on average 0.5 births per woman per decade. In sub-Saharan Africa, during the mid-transition stage, the pace of decline is slightly above 0.8 births per woman per decade, comparable to that in Latin America and the Caribbean.

In the late stage of transition, there is less variation in the pace of fertility decline with the pace of fertility decline in all regions that have reached the late stage of transition being close to that of the average world's level, 0.3 births per woman per decade. In sub-Saharan Africa the pace of fertility decline is lower than the world's level but still higher than that in Europe and Northern America. The data in figure II.10 provides no visible support that fertility transition in Africa, once it has started, is exceptionally slower than in other parts of the world. Unusually slow fertility declines were found, however, in Oceania, in the countries other than Australia and New Zealand—in this group of countries, the pace of fertility decline in the early- and mid-transition stages was unusually slow as compared with the rest of the world.

For individual countries or areas, estimates of durations of fertility transitions, the timespan between onset and completion of fertility transition, are available for 44 countries (for most European countries fertility transition started before 1950, and for most African countries it is not yet completed). For this group of countries, the median pace of fertility decline was 0.98 births per woman per decade with half of the countries experiencing an average pace of fertility declines between 0.76 and 1.34 births per woman per decade. Extremely fast fertility transitions occurred in Macao SAR (China) at a pace of 2.89 births per woman per decade, in the Islamic Republic of Iran with a pace of 2.59 births per woman per decade, and in Singapore at a pace of 2.33 births per women per decade. At the other end of the spectrum, in countries such as Antigua and Barbuda, and Bahamas, the average pace of their fertility decline was more than four times lower than that of the fast-decline countries, only 0.43 and 0.56, respectively. The median duration of the fertility transition in this group of countries considered was 33 years with 50 per cent of the observed values falling between 22 and 39 years. Very short fertility transitions occurred in Macao SAR (China) (it took only nine years to complete the fertility transition), Antigua and Barbuda (13 years), Barbados (14 years), and Hong Kong SAR (China) (14 years). On the other hand, in countries such as French Polynesia, Turkey and Brunei Darussalam it took nearly 50 years for the transition to complete. Generally, it took longer to complete the fertility transition for the countries starting at a higher level of fertility.

Figure II.10: Pace of fertility decline by stage of fertility transition



NOTES: The estimates of pace of fertility transition are based on estimates of fertility trends for individual countries since 1950, the first year for which fertility estimates are produced by the United Nations Population Division. Regional estimates were computed by averaging estimates for individual countries. For Europe no estimates were produced for the early stage of fertility transition as fertility transition in most European countries started before the year 1950.

Source: United Nations (2015a).

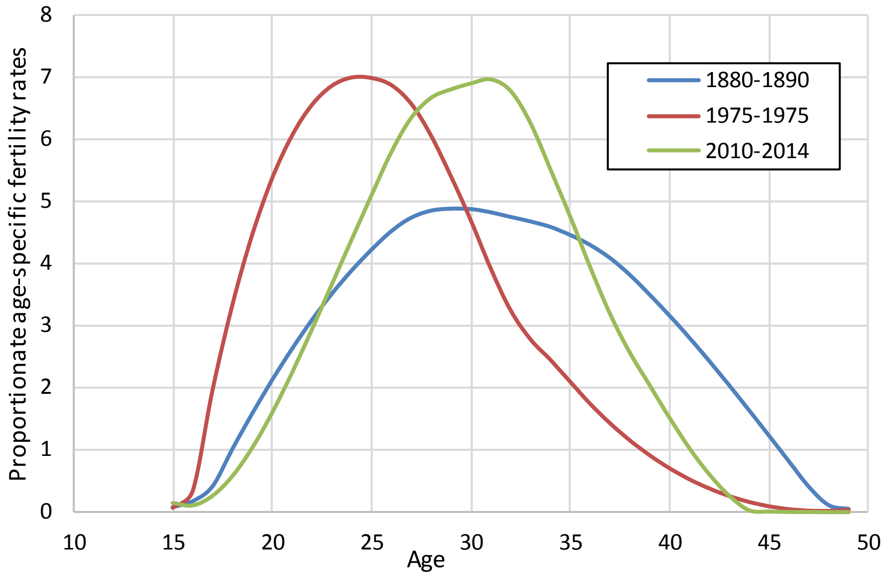
D. THE TIMING OF CHILDBEARING

Along with the transition to lower levels of total fertility, the world has witnessed dramatic changes in the age pattern of childbearing. Before the beginning of the fertility transition, fertility levels in most populations are at or close to their natural levels[13]. The levels of natural fertility differ extensively from one population to another (Malaurie, Tabah and Sutter, 1952; Eaton and Mayer, 1953; Leridon, 1977; Campbell and Wood, 1988) but the age pattern of fertility within marriage is rather uniform (Henry, 1961). Pre-transitional patterns of fertility are characterized by spread-out shapes with a flat top, with a large proportion of children borne by mothers in their thirties or older as illustrated by the example of Finland for the period 1880-1890 in figure II.11. The typical mean age at childbearing[14] (MAC) is generally quite high: close to 30 years or higher. For comparison, patterns of Finnish fertility are also shown for 1970-1970, the period with the lowest MAC, and for the latest period with available data, 2010-2014.

[13] Concept of natural fertility was introduced by Henry (1961) for populations with little or no voluntarily control of fertility with voluntarily control defined as any behaviour affecting fertility that is modified as parity increases.

[14] The mean age at childbearing is the most frequently used summary measure of the age pattern of fertility. It is the average age at which women bear their children subject to age-specific fertility rates prevailing in a given year and assuming that mortality is negligible over their reproductive life span.

Figure II.11 Finnish proportionate age-specific fertility rates in 1880-1890, 1970-1975 and 2010-2014



Historically, during the early stages of the fertility transition, deliberate parity-specific family size limitations within marriage appeared to be the major behavioral mode through which marital fertility was controlled (Knodel, 1987; Prioux, 1990). Because births of high parity take place at older ages, the MAC (and the age at last birth) tends to fall even if there is no change in the timing of births of each order. Indirectly, the limitation of higher parity births is manifested in dramatic declines of birth rates at older ages. While fertility declines at low orders of births are also common during the initial stages of the fertility transition, as are changes in the timing of births of each order, these changes are usually too small to offset declines in the mean age at childbearing (MAC). Towards the end of the fertility transition when total fertility is close to the replacement level, changes in birth rates at higher parities exert much less influence on the MAC, and it becomes influenced mostly by the age at first birth. In many developed countries at the end of the 1960s[15] women, aided by the widespread availability of contraception, started to postpone their first births, space out subsequent ones and, as a result, childbearing began to be progressively shifted to the higher ages. The MAC started to increase again, reaching 30 years of age or higher in many countries (Council of Europe, 1998).

Figure II.12 illustrates the relationship between level and timing of childbearing using the example of historical Finnish data. The fertility transition in Finland occurred between the beginning of the 20th century and the early 1940s, with fertility declining from 4.8 births per woman to the replacement level (red curve) in about 40 years. The MAC (blue curve) over the same period declined from close to 32 years to about 30 years. After a sharp increase during the baby boom of the late 1940s and 1950s, total fertility resumed its decline, dropping by the early 1970s to the lowest levels ever recorded. MAC continued to decline through the early 1970s, interrupted only by the adversities of World War II. Starting in the early 1970s until 2014, total fertility tended to increase but remained well below replacement levels. Meanwhile,

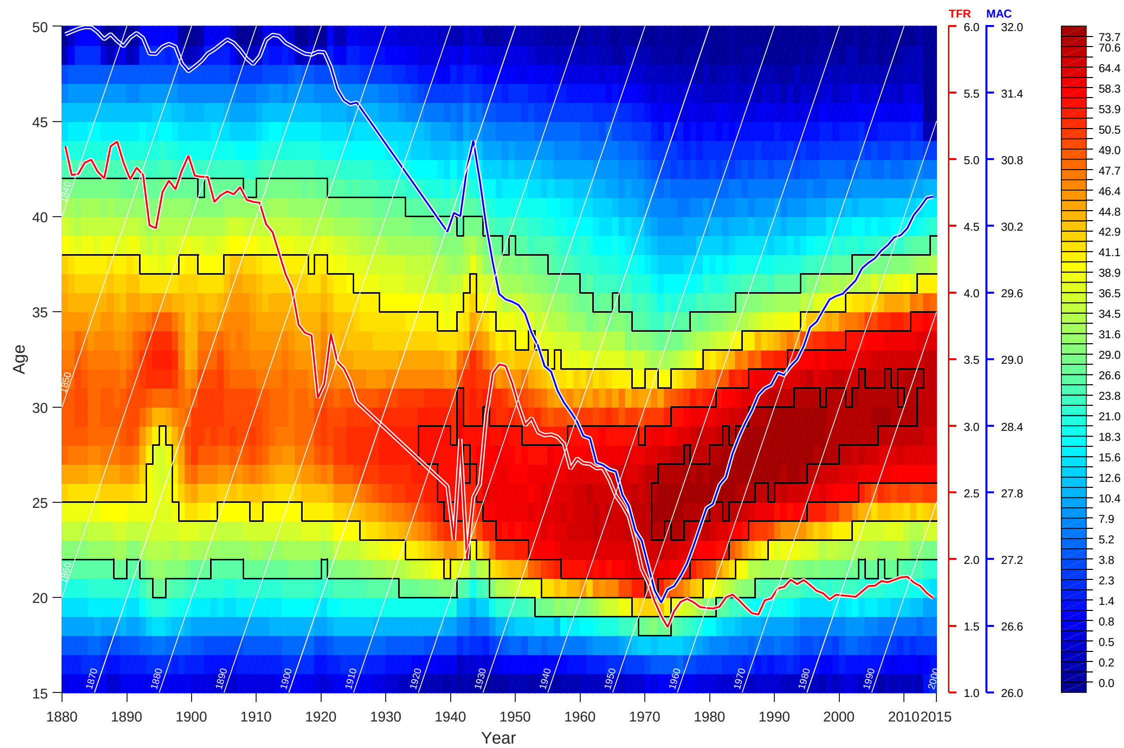
[15] Postponement of births started in Northern Europe and over next decade spread out to Central, Western and finally Southern Europe (Prioux, 1990).

due to the postponement of births, the MAC increased dramatically from about 26.5 years to more than 30 years over the same period of time.

Trends in Finnish total fertility and the MAC are superimposed on a Lexis map of Finnish proportionate age-specific fertility rates (PASFRs) by single year of age from 15 to 49 and single year of time from 1880 to 2014. Each small rectangle on this map refers to the single PASFR for the given year and age. Figure II.12 shows simultaneously 135 fertility distributions: one distribution for each year from 1880 to 2014. In a single year, each distribution includes 35 values of PASFRs (one value for a single age from 15 to 49). The equidistant scale on the right partitions all PASFRs into groups assigning colors depending on their value. For example, all PASFRs that are less than 0.00427 are painted in deep blue (the lowest level of the scale), and those higher than 73.8 are painted in dark brown (the highest rectangle on the scale legend).

The map shows graphically changes in the age pattern of fertility in Finland at all ages simultaneously. Before the fertility transition, there was little change in the age pattern of fertility: no trend is discernable in the fertility contours, and the age range where childbearing was concentrated as depicted by yellow, brown and red hues stretches from age 25 to 38. The steep decline in the fertility contours for both older and younger ages from the beginning of the fertility transition through the early 1970s reflects the disappearance of high-parity births with no changes in the age at first birth (i.e., the proportionate contribution of younger ages became larger). Over this period, the age distribution of fertility was becoming concentrated at and skewed towards younger ages, with fertility concentrated around age 25 as indicated by the emerging dark-brown area on the Lexis map. The marked increase in the contours at younger ages over the last four decades reveals a shift to later childbearing. Birth rates below age 25 dramatically declined and birth rates above age 30 equally markedly increased (there were insignificant changes in fertility rates in the age group 25-29). It appears that over the last decade the earlier shift to later childbearing has somewhat decelerated and the age distribution of fertility is now more spread out than before.

