Economic & Social Affairs

Changing Levels and Trends in Mortality: the role of patterns of death by cause

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Department of Economic and Social Affairs
Population Division

Changing Levels and Trends in Mortality: the role of patterns of death by cause

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DESA

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PREFACE

The potential to live a long and healthy life is a fundamental aspect of human development. The second part of the twentieth century witnessed enormous progress in improving health and survival around the world. Life expectancy at birth for the world population rose from 48 years in 1950-1955 to 68 years in 2005-2010. However, wide disparities remain in levels of mortality across countries and regions. Those differences reflect inequalities in access to food, safe drinking water, sanitation, medical care and other basic human needs. They also reflect differences in risk factors, behavioural choices and societal contexts that affect the survival of individuals. The reduction of mortality, particularly child and maternal mortality, is part of the internationally agreed development goals, such as those contained in the Programme of Action of the International Conference on Population and Development and in the United Nations Millennium Declaration. The international community has recently focused attention on the challenges to development posed by morbidity and mortality due to the non-communicable diseases as well, in part through the 2011 Political Declaration on the Prevention and Control of Non-communicable Diseases.

To fulfil its task of documenting levels and trends of mortality, the Population Division of the Department of Economic Affairs of the United Nations Secretariat presents this new report entitled "*Changing Levels and Trends in Mortality: the role of patterns of deaths by cause"*. The report aims to describe global and regional levels and trends in life expectancy at birth and assess the contribution of various major causes of death to differences in survival between populations. The analysis incorporates life table values for regions representing 230 countries or areas from the Population Division's *World Population Prospects: The 2010 Revision*, as well as estimates of the distribution of deaths by cause from the World Health Organization's *Mortality estimates by cause, age and sex for the year 2008*. The report provides a detailed analysis of the sex- and age-patterns of mortality that produce regional trends and differences in the levels of life expectancy at birth. In addition, the report contains a decomposition analysis to pinpoint the specific causes of death that are responsible for deficits in survival among populations of selected regions compared to the longest-lived populations in the world.

The Population Division is grateful to the World Health Organization for providing the country-level sex- and age-disaggregated estimates of the number of deaths by cause in 2008. Responsibility for any errors or omissions rests solely with the Population Division.

Inquiries regarding this report may be addressed to the Director, Population Division, Department of Economic and Social Affairs, United Nations Secretariat, New York, N.Y. 10017, fax number (212) 963-2147.

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References to countries, territories and areas:

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

More developed regions comprise all regions of Europe plus Northern America, Australia/New Zealand and Japan.

Less developed regions comprise all regions of Africa, Asia (excluding Japan) and Latin America and the Caribbean, as well as Melanesia, Micronesia and Polynesia.

The designation sub-Saharan Africa is used to indicate all of Africa except Northern Africa. In this report, Sudan is included in Northern Africa.

For analytical purposes, country groupings in the following table have been used. These groupings differ from those normally used in reports of the Population Division/DESA. The changes were made in order to better capture regional similarities in childhood mortality differentials by sex.

The following abbreviations have been used:

AIDS	Acquired Immune Deficiency Syndrome
CHERG	Child Health and Epidemiology Reference Group
COPD	Chronic Obstructive Pulmonary Disease
HIV	Human Immunodeficiency Virus
MDG	Millennium Development Goals
NCDs	Non-communicable diseases
UNPD	United Nations Population Division
WHO	World Health Organization

For analytical purposes, the following country groupings have been used:

1. Less developed regions

Africa

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

Developing Oceania

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

NOTES:

* Indicates a country or area for which the World Health Organization did not produce estimates of the numbers of deaths by cause for 2008.

× Countries or areas with a population of less than 100,000 in 2010. These countries or areas are included in the regional totals of the mortality indicators included in *World Population Prospects: The 2010 Revision*, but are not listed separately.

[§] Including South Sudan.

CLASSIFICATION OF COUNTRIES (*continued*)

Asia

South-Central Asia

Afghanistan
Bangladesh
Bhutan
India
Iran (Islamic Republic of)
Kazakhstan
Kyrgyzstan
Maldives
Nepal
Pakistan
Sri Lanka
Tajikistan
Turkmenistan
Uzbekistan

South-Eastern Asia

Brunei Darussalam
Cambodia
Indonesia
Lao People's Democratic Republic
Malaysia
Myanmar
Philippines
Singapore
Thailand
Timor-Leste
Viet Nam

Western Asia

Armenia
Azerbaijan
Bahrain
Cyprus
Georgia
Iraq
Israel
Jordan
Kuwait
Lebanon
Occupied Palestinian Territory*
Oman
Qatar
Saudi Arabia
Syrian Arab Republic
Turkey
United Arab Emirates
Yemen

Eastern Asia

China
China, Hong Kong SAR*
China, Macao SAR*
Democratic People's Republic of Korea
Japan
Mongolia
Republic of Korea

Latin America and the Caribbean

Caribbean

Anguilla*×
Antigua and Barbuda ×
Aruba*
Bahamas
Barbados
British Virgin Islands*×
Cayman Islands*×
Cuba
Dominica ×
Dominican Republic
Grenada
Guadeloupe*
Haiti
Jamaica
Martinique*
Montserrat*×
Netherlands Antilles*
Puerto Rico*
Saint Kitts and Nevis ×
Saint Lucia
Saint Vincent and the Grenadines
Trinidad and Tobago
Turks and Caicos Islands*×
United States Virgin Islands*

Central America

Belize
Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama

South America

Argentina
Bolivia (Plurinational State of)
Brazil
Chile
Colombia
Ecuador
Falkland Islands (Malvinas)* ×
French Guiana*
Guyana
Paraguay
Peru
Suriname
Uruguay
Venezuela (Bolivarian Republic of)

2. More developed regions

More developed regions, excluding Eastern Europe

Northern Europe

Channel Islands*
Denmark
Estonia
Faeroe Islands*×
Finland
Iceland
Ireland
Isle of Man*×
Latvia
Lithuania
Norway
Sweden
United Kingdom of Great Britain and Northern Ireland

Southern Europe

Albania
Andorra×
Bosnia and Herzegovina
Croatia
Gibraltar*×
Greece
Holy See*×
Italy
Malta
Montenegro
Portugal
San Marino×
Serbia
Slovenia
Spain
The former Yugoslav Republic of Macedonia

Western Europe

Austria
Belgium
France
Germany
Liechtenstein*×
Luxembourg
Monaco ×
Netherlands
Switzerland

Northern America

Bermuda*×
Canada
Greenland*×
Saint Pierre and Miquelon*×
United States of America

Other more developed countries

Australia
Japan
New Zealand

Eastern Europe

Belarus
Bulgaria
Czech Republic
Hungary
Poland
Republic of Moldova
Romania
Russian Federation
Slovakia
Ukraine

"Longest-lived" populations
(countries or areas with life expectancy at birth greater than 80 years in 2005-2010)

Australia
Austria
Canada
China, Hong Kong SAR*
China, Macao SAR*
France
Iceland
Israel
Italy
Japan
Martinique*
Netherlands
New Zealand
Norway
Republic of Korea
Singapore
Spain
Sweden
Switzerland

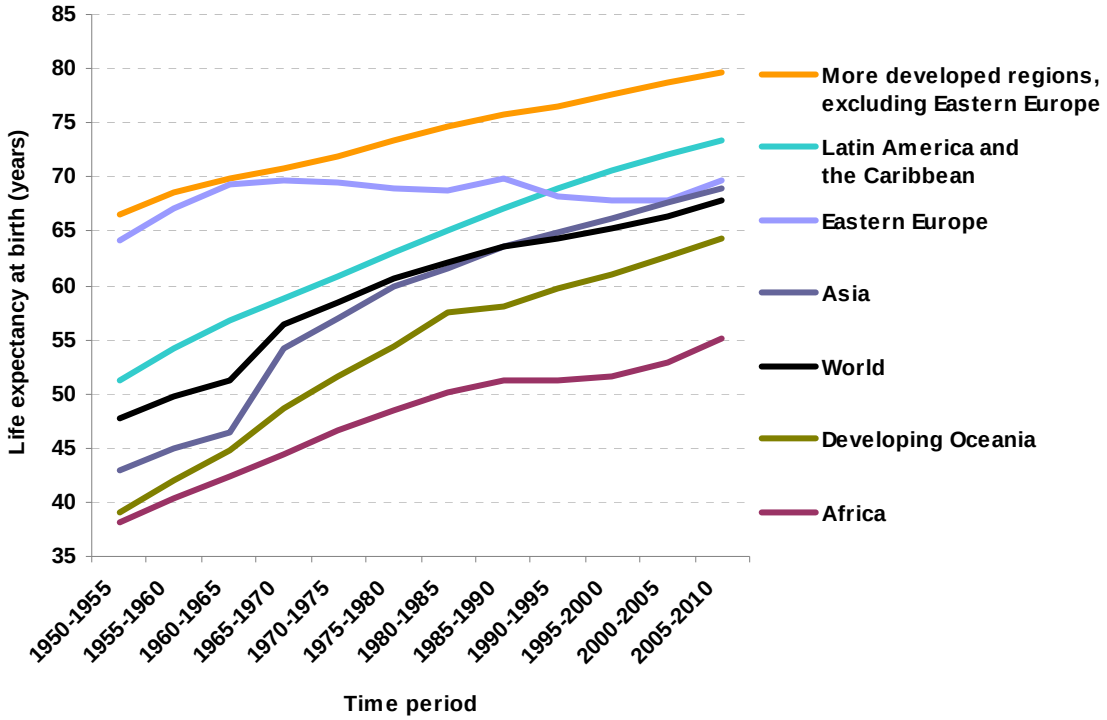
EXECUTIVE SUMMARY

1. The ability to enjoy a long and healthy life is a critical component of the development process. Over the past 60 years a growing proportion of the world's population has come closer to that goal as tremendous gains in survival have been achieved, with life expectancy for the world's population increasing from 48 years in 1950-1955 to 68 years in 2005-2010 according to estimates presented in the United Nations' *World Population Prospects: The 2010 Revision*. This trend reflects reductions in mortality rates, which, together with declining fertility, mark progress through the demographic transition.

2. While each of the world's regions has achieved gains in survival, the pace of improvement has varied such that the average length of life among populations of the less developed regions continues to lag well behind that of the more developed regions. By 2005-2010, life expectancy at birth in the "more developed regions, excluding Eastern Europe" had surpassed 80 years, while the average length of life was 6 years shorter in Latin America and the Caribbean, 11 years shorter in Asia, 15 years shorter in developing Oceania and nearly 25 years shorter in Africa (figure I).

3. The disparities in survival across the world's regions are indicative of differential progress through the demographic transition. Many developed countries began their transitions in the 19th century and by the mid-20th century were already in the advanced stages of the transition with fertility rates close to or below the replacement level of 2.1 children per woman, on average, and life expectancy at birth exceeding 70 years. Most developing countries initiated their transitions

Figure I. Life expectancy at birth for the world and selected regions, 1950-1955 to 2005-2010



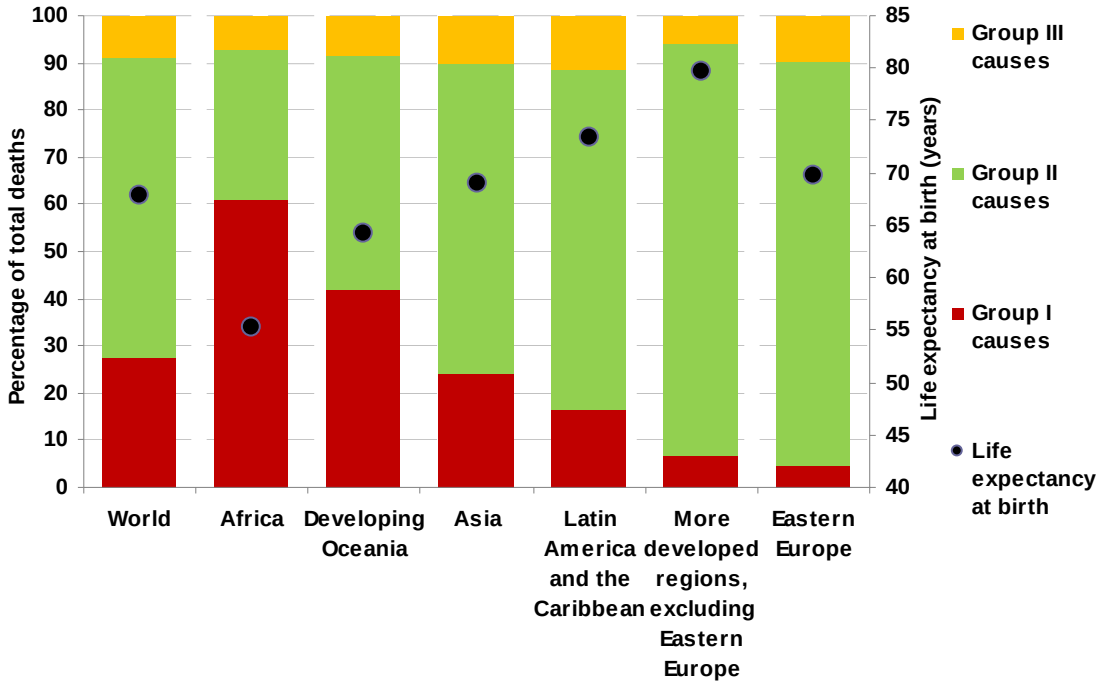
Source: World Population Prospects: The 2010 Revision (United Nations publication, ST/ESA/SER.A/306).

somewhat later than the developed countries and while many had achieved substantial progress in survival by 2005-2010—particularly in parts of Latin America and the Caribbean, Asia, and Northern Africa—others continued to experience persistent high fertility and mortality. Eastern Europe, despite having achieved relatively high life expectancy at birth by the mid-century, experienced stalled progress in survival such that life expectancy in 2005-2010 at just under 70 years was no higher than 40 years earlier.

4. Underlying improvements in longevity that occur with the demographic transition is a common pattern of change in the cause-specific mortality risks over time that has been observed in many of the world's populations. This pattern, known as the epidemiologic transition, is characterized by initial declines in the rates of death due to communicable diseases in the early stages of the transitions, which are followed by subsequent reductions in mortality attributable to non-communicable diseases (NCDs) in the advanced stages of the transitions.

5. The WHO cause of death estimates indicate that in 2008 in the "more developed regions, excluding Eastern Europe" less than 10 per cent of all deaths were attributable to Group I causes, which include communicable diseases as well as maternal, perinatal and nutritional conditions (figure II). Group II causes of death, which comprise NCDs, were responsible for 80 per cent of deaths in the "more developed regions, excluding Eastern Europe", while Group III causes, which include injuries (external causes of death), accounted for the remaining 7 per cent of mortality. Together with the high life expectancy at birth, this pattern of deaths by cause reveals that this group of countries as a whole is in the advanced stages of the demographic and epidemiologic transitions.

Figure II. Percentage distribution of deaths by group of causes, 2008, and life expectancy at birth, 2005-2010, for the world and selected regions



Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

6. In stark contrast, Group I causes of death continued to be responsible for a large proportion of mortality in several regions where life expectancy at birth was substantially lower than in the more developed regions. In Africa, the region of the world with the lowest life expectancy at birth at 55 years, the majority of deaths in 2008 (61.0 per cent) was due to Group I health conditions, while the NCDs in Group II and the injuries in Group III accounted for 32.0 per cent and 7.0 per cent of deaths respectively. The high concentration of deaths from Group I conditions in Africa indicates that the region is still in the early stages of the epidemiologic transition. The populations of developing Oceania, Asia, and Latin America and the Caribbean were more advanced in their demographic and epidemiologic transitions relative to Africa, with higher life expectancies at birth and lower percentages of deaths due to Group I causes (and thus greater percentages of deaths due to Group II causes).

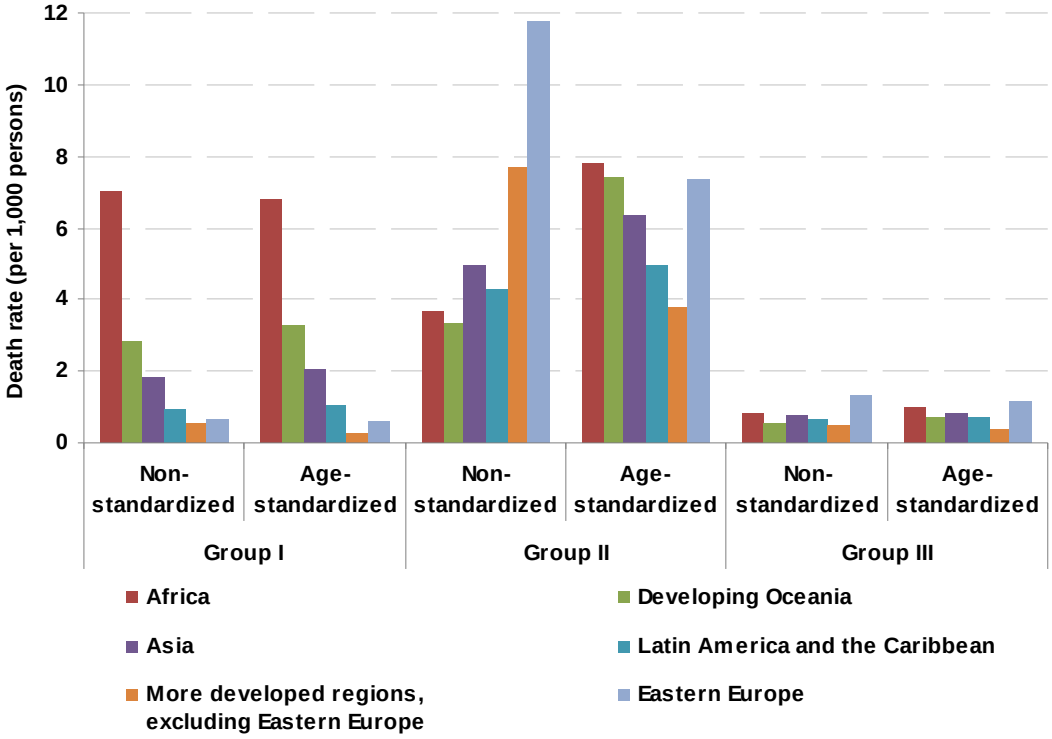
7. The mortality patterns of Eastern Europe have deviated from the patterns typical of the demographic and epidemiologic transitions. Despite having a smaller proportion of deaths attributable to Group I causes compared to the "more developed regions, excluding Eastern Europe", Eastern Europe lagged behind in terms of life expectancy at birth as a consequence of excess mortality due to NCDs occurring among adults aged 30 years and above.

8. The distribution of deaths by cause group that is characteristic of the epidemiologic transition shown in figure II influences the improvements in survival observed during the demographic transition. In turn, the cause-specific mortality risks experienced in a population are shaped by the shifts in population age structure that occur during the demographic transition. As fertility rates fall and survival improves through the transition, the size of each successive birth cohort shrinks relative to the size of the parental generations such that, over time, an increasing proportion of the population is concentrated at older ages. Because the risk of death from NCDs increases with age, in part because exposures to NCD risk factors—such as tobacco and alcohol use, unhealthy diets and physical inactivity—accumulate over the life course, populations with relatively old population age structures tend to experience a greater percentage of deaths due to Group II causes (NCDs).

9. Standardizing cause-specific mortality rates by age permits an assessment of the degree to which the disparities in cause-specific mortality observed across regions are due to differences in the respective age structures of the populations. As shown in figure III, the ranking of regions by the non-standardized Group I death rate and the corresponding age-standardized Group I death rate are identical, thus the fact that Africa's mortality rate due to Group I causes is nearly four times higher than in Asia and seven times higher than in Latin America and the Caribbean cannot be attributed to Africa's relatively youthful population age structure. Rather, other factors related to the physical and social environment and the capacity of health systems to prevent and treat illness likely account for the greater risk of mortality due to Group I causes in Africa.

10. In direct contrast to the conclusion drawn for Group I causes, the ranking of regions by the Group II death rate reverses after age-standardizing the cause-specific mortality rates (figure III). The non-standardized death rates indicate that the risk of mortality due to Group II causes in Africa was about half the risk in the "more developed regions, excluding Eastern Europe", but removing the effect of population age structure yields an age-standardized Group II death rate in Africa that was close to double that of the "more developed regions, excluding Eastern Europe". These patterns indicate that the main reason the "more developed regions, excluding Eastern Europe", experienced much higher death rates from NCDs than other regions is that the corresponding population was relatively old. Once the influence of age structure was removed, the risk of dying from a NCD was actually higher in populations with relatively young age structures, namely Africa, developing Oceania and Asia.

Figure III. Non-standardized and age-standardized death rates by group of causes for selected regions, 2008



Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

11. To assess the contributions of the specific causes of death to disparities in longevity across the world's regions at different stages of their demographic and epidemiologic transitions, a decomposition analysis was undertaken, uniting age-specific mortality estimates for the period 2005-2010 from *World Population Prospects: The 2010 Revision* with estimates of the distribution of deaths by cause in 2008 from the WHO. Estimates of the age- and cause-specific mortality rates in selected regions were compared to those of the world's "longest-lived" populations (countries or areas with life expectancy at birth greater than 80 years in 2005-2010) in order to identify the various causes of death that were causing regions to lag behind in terms of longevity. This approach differs from a traditional comparison of cause-specific mortality rates by focusing on the potential gain in life expectancy at birth each region would achieve by reducing their cause-specific mortality rates to the levels estimated in the "longest-lived" populations.

12. Many countries lack complete coverage of deaths through vital registration and, even where vital registration coverage is good, the reporting of cause-of-death on death certificates often suffers from inaccuracies. As a consequence, the mortality and cause of death estimates produced by the United Nations Population Division and the WHO, respectively, for many countries rely upon models that relate available measurements of mortality to what has been observed in other populations in the past. These models incorporate various assumptions about typical patterns of mortality by age, sex and cause of death. The results of the decomposition analysis must thus be interpreted with an appreciation of the high degree of uncertainty associated with the estimates of mortality levels and the distribution of deaths by cause in many countries and especially in regions where mortality is highest.

13. Results of the analysis illustrate the impact of the three groups of causes of death in preventing the populations of many of the world's regions from enjoying the same longevity as the world's "longest-lived" populations (figure IV) and point to the specific causes of death that must be addressed in each region to advance progress through the demographic and epidemiologic transitions (table I). Highlights from the conclusions are listed below.

    a. In Africa, if mortality rates due to Group I causes were to fall to equal those in the "longest-lived" populations, the region would achieve a 17-year increase in life expectancy at birth, from 55 years to 72 years. Across Africa's five regions, the gains to be had from such a reduction in Group I mortality range from 4 years in Northern Africa to 23 years in Southern Africa.

    b. In both Southern Africa and Eastern Africa, HIV/AIDS was the leading cause of the gap in life expectancy relative to the "longest-lived" populations, causing shortfalls in survival of 14.2 years and 5.3 years, respectively. Pneumonia, diarrhoeal diseases and perinatal conditions were the other Group I causes of death that ranked among the top five contributors to the survival gaps across all five African regions.

    c. While Group I causes accounted for most of Africa's lower survival compared to the "longest-lived" populations, excess mortality due to Group II NCDs was responsible for a substantial proportion of the shortfall in life expectancy at birth as well, ranging from 6 years in Southern Africa to nearly 9 years in Middle Africa. Heart diseases were the leading Group II causes of the survival gaps, responsible for 2.2 years of lost life expectancy at birth in Southern Africa, up to 4.3 years of lost life expectancy at birth in Northern Africa.

    d. All three groups of causes contributed importantly to the difference in life expectancy at birth between developing Oceania and the "longest-lived" populations. Close to 46 per cent of the 17-year gap was due to Group I causes, 49 per cent to Group II NCDs, and 5 per cent to Group III injuries. Heart diseases were the leading cause of the shortfall in survival in developing Oceania, responsible for 4.3 years of the total gap. Perinatal conditions, pneumonia, stroke, and chronic obstructive pulmonary disease (COPD) also ranked among the top five causes in terms of their contributions to the survival gap in developing Oceania.

    e. Similar to developing Oceania, in South-central Asia and South-eastern Asia, large portions of the survival gaps continued to be attributable to excess mortality due to Group I causes, such as pneumonia and diarrhoeal diseases, at the same time that Group II NCDs like heart diseases, stroke and COPD were exacting an impact on survival deficits. In South-central Asia, although Group I causes were responsible for more than half of the 17-year shortfall in life expectancy at birth relative to the "longest-lived" populations, heart diseases in Group II were the single greatest contributor to the gap. If South-central Asia were to reduce heart disease mortality rates to equal those in the "longest-lived" populations, it would advance life expectancy at birth by 2.7 years. A comparable gain (2.4 years) would be achieved in South-eastern Asia with a similar reduction in heart disease mortality.

    f. Regions of Asia that have successfully reduced death rates from Group I causes of death to close to the levels achieved in the "longest-lived" populations, including Western Asia and Eastern Asia, still experienced excess mortality due to NCDs. In Western Asia, heart diseases were the leading source of the survival gap, responsible for a 4.5-year deficit in

g. Each of the three regions of Latin America and the Caribbean faces its own unique epidemiologic risk profile. In both the Caribbean and South America, heart diseases were the number one contributor to the deficits in life expectancy at birth relative to the "longest-lived" populations. However, while in South America NCDs accounted for more than half of the 8-year total survival gap, these Group II causes of death accounted for only 35 per cent of the total gap in the Caribbean. The Caribbean region additionally counted Group I causes such as HIV/AIDS and pneumonia among the leading challenges to progress in longevity.

h. Central America was the only region of the world where diabetes and nutritional deficiencies ranked among the top five causes of death contributing to the survival gap. If Central America were to reduce mortality rates from diabetes to equal those in the "longest-lived" populations, it would achieve a 1.5-year gain in average survival, bringing the life expectancy at birth close to 77 years.

i. At 16 per cent, the proportion of the survival gap due to Group III injuries in South America was larger than in any other region other than Eastern Europe. Excess mortality due to homicide accounted for most of this phenomenon. South America would gain close to 0.8 years of life expectancy at birth by reducing homicide rates to equal those in the "longest-lived" populations. Homicide was among the top five causes of death responsible for the survival gap in Central America as well, contributing to 0.6 years of the deficit in life expectancy at birth.

j. Within the more developed regions, the mortality risks posed by the NCDs constitute the biggest challenge to further improvements in longevity. Group II causes accounted for close to 86 per cent of the 1.7-year survival gap between the "more developed regions, excluding Eastern Europe" and the "longest-lived" populations. Heart diseases were responsible for the majority of that deficit: the "more developed regions, excluding Eastern Europe" would gain 0.9 years of life expectancy at birth by reducing death rates due to heart diseases to equal those in the "longest-lived" populations.

k. With life expectancy at birth that was nearly 12 years shorter than in the "longest-lived" populations, Eastern Europe was faced with high risks of mortality due to both NCDs and injuries. Heart diseases alone accounted for half of Eastern Europe's total survival gap: the region would achieve a 5.9-year gain in life expectancy at birth by reducing mortality from heart diseases to equal that in the "longest-lived" populations. Injuries contributed 18 per cent of Eastern Europe's survival gap, more than in any other region, with road traffic accidents and poisonings accounting for much of the excess mortality in this category.