Figure II.12 Finnish trajectories of total fertility, mean age at childbearing, and proportionate age-specific fertility rates, year 1880 to 2014 and age 15 to 49

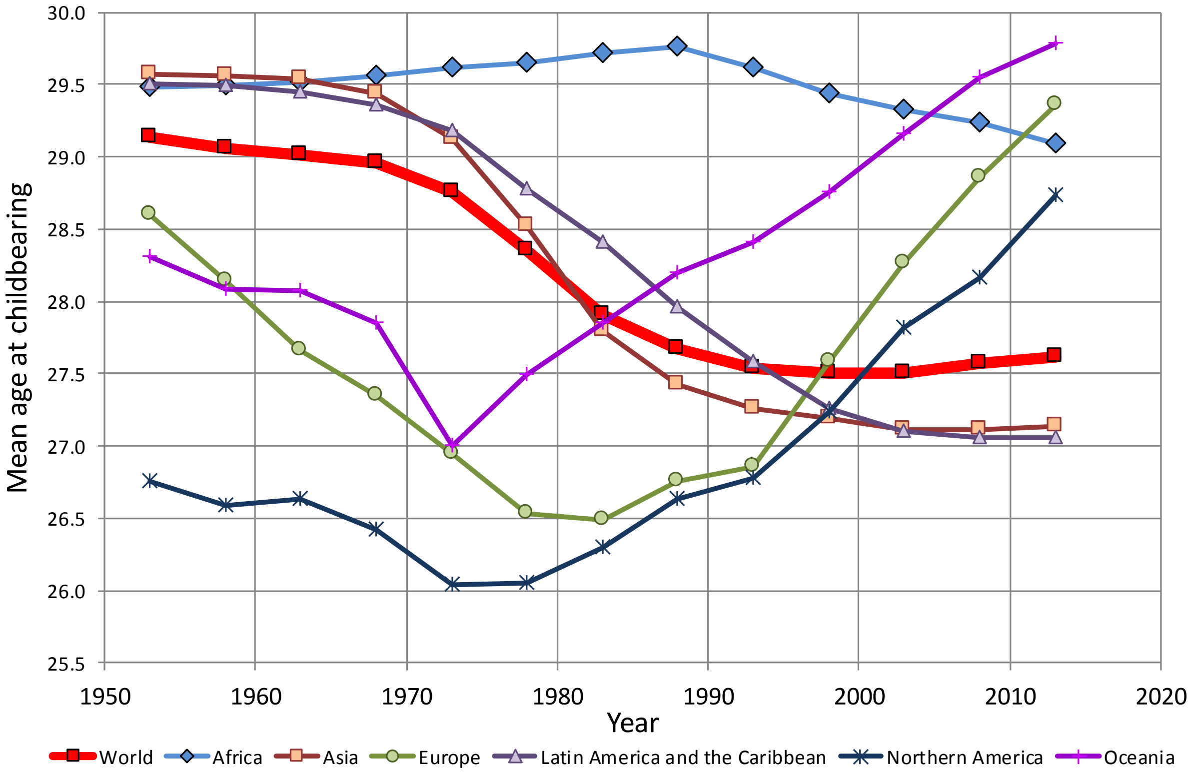


NOTE: Selected contour lines are shown at levels 26.6, 39.9, 53.9, and 70.5 levels of fertility.

Source: United Nations (2015c), originally from Turpeinen (1979) updated with the recent estimates published by Statistics Finland.

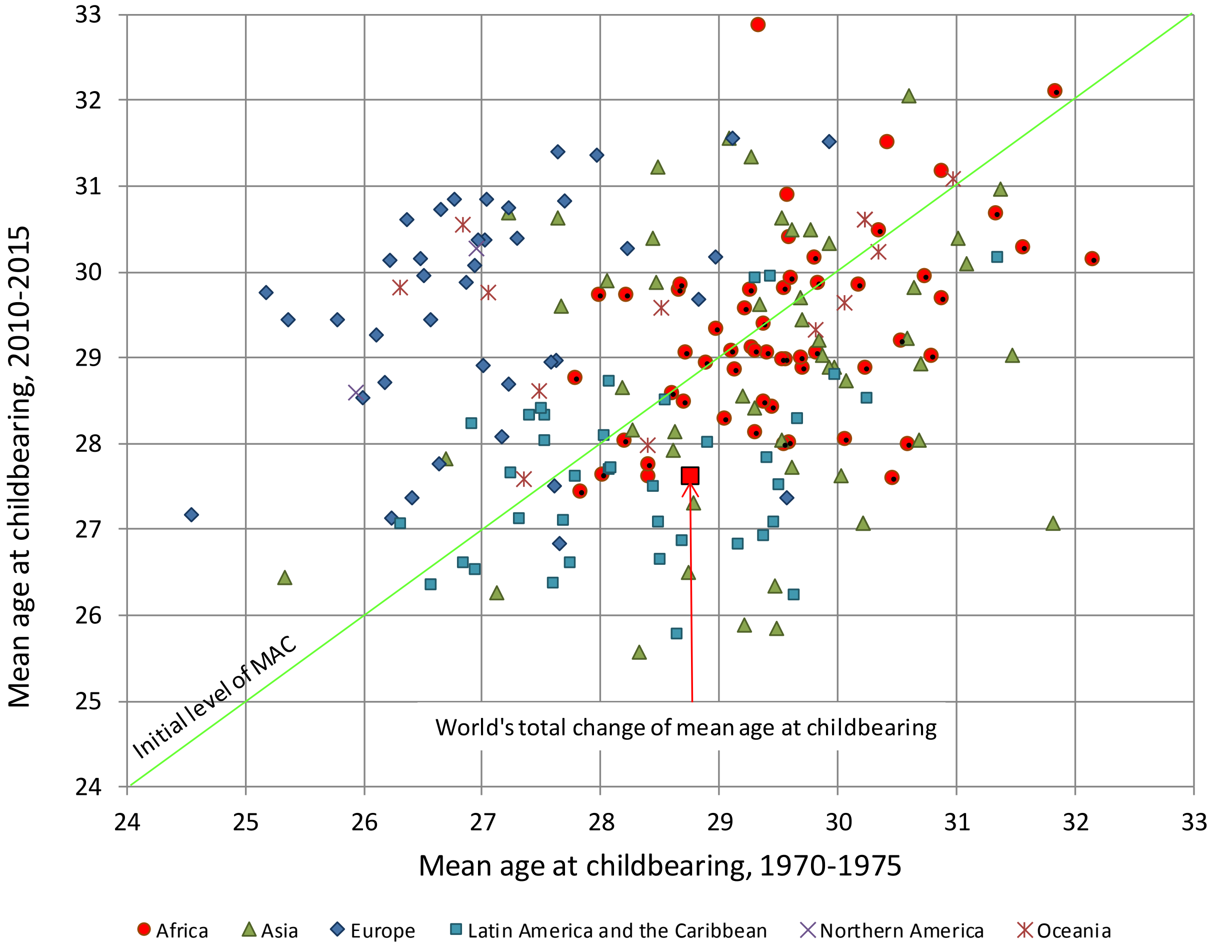
Figure II.13 presents the levels and trends in the MAC globally and for all regions. At the world level, the MAC declined from 29.1 in 1950-1955 to 27.5 in 1990-1995, and remained generally at this level through 2015. In Asia and in Latin America and the Caribbean, trends in the MAC were very similar to the global average. Starting from the early 1970s, the MAC declined very rapidly, especially in Asia. However, by the end of the 1990s the decline had largely decelerated and the average age at birth has stayed at about 27 years of age in both regions ever since. Initially, the MAC in Europe, Northern America, and Oceania declined through the mid-1970s, dropping to the lowest levels recorded, and reversed ever since towards continued and sustained birth postponements. In Europe, for example, the MAC dropped from 28.6 in 1950-1955 to a minimum of 26.5 in 1980-1985, and then increased to 29.4 in 2010-2015. In Oceania, the MAC reached an all-time high with 29.8 years of age in 2010-2015, from a low of 27.0 in the mid-1970s, driven mostly by the steep rise in the average age at birth in Australia and New Zealand. Different from the evolution of the MAC in the rest of the world, the MAC in Africa has been relatively stable over the past 60 years with variations of less than one year only. Many countries in Africa are still at the beginning of the fertility transition and the MAC has remained over 29 years of age albeit gradually declining since the 1990s. The estimates of the MAC pertaining to earlier years, especially to years before 1970, have to be interpreted with caution, given the scarcity and questionable quality of the available data for this region of the world.

Figure II.13: Mean age at childbearing (years), world and regions, 1990-1995 to 2010-2015



Source: United Nations (2015a).

Figure II.14. Mean age at childbearing in 1970-1975 and 2010-2015



NOTES: Distance between the diagonal labelled "Initial level of mean age at childbearing" and location of a particular data point shows the change in MAC between 1970-1975 and 2010-2015. The large red square shows the change of the world's mean age at childbearing.

Figure (II.14) shows the diversity of the changes in the MAC from 1970-1975 to 2010-2015 for individual countries and the world. Due to the postponement of births, the MAC increased over this period in all but one country in Europe and Northern America. This trend began at the end of the 1960s in Northern Europe, during the 1970s in Western Europe, and during the late 1970s and early 1980s in Southern Europe. Among Eastern European countries, the postponement of births started in the late 1980s in countries such as Czechia, Hungary, Poland, and Slovenia, and in the early 1990s, at the time of the dissolution of the USSR, in the other countries of this group. In the countries that started transition to later childbearing earlier in time, the average pace of increase in the MAC was about 1.0 year per decade. In the countries where postponement of births begun later, the increase in the MAC proceeded at an accelerated pace, close to 1.5 years per decade, with the fastest increase registered in Czechia, 2.2 years per decade. In 19 countries of Europe and Northern America MAC was more than 30 years of age in 2010-2015. Albania was the only European country where no increase in the MAC has been observed yet even though total fertility there dropped to the replacement level by the year 2000 with a concomitant decline in the MAC from 31.0 to 27.5 years of age. In Oceania, rapid postponements of births occurred in Australia and New Zealand, where the MAC started to increase in the late 1970s at a pace similar to that of Western and Northern Europe. The

MAC in Australia is now more than 30 years and in New Zealand it is just shy of it. In other countries of Oceania, changes in the timing of births were insignificant.

While most countries of Latin America and the Caribbean have completed their fertility transitions, the dramatic changes in fertility that took place in this region over last four decades did not lead to postponements in childbearing: The MAC declined in 27 out of 37 countries, and increased by more than 0.5 years of age in only 7 countries. Latin America and the Caribbean is the only region where childbearing has become more concentrated at younger ages, and adolescent birth rates remained high.

The rapid downward trend in the MAC in Asia (II.14) conceals significant differences and disparate trends within this region and between countries. In 12 countries, mostly economically better-off countries, the tendency towards postponement of births is now well established. The trend started in the late 1970s in Japan and Singapore, followed a decade later by the Republic of Korea, Hong Kong SAR (China), the Taiwan Province of China, and Cyprus. The increase was particularly rapid in the Republic of Korea where the MAC increased from a minimum of 26.8 years of age in 1985-1990 to 31.3 in 2010-2015, a pace of 1.8 years per decade. In Armenia, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, and Turkey persistent postponements of births started later, at the end of 1990s.