Figure IV. Years of life expectancy at birth to be gained by reducing cause group-specific death rates to equal those in the "longest-lived" populations, 2005-2010

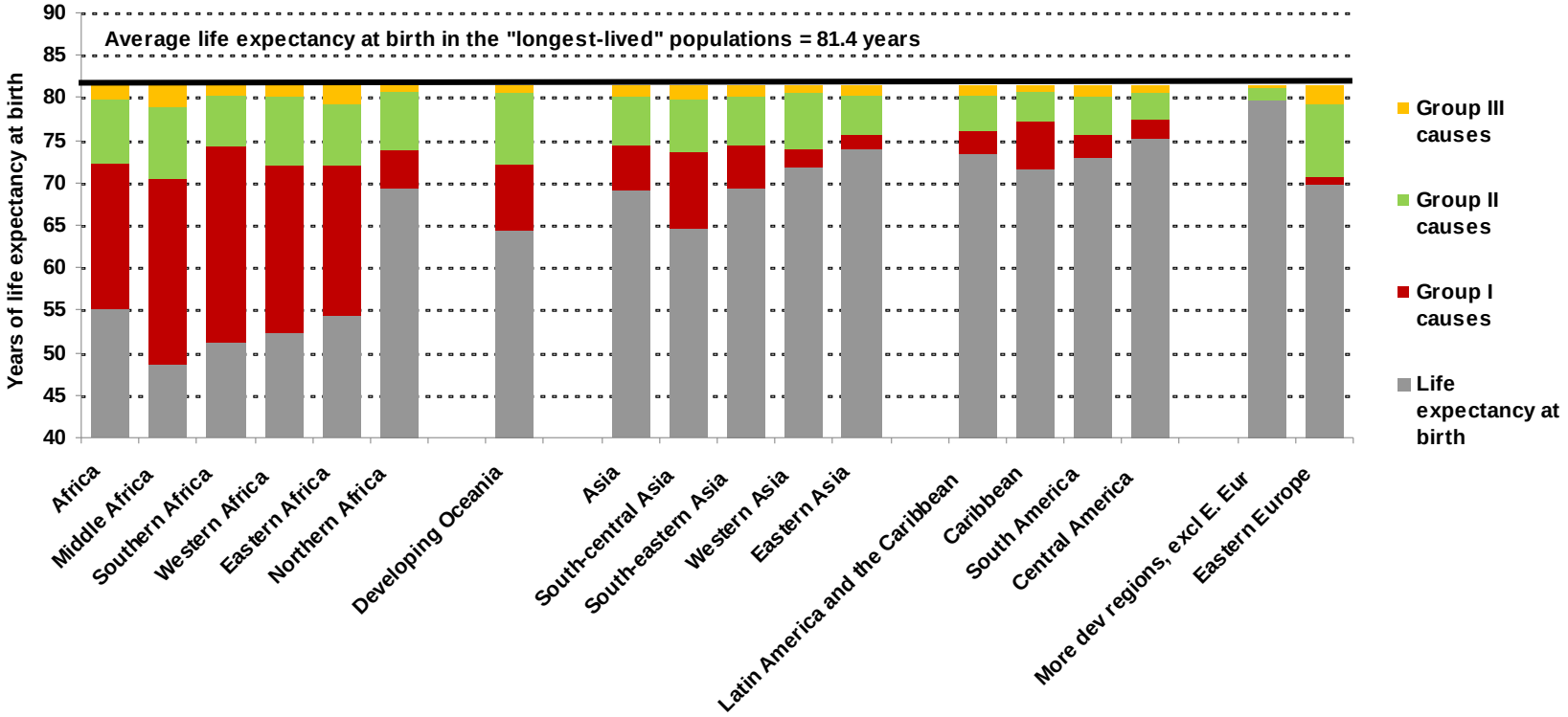


TABLE I. LEADING CAUSES OF DEATH CONTRIBUTING TO THE DIFFERENCE IN LIFE EXPECTANCY AT BIRTH (SURVIVAL GAP) BETWEEN SELECTED REGIONS AND THE "LONGEST-LIVED" POPULATIONS, 2005-2010

Rank	*Cause of death*	*Survival gap (years*	*Rank*	*Cause of death*	*Survival gap (years)*	*Rank*	*Cause of death*	*Survival gap (years*	*Rank*	*Cause of death*	*Survival gap (years)*
					Less developed regions						
	Africa			*Developing Oceania*			*Asia*			*Latin America and the Caribbean*	
	Middle Africa						*South-central Asia*			*Caribbean*	
1	Pneumonia	4.7	1	Heart diseases	4.3	1	Heart diseases	2.7	1	Heart diseases	1.9
2	Perinatal cond.	4.1	2	Perinatal cond.	1.8	2	Perinatal cond.	2.6	2	Perinatal cond.	1.4
3	Heart diseases	3.4	3	Pneumonia	1.8	3	Diarrhoeal disease	2.4	3	HIV/AIDS	1.0
4	Diarrhoeal disease	3.1	4	Stroke	1.6	4	COPD	2.0	4	Stroke	0.9
5	HIV/AIDS	2.8	5	COPD	0.8	5	Pneumonia	1.7	5	Pneumonia	0.9
	Southern Africa						*South-eastern Asia*			*South America*	
1	HIV/AIDS	14.2				1	Heart diseases	2.4	1	Heart diseases	1.7
2	Pneumonia	2.8				2	Stroke	1.6	2	Perinatal cond.	1.0
3	Heart diseases	2.2				3	Pneumonia	1.5	3	Homicides	0.8
4	Perinatal cond.	2.0				4	Perinatal cond.	1.3	4	Stroke	0.6
5	Diarrhoeal disease	1.9				5	Tuberculosis	0.9	5	Pneumonia	0.6
	Western Africa						*Western Asia*			*Central America*	
1	Perinatal cond.	3.7				1	Heart diseases	4.5	1	Diabetes	1.5
2	Pneumonia	3.7				2	Stroke	1.6	2	Heart diseases	1.1
3	HIV/AIDS	3.3				3	Perinatal cond.	1.3	3	Perinatal cond.	0.8
4	Heart diseases	3.2				4	COPD	0.5	4	Homicides	0.6
5	Diarrhoeal disease	2.7				5	Pneumonia	0.4	5	Nutritional def.	0.4
	Eastern Africa						*Eastern Asia*				
1	HIV/AIDS	5.3				1	Stroke	2.4			
2	Perinatal cond.	3.2				2	COPD	1.8			
3	Pneumonia	3.0				3	Perinatal cond.	0.8			
4	Heart diseases	2.9				4	Heart diseases	0.7			
5	Diarrhoeal disease	2.2				5	Cancers	0.4			
	Northern Africa										
1	Heart diseases	4.3									
2	Perninatal cond.	1.7									
3	Stroke	1.4									
4	Pneumonia	1.1									
5	Diarrhoeal disease	0.6									
					More developed regions						
				More developed regions, excluding Eastern Europe			*Eastern Europe*				
			1	Heart diseases	0.9	1	Heart diseases	5.9			
			2	COPD	0.2	2	Stroke	2.4			
			3	Perinatal cond.	0.1	3	HIV/AIDS	0.6			
			4	Road traffic acc.	0.1	4	Road traffic acc.	0.3			
			5	Homicides	0.1	5	Perinatal cond.	0.3			

COPD: Chronic Obstructive Pulmonary Disease
Perinatal cond: Perinatal conditions
Road traffic acc.: Road traffic accidents

I. INTRODUCTION

Recent decades have witnessed tremendous advancements in health and survival throughout the world. According to the United Nations' *2010 Revision* of *World Population Prospects*, life expectancy at birth for the world's population as a whole rose from 48 years in 1950-1955 to 68 years in 2005-2010. Yet, while longevity has improved in virtually all of the world's populations, progress in some regions has outpaced that in others. Asia, for example, saw a 26-year increase in life expectancy at birth, from 43 years in 1950-1955 to 69 years in 2005-2010, while in Africa the average length of life increased by 17 years over the last half century, from 38 years in 1950-1955 to 55 years in 2005-2010.

Together with declining fertility, improvements in survival are a marker of a population's progress through the demographic transition. Underlying those gains in longevity is a common pattern in cause-specific mortality known as the epidemiologic transition, whereby initial declines in the rates of death due to communicable diseases in the early stages of the transitions are followed by subsequent reductions in mortality attributable to non-communicable diseases (NCDs) in the advanced stages of the transitions. Differential risks of cause-specific mortality thus explain the persistent disparities in the pace of improvements in survival across the world's populations. Countries that have reduced the risk of childhood death from pneumonia and diarrhoeal diseases, for example, have achieved more rapid gains in longevity and advanced further through their demographic and epidemiologic transitions compared to those countries that continue to face large burdens of those infections.

The international community has intensified its focus on global disparities in health and survival in recent years. The roles of selected infectious causes of death, such as HIV/AIDS, malaria and tuberculosis, in impeding progress in survival in many of the world's less developed regions has received unprecedented attention, particularly through the Millennium Development Goals framework. Consequently, declining death rates due to these causes have ensued. More recently, the international community has highlighted the role of increasing incidence of NCDs as well in further exacerbating the survival disadvantages experienced in less developed regions (Geneau and others, 2010). The *Political Declaration of the High-Level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases*[1] adopted in September 2011 identified prevention as the cornerstone of the global response to NCDs and advocated multi-sectoral action to reduce morbidity and mortality due to NCDs in both developed and developing regions.

This report examines the patterns in the distribution of various causes of death that produce differences in longevity across populations. Drawing primarily on the population and mortality estimates produced by the United Nations Population Division in *World Population Prospects: The 2010 Revision* together with estimates of the number of deaths by cause in 2008 produced by the World Health Organization (WHO)[2], this report identifies the roles of communicable diseases, non-communicable diseases, and injuries, among other major causes of death in producing the patterns of mortality observed in the demographic transition process. The report is organized in two parts. First, the changes in overall and age-specific mortality patterns that characterize the demographic transition are described and related to the shifting pattern in the distribution of deaths by broad cause groups that is a hallmark of the epidemiologic transition model. Second, the roles of the specific major causes of death in contributing to global disparities in survival are explored. The report highlights how persistently large burdens of communicable diseases, including HIV/AIDS, together with premature mortality due to NCDs, impede progress through the demographic and epidemiologic transitions in many populations. This "double burden" of communicable and non-communicable disease mortality is responsible for the survival disadvantages experienced by many of the populations of the world's less developed regions.

[1] A/66/L.1

[2] World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

II. UNDERSTANDING MORTALITY PATTERNS THROUGH THE LENSES OF THE DEMOGRAPHIC AND EPIDEMIOLOGIC TRANSITIONS

The demographic transition theory describes the typical trends in mortality by age that produce improvements in longevity over time.

A. THE DEMOGRAPHIC TRANSITION

Historically, populations have tended to shift over time from being characterized by high fertility and mortality to low fertility and mortality. This process, known as the demographic transition, is a fundamental component of development (Dyson, 2010) that occurs often, but not always, in tandem with economic growth (Caldwell, 2006). The demographic transition began among many countries of the more developed regions of the world during the 19th century and, during the 20th century, most countries of the less developed regions initiated their transitions as well. Fertility decline is a key feature of the demographic transition: pre-transition societies are characterized by high fertility – in excess of 5 or 6 children per woman, on average – and, through the transition, fertility declines toward the replacement level of 2.1 children per women or even lower. Mortality decline is a second key feature of the demographic transition: pre-transition societies are marked by high mortality rates among all age groups, but as the transition progresses, mortality rates fall, first among children and gradually among adults as well.

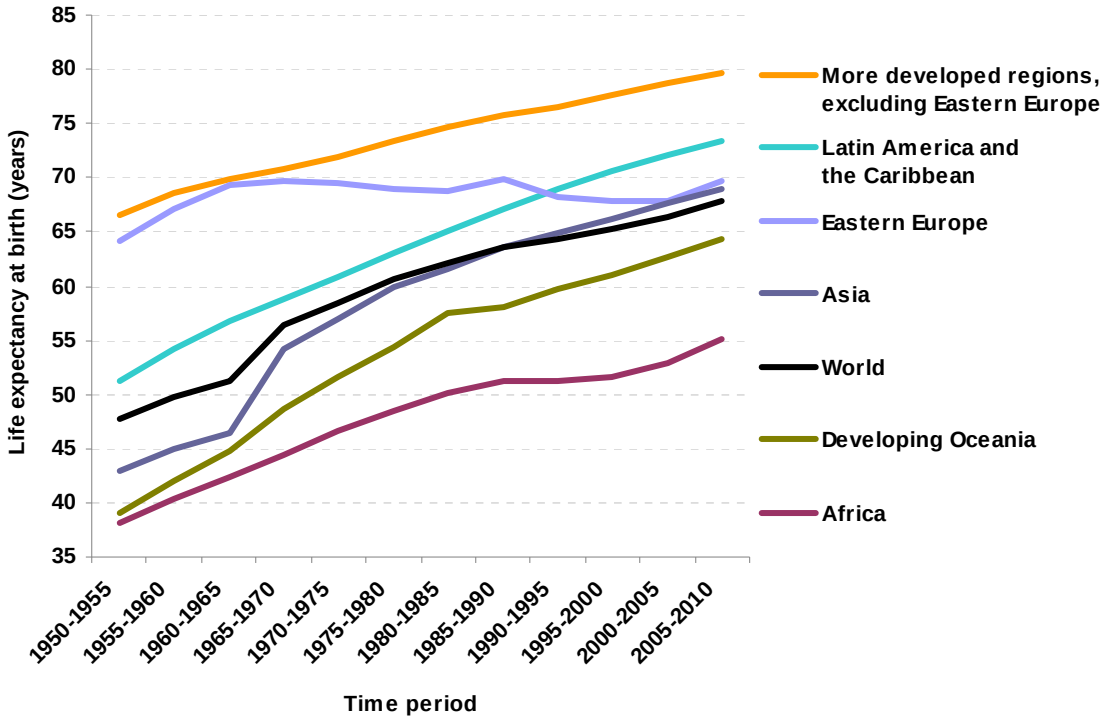
Mortality declines that have taken place through the demographic transition are partly depicted figure II.1, which displays estimated levels and trends in life expectancy at birth[4] over the past 60 years for selected groups of countries or regions.[5] For the world's population as a whole, life expectancy at birth increased from 48 years in 1950-1955 to 68 years in 2005-2010. Asia was the region with the largest increase in life expectancy, from 43 years in 1950-1955 to 69 years in 2005-2010. Latin America and the Caribbean also saw large gains in survival over the last half century, with an increase in life expectancy from 51 years in 1950-1955 to 73 years in 2005-2010. In 1950-1955 developing Oceania (including the populations of Melanesia, Micronesia and Polynesia) and Africa were the regions of the world with the lowest life expectancies at birth at 39 years and 38 years respectively and, despite progress, both regions continue to lag behind the rest of the world in terms of survival. Developing Oceania witnessed a 25-year increase in life expectancy by 2005-2010, while in Africa, life expectancy at birth advanced by 17 years over the same period. In the "more developed regions, excluding Eastern Europe," average life expectancy at birth exceeded 66 years in 1950-1955 and gains in survival were somewhat slower than those in many of the other groups of countries shown in figure II.1, with life expectancy increasing to 80 years in 2005-2010.

Trends in survival in Eastern Europe deviate markedly from the average of the more developed regions and thus are shown separately in figure II.1. Life expectancy at birth increased in Eastern Europe over the period 1950-1955 to 1965-1970 from 64 years to 70 years, but then stagnated and even declined somewhat at various periods over the next several decades. By 2005-2010, life expectancy at birth in Eastern Europe was 70 years, no higher than the level estimated in 1965-1970.

[4] Throughout this report, all mortality indicators are for both sexes combined, unless otherwise specified.

[5] The groups of countries shown in figure II.1 are selected for the purposes of illustration. The more developed regions include the populations of all regions of Europe, Northern America, as well as Japan, Australia and New Zealand. Eastern Europe is shown separately from the rest of the countries in the more developed regions because its mortality patterns and trends differ markedly from those countries. "Developing Oceania" includes all countries of Oceania with the exceptions of Australia and New Zealand. Japan is included in two of the groups of countries depicted in figure II.1: Asia and the group of countries that comprise the more developed regions, excluding Eastern Europe. Excluding Japan from the Asia group yields only a small change in the estimated life expectancy at birth from 69.0 years in 2005-2010 for Asia including Japan to 68.4 years for Asia excluding Japan.

Figure II.1. Life expectancy at birth for the world and selected regions, 1950-1955 to 2005-2010



Source: World Population Prospects: The 2010 Revision (United Nations publication, ST/ESA/SER.A/306).

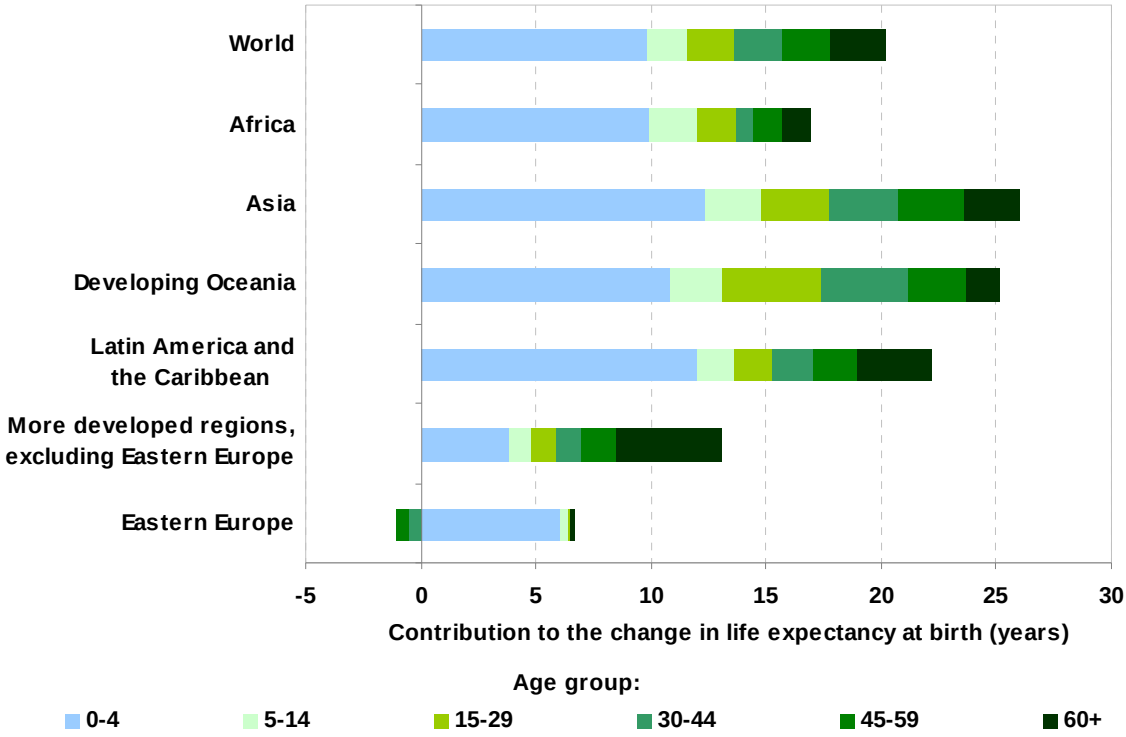
When life expectancy improves, it is nearly always the result of progress in survival among both children and adults, but the relative contribution of the different age groups changes according to the stage of the demographic transition. In populations with low life expectancy at birth in the early stages of their demographic transitions, the proportion of progress in longevity that is due to improvements in survival among children tends to outweigh that that is attributable to improvements among adults. As life expectancy at birth increases, the marginal improvement contributed by progress in survival in each age group shifts towards older ages.

Figure II.2 illustrates this phenomenon by decomposing the changes in the levels of life expectancy at birth between 1950-1955 and 2005-2010 according to the contributions of mortality decline in the various age groups[6]. Because the decomposition reflects estimated trends in age-specific mortality based on demographic back-projection techniques for some periods in certain countries, the results presented in figure II.2 should be interpreted with some caution.

The analysis reveals that with the exception of Eastern Europe, each of the regions shown in figure II.2 achieved improvements in survival among all age groups over the period 1950-1955 to 2005-2010. In regions that had low life expectancy at birth in 1950-1955—including Africa, developing Oceania, Asia, and Latin America and the Caribbean—the majority of gains in survival to 2005-2010 were achieved through reductions in mortality below the age of 15. In Africa, for example, 59 per cent of the 17-year gain in life expectancy between 1950-1955 and 2005-2010 was due to mortality decline among children under five. Another 12 per cent of that gain was due to improvements in survival between ages 5 and 14, while the other

[6] The decomposition methodology is described in Preston, Heuveline and Guillot (2001), pp. 64-5.

Figure II.2. Contribution of age-specific mortality decline to the change in life expectancy at birth between 1950-1955 and 2005-2010 for the world and selected regions



Source: World Population Prospects: The 2010 Revision (United Nations publication, ST/ESA/SER.A/306).

four age groups each contributed less than 10 per cent of overall improvement in life expectancy. In regions that were already more advanced through the stages of their demographic transitions by 1950-1955, represented here by the "more developed regions, excluding Eastern Europe," the pattern of improvement has been quite different. In these regions survival above age 60 accounted for a far greater proportion of overall gains in life expectancy over the last half century: 35 per cent of the 13-year increase in life expectancy was attributable to survival gains above age 60.

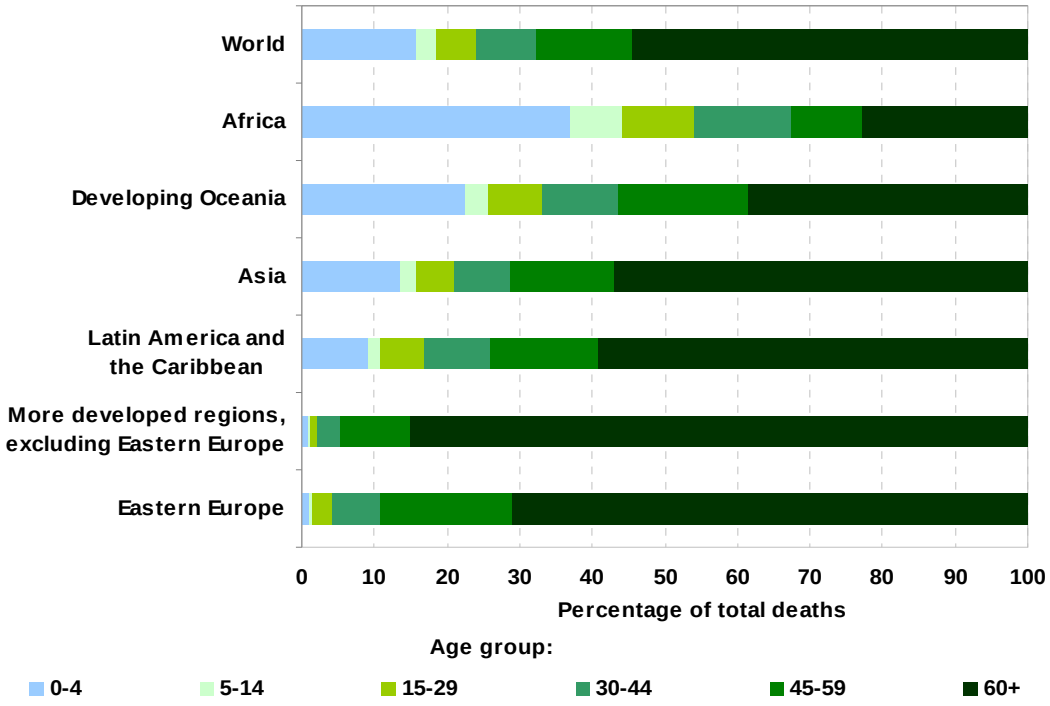
Despite having had life expectancy above 60 years in 1950-1955, the pattern of age contribution to improvements in longevity in Eastern Europe differs substantially from that of the other countries in the more developed regions. Only 0.1 year of the total 5.6-year gain in life expectancy over the period 1950-1955 to 2005-2010 in Eastern Europe was attributable to mortality decline above age 60. Because mortality rates among adults aged 30-59 actually increased in Eastern Europe over that period, these age groups contributed to a loss of life expectancy of just over 1 year, while improvements in survival of children under five accounted for nearly all of the gain in life expectancy at birth. But although deviations from the typical course of mortality decline can occur (Caselli and others, 2002), as is the case in Eastern Europe, figure II.2 illustrates how the usual course of the demographic transition is characterized by mortality decline among all age groups, with reductions in death rates among children dominating survival improvements in the early stages of the transition and mortality decline among older adults becoming increasingly dominant in the advanced stages of the transition.

Together, falling fertility and mortality rates produce a third key feature of the demographic transition: population ageing. Early in the transition, large birth cohorts coupled with low probabilities of survival to old age mean that a larger proportion of the population is concentrated in young age groups compared to older age groups. As birth cohorts shrink relative to the size of their parents' generation and as longevity increases such that survival to old age becomes common, children make up a declining proportion of the population, while the share contributed by older age groups grows. Declining mortality rates among young people, together with population ageing, yields an increasing concentration of deaths at older ages as populations progress through the demographic transition.

Figure II.3 displays the age distribution of deaths over the period 2005-2010 for the world and selected regions. In Africa, the region of the world with the lowest life expectancy at birth and thus earliest in its demographic transition, 37 per cent of deaths took place among children under five, while 22 per cent occurred among adults aged 60 or over. Regions with higher life expectancy at birth experienced a smaller proportion of total deaths among children and a larger proportion among adults aged 60 or over. In Asia, for example, 14 per cent of deaths were to children under five and 57 per cent were to older adults, while in the "more developed regions, excluding Eastern Europe," less than 1 per cent of deaths were to children under five and 85 per cent were concentrated among adults over 60.

Eastern Europe departs from the typical pattern of the demographic transition, with a smaller proportion of deaths occurring among children under five (1 per cent) compared to Latin America and the Caribbean (9 per cent) where life expectancy is higher. Notably, the proportion of deaths occurring between the ages of 45 and 59 is higher in Eastern Europe at 18 per cent than in all of the other regions shown in figure II.3, reinforcing the evidence that stalled progress in longevity in Eastern Europe is not a result of persistent high mortality among children, but rather is attributable to mortality risks in adulthood.

Figure II.3. Percentage distribution of deaths by age group for the world and selected regions, 2005-2010



Source: World Population Prospects: The 2010 Revision (United Nations publication, ST/ESA/SER.A/306).

The increasing concentration of deaths at older ages that occurs as populations age through the demographic transition is a key phenomenon contributing to the changing patterns of deaths by cause, as is explored in the discussion that follows.

The epidemiologic transition characterizes changes in the predominant causes of death that occur as life expectancy increases.

B. THE EPIDEMIOLOGIC TRANSITION

Underlying patterns of mortality decline that occur with the demographic transition is a change in the distribution of deaths by cause away from a pattern dominated by communicable diseases toward one in which non-communicable diseases account for the overwhelming majority of deaths. This process, known as the epidemiologic transition, was first elaborated by Abdel Omran in 1971. He described, for example, how infectious diseases, including tuberculosis and diarrhoeal diseases among others, accounted for more than half of all deaths in England and Wales around the mid-19th century. The contributions of these causes to overall mortality declined dramatically over the next 100 years however, such that by the mid-20th century they accounted for around one in ten deaths. A similar transition was observed in Japan, although it occurred somewhat later and over a shorter period of time compared to that in England and Wales. Infectious diseases accounted for approximately 40 per cent of all deaths in Japan around 1945, but by 1964 their contribution had fallen to less than 10 per cent of overall mortality (Omran, 1971).

Examinations of vital statistics records detailing the causes of death in many countries demonstrate that the timing and pace of the epidemiologic transition, like the demographic transition, have varied markedly across populations. Among those countries that initiated their epidemiologic transitions in the mid-19th century, the declining burden of infectious diseases and increasing predominance of non-communicable diseases occurred gradually over a period of around 100 years. In contrast, countries that began their transitions in the mid-20th century or later have tended to progress much more rapidly. In Sri Lanka, for example, where the epidemiologic transition began around 1940, the proportion of deaths due to infectious diseases declined by about 20 percentage points (from around 40 per cent to around 20 per cent) in just 25 years (Omran, 1971).

Estimates of the distribution of deaths by cause shed light on various populations' stages within the epidemiologic transition. The World Health Organization (WHO) produces estimates of the number of deaths by cause for 193 of its Member States. The most recent set of estimates, which refer to deaths occurring in 2008, were published in 2011. The quality of the data available to the WHO for estimating mortality by cause varies widely from country to country. For the 2008 estimates[7], 76 countries representing 24 per cent of all deaths globally had reasonably complete cause-of-death information from vital registration corresponding to the International Classification of Diseases versions 9 or 10 (ICD-9 or ICD-10) and with less than 15 per cent of deaths with inappropriate or non-specific cause of death codes. For an additional 36 countries representing 46 per cent of global deaths in 2008, death registration was incomplete or cause-of-death information was available from other nationally representative sources, such as verbal autopsy or sample registration data. In many of these cases, both cause-of-death models and country-specific information for select causes were used to derive estimates of the numbers

[7] World Health Organization. 2011. Causes of death 2008: data sources and methods. Geneva: World Health Organization. Available at http://www.who.int/healthinfo/global_burden_disease/cod_2008_sources_methods.pdf

of deaths by cause from the available data. For the remaining 79 countries, representing 30 per cent of all deaths in 2008, country information on causes of death was not available for most causes, thus the 2008 cause of death estimates are based entirely upon cause-of-death models that infer the distribution of deaths by cause by age and sex according to the level of all-cause mortality and per capita income of the country, as well as the death registration data for other countries in the region. In interpreting the numbers, it is important to keep in mind the high degree of uncertainty in the cause of death estimates, especially for countries and regions with high mortality.

In summarizing deaths by cause, the WHO considers three broad categories of causes of death (WHO, 2008): Group I encompasses communicable diseases as well as maternal, perinatal and nutritional conditions[8]; Group II includes non-communicable diseases[9]; and Group III comprises causes of death resulting from external sources, namely injuries, including both intentional and unintentional injuries[10]. The three broad cause-of-death categories are shown in table II.1 along with the major specific causes of death that compose each group. Of the estimated 56.9 million deaths worldwide during 2008, 36.1 million (63.5 per cent) were caused by Group II NCDs, especially cardiovascular diseases, cancers, diabetes and chronic respiratory diseases.