In most of the Asian countries, including the most populous ones, the majority of births now occur at younger ages. Many of these countries experienced precipitous declines in the MAC, but currently do not experience evident postponements of births. The most dramatic changes took place in China, where the MAC plummeted from nearly 30 years of age in 1970-1975 to 25.5 years in the late 1980s, which translates into a decline of 2.4 years per decade, driven by Chinese birth control policies[16]. A rapid decline in the MAC, by more than 3 years of age since 1970-1975, has been has also been registered in Azerbaijan, Nepal, Viet Nam, Thailand, and Uzbekistan. The changes in the timing of childbearing in these countries, however, were less rapid than in China. In the rest of South-Eastern Asia, the MAC either remained constant at an elevated level (Brunei Darussalam, Indonesia) or even increased without having declined earlier (Malaysia, Myanmar, Timor-Leste). Similar stagnant or increasing trends in the timing of births have also been observed in the majority of countries of Western Asia. However, in the case of a few countries (United Arab Emirates, Iraq), the MAC resumed its decline after an initial increase.

In Africa changes in timing of births were modest. MAC remained essentially constant in 23 countries, increased in 10 countries, and perceptibly declined, by more than a half of a year, in 24 countries (figure II.14). Declines in the MAC were generally small: only four countries (Cabo Verde, Lesotho, Somalia, and South Africa), saw their respective MAC decline by more than 2 years of age since 1970-1975. Currently, the postponement of births that is widespread in Europe and in many countries in Asia is not a common phenomenon in Africa. The distinctiveness of fertility trends in Africa led some authors to suggest that the fertility transition in Africa might be fundamentally different from that of Europe and Asia (Caldwell and others 1992; Moultrie and others 2012).

Several countries in Northern Africa and Western Asia, such as Algeria, Kuwait, Libya, Qatar, Saudi Arabia, and Western Sahara have also experienced different trends in their MAC than Europe and other parts of Asia. While fertility dropped rapidly from high levels, often seven births per woman and more in 1970-1975, to nearly replacement levels in 2010-2015, the MAC increased over this period rather than decreased as could have been expected. The disappearance of high-parity births was completely offset by changes in timing of births at younger ages with the net effect of an increase in the MAC. The most dramatic changes were observed in Libya where fertility declined from 8.1 to 2.5, or by 5.6 births per

[16] The one-child policy was introduced in 1979 and other, less stringent family planning policies were in place before that.

woman, while, over the same period, the MAC increased from 29.3 to 32.9, or by 3.5 years of age. Discussing fertility transition in Algeria, Ouadah-Bedidi and Vallin (2013) put forward the rapid rise in the mean age at marriage as the main factor behind the fertility transition in that country, facilitated by the introduction of a minimum legal age at marriage in 1984, expansion of education and better access of women to the labour market.

In 2010-2015, Libya had the highest MAC at 32.9 years and Bangladesh had the lowest MAC at 25.6 years, globally. Among the developed countries, the highest MAC was in Ireland, 31.5 years, and the lowest in the Republic of Moldova, 26.8 years. In 52 countries MAC was more than 30 years of age, and in 3 of them, it was higher than 32 years (Libya, Djibouti, and Saudi Arabia). Only 4 countries (Azerbaijan, Bangladesh, Dominican Republic, and Nepal) had a MAC lower than 26 years. Viet Nam stands out as the country where the fertility transition led to the greatest reduction in the MAC, from 31.8 years in 1970-1975 to 27.1 in 2010-2015, a decline of 4.7 years. The largest increases occurred in European countries, led by Czechia, where mean age at childbearing increased from 25.2 years in 1970-1975 to 29.8 in 2010-2015, or by 4.6 years.

Annex figures[17] 1-4 further facilitate the exploration of fertility changes in regions and individual countries. Annex figure 3 includes plots of time trends in total fertility, MAC, standard deviation and skewness of age patterns of fertility, along with age patterns of fertility for quinquennial periods[18]. Annex figure 1 shows changes in total fertility between 1970-1975 and 2010-2015 in a context of changes in other regions and individual countries. And finally, similar to figure II.12, annex figure 4 illustrates relations between the level and timing of childbearing in a Lexis map display.

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[17] Online annex figures are available at http://www.un.org/en/development/desa/population/publications/fertility/world-fertility-2015.shtml.

[18] Standard deviation is a measure of the dispersion of age pattern of childbearing. If childbearing is spread out among reproductive span, standard deviation will be high, if, on contrary, it is concentrated at certain ages only, standard deviation will be low. Skewness is a measure of symmetry of age pattern of childbearing. If age pattern of fertility is symmetric, this measure will be lower, and, on opposite, it will be high if age pattern is high asymmetrical, for example, with most of childbearing concentrated at younger ages, with a heavy tail at older ages.

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III. FERTILITY PROJECTIONS

Projections of future fertility levels and trends prepared by the United Nations Population Division rely on the theory of demographic transition: as a country moves from a pre-industrial to a post-industrial stage fertility declines reflect a new demographic regime (Caldwell, 2006). Broadly speaking, there are three phases of a fertility transition: (a) a high-fertility, pre-transition phase, (b) a fertility transition phase, the phase when fertility is declining from a high pre-transitional level to a low post-transitional level, and, (c) a low-fertility, post-transition phase. Once a country reaches the post-transitional stage, it is assumed that fertility will fluctuate around or below the replacement level.

Before the *2010 Revision* of the *World Population Prospects*, the Population Division used a deterministic model of fertility transitions. The transition from the current level of fertility to the post-transitional level of fertility was expressed by three models of fertility change over time. Each model postulated dependency of pace of fertility decline on the current fertility level (United Nations, 2006). The appropriate model for a country was selected by an analyst taking into consideration the history of country specific fertility trends as well as its the outlook on future fertility development. These fertility projection models were formalized in the *2004 Revision* using a double-logistic function, defined by six deterministic parameters. For the countries with below-replacement fertility, it was assumed that fertility would recover uniformly from very low levels of fertility to a fertility floor of 1.85 children per woman.

Starting with the *2010 Revision* of *World Population Prospects*, the Population Division adopted a probabilistic model for fertility projections (United Nations, 2015a). The model is based on the same principles of fertility transition but differs from the deterministic model in several important aspects. First, it is assumed that the pace of fertility decline modelled by a double-logistic curve is individual for each country. For many countries, especially for high-fertility countries in the pre-transitional phase or at the beginning of the fertility transition, there is no data to support the estimation of individual double-logistic curves and it is further assumed there is a world pattern of fertility decline (also modelled by a double-logistic curve). Fertility declines for individual countries are then modelled as weighted averages of individual and world patterns of fertility declines. For countries that have completed the fertility transition, a time series model is used to project fertility based on the assumption that fertility in the long run would approach and fluctuate around country-specific ultimate levels rather than converging to a pre-selected ultimate level of 1.85 live births as in earlier revisions. The model estimation and forecasting is carried out applying a Bayesian hierarchical model which, in addition to the median projection, generates probabilistic prediction intervals. Further details about the methodology can be found in Alkema and others (2011), Raftery and others (2014), and United Nations (2015a).

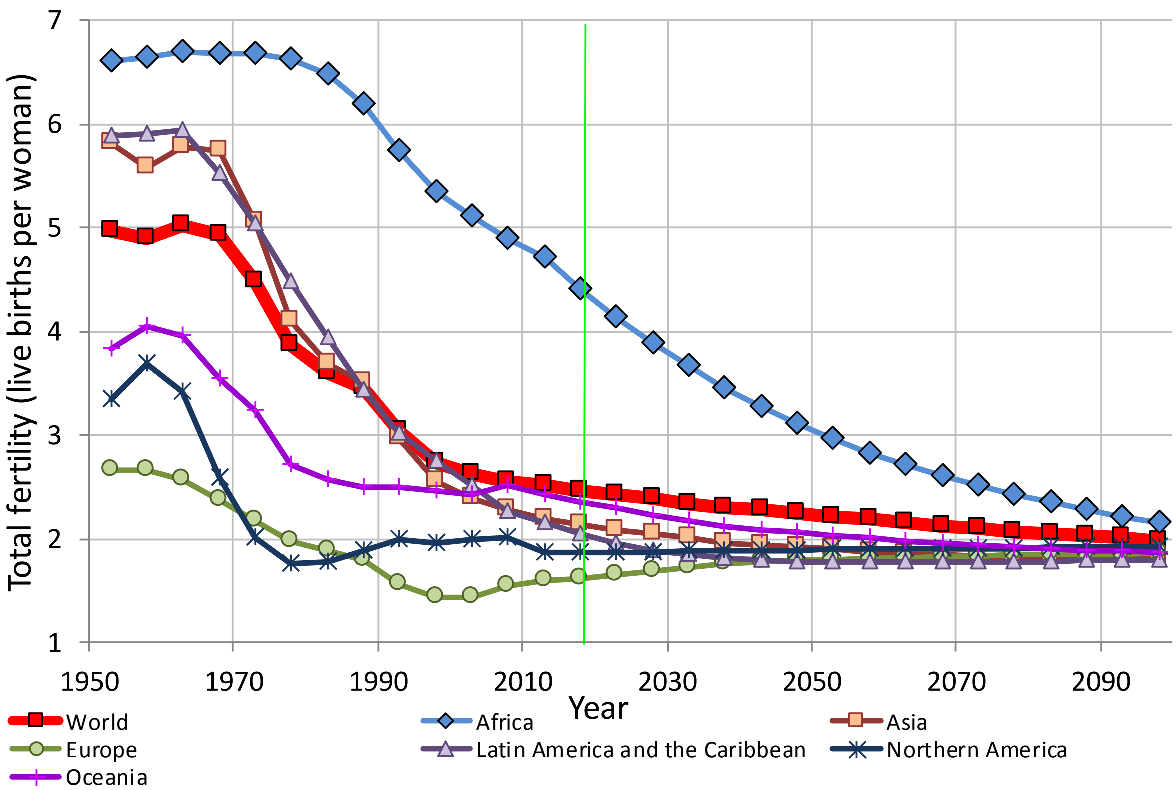
A. PROJECTIONS OF TOTAL FERTILITY

At the world level, the medium variant projects that total fertility will gradually decline from 2.51 births per woman in 2010-2015 to 2.25 in 2045-2050 and further to 1.99 births per woman in 2095-2100 (figure III.1). Similar gradual and uniform declines in total fertility are expected in Asia, where fertility is expected to fall from 2.20 births per woman in 2010-2015 to 1.83 births per woman in 2095-2100, and in Oceania, where fertility is projected to decline from 2.42 births per woman to 1.87 births per woman. A slightly different trajectory of future fertility is expected in Latin America and the Caribbean: starting with total fertility of 2.15 births per woman in the period 2010-2015, it is projected to drop to a minimum of 1.77 births per woman in the mid-2050s and then rebound slightly to 1.80 births per woman at the end of the century. Europe and Northern America are the two regions where total fertility was below replacement level in 2010-2015: 1.60 births per woman and 1.86 births per woman, respectively. In both cases, fertility is expected to recover in the coming decades. A stronger recovery is expected in Europe, where fertility is expected to reach 1.86 births per woman in 2095-2100, and a somewhat moderate recovery is expected in

Northern America to a level of 1.92 births per woman. Whether fertility will increase in low fertility countries in the coming decades is subject of an ongoing debate (Lutz and others, 2014).