Group I health conditions caused 15.6 million deaths (27.5 per cent) worldwide in 2008, with lower respiratory infections (pneumonia), perinatal conditions and diarrhoeal diseases as the leading causes of Group I mortality. The injuries classified in Group III caused the remaining 5.1 million deaths (9.0 per cent) in 2008, with road traffic accidents, suicides and homicides accounting for the largest shares of deaths in this cause group.

Considerable variation in the contributions of the three categories of health conditions to overall mortality is observed across the regions of the world, revealing substantial variability in progress through the epidemiologic transition. Figure II.4 displays the proportion of all deaths in 2008 in each region due to the three broad cause groups as well as the life expectancy at birth in those regions during the period 2005-2010. In Africa, the region of the world with the lowest life expectancy at birth at 55 years, the majority of deaths in 2008 (61.0 per cent) were due to Group I health conditions, while the NCDs in Group II and the injuries in Group III accounted for 32.0 per cent and 7.0 per cent of deaths respectively. The high concentration of deaths from Group I conditions in Africa indicates that the region is still in the early stages of the epidemiologic transition. In contrast, in the "more developed regions, excluding Eastern Europe", where life expectancy at birth reached 80 years in 2005-2010, 6.6 per cent of deaths in 2008 were attributed to Group I causes, while Group II NCDs caused 87.5 per cent of deaths; Group III injuries were responsible for 5.8 per cent of deaths. The low percentage of deaths due to Group I conditions and high percentage of deaths due to Group II conditions confirms the "more developed regions, excluding Eastern Europe", to be in the later stages of the epidemiologic transition.

The other regions of the world fall somewhere in between Africa and the "more developed regions, excluding Eastern Europe," in terms of their stages within the epidemiologic transition. In developing Oceania, where 78 per cent of deaths were located in Papua New Guinea and life expectancy for the region was 64 years, 41.9 per

[8] The communicable diseases are those that can be transmitted from one person to another or from animals to humans, such as respiratory infections, diarrhoeal diseases, parasitic diseases and sexually transmitted infections, including HIV/AIDS. Maternal conditions are related to pregnancy, labour or delivery, including maternal haemorrhage and sepsis, hypertensive disorders associated with pregnancy, obstructed labour, and complications associated with abortion. Perinatal conditions are related to the late-foetal period or the first weeks of life; they include prematurity and low birth weight, birth asphyxia and birth trauma, and neonatal infections and other conditions related to the neonatal period. They include 'causes arising in the perinatal period' as defined in the International Classification of Diseases, but not all conditions occurring in the perinatal period of life. Nutritional deficiencies refer to deficiencies in iodine, vitamin A and iron, as well as protein-energy malnutrition.

[9] Non-communicable diseases include cardiovascular diseases, cancers, diabetes and chronic respiratory diseases, which together accounted for 84 per cent of Group II deaths globally in 2008, as well as other chronic diseases, such as, *inter alia*, neuropsychiatric disorders, sense organ disorders, and digestive diseases.

[10] Intentional injuries may be self-inflicted or result from war or violence. Unintentional injuries include those resulting from road traffic accidents as well as accidental falls, poisonings, drownings, fires, and other causes of unintentional injury.

TABLE II.1. LEADING CAUSES OF DEATH BY GROUP OF CAUSES, 2008*

Group I causes	*Deaths ('000s)*	*Group II causes*	*Deaths ('000s)*	*Group III causes*	*Deaths ('000s)*
Total	**15 637**	**Total**	**36 122**	**Total**	**5 129**
Lower respiratory infections	3 463	Ischaemic heart disease	7 254	Road traffic accidents	1 209
Perinatal conditions	2 603	Cerebrovascular disease	6 152	Self-inflicted	782
Diarrhoeal diseases	2 464	Chronic obstructive pulmonary disease	3 278	Violence	535
HIV/AIDS	1 776	Trachea/bronchus/lung cancers	1 387	Falls	510
Tuberculosis	1 342	Diabetes mellitus	1 256	Drowning	306
Malaria	827	Hypertensive heart disease	1 153	Poisoning	252
Maternal conditions	361	Cirrhosis of the liver	849	Fires	195
Meningitis	340	Nephritis/nephrosis	775	War and conflict	182
Protein-energy malnutrition	242	Stomach cancer	758	Other Group III causes	1 157
Pertussis	195	Liver cancer	695		
Measles	155	Colon/rectum cancer	647		
Tropical diseases	133	Alzheimer and other dementias	540		
Hepatitis B	128	Breast cancer	482		
STDs excluding HIV	120	Congenital abnormalities	428		
Iron-deficiency anaemia	103	Oesophagus cancer	414		
Tetanus	88	Inflammatory heart disease	402		
Hepatitis C	69	Nutritional/endocrine disorders	318		
Upper respiratory infections	66	Lymphomas, multiple myeloma	305		
Other Group I causes	1 161	Peptic ulcer disease	298		
		Asthma	284		
		Mouth and oropharynx cancers	281		
		Cervix uteri cancer	277		
		Prostate cancer	272		
		Pancreas cancer	270		
		Leukaemia	267		
		Rheumatic heart disease	220		
		Other Group II causes	6 857		

* Causes shown resulted in at least 20,000 deaths in 2008.

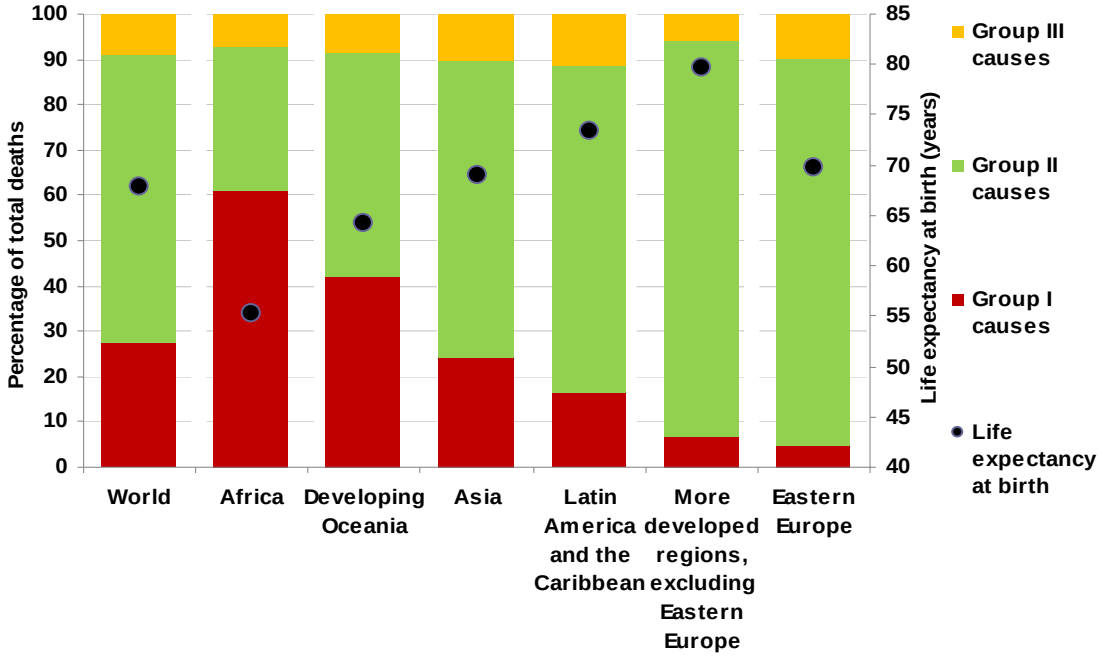
Source: World Health Organization, Cause-specific mortality, 2008, Global Health Observatory Data Repository. Available from http://apps.who.int/ghodata/ (accessed 23 May 2011).

cent of mortality was due to Group I conditions, but close to half of deaths (49.7 per cent) were caused by Group II NCDs. In both Asia and Latin America and the Caribbean where life expectancies at birth exceed those in Africa and developing Oceania, the NCDs in Group II caused the majority of deaths in 2008 (65.5 per cent and 72.0 per cent, respectively), while Group I conditions were responsible for 16.4 per cent and 14.0 per cent of deaths.

Again, figure II.4 illustrates how Eastern Europe deviates from the typical demographic and epidemiologic transition pattern. Despite having a lower life expectancy at birth than Latin America and the Caribbean, the proportion of deaths due to Group II NCDs was large (85.5 per cent in 2008), while the proportion due to Group I causes was comparatively small (4.7 per cent in 2008). Eastern Europe's unique path through its epidemiologic transition is driven in large part by exceptionally high risk of mortality before age 60, especially among men. During 2005-2010, 336 of 1,000 males aged 15 in Eastern Europe were expected to die before age 60, compared to 192 of 1,000 males in Latin America and the Caribbean (data not shown).

The association between the demographic and epidemiologic transition models is summarized in figure II.5. According to Omran's epidemiologic transition model, during the early stages of the demographic and epidemiologic transitions mortality is high among both children and adults as the result of frequent epidemics and periods of famine that produce a large burden of Group I health conditions. With improvements in nutrition, hygiene, sanitation, public health and medical technologies, such as vaccines, the incidence of Group I conditions declines – especially among children – and the population progresses to the mid-stage of the epidemiologic transition, which Omran labelled the "age of receding pandemics". During this stage, Group I health conditions account for a

Figure II.4. Percentage distribution of deaths by group of causes, 2008, and life expectancy at birth, 2005-2010, for the world and selected regions



Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

Figure II.5. Stages of the epidemiologic transition and mortality patterns in the demographic transition

Stage of the epidemiologic transition

	Pre-transition: age of pestilence and famine	**Mid-transition:** age of receding pandemics	**Late-transition:** age of degenerative and man-made diseases	**Post-transition:** age of delayed degenerative diseases
Cause of death pattern in the epidemiologic transition	Predominance of Group I health conditions	Decreasing importance of Group I conditions	Predominance of Group II health conditions	Predominance of Group II health conditions
Mortality pattern in the demographic transition	e^0 < 40 years High mortality in children and adults	e^0 increasing Declining mortality in children	e^0 > 70 years Most people survive to adulthood	e^0 increasing Death delayed to even older ages

e^0: life expectancy at birth
Sources: Based on the epidemiologic transition model as explicated by Omran (1971) and Olshansky and Ault (1986).

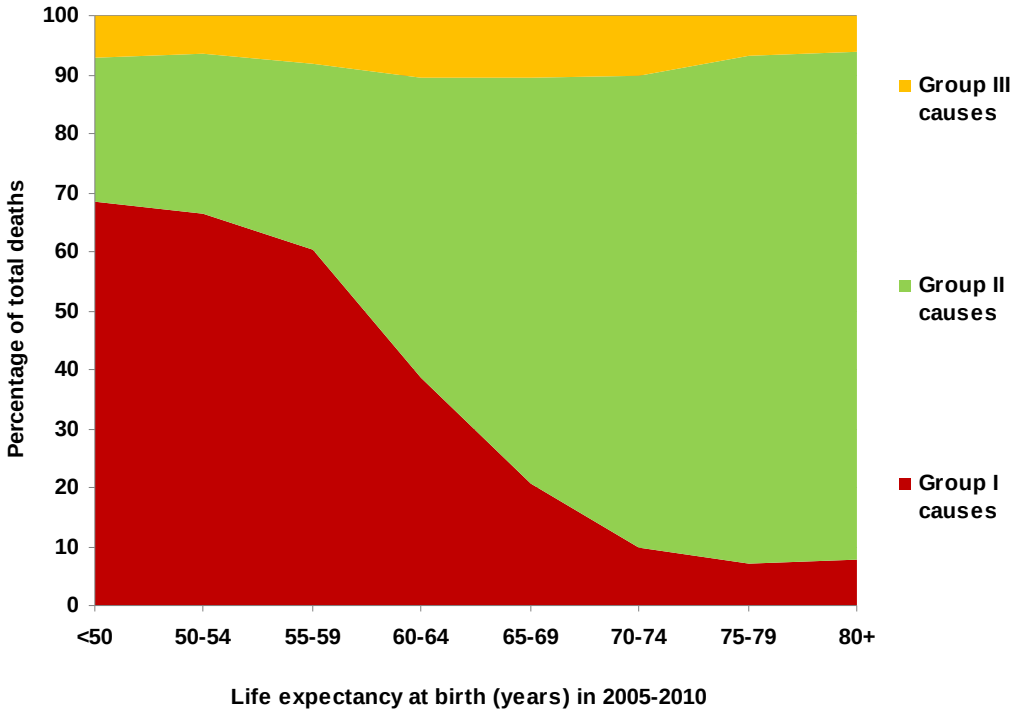
shrinking proportion of all deaths, giving way to an increasing predominance of non-communicable diseases. In the late-stage of the epidemiologic transition, Group II NCDs, which Omran referred to as the "degenerative and man-made diseases", are the main drivers of mortality patterns. Rapidly falling mortality among children during the mid-transition means that by the late-transition most people survive to adulthood, where they are more vulnerable to the NCDs as many of these diseases develop as a result of accumulated exposures to risk factors over the lifetime.

In 1986, Olshansky and Ault proposed a fourth stage of the epidemiologic transition to be appended to Omran's model. The "age of delayed degenerative diseases" is characterized by continued improvements in life expectancy that result in part from improvements in medical technologies and the introduction of social and public health programmes that target chronic disease, producing a shift in Group II NCD mortality to progressively older ages. During this stage, further shifts in the percentage distribution of deaths by broad cause group do not occur. However, the extent to which postponement of death means healthier lives for older persons depends on the extent to which disability from NCDs is alleviated as well[11].

Grouping countries by level of life expectancy at birth yields some insight into the associations between the improvements in longevity that occur with the demographic transition and progress through the epidemiologic transition. Figure II.6 displays the relative contribution of the three categories of causes of death to overall mortality for groups of countries classified according to the life expectancy at birth in 2005-2010. For populations with the lowest life expectancies, below 50 years in 2005-2010, nearly 70 per cent

[11] While the burden of morbidity is not addressed in this report, information on the measurement of morbidity and the global burden of disease caused by major health conditions can be found in the WHO's *The Global Burden of Disease: 2004 Update*.