Total fertility in Africa, 4.71 births per woman in 2010-2015, is much higher than in the rest of the world. However, it is assumed that the African continent will also see a decline of its fertility to 3.11 births per woman in 2045-2050, and to 2.16 births per woman, around the replacement level, in 2095-2100. The pace of the fertility transition in Africa is expected to be significantly slower than historically observed in other countries and areas. In Sweden, for example, before the widespread use of modern contraceptive methods, the fertility transition was completed in about 50 years: fertility dropped from 4.50 in about 1880 to the replacement level in 1930 (Hofsten and Lundström, 1976). In Asia, the fertility transition is expected to be completed around 2016—it will have taken about 42 years for fertility to decline from 4.71 in 1975[1] (the current level of fertility in Africa) to 2.16 in 2016 (the level of African fertility expected at the end of the century). In Latin America and the Caribbean, it took only 36 years for fertility to drop from a level of 4.71 in 1976 to 2.16 in 2012. In contrast, the medium variant projects that the fertility transition in Africa will be completed in about 85 years (United Nations, 2015a).

Figure III.1 Total fertility trajectories for the world and regions, 1950-2015 estimation and 2015-2100 projection (medium variant)



NOTE: The green vertical line designates the onset of fertility projection period.

Considerable heterogeneity exists in projected fertility declines for individual countries (figure III.2). In 20 countries, total fertility is expected to decline by more than two children per women from 2010-2015 to 2045-2050. Three of them are in Asia (Afghanistan, Timor-Leste and Yemen) and the rest are in Africa. The largest declines are projected for Afghanistan, Timor-Leste and Chad. In 46 countries (29 in Africa, 9 in Asia, 2 in Latin America and the Caribbean, and 6 in Oceania), the decline is expected to be

[1] The figures cited for Asia and Latin America and the Caribbean are interpolated annual total fertility from the *2015 Revision*.

more moderate: still higher than one child but less than two children per woman. Among the remaining 82 countries with projected fertility declines, 45 countries are projected to have fertility decline by less than 0.5 births per woman while the rest will see declines ranging between 0.5 and 1.0 births per woman.

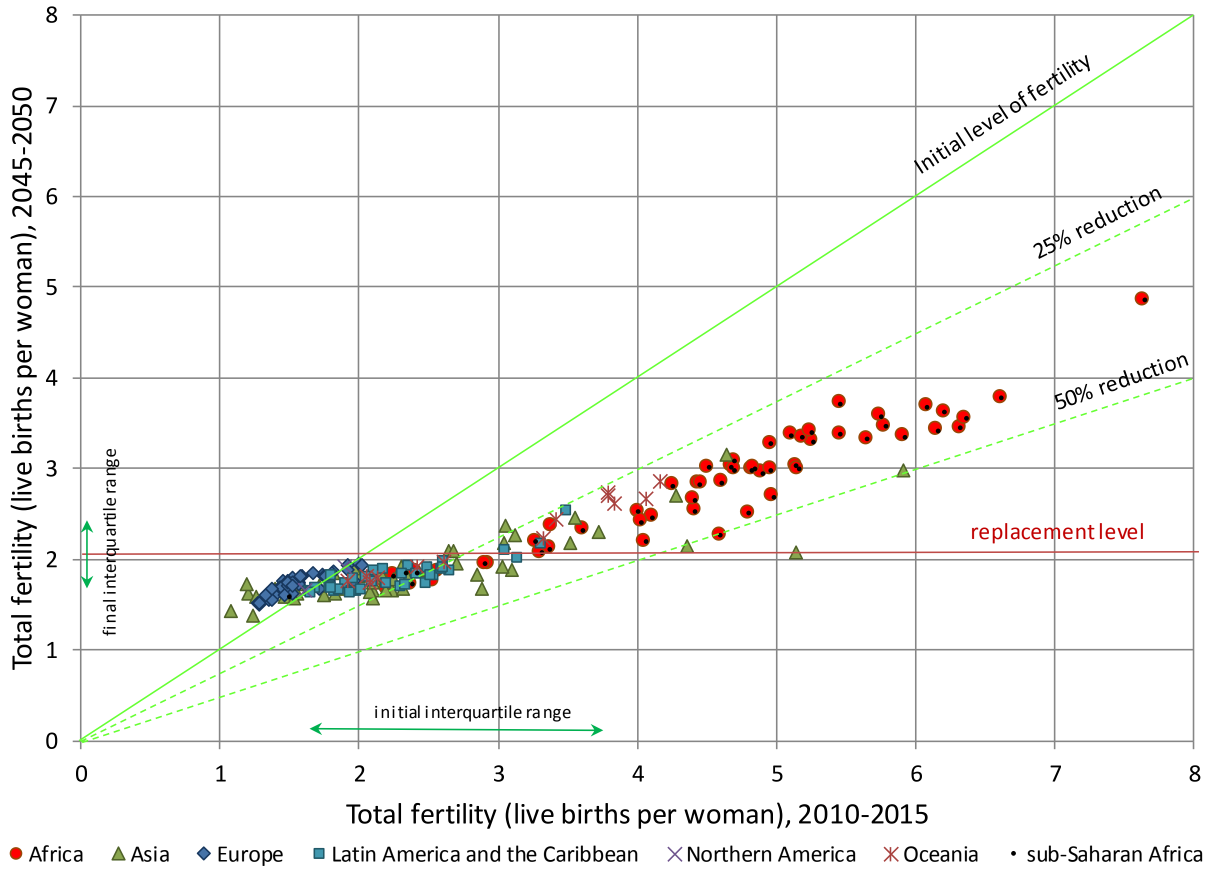
Fertility is expected to fall to below-replacement levels in an increasingly large number of countries. In 2010-2015, below-replacement fertility was observed in 86 countries. By 2045-2050, this number is expected to rise to 135 countries, and, by the end of the century, 180 countries, 90 per cent of all countries worldwide, are expected to experience below-replacement fertility. The share of the world's population living in countries with below-replacement fertility is expected to increase from 47 per cent in 2010 to 70 per cent in 2050 and to 72 per cent in 2100. The relatively small increase from 2050 to 2100 in the proportion of the total population living in countries with below-replacement fertility is explained by the continued growth in the total population of the countries with fertility above replacement in this period. By 2095-2100, fertility in 21 countries[2] is expected to be still above the replacement level, and the total population of this group of countries is projected to increase from 1.5 billion people in 2050 to 3.2 billion people in 2100.

For about a quarter of all countries globally, fertility is expected to increase over the projection period (the countries indicated by the markers above the green line, the line of initial fertility of the countries in 2010-2015, figure III.2). Most of these countries (34) are in Europe, 12 in Asia, 4 in Latin America and the Caribbean, 2 in Northern America, and 1 in Africa. The projected pace of fertility recovery is moderate: on average fertility is expected to increase by 0.2 births per women by 2045-2050. None of the countries with anticipated fertility increases over the projection period will reach replacement levels by that time.

Assumptions underpinning the current population projections of the United Nations imply marked reductions in variability of fertility levels between countries. In 2010-2015, the interquartile range was about 2 births per women and for 2045-2050 it is expected to drop sharply to 0.67 births per women (figure III.2). The interquartile range will further decline to 0.12 births per woman in the last projection period, 2095-2100. Thus the substantial demographic diversity existing now with respect to fertility levels of different countries is expected to be drastically reduced over future decades.

[2] Angola, Burkina Faso, Burundi, Chad, Congo, Côte d'Ivoire, Dem. Republic of the Congo, Iraq, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Sao Tome and Principe, Senegal, Somalia, Uganda, United Republic of Tanzania, Zambia

Figure III.2 Fertility changes from 2010-2015 to 2045-2050 for individual countries

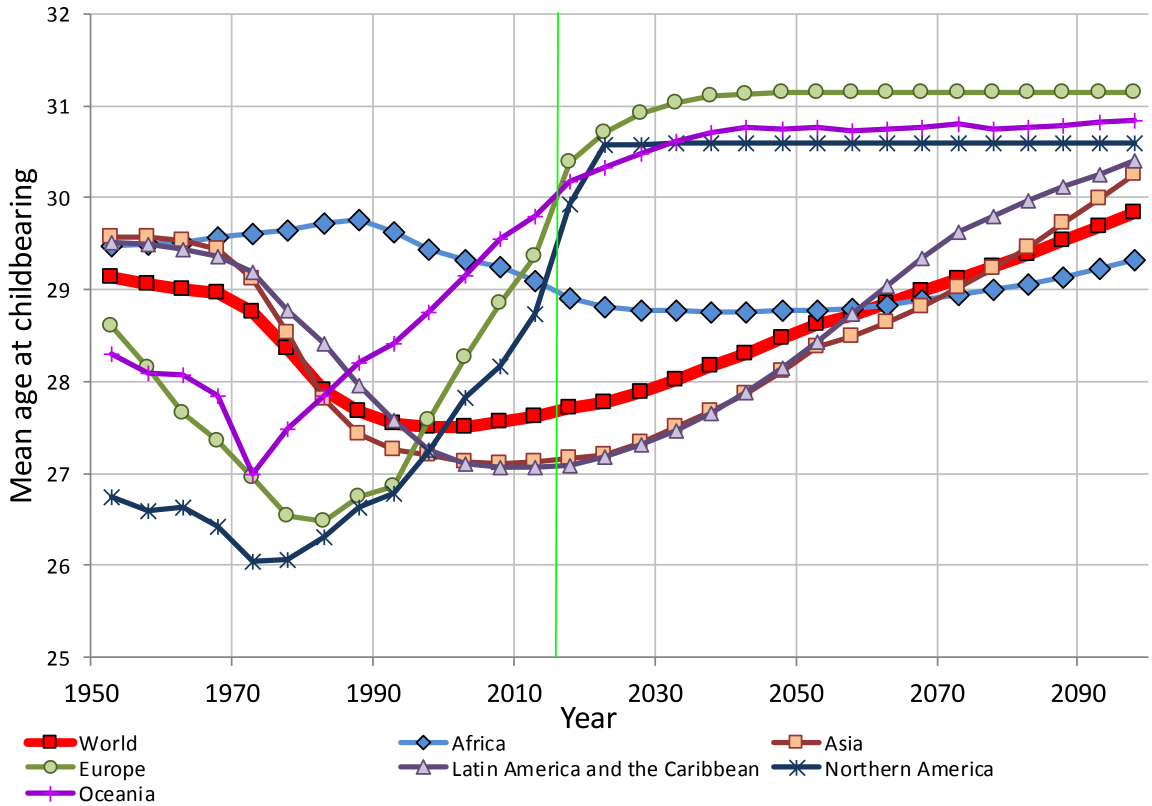


Changes in total fertility for regions and individual countries can be further explored in annex figure 2 that highlights changes for each region or country in the context of changes for other regions and countries. Additionally, the annex figure displays a prediction interval to communicate uncertainty of the future trends.

B. Projected mean age at childbearing

The *2015 Revision* of the *World Population Prospects* introduces a new uniform method of projection of age patterns of childbearing for all countries in the world. The projected age patterns of fertility are based on past national trends combined with a trend leading toward a global model age pattern of fertility (United Nations, 2015a; Ševčíková and others, 2015). At the world level, the mean age at childbearing (MAC), after declining from 29.1 years in 1950-1955 to an all-time low of 27.6 years in 2010-2015, is expected to increase again, reaching almost 30 years by the end of the century (figure III.3). In Asia and in Latin America and the Caribbean, the observed and expected trends in the MAC are similar to those at the world level. In both regions, the MAC initially declined, and after hitting the lowest point around 2010, it is projected to increase unabated, reaching a maximum of 30.4 years by the end of the century. In Europe, Northern America, and Oceania the MAC dropped to lower levels than in other regions but the subsequent rebound was steeper. In Europe, for example, the MAC declined from 28.6 years in 1950-1955 to a minimum of 26.5 years in 1980-1985, and then increased again to 29.4 years by 2010-2015. For the projection period, the MAC in Europe is expected to reach a limit of 31.1 years by 2030. Similarly, in Northern America and Oceania, after declines to historical minima in the 1970s, 26.0 years in Northern America and 27.0 years in Oceania, the MAC has increased and is projected to further increase to limiting values of about 30.5 years by 2030; somewhat lower than expected for Europe. In contrast to other regions, no large variation in the MAC was observed for Africa over the estimation period and no large changes are expected over the projection period: the MAC increased slightly over 1950-1990, from about 29.5 years to almost 30 years, and then gradually declined to 29 years by 2010. For the projection period, it is expected to remain essentially unchanged.

Figure III.3 Trajectories of mean age at childbearing for the world and regions, 1950-2015 estimation and 2015-2100 projection (medium variant)



NOTE: Green vertical line designates onset of fertility projection period.

Changes in MAC are often accompanied by changes in variability of age at childbearing. Figure III.4 presents trends and projections of the standard deviation[3] of the distribution of ages at childbearing, for the world and the regions. At the world level, the standard deviation shows a continual decline, both over the estimation and the projection periods: from a standard deviation of 7.2 in 1950-1955 to 6.4 in 2010-2015, and further to 5.8 at the end of the century. In Europe, Northern America, and Oceania, the initial decline in the MAC was accompanied by a reduction in the variability of age at childbearing—largely due to reductions in high-parity births and the disappearance of large families (Knodel, 1987; Prioux, 1990). In the early 1980s, in all three regions, the MAC started to increase rapidly, marking the onset of the postponement of childbearing to higher ages. At the same time, childbearing became more and more spread over age as indicated by a reversal of the trend, less sharp but still evident, in the standard deviation of the distribution of ages at childbearing over the same period (figure III.4). In contrast to these three regions, in Africa, Asia, Latin America and the Caribbean the variability of age at childbearing was persistently declining over the estimation period, 1950-2015. The sharpest decline took place in Asia, while the declines were more gradual in Latin America and the Caribbean and in Africa.

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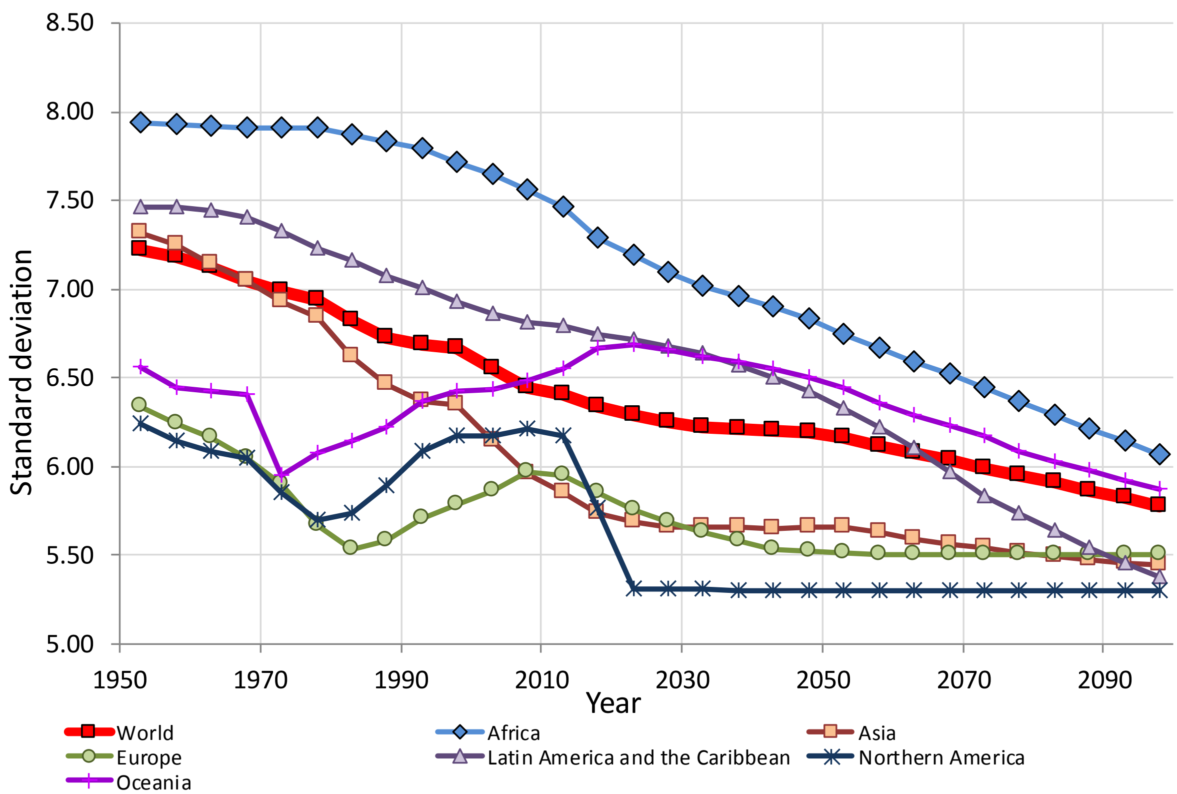
[3] Standard deviation is one of the measures of variability of age at childbearing of mothers. As mother's age at birth becomes less variable, this measure decreases, and vice versa.

For the projection period (2015 – 2100), it is generally assumed that childbearing will be more and more compressed into a narrower age range. For Europe, Northern America, and Oceania it is expected that the currently rising trends in the standard deviation would shift towards a decline shortly after 2015 and for the rest of the regions and the world as a whole, fertility is expected to follow earlier observed trends and continue to compress into a narrow age range by the end of the projection period. It would be important to note that the European average masks the heterogeneity of fertility age patterns and their changes over time. In many European countries, for example in Austria, the Netherlands, and Sweden, to name a few, the increase in the MAC since about 1980 was not accompanied by an increase in the variability of age at childbearing as depicted by the European average in Fig. (III.4). Instead, the age schedule of fertility in these countries was simply shifting to higher ages, while the standard deviation remained practically unchanged.

Fig III.4 Trajectories of standard deviation of the distribution of ages at childbearing for the world and regions, 1950-2015 estimation and 2015-2100 projection (medium variant)



Source: United Nations (2015a).

Online annex figures[4] further facilitate the exploration of fertility projections by displaying animated trends of the total fertility rate, the mean age at childbearing and the standard deviation of the distribution of ages at childbearing, both for regional groupings as well as for individual countries.

[4] http://www.un.org/en/development/desa/population/publications/fertility/world-fertility-2015.shtml

C. CONTRIBUTION OF FERTILITY TO POPULATION GROWTH OVER 2010-2050

Population growth over a period of time can be attributed to four demographic components: fertility, mortality, migration, and the current age structure of a given population. All four demographic components can have a significant impact, either positive or negative, on future population growth.

Fertility provides a positive contribution to population growth if fertility is above replacement level and a negative contribution if fertility is below replacement. If fertility of a given population is above replacement, with constant mortality and zero migration, the population will grow indefinitely. Similarly, if fertility stays below the replacement level, the population will eventually become extinct. Maintaining fertility at the replacement level in the long run leads to stabilization of the population size with zero population growth (e.g. Preston and others, 2000). In a population in which all women survive through the reproductive years (15-49 years) and the probability of having a daughter after each pregnancy is 50 per cent, total fertility at the replacement level will be 2.0 births per woman. In reality, replacement-level fertility is slightly higher than 2.0 births per woman in low-mortality populations because the chance of survival from birth to reproductive age is less than 100 per cent and generally the sex ratio at birth is greater than 100 (more boys than girls are born). In high-mortality populations, replacement-level fertility could be significantly higher than 2.0 births to offset the lower chances of survival of women until the end of the reproductive period.

The contribution of mortality to population growth in a given population will be positive if mortality is declining and negative if mortality is increasing. In population projections, a positive outlook for future mortality patterns is usually adopted: life expectancy at birth is expected to continue to increase and death rates are expected to decline over all age groups. Under this assumption, the contribution of mortality to population growth will be positive. In more complex cases, death rates are not declining uniformly over all age groups but may increase for some age groups and decline for others. One such example are countries that have seen their adolescents and young adult populations severely affected by the HIV/AIDS pandemic. In such complex cases, the contribution of mortality to population growth is less clear and less straight-forward. The contribution of mortality may also be related to the interplay between age-specific mortality rates and a given population age structure.

The contribution of migration to population growth is determined by net migration: positive net migration will contribute to population increase and negative net migration will reduce population size. On the world level, net migration is zero, and population growth is affected by three components only: fertility, mortality, and the initial age structure of the population.

If in a given population fertility is maintained at replacement level, mortality is assumed to be constant and net migration is zero, the total population size will not necessarily remain constant. It could either increase or decrease before reaching a stationary ultimate population size. This phenomenon is called momentum of population growth. If the ultimate population size is higher than the current population size, the population momentum is positive and if the ultimate population size is lower than the current population size, the population momentum is negative. Populations with a positive population momentum are characterized by young age structures: the excess of births over deaths in such populations is due to the large number of women in reproductive ages rather than due to above-replacement fertility rates.

The contribution of each demographic component—fertility, mortality, migration and the current age structure of a population—to future population growth has been assessed by constructing a series of four variants of appropriate cohort-component population projections based on the *2015 Revision* of *World Population Prospects*: standard, natural, replacement and momentum (United Nations, 2015d). The standard variant incorporates effects of all four demographic components and is set equal to the medium variant in the *2015 Revision* (United Nations, 2015a). The natural variant is derived from the standard variant by setting net migration to zero. The replacement variant is derived from the natural variant by setting total fertility at the replacement level for each five-year projection period. The momentum variant uses constant mortality rates as of 2010, constant fertility at the replacement level and sets net migration to zero[5]. Further details on methodology are provided in Andreev, Kantorová and Bongaarts (2013) and Bongaarts and Bulatao (1999).

D. RESULTS

The world's population is projected to increase from 6.9 billion in 2010 to 9.7 billion in 2050 or by 40 per cent[6] according to the medium projection variant of the *2015 Revision* (table III.1). Out of these 40 per cent, 26 per cent, or more than half of the projected population growth, is due to population momentum, 8 per cent due to above-replacement fertility, and 6 per cent can be accredited to mortality decline. Population momentum alone will account for the addition of 1.8 billion people to the world's population between 2010 and 2050. The contribution of migration is zero at the world level, as noted above.

Most developed countries have already reached the end of the demographic transition, while the majority of the developing countries are in the midst or at the beginning of it. As a result, the impact of the earlier discussed four demographic components on future population growth differs considerably between more developed and less developed regions. More developed regions will experience a small increase in their total population over the period 2010 to 2050, about 4 per cent compared to the 2010 population. Declining mortality and positive net migration will provide positive contributions to population growth while population momentum and below-replacement fertility will contribute negatively. Fertility is the most important component responsible for the negative population change expected to characterize these countries. Its contribution, -9.8 per cent or -121 million people, is largely offsetting the expected increase in the total population of the more developed regions resulting from net migration, 10.2 per cent or 123 million people (table III.2). The contribution of mortality decline to population growth is 5.8 per cent or 72 million people, and the contribution of the population momentum is -1.9 per cent or -23 million people.