Figure II.6. Percentage distribution of deaths by group of causes in 2008 classified by life expectancy at birth in 2005-2010



Sources: Deaths by cause are from World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/); life expectancy at birth estimates are from *World Population Prospects: The 2010 Revision* (United Nations publication, ST/ESA/SER.A/306).

of all deaths were attributable to Group I causes. At progressively higher levels of life expectancy at birth, the percentage of all deaths that were due to communicable, maternal, nutritional and perinatal conditions declined. Accordingly, Group I causes accounted for 21 per cent of deaths in countries with life expectancies at birth between 65 and 69 years and only 7 per cent of deaths in countries with life expectancies between 75 and 79 years. While less than one quarter of deaths in countries with life expectancies at birth below 50 years in 2005-2010 were due to NCDs, in countries with life expectancies greater than 75 years, 86 per cent of all deaths were attributable to NCDs.

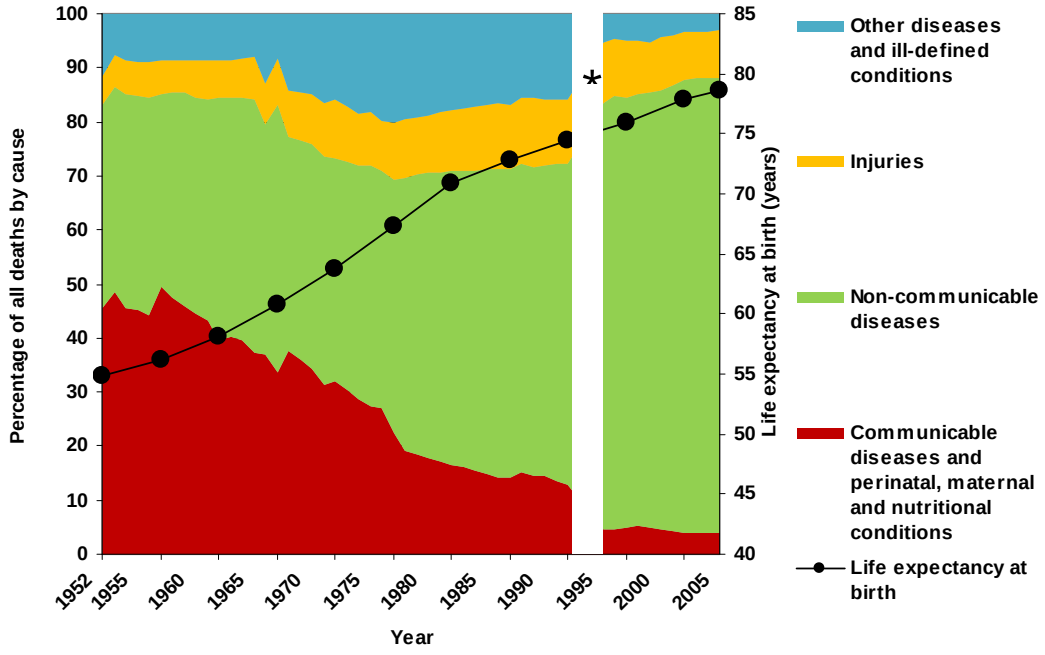
Compared to the changes in the proportion of deaths due to Group I and Group II causes over the course of the demographic and epidemiologic transitions, the proportion of deaths due to injuries classified in the WHO's Group III changes relatively little. Countries that experienced high mortality, as evidenced by life expectancies at birth below 50 years in 2005-2010, experienced around 7 per cent of all deaths due to Group III causes. Countries in the middle-stages of their demographic and epidemiologic transitions, with life expectancy at birth between 60 and 64 years had the greatest percentage of deaths due to external injuries in 2008, at close to 11 per cent. For countries advanced in their transitions, with life expectancy at birth greater than 80 years in 2005-2010, around 6 per cent of deaths were due to Group III causes.

While figure II.6 provides a snapshot of the association between the groups of causes of death and life expectancy in the world at a single point in time, a similar shift in the major causes of death can be observed within a population over time as it progresses through the mortality decline that occurs during the demographic transition.

Figure II.7 shows the changes over the course of the demographic transition in Chile. Vital registration records indicate that in the middle part of the 20th century, when life expectancy at birth in Chile was around 55 years, more than 40 per cent of deaths were attributable to communicable diseases and perinatal, maternal and nutritional conditions. Over the last 50 years however, mortality from Group I causes has declined substantially in Chile such that by 2005 these conditions were responsible for less than 10 per cent of all deaths and life expectancy at birth soared to nearly 79 years (figure II.7).

The lack of complete death registration in much of the less developed regions implies that a similar figure as that shown above for Chile cannot be reproduced for most developing countries. Selected sub-national data, however, offer evidence of the epidemiologic transition as well. For instance, data from demographic surveillance in Matlab, Bangladesh provide a picture of that population's progress through its epidemiologic transition since the mid-1980's (figure II.8). In 1986 more than 60 per cent of all deaths in the Matlab surveillance area were the result of communicable diseases and maternal and neonatal conditions, while less than 10 per cent were attributable to non-communicable diseases and five per cent were due to injuries. By 2006, the pattern of deaths by cause had shifted dramatically such that communicable diseases and maternal and neonatal conditions as a group accounted for less than 20 per cent of all deaths, while non-communicable diseases were responsible for the majority of mortality during the year (68 per cent). A 10-year improvement in life expectancy at birth was observed in Matlab over this period, from 58 years in 1986 to close to 68 years in 2006.

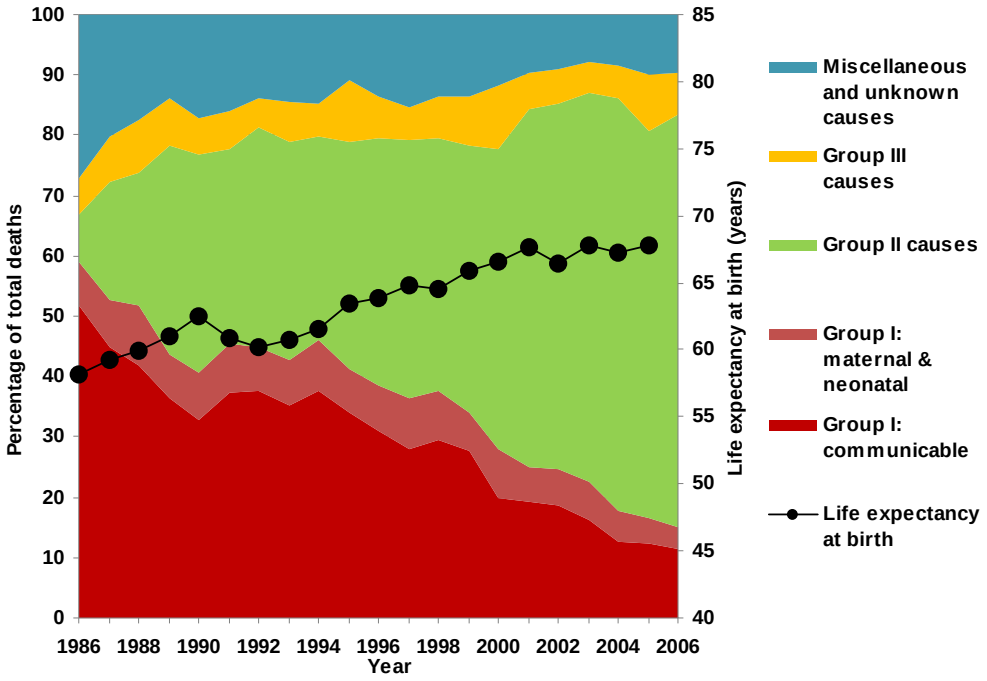
Figure II.7. Percentage distribution of deaths by group of causes and life expectancy at birth, Chile, 1952-1992 and 1995-2005



* Indicates gap in Demographic Yearbook records.

Sources: Data for 1952-1992 are from United Nations Demographic Yearbooks, Tables G03. Data for 1995-2005 are from United Nations Demographic Yearbooks, Tables G33 and include WHO adjustment for ill-defined conditions. Life expectancy at birth estimates are from World Population Prospects: The 2010 Revision (United Nations publication, ST/ESA/SER.A/306).

Figure II.8. Percentage distribution of deaths by group of causes and life expectancy at birth, Matlab, Bangladesh, 1986-2006



Source: Karar and others. (2009), Figure 1. Reproduced with authors' permission.

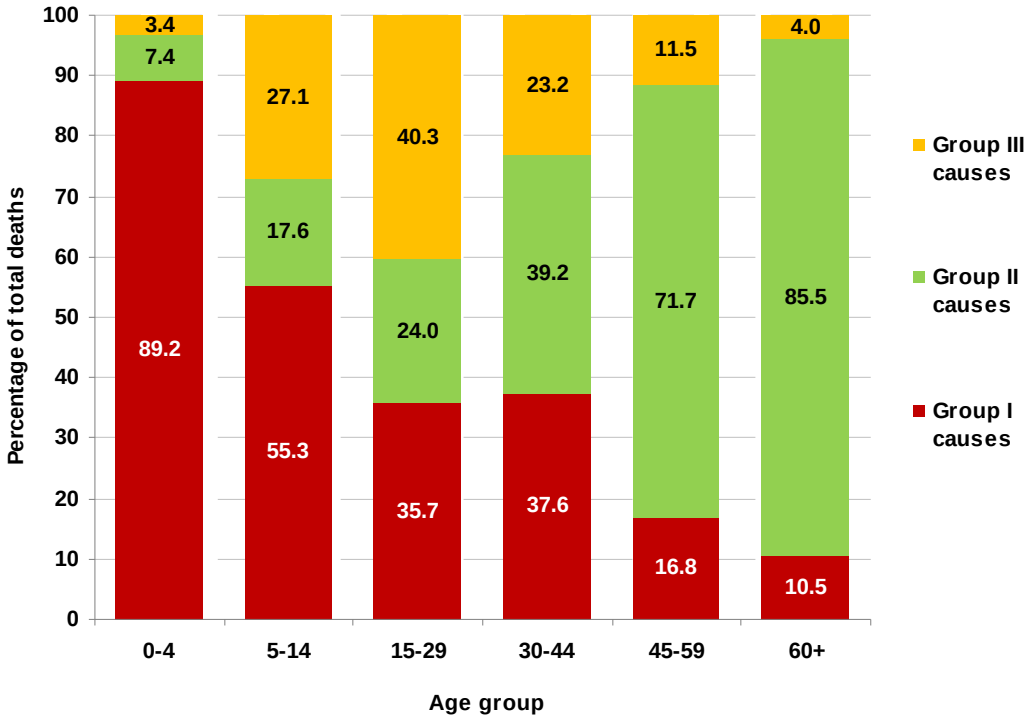
Changes in the demographic composition of a population that occur with the demographic transition help to shape the cause-specific mortality patterns observed in the epidemiologic transition.

C. AGE AND SEX IN THE DEMOGRAPHIC AND EPIDEMIOLOGIC TRANSITIONS

The impacts of different health conditions vary by age and sex as a result of both biological and behavioural factors that determine susceptibility to certain illnesses or injuries. Also, the relative weight of different age groups in the population interacts with the age-specific risks of death from various causes to determine the percentage distribution of deaths by cause over the course of the demographic and epidemiologic transitions. Therefore, examining causes of mortality by age and sex is critically important for understanding the transition processes.

Figure II.9 shows the distribution of global deaths by cause across broad age groups (0-4, 5-14, 15-29, 30-44, 45-59 and 60 and over) in 2008. Among children under five, Group I causes accounted for the overwhelming majority of deaths (89.2 per cent), while Group II and Group III causes accounted for 7.4 per cent and 3.4 per cent, respectively, of deaths in this age group. Deaths of older children aged 5 to 14 were more likely than deaths of children under five to be caused by Group II and Group III causes. NCDs were responsible for 17.6 per cent of deaths of children aged 5 to 14 in 2008, while injuries accounted for another 27.1 per cent of deaths in this age group. The proportion of deaths due to Group I causes continued to decline with increasing age, such that these causes accounted for 35.7 per cent of deaths to those aged 15 to 29. NCDs were responsible for 24.0 per cent of deaths in the 15 to 29 year age group, while injuries caused the largest proportion of deaths among this age group in 2008 (40.3 per cent)

Figure II.9. Percentage distribution of deaths by group of causes for broad age groups, world, 2008



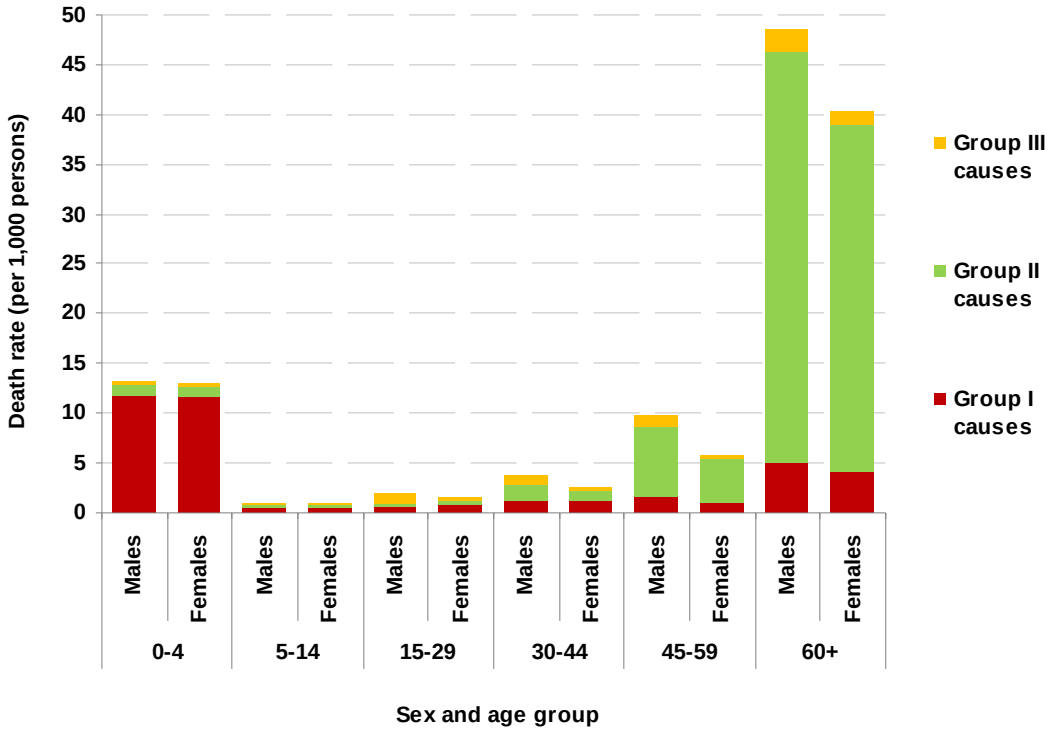
Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

Within the age groups 30 to 44 years and higher, NCDs (Group II) caused the greatest proportion of deaths in 2008, ranging from 39.2 per cent among those aged 30 to 44 to 85.5 per cent among those aged 60 or above. In turn, Group I and Group III conditions accounted for a shrinking proportion of total deaths across these age groups. While Group I conditions caused 37.6 per cent of deaths among adults aged 30 to 44, reflecting a concentration of AIDS-related mortality in this age group, the proportion of deaths due to Group I causes fell to 16.8 per cent for those aged 45 to 59 and to 10.5 per cent among those aged 60 and above. The relative burden of death due to injuries declined similarly across the adult age groups: Group III conditions accounted for 23.2 per cent of mortality among those aged 30 to 44 in 2008, but only 4.0 per cent of mortality among those aged 60 and above.