The population in the less developed regions is projected to increase by 48 per cent between 2010 and 2050. The demographic transition in these countries started later than in developed regions, and in most countries the population age structures are still young. In this group of countries, the largest positive impact on population growth can be attributed to the population momentum (about 32 per cent of the 2010 population). Fertility, although quite different across countries in the less developed regions, accounts for an additional 12 per cent population growth relative to 2010 while mortality is expected to contribute a total of 7 per cent. The contribution of migration is small but negative, about -2 per cent (table III.2).

The highest population growth is expected in the least developed countries: more than a billion people will be added from 2010 to 2050 (or 124 per cent of the 2010 population, table III.1). This growth is largely due to above-replacement fertility, accounting for 73 per cent growth from the 2010 population, contributing more than 600 million people. The second largest contributor is the young age structure in this group of countries: 48 per cent or more than 400 million people will be added due to the effects of the population momentum. The contributions of mortality decline and migration are small and largely offsetting each other, at 8 and -6 per cent, respectively.

Among regions, the largest population growth over the period from 2010 to 2050 is expected in Africa: more than 1.4 billion people will be added to the population of the continent over these 40 years

[5] We used population estimates in 2010 as a base population for the projections because at the time of the analysis only a few countries produced population estimates for 2015.
[6] The per cent values discussed here are per cent increases of total population until 2050 relative to total population in 2010

(table III.1, figure III.7). Fertility is by far the largest contributor to population growth in this region. More than 900 million people or 87 per cent of the 2010 population in Africa will be added as a consequence of above-replacement fertility alone (figure III.7, figure III.8).

In the case of Asia, more than 1 billion people will be added. However, unlike in Africa, the major contribution will be stemming from population momentum, 1.1 billion people, with 440 million people or about 40 per cent of the total increase from India alone (United Nations, 2015d). Fertility will provide a negative contribution to population growth in this region, -192 million people (figure III.8), largely due to below-replacement fertility in China[7]. In relative terms, the population increase of 26 per cent in Asia is significantly smaller than that projected for Africa, 137 per cent.

Fertility will provide the largest negative contribution to population growth in Europe, in Latin America and the Caribbean, and in Northern America (figure III.8). In Oceania, the contribution of fertility will be negative in Australia and New Zealand but will be outweighed by the positive contribution of fertility in the other countries in this region. Negative population growth due to below-replacement fertility will be offset by positive net migration in Europe, by positive net migration and population momentum in Northern America and Oceania, and largely by population momentum in Latin America and the Caribbean. Mortality is projected to be declining in future, and the contribution of this component will be positive in all regions. Europe, with the longest history of below replacement fertility, is now the only region experiencing a negative population momentum.

Future trends in total fertility will have a large impact on projected population growth in many countries. Nigeria's future fertility trends will have the highest absolute contribution to population growth of any country and any demographic component with the exception of India's momentum component. In Nigeria, the fertility component alone is estimated to account for 170 million people by 2050 (or more than double Nigeria's population in 2010). In other populous African countries with high total fertility, such as the Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Niger, Uganda, and United Republic of Tanzania, the fertility component is expected to account in total for more than 365 million additional people by 2050 (figure III.5). Outside of Africa, the largest contributions of fertility to population growth in absolute numbers are expected in Pakistan and Iraq: 60 and 33 million, respectively.

In relative terms, the highest contribution of fertility to population growth of any country and any demographic component is for Niger: the population of this country is expected to nearly triple by 2050 due to the fertility component alone. Large relative effects of the fertility component are also projected for Angola, Burundi, Gambia, Mali, Somalia, Uganda, United Republic of Tanzania, and Zambia. In these countries the fertility contribution to population growth will be more than 140 per cent. Overall, continuing trends in total fertility above replacement level will make positive contributions to population growth in 91 countries. In the case of 20 of these countries the fertility component will be responsible for at least a doubling the population, and for 46 countries, fertility will contribute more than 50 per cent more people between 2010 and 2050.

Fertility below replacement level is of concern for governments as it leads to population decline and accelerates population ageing. By far the largest decline in total population attributed to fertility, the largest negative contribution of any component in any country, is expected in China: -236 million people between 2010 and 2050 or 18 per cent of China's population. Other countries with the fertility component accounting for a population decline of 11 million or more people are Bangladesh, Brazil, Germany, India, the Islamic Republic of Iran, Japan, the Russian Federation, Thailand, and the United States of America (figure III.6). In terms of the largest impact relative to population size, 11 countries or areas will see their populations shrink by more than 20 per cent by 2050 due to fertility below the replacement level: Armenia,

[7] Recent changes in China's fertility policy are not incorporated into the projections of fertility for China.

Bosnia and Herzegovina, Cyprus, the Islamic Republic of Iran, Macao SAR of China, Mauritius, Poland, the Republic of Moldova, Singapore, Taiwan Province of China, and Thailand. For another 52 countries, the contribution of the fertility component to population decline will be between 10 and 20 per cent. Altogether, between 2010 and 2050, fertility below replacement level will contribute to a decline of the total population for 110 countries.

Figure III.5 Countries with the largest absolute contributions of fertility levels above replacement to population growth between 2010 and 2050 (millions)

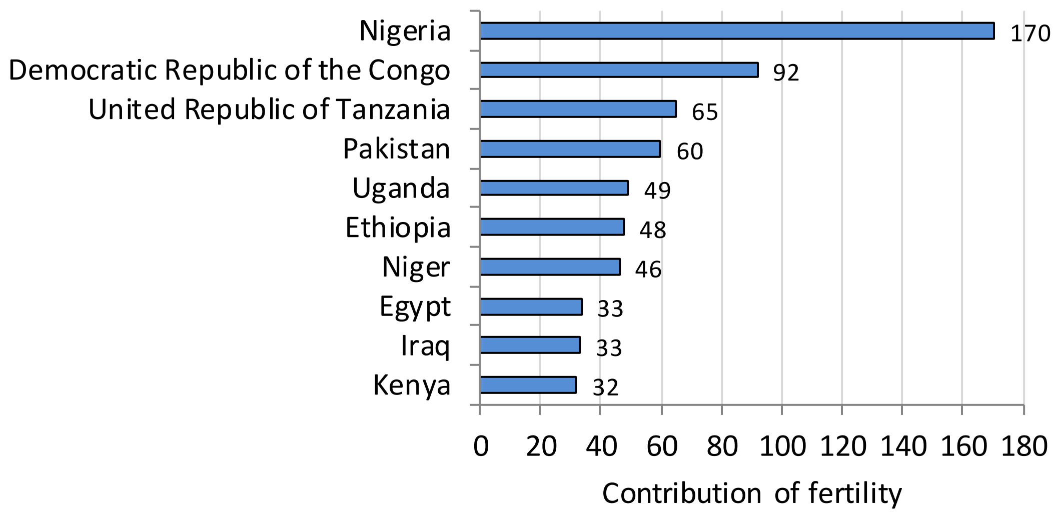


Figure III.6 Countries with the largest absolute contributions of fertility levels below replacement to population decline between 2010 and 2050 (millions)

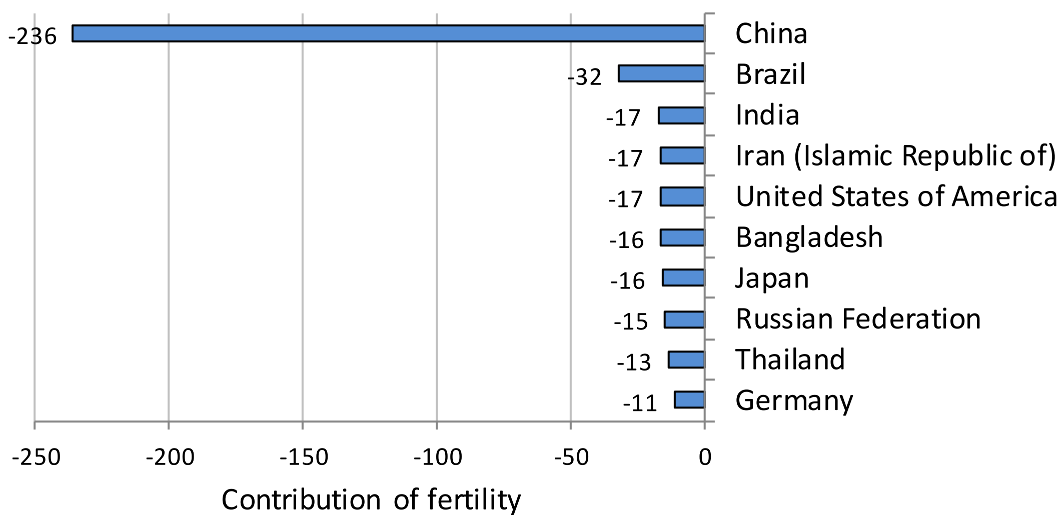


TABLE III.1 TOTAL POPULATION IN 2010 AND 2050, THE WORLD, REGIONS AND DEVELOPMENT GROUPS

Regions or development group	*Total population (millions)* 2010	2050	*Population change 2010-2050* Absolute (millions)	Relative to 2010 (per cent)
World	6,930	9,725	2,795	40.3
More developed regions	1,233	1,286	53	4.3
Less developed regions	5,696	8,439	2,742	48.1
Least developed countries	847	1,897	1,050	123.9
Africa	1,044	2,478	1,433	137.3
Asia	4,170	5,267	1,097	26.3
Europe	735	707	-29	-3.9
Latin America and the Caribbean	600	784	184	30.7
Northern America	344	433	89	25.9
Oceania	36	57	20	55.5

TABLE III.2 CONTRIBUTION OF DEMOGRAPHIC COMPONENTS TO POPULATION GROWTH FROM 2010 TO 2050, THE WORLD, REGIONS AND DEVELOPMENT GROUPS

Regions or development group	*Contributions of demographic components* Momentum	Mortality	Fertility	Migration	**Total**
	Relative to total population in 2010 (per cent)				
World	25.6	6.5	8.3	0.0	40.3
More developed regions	-1.9	5.8	-9.8	10.2	4.3
Less developed regions	31.6	6.6	12.2	-2.3	48.1
Least developed countries	48.4	8.3	72.6	-5.5	123.9
Africa	44.2	8.8	87.3	-3.1	137.3
Asia	26.7	6.1	-4.6	-1.8	26.3
Europe	-5.2	6.1	-11.2	6.4	-3.9
Latin America and the Caribbean	34.1	6.5	-6.9	-3.0	30.7
Northern America	7.4	5.4	-6.2	19.3	25.9
Oceania	19.9	5.6	5.7	24.3	55.5
	Absolute (millions)				
World	1,774.1	449.0	572.3	0.0	2,795
More developed regions	-23.3	71.5	-121.3	126.1	53
Less developed regions	1,797.4	377.5	697.6	-130.2	2,742
Least developed countries	410.3	70.6	615.1	-46.4	1,050
Africa	461.8	91.6	911.9	-31.9	1,433
Asia	1,113.5	252.9	-192.9	-76.5	1,097
Europe	-38.4	44.9	-82.4	47.3	-29
Latin America and the Caribbean	204.4	39.2	-41.1	-18.0	184
Northern America	25.5	18.4	-21.2	66.3	89
Oceania	7.2	2.0	2.1	8.9	20

Figure III.7 Population Growth over 2010-2050 by regions and by Demographic Components