An examination of the cause group-specific mortality rates by age and sex yields some insight into the disease processes that produce age and sex differentials in the burden of mortality through variable risks of death due to different causes. Figure II.10 shows the death rates per 1,000 persons by age and sex due to each of the three groups of causes against the backdrop of the overall mortality rate in each population subgroup. At the world level among children under five, death rates from the three major groups of causes were similar by sex. Cause-specific death rates also differed little by sex among children and adolescents aged 5 to 14.

But within the age groups 15-29 years and 30-44 years mortality rates of males began to exceed those of females, largely due to the higher risk of death from injuries among males compared to females. Among those aged 15 to 29 years, the mortality rate due to Group III causes among males (1.0 death per 1,000 persons) was more than twice the rate among females (0.4 deaths per 1,000 persons). This gender disparity in the risk of deaths from injury persists into the older age groups. Beginning in the age group 30-44 years a male disadvantage in the risk of death from NCDs also emerges: the death rate due to Group II

Figure II.10. Death rates by group of causes for broad age groups, by sex, world, 2008



Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

conditions among males (1.5 deaths per 1,000 males) was about 50 per cent higher than among females (1.0 deaths per 1,000 females). The death rates due to Group I conditions among those aged 30-44 were identical for males and females (1.2 deaths per 1,000 persons), thus the higher male mortality in this age group was due entirely to excess deaths from NCDs and injuries

The male mortality disadvantage continues at older ages, where all three groups of causes contributed to higher death rates among males relative to females. At ages 45-59 years, males were 59 per cent more likely than females to die from a Group I cause, 58 per cent more likely to die from a Group II NCD and 189 per cent more likely to die as a result of a Group III injury. These gender disparities persisted at ages 60 and above, although the gaps were somewhat smaller: males aged 60 and above were 18 per cent more likely than females in that age group to die of a Group I cause, 19 per cent more likely to die of a Group II NCD, and 53 per cent more likely to die from a Group III injury.

While gender is an important determinant of vulnerability to specific health conditions, age plays a more prominent role in shaping the shifting trends in the distribution of deaths by cause observed in the epidemiologic transition. As highlighted earlier, the age structure of the population tends to shift markedly through the course the demographic and epidemiologic transitions, with a very young population age structure characterizing the early and mid-stages of the transitions, and an ageing population age structure emerging during the late-transition and continuing through the post-transition stage. To appreciate the role of shifting age structures in contributing to the mortality patterns observed during the demographic and epidemiologic transitions, it is helpful to understand the basic mechanisms that link age to the risks of death associated with the various cause groups.

Young children are particularly susceptible to death from communicable diseases both because their immune systems are relatively immature and because they are more frequently exposed to disease-causing organisms (Simoes and others, 2006). Worldwide in 2008, the rate of death from Group 1 causes was highest amongst children, with 11.7 deaths per 1,000 children under age five (figure II.11). After age five, death from Group I causes remained rare until old age: among those aged 60 and over, the mortality rate from Group I causes was 4.6 per 1,000. The sharp increase in the death rate from Group I causes above age 60 was due largely to an increase in the risk of death from pneumonia at older ages. Pneumonia was responsible for 55 per cent of Group I deaths above age 80 in 2008.

Compared to young children, the immune systems of older children, adolescents and young adults are more adept at fighting off the infections common in childhood. As a result, death rates from Group I causes were substantially lower among those aged 5 to 14 years and 15 to 29 years compared to children under five. Deaths from Group II and Group III causes were similarly rare among these age groups, with each group of causes resulting in fewer than 1 death per 1,000 persons aged 5 to 14 years and 15 to 29 years in 2004.

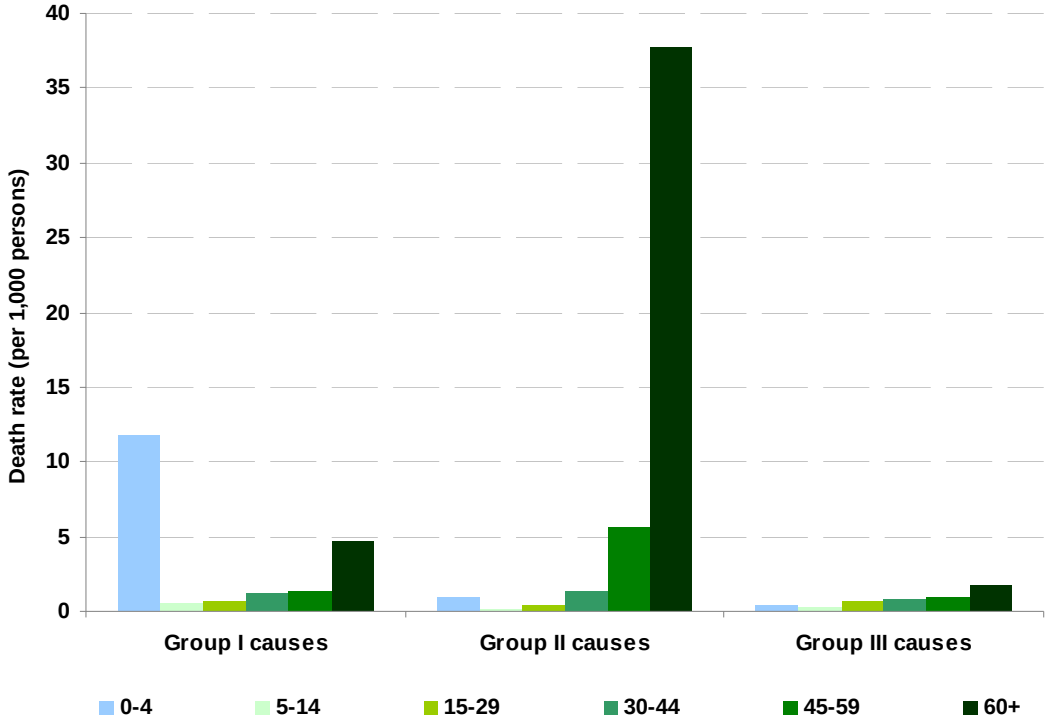
With advancing age, the risk of illness and death increasingly reflects exposures to health risk factors accumulated over a lifetime. Evidence of accumulated risk with age is especially pronounced in the age pattern of mortality from the NCDs in Group II, which often emerge as the result of a combination of exposures to risk factors such as smoking or unhealthy diet that interact with an individual's biological susceptibility to disease (WHO, 2009). While Group II causes produced only 0.4 deaths per 1,000 persons aged 15 to 29 in 2008, the death rate from NCDs increased sharply with age to 1.3 deaths per 1,000 persons aged 30 to 44, 5.7 deaths per 1,000 persons aged 45 to 59 and 37.7 deaths per 1,000 persons over age 60.

Overall, the risk of mortality due to injury tends to increase with age. In 2008, global death rates from Group III causes ranged from 0.3 per 1,000 among those aged 5 to 14 years to 1.8 deaths per 1,000 among people aged 60 and over. Despite a common perception that adolescents and young adults face higher risk of death from injury (WHO, 2003), the mortality rate from injuries was lower among those aged 15 to 29 compared to older adults (0.7 injury-related deaths per 1,000 people aged 15 to 29 versus 1.8 injury-related deaths per 1,000 people aged 60 and over). However, because the death rate from all causes was low among those aged 15 to 29, Group III causes comprised a larger proportion of all deaths in this age group (40.3 per cent; figure II.9) relative to the other age groups. However, adolescents and young people, particularly males, did face relatively high risks of death from injuries related to violence. Globally, the death rate due to homicide in males aged 15 to 29 was 11 per cent higher than among males aged 30 to 44 and 46 per cent higher than among males aged 45 to 59 (data not shown).

Because susceptibility to mortality from the various causes of death varies so prominently by age, it is reasonable to presume that the age structure of a population is correlated with the distribution of deaths by cause. Indeed, as shown in figure II.12, countries with the largest proportion of population under age five in 2008 tended to have the greatest proportions of deaths due to Group I causes, while countries with the smallest proportion of population under age 5 had the smallest proportion of deaths caused by Group I conditions. In Niger, for example, where 20 per cent of the population was under age 5 in 2008, making it the youngest population in the world, more than 80 per cent of deaths were caused by Group I health conditions.

Other countries with similarly young populations, such as Mali and Sierra Leone, also experienced greater than 70 per cent of deaths due to Group I causes. At the other end of the spectrum, populations with comparatively small proportions of population under age five, such as Germany and Bosnia and Herzegovina, where four per cent of the population was under age five in 2008, attributed only a small fraction of deaths to Group I causes (4.5 per cent in Germany and 1.8 per cent in Bosnia and Herzegovina).

Figure II.11. Death rates by groups of causes and age group, world, 2008



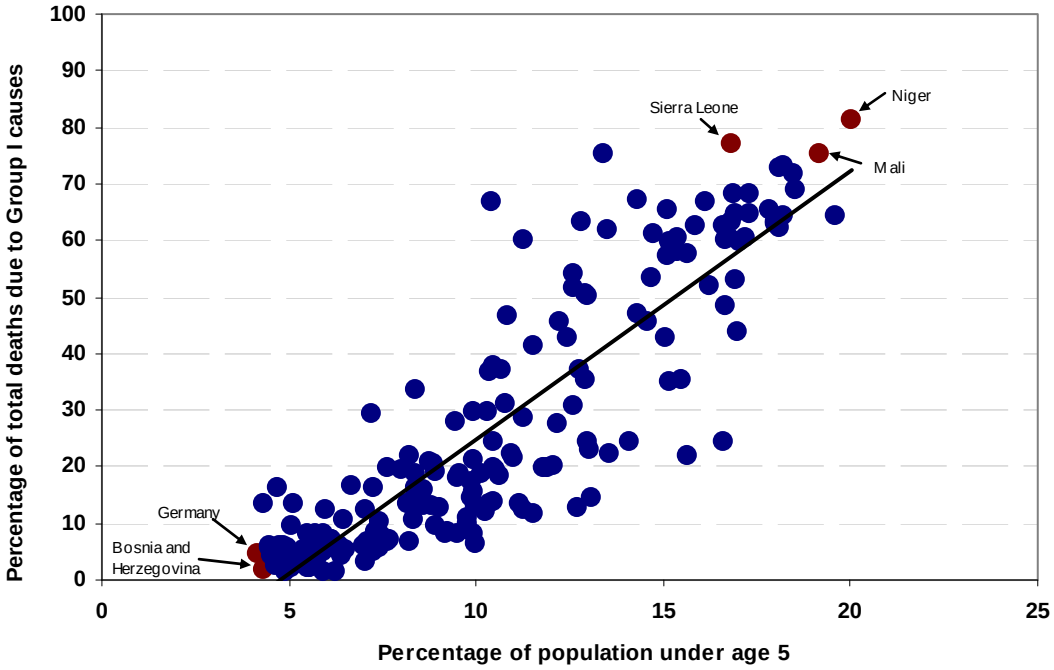
Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

Despite the strong correlation shown in figure II.12 (R^2 = 0.79), differences in the population age structure alone cannot fully explain the observed differences in the percentage of deaths due to Group I causes across countries and regions. Age is only one of several factors influencing susceptibility to disease and subsequent mortality risk. Other risk factors relate to biology (e.g., sex and genetic susceptibility), behaviours (e.g., smoking or unhealthy diet), environmental exposures (e.g., air pollution, unsafe drinking water or inadequate sanitation), and the ability of the public health system to prevent and treat illness.

Removing the effect of different population age structures in the comparison of cause-specific death rates makes it possible to see the role that other risk factors play in shaping the burdens of the various causes of death. Such age-standardized death rates are obtained by re-calculating the cause-specific death rates for each country that would have been observed if every country had an identical population age structure. The standard population age structure utilized by the WHO is based on the average world population age structure for the period 2000-2025 as presented in the *1998 Revision* of the United Nations Population Division's *World Population Prospects* (Ahmad and others, 2001).