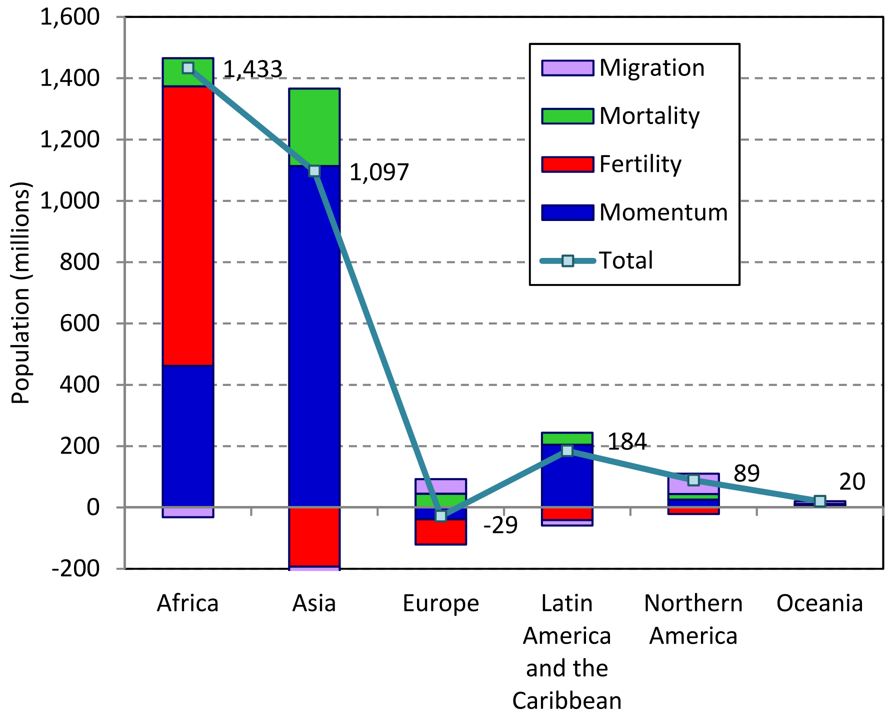
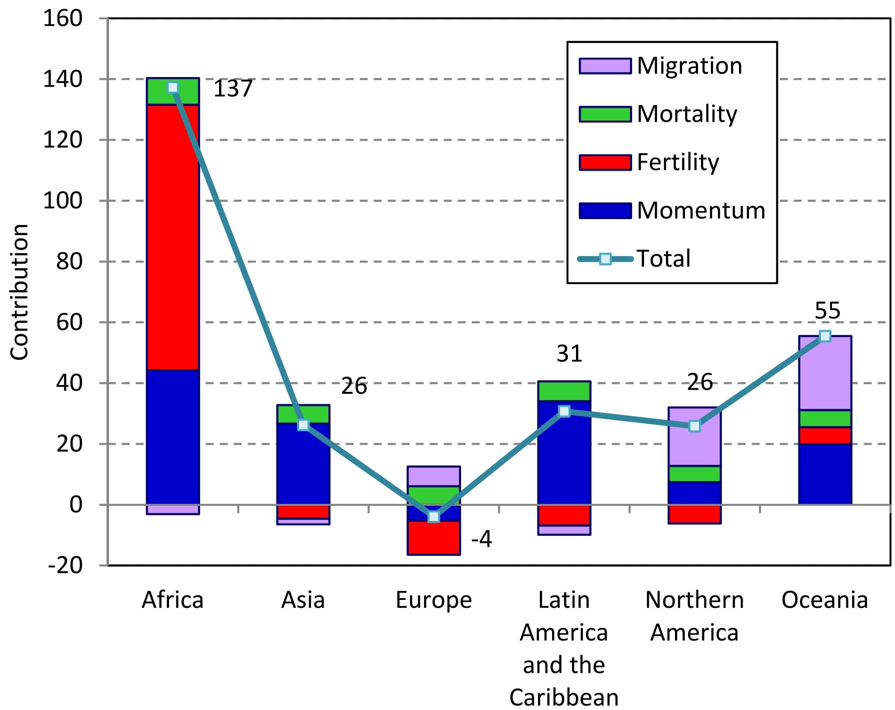


Figure III.8 Relative Contribution of demographic components to population growth from 2010 to 2050



CONCLUSIONS

The analysis in this report of trends in fertility from 1950 to 2050 and beyond shows steady fertility declines in most countries in the world, as well as a slow-down of population growth at the global level. These trends are particularly marked for high and middle-income countries in Europe and Northern America, but they are also observed in much of Oceania, Asia, Latin America and the Caribbean, as well as in Northern and Southern Africa. Similar trends, albeit with a time lag, are beginning to take place in low-income countries in Africa and Asia. Almost all countries that have experienced fertility declines have either already completed their fertility transitions or have reached rather advanced stages, characterized by low fertility and mortality. More and more countries are reaching below-replacement fertility levels, in some cases resulting in negative population growth rates. High fertility remains increasingly a characteristic of the least developed countries, with nearly all pre-transitional and early-transition countries located in sub-Saharan Africa.

Akin to the changes in total fertility, the age pattern of childbearing has changed markedly over last decades. In Europe, Northern America and in the high-income countries of Asia and Oceania, the age pattern of childbearing has been shifting to higher ages, with the mean age at childbearing reaching in many low-fertility countries 30 years or over.

Childbearing in adolescence has also undergone major changes over time. Between 1990-1995 and 2010-2015, the world’s average adolescent birth rate declined by nearly 30 per cent, from 65 per 1,000 women aged 15-19 to 46 per 1,000. The reductions were largest in Asia, Europe and Northern America, and were very modest in Africa, Latin America and the Caribbean, and Oceania. The Latin America and Caribbean region stands out because it has the largest share of births to adolescent mothers among all births, resulting mainly from rapid declines in fertility of women aged 20 years or over and fertility now concentrated in younger ages.

Considerable uncertainty exists about the future paths of fertility in high-fertility as well as in low-fertility countries. In high-fertility countries, uncertainty of fertility trends is rooted in the uncertainty about the evolution of socio-economic conditions that support the advancement of women, such as female education and labor force participation, as well as the availability of contraceptives, to only name a few of the known determinants of fertility declines. The Projections prepared by the United Nations Population Division foresee that fertility in high-fertility countries will eventually decline, and that most, but not all countries will reach below-replacement fertility by the end of this century. Population momentum will continue to play a significant role in future population growth. The maintenance of above-replacement fertility in Africa alone will add more than 900 million people over the period from 2010 to 2050, which represents 87 per cent of the projected population growth in Africa.

In the case of low-fertility countries, there is no compelling evidence that the recent increases in period fertility in some European countries will be emulated by countries in other regions with very low fertility, such as Eastern Asia. The projections of future fertility levels and trends prepared by the United Nations Population Division assume that fertility in low-fertility countries will be generally recovering towards replacement levels. Despite this built-in “recovery” of fertility levels into the projections, below-replacement fertility is nonetheless the largest contributor to population decline in the more developed regions, particularly in Europe, over the period 2010 to 2050.

Fertility levels and trends are fundamentally interrelated to development. The linkages between population dynamics and sustainable development have been recognized since the adoption of the 1992 Rio Declaration and Agenda 21 that placed human beings at the center of development. This was reiterated in the Programme of Action of the International Conference on Population and Development (ICPD) in 1994 that approached population and development issues from a human rights perspective, including the promotion of reproductive health and family planning, education and gender equality as intrinsic components of sustainable development. The ICPD also recognized population ageing as a growing global phenomenon. While the Millennium Declaration did not make specific references to the relationship between population and development, several of the Millennium Development Goals reflected in their targets and indicators timebound commitments to improve reproductive health of women and young girls and to promote inclusive societies. The Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development bring together major threads of development thinking from these past 25 years, by linking population dynamics with all three dimensions of sustainable development—social, economic and environmental. This new framework contains goals on healthy lives and gender equality, and timebound targets on sexual and reproductive health, including adolescent fertility and family planning, and on issues related to population ageing.

To fulfil the pledge 'to leave no one behind' made at the adoption of the 2030 Agenda for Sustainable Development, Governments were called upon to provide legal frameworks and offer opportunities for schooling and advanced training, and to provide quality health care and access to sexual and reproductive health care services, including family planning, for all women and men. Further, the challenges and opportunities of ageing societies need to be recognized by all. The international community will need to continue to invest in the poorest countries to expand family planning and reproductive health initiatives and, at the same time, support initiatives to cope with ageing populations. With the right development policies, economic and social gains, the advancement of women and girls as well as the improvement of living conditions of older persons will contribute to the achievement of the SDGs.

REFERENCES

Alkema, L., Raftery, A., Gerland, P., Clark, S., Pelletier, F., Buettner, T., and Heilig, G. (2011). Probabilistic projections of the total fertility rate for all countries. *Demography,* vol. 48, No. 3, pp. 815-839. doi: 10.1007/s13524-011-0040-5.

Andreev, K., Kantorová, V., and Bongaarts, J. (2013). Demographic Components of Future Population Growth. Technical report, Population Division, United Nations. www.un.org/en/development/desa/population/publications/technical/2013-3.shtml

Arriaga, E. (1983). *Estimating fertility from data on children ever born, by age of mother*. U.S. Bureau of the Census, International Research Document No. 11, ISP-RD-11. U.S. Government Printing Office, Washington, DC. 20402

Avery, C., Clair, T. St., Levin, M., and Hill, K. (2013). The 'Own Children' fertility estimation procedure: A reappraisal. *Population Studies*, vol. 67, No. 2, 171-183. http://dx.doi.org/10.1080/00324728.2013.769616

Badurashvili, I., McKee, M., Tsuladze, G., Mesle´, F., Vallin, J., and Shkolnikov, V. (2001). Where there are no data: what has happened to life expectancy in Georgia since 1990? *Public Health*, vol. 115, pp. 394–400.

Billari, F., Kohler, H. P.; Anderson, G., and Lundström, H. (2007). Pushing the limit: long term trends in fertility in Sweden. MPIDR Working Paper 2007-004. http://www.demogr.mpg.de/papers/working/wp-2007-004.pdf

Bogue, D., Arriaga E. E, Andelton, D. L., and Rumsey, G. W. (1993). Readings in Population Research Methodology. New York: United National Population Fund.

Bongaarts, J. (2002). The end of the fertility transition in the developing world. In *Completing the fertility transition*. Paper presented at the United Nations Population Division Expert Group Meeting on Completing the Fertility Transition, Population Division, Department of Economic and Social Affairs, United Nations, New York, New York. http://www.un.org/esa/population/publications/completingfertility/RevisedBONGAARTSpaper.PDF

Bongaarts, J. (2013). How exceptional is the pattern of fertility decline in sub-Saharan Africa? Expert Paper No. 2013/4. New York: United Nations. http://www.un.org/en/development/desa/population/publications/pdf/expert/2013-4_Bongaarts_Expert-Paper.pdf

Bongaarts, J. and Bulatao R. A. (1999). Completing the demographic transition. Population and Development Review, vol. 25, No. 3, pp. 515–529.

Bongaarts, J. and Casterline, J. (2012). Fertility transition: Is sub-Saharan Africa different? *Population and* Development *Review*, vol. 38 (Supplement), pp. 153-168.

Brass, W. (1964). Uses of census or survey data for the estimation of vital rates. E/CN.14/CAS.4/V57. Paper prepared for the African Seminar on Vital Statistics. Addis Ababa.

Caldwell, J. C. (2006). *Demographic Transition Theory*. Springer.

Caldwell, J. C., Orubuloye, I. O., and Caldwell, P. (1992). Fertility decline in Africa: a new type of transition? *Population and Development Review*, vol. 18, No. 2, pp. 211-242.

Campbell, K. L. and Wood, J. W. (1988). Fertility in Traditional Societies. In Diggory, P, Potts, M., and Teper, S. (eds.), *Natural Human Fertility: Social and Biological Determinants*, pp. 39–69, London, United Kingdom: The Macmillan Press. ISBN 978-1-349-09963-4. doi 10.1007/978-1-349-09961-0

Casterline, J. B. (2001). The pace of fertility transition: National patterns in the second half of the twentieth century. *Population and Development Review*, vol. 27 (Suppl.), pp. 17–52.

Coale, A. J. and Treadway, R. (1986). A summary the changing distribution of overall fertility, marital fertility, and *the* proportion married in the provinces of Europe, in Coale, A. J. and Watkins, S. C. (eds.) *The Decline of Fertility in Europe*, pp. 31-181. Princeton: Princeton University Press.

Collier, J. (2009). The rising proportion of repeat teenage pregnancies in young women presenting for termination of pregnancy from 1991 to 2007. *Contraception*, vol. 79, No. 5, pp. 393–396.

Council of Europe (1998). *Recent demographic developments, in Europe*. F-67075 Strasbourg Cedex, ISBN 92-871-3726-9.

Croft, T. (1991). Date Editing and Imputation. *Demographic and Health Surveys World Conference Proceedings*, *II*: 1337–1356, Columbia, Maryland: IRD/ORC Macro.

Eaton, J.W. and Mayer, A.J. (1953). The social biology of very high fertility among the Hutterites; the demography of a unique population. *Human Biology*, vol. 25, pp. 206--64.

Grabill, W. and Cho, L. J. (1965). Methodology for the measurement of current fertility from population data on young children. *Demography*, vol. 2, pp. 50-73.

Henry, L. (1961). Some Data on Natural Fertility. *Eugenics Quarterly*, vol. 8, issue 2, pp. 81-91.

Hofsten, E. and Lundström, H. (1976). *Swedish population history: Main trends from 1750 to 1970*. Stockholm: Liber Förlag.

Hull, T. H. and Hartanto, W. (2009). Resolving contradictions in Indonesian fertility estimates. *Bulletin of Indonesian Economic Studies*, vol. 45, No.1, pp. 61-71.

Kirk, D. and Pillet, B. (1998). Fertility levels, trends, and differentials in sub-Saharan Africa in the 1980s and 1990s. *Studies in Family Planning*, vol. 29, No. 1, pp. 1-22.

Knodel, J. (1987). Starting, stopping, and spacing during the early stages of fertility transition: the experience of German village populations in the 18th and 19th centuries. Demography, vol. 24, No. 2, pp. 143–162.

Larsen, U. (1994). Sterility in sub-Saharan Africa. *Population Studies*, vol. 48, No. 3, pp. 459-474.

Leridon, H. (1977). *Human Fertility: The Basic Components*. Chicago: University of Chicago Press.

Lim, L., Wong, H., Yong, E., and Singh, K. (2012). Profiles of women presenting for abortion in Singapore: focus on teenage abortions and late abortions. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, vol. 160, pp. 219–222.

Lutz, W., Butz, W. P., and Samir, K. C., (eds.) (2014). *World Population & Human Capital in the 21st Century*. Oxford: Oxford University Press.

Malaurie, J., Tabah, L., and Sutter, J. (1952). L'isolat esquimau de Thulé (Groenland), *Population*, vol. 7, No.4, pp. 675-712.

Marckwardt, A. and Rutstein, S.O. (1996). Accuracy of DHS-II demographic data: gains and losses in comparison with earlier surveys. DHS Working Papers, No. 19. Calverton, Maryland, USA: Macro International Inc.

Mathews, T.J. and Hamilton B.E. (2009). Delayed childbearing: More women are having their first child later in life. *NCHS Data Brief*, No. 21. Hyattsville, MD, United States: National Center for Health Statistics.

Matthews, Z., Padmadas, S., Hutter, I., McEachran, J., and Brown, J. (2009). Does early childbearing and a sterilization-focused family planning programme in India fuel population growth? *Demographic Research,* vol. 20, No. 28, pp. 693-720. http://www.demographic-research.org/volumes/vol20/28/20-28.pdf

Ministère du Plan et Suivi de la Mise en oeuvre de la Révolution de la Modernité (MPSMRM), Ministère de la Santé Publique (MSP) et ICF International. (2014). *Enquête Démographique et de Santé en République Démocratique du Congo 2013-2014*. Rockville, Maryland, USA: MPSMRM, MSP et ICF International.

Moriyama, I. M. (1990). Measurement of birth and death registration completeness. Technical Papers, No. 43. International Institute for Vital Registration and Statistics 9650 Rockville Pike, Bethesda, Maryland 20814, USA.

Moultrie, T. A., Sayi, T. S., and Timæus, I. M. (2012). Birth intervals, postponement, and fertility decline in Africa: A new type of transition? *Population Studies*, vol. 66, No.3.

Moultrie, T., Dorrington, R., Hill, A., Hill, K., Timæus, I., and Zaba, B. (2013). *Tools for Demographic Estimation*. Paris: International Union for the Scientific Study of Population. http://demographicestimation.iussp.org/

Nove A., Matthews Z., Neal S., and Camacho A. V. (2014). Maternal mortality in adolescents compared with women of other ages: evidence from 144 countries. *Lancet Global Health*, vol. 2, No. 3, pp. e155-e164. doi: 10.1016/S2214-109X (13)70179-7

Ouadah-Bedidi, Z. and Vallin, J. (2013). *Reproduction and politics Fertility and Population Policy in Algeria: The Ironies of Planning*. The 2013 Annual Meeting of Population Association of America.

Poulain, M. and Herm, A. (2013). Central population registers as a source of demographic statistics in Europe. *Population-E*, vol. 68, No. 2, pp. 183-212.

Preston, S., Heuveline, P., and Guillot, M. (2001). *Demography: Measuring and Modeling Population Processes*. Blackwell Publishers. ISBN: 1-55786-451-9.

Prioux, F. (1990). Fertility and Family Size in Western Europe. *Population: An English Selection*, vol. 2, pp. 141-161. Published by: Institut National d'Etudes Démographiques. Stable URL: http://www.jstor.org/stable/2949094

Raftery, A., Alkema, L., and Gerland, P. (2014). Bayesian population projections for the United Nations. *Statistical Science*, No. 29, pp. 58-68.

Romaniuk, A. (1980). Increase in Natural Fertility During the Early Stages of Modernization: Evidence from an African Case Study, Zaire. *Population Studies*, vol. 34, No. 2, pp. 293-310. doi:10.2307/2175188

Rutstein, S.O. and Rojas, G. (2006). *Guide to DHS Statistics*. Demographic and Health Surveys. Calverton, MD: ORC Macro.

Schoumaker, B. (2013). A Stata module for computing fertility rates and TFRs from birth histories: tfr2. *Demographic research*, vol. 28, article 38, pp. 1093-1144. doi: 10.4054/DemRes.2013.28.38 http://www.demographic-research.org/Volumes/Vol28/38/

Schoumaker, B. (2014). *Quality and Consistency of DHS Fertility Estimates, 1990 to 2012*. DHS Methodological Reports No. 12. Rockville, Maryland, USA: ICF International.

Ševčíková, H., Li, N., Kantarová, V., Gerland, P., and Raftery, A. E. (2015). Age-specific mortality and fertility rates for probabilistic population projections, Working paper No. 150, Center for the Statistics and the Social Sciences (CSSS), University of Washington. https://www.csss.washington.edu/Papers/2015/wp150.pdf

Shah, I. H. and Ahman, E. (2012). Unsafe abortion differentials in 2008 by age and developing country region: high burden among young women. *Reproductive Health Matters*, vol. 20, No. 39, pp. 169-173.

Shryock, H. S., Siegel, J. S., and Associates. (1980). The methods *and materials of demography*. U.S. Department of Commerce. Bureau of the Census. Fourth Printing (rev.). U S Government Printing Office Washington, D.C.

Skenderi, A. (2015). Demographic Evidence from Civil Registration Systems. United Nations expert group meeting on strengthening the demographic evidence base for the post-2015 development agenda, New York. http://www.un.org/en/development/desa/population/events/pdf/expert/23/Presentations/EGM-S4-Skenderi%20presentation.pdf

Sneeringer, S. (2009). Fertility transition in sub-Saharan Africa: Comparative analysis of cohort trends in 30 countries. DHS Comparative Reports No. 23. Calverton, MD. http://dhsprogram.com/pubs/pdf/CR23/CR23.pdf

Spoorenberg, T. (2014). Reverse survival method of fertility estimation: An evaluation. *Demographic research*, vol. 31, article 9, pp. 217−246. doi: 10.4054/DemRes.2014.31.9

Turpeinen, O. (1979). Fertility and mortality in Finland since 1750. *Population Studies*, vol. 33, No. 1, pp. 101-14. doi: 10.1080/00324728.1979.10412779.

UNFPA. (2004). *Programme of Action*. Adopted at the International Conference on Population and Development, Cairo, 5. https://www.unfpa.org/sites/default/files/event-pdf/PoA_en.pdf

________(2013*). Adolescent pregnancy: A Review of the Evidence.* https://www.unfpa.org/sites/default/files/pub-pdf/ADOLESCENT%20PREGNANCY_UNFPA.pdf
United Nations. 1963. *Population Bulletin of the United Nations*, vol. 7, New York.

United Nations. (1966). World population prospects, as assessed in 1963. *Population Studies*, No. 41. United Nations, New York.

________(1967). *Manual IV. Methods of Estimating Basic Demographic Measures from Incomplete Data.* ST/SOA/Series A/42 http://ec.europa.eu/eurostat/ramon/statmanuals/files/UNSD_manual4_estimating_demo_figures_from_incomplete_data_EN.pdf

________(1983*). Manual X: Indirect Techniques for Demographic Estimation*. United Nations publication, Sales No. E.83.XIII.2.

________(1994). *Report of the International Conference on Population and Development*. United Nations: A/CONF.171/13/Rev.1.

________(2006). Methodology of the United Nations population estimates and projections. *World Population Prospects: The 2004 Revision* (vol. III). Department of Economic and Social Affairs, Population Division, United Nations, New York.

________(2013). *Adolescent Fertility since the International Conference on Population and Development (ICPD) in Cairo*. Department of Economic and Social Affairs, Population Division, United Nations, New York. http://www.un.org/en/development/desa/population/publications/pdf/fertility/Report_Adolescent-Fertility-since-ICPD.pdf

________(2014). *Principles and Recommendations for a Vital Statistics System*, Revision 3, Department of Economic and Social Affairs, Statistics Division, Statistical Papers, Series M, No. 19/Rev.3, United Nations, New York.

________(2015a). *World Population Prospects: The 2015 Revision.* Department of Economic and Social Affairs, Population Division, United Nations, New York.

________ (2015b). *Trends in Contraceptive Use Worldwide 2015*. Department of Economic and Social Affairs, Population Division, United Nations, New York. http://www.un.org/en/development/desa/population/publications/pdf/family/trendsContraceptiveUse2015Report.pdf

_______ (2015c). *World Fertility Data 2015*. POP/DB/Fert/Rev2015. Department of Economic and Social Affairs, Population Division, United Nations, New York. http://www.un.org/en/development/desa/population/publications/dataset/fertility/wfd2015.shtml.

_______ (2015d). *Demographic Components of Future Population Growth: 2015 Revision*. Department of Economic and Social Affairs, Population Division, United Nations, New York. http://www.un.org/en/development/desa/population/theme/trends/dem-comp-change.shtml

United Nations, General Assembly (2015). *Transforming our world: The 2030 Agenda for Sustainable Development.* A/RES/70/1. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

WHO. (2014). *Adolescent pregnancy*. *Fact sheet N° 364*. http://www.who.int/mediacentre/factsheets/fs364/en/ (accessed October 2016).