Figure II.13 shows the non-standardized and age-standardized cause-specific death rates for the selected regions of the world. The non-standardized death rates are those estimated for the population in 2008, while the age-standardized death rates show what the cause-specific death rates would have been in each region if all regions had the population age structure of the WHO standard population. According to the data shown in figure II.13, the death rate from Group I causes in Africa (7.1 per 1,000 in 2008) was more than twice that in developing Oceania (2.8 per 1,000), the region with the next highest death rate from Group I causes, and nearly four times that in Asia (1.8 per 1,000). Adjusting for the differences in age structure between the major areas did little to shrink the disparities in the rate of deaths from

Figure II.12. Percentage of deaths due to Group I causes and percentage of population under age 5, 2008

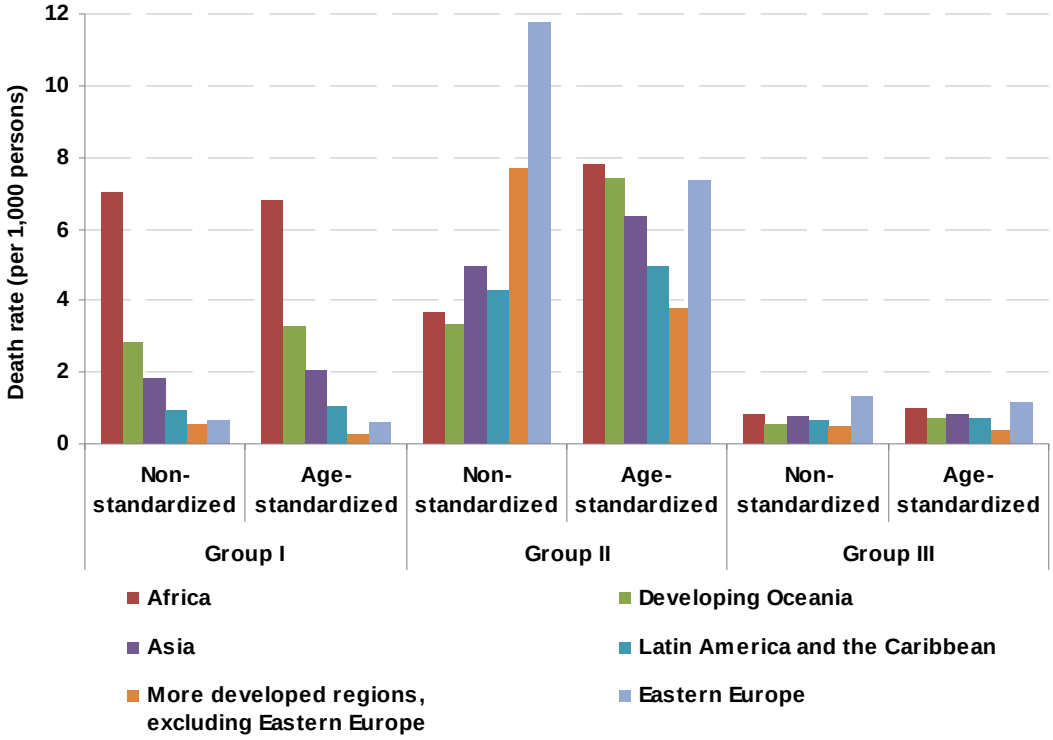


Sources: Percentages of population under age 5 are from United Nations (2011), *World Population Prospects, The 2010 Revision*; percentages of deaths from Group I causes are from World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

Group I causes. After age standardization the death rate from Group I causes in Africa was still twice that in developing Oceania, more than three times higher than in Asia, and more than six times higher than in Latin America and the Caribbean. Thus very little of the higher rate of death from Group I causes in Africa compared to the other regions of the world may be attributed to Africa's youthful population age distribution. Rather, other factors that influence the populations' susceptibility to communicable diseases and maternal, perinatal and nutritional conditions were responsible for the large regional disparities in rates of death from Group I causes.

The effect of population age structure in shaping the regional differences in rates of death from Group II causes was considerably more pronounced than for Group I causes of death. The non-standardized death rates from Group II causes show that of the six regions, Eastern Europe had the highest death rate due to NCDs (11.8 Group II deaths per 1,000 persons), followed by the "more developed regions, excluding Eastern Europe", as a group (7.7 Group II deaths per 1,000 persons). Africa and developing Oceania were the two regions with the lowest death rates from Group II causes in 2008 (3.7 per 1,000 and 3.4 per 1,000, respectively). A look at the age-standardized death rates from Group II causes reveals that the regional patterns we observe were highly influenced by differences in the age structures of the populations. After age-standardization, Africa became the region with the highest death rate from NCDs: more than 100 per cent higher than in the "more developed regions, excluding Eastern Europe", and 57 per cent higher than in Latin America and the Caribbean. It is notable that the "more developed regions, excluding Eastern Europe", the group of countries with the second highest death rate from Group II causes, had the lowest age-standardized death rate from Group II causes of the selected regions shown in figure II.13. Conversely, developing Oceania, the region with the lowest non-standardized Group II death rate had the

Figure II.13 . Non-standardized and age-standardized death rates by group of causes for selected regions, 2008



Source: World Health Organization. Mortality estimates by cause, age and sex for the year 2008 (http://www.who.int/healthinfo/global_burden_disease/en/).

second highest age-standardized death rate due to NCDs. These patterns indicate that the reason that the "more developed regions, excluding Eastern Europe", experienced much higher death rates from NCDs than other regions is that the corresponding populations are relatively old. Once the influence of age structure was removed, the risk of dying from a NCD was actually higher in populations with relatively young age structures, namely Africa, developing Oceania and Asia.

With respect to Group III injuries, the non-standardized death rates in figure II.13 show that Eastern Europe faced the highest rates of mortality from injuries (1.35 deaths per 1,000 persons), followed by Africa (0.81 deaths per 1,000 persons) and Asia (0.77 deaths per 1,000 persons). In general, regional disparities in rates of death from Group III injuries changed very little after adjusting for differences in the population age structures.

D. Conclusions

In summary, the epidemiologic transition influences mortality trends in a population by shifting the age pattern of mortality over time. Early in the epidemiologic transition, Group I causes dominate and, because children are most vulnerable to many of these conditions, death rates among children are high. As the burden of Group I causes of death declines, more children survive to adulthood and the burden of mortality shifts to those conditions that disproportionately affect adults—namely, the NCDs in Group II. The dissimilar distributions of deaths by cause exhibited across the regions of the world reflect their different locations within the epidemiologic transition process. In Africa, for example, many countries remain in the early stages of their transitions, and the burden of mortality from Group I causes is large. In contrast, most countries in Latin America and the Caribbean have advanced through their epidemiologic

transitions and Group I causes today account for less than one fifth of mortality in that region. These countries now face a growing burden of NCDs among their ageing populations.

Thus far in this report, it has been shown that the demographic and epidemiologic transitions are inextricably linked. The epidemiologic transition shapes the mortality patterns of the demographic transition, while the shifting age structure that occurs with the demographic transition influences the distribution of deaths by cause observed in the epidemiologic transition. It has also been shown that the role of population age structure is non-negligible in accounting for disparities across the world's regions in the cause specific risks of death. However, large differences still remain after removing the effects of the population age structures, indicating that other factors are responsible for the bulk of the inter-regional disparities. These factors may include differences in the populations' health risks associated with the natural or built environments, prevalence of behavioural risk factors, or gaps in the capacities of health systems to respond to specific disease challenges, to name a few. The remainder of this report explores the regional disparities in the risks of mortality due to specific causes of death within the three broad cause groups and how those specific health challenges contribute to differences in longevity among the world's populations as they progress through the demographic and epidemiologic transitions.

III. DECOMPOSING SURVIVAL GAPS BY CAUSE

A: BACKGROUND

Each of the three broad groups of causes of death contains numerous specific health conditions, each with their own etiologies and risk factors. Group I, for example, is quite heterogeneous, including such causes of death as perinatal conditions—for which risk is tied closely to maternal health, nutrition and access to skilled care on delivery (Bhutta and others, 2010)—as well as tuberculosis—for which mortality risk is linked to poverty, crowded living or working conditions, and co-infection with HIV/AIDS. The Group II and Group III categories are similarly diverse in terms of their constituent causes of death and the relevant risk factors linked to those causes. The degree to which each specific cause contained within the three cause groups contributes to the disparities in survival described in the first part of this report varies sharply across the world's regions. The following section of the report undertakes an examination of the roles of selected major causes of death in contributing to disparities in survival and, in doing so, identifies some priorities for intervention to ensure continued progress through the demographic and epidemiologic transitions.

Multiple approaches are available to evaluate regional disparities in the impact of the various causes of death. A common strategy compares the non-standardized and age-standardized cause-specific death rates across populations, similar to the approach taken to assess the roles of the three broad cause groups in contributing to global and regional patterns in mortality earlier in this report. Non-standardized death rates indicate the overall burden of mortality due to each cause in a population, while the age-standardized death rates yield a comparative assessment of cause-specific mortality risk that is independent of the population age structure. An alternative analytic approach that reflects the cumulative differences in the age-specific risks of death by cause across populations entails the application of specialized demographic techniques that decompose differences in the levels of life expectancy at birth between two populations into the contributions of the differentials in the cause-specific mortality rates. This approach has the advantage of highlighting the magnitude of the effect of excess mortality due to a given cause of death on the longevity of a population.

By identifying the degree to which specific causes of death exact excess mortality risk on a population that is undergoing its demographic and epidemiologic transitions relative to a reference population that is in the advanced stages of the transitions, it is possible to pinpoint the specific causes of death that need to be addressed in order to achieve continued progress through those transitions. For the analysis that follows, the reference population is defined as the combined populations of countries or areas with life expectancy at birth (both sexes combined) greater than 80 years in 2005-2010. These "longest-lived" populations include Australia, Austria, Canada, China-Hong Kong Special Administrative Region, China-Macao Special Administrative Region, France, Iceland, Israel, Italy, Japan, Martinique, the Netherlands, New Zealand, Norway, Republic of Korea, Singapore, Spain, Sweden and Switzerland. The cause-specific mortality profiles of the world's regions are compared to the cause-specific mortality profile of these "longest-lived" populations as a group to decompose the disparities in longevity according to the contributions of the various causes of death. A detailed description of the demographic techniques employed in the decomposition analysis may be found in Annex I of this report.

The proportional contributions of the three broad cause groups to survival gaps are consistent with the stages of the demographic and epidemiologic transitions.

B. SURVIVAL GAPS DUE TO BROAD CAUSE OF DEATH GROUPS

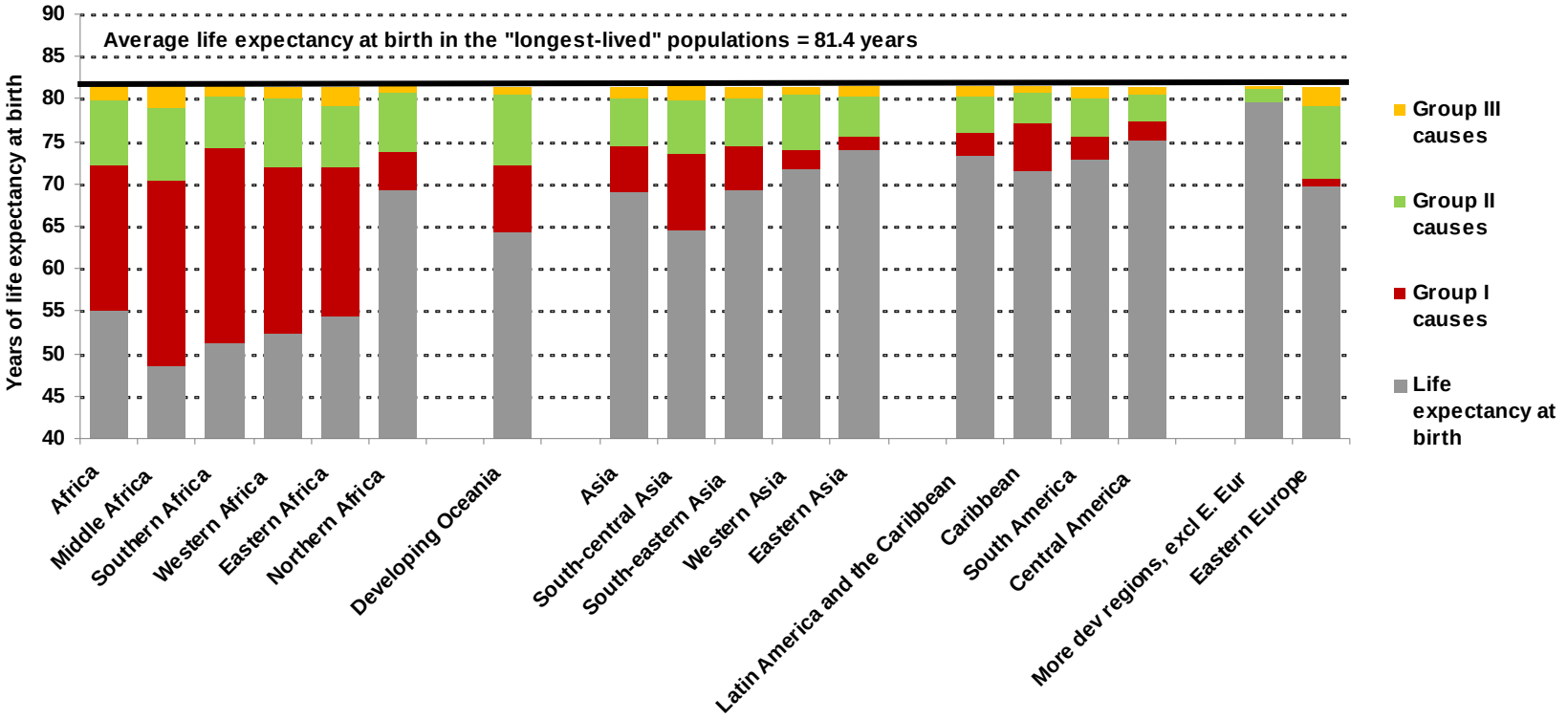
The outcome of interest for the decomposition analysis is the "survival gap", which refers to the difference in years of life expectancy at birth between the "longest-lived" populations as a group, and each of the populations that were on the whole at earlier stages of the demographic and epidemiologic transitions in 2005-2010. Figure III.1 presents a summary of the results of this exercise, with the life expectancy at birth in each region represented by the gray portion of each bar and the three broad cause groups represented by the coloured portions of each bar. Because the epidemiological profile varies importantly within Africa, Asia and Latin America and the Caribbean, the decomposition analysis is disaggregated according to the smaller regions that comprise those areas. Developing Oceania, due to its small population (approximately 10 million in 2010), has not been disaggregated for analysis into its constituent regions, Melanesia, Micronesia and Polynesia.

In 2005-2010 life expectancy at birth in the "longest-lived" populations averaged 81.4 years. Africa, with life expectancy equal to 55.2 years, had a 26-year survival gap relative to the "longest-lived" populations for the period 2005-2010. Of the five regions of Africa, the largest survival gap occurred in Middle Africa, where life expectancy at birth was 48.5 years, close to 33 years less than in the "longest-lived" populations. The regions of Southern Africa, Western Africa, and Eastern Africa had smaller but still sizable shortfalls in life expectancy relative to the "longest-lived" populations as well. The survival gap between Northern Africa and the "longest-lived" populations was notably smaller than those for the other regions of Africa: life expectancy at birth was 69.4 years in 2005-2010, 12 years less than in the "longest-lived" populations.

Comparing the contributions of each of the three major cause groups to the survival gaps across Africa's regions again illustrates the association between a population's stage in the demographic and epidemiologic transitions and the roles of mortality due to the three cause groups. In regions that remain at relatively early stages of their transitions – Middle Africa, Southern Africa, Western Africa and Eastern Africa – the Group I causes of death accounted for more than 65 per cent of the total survival gaps with the "longest-lived" populations, while the share that was due to the non-communicable diseases in Group II was comparatively small at 26 per cent. In contrast, in Northern Africa, which was advanced in its transitions relative to the other regions of Africa, the proportion of the survival gap that was due to Group I causes shrank to 36 per cent, and mortality due to the non-communicable diseases accounted for the majority of the gap (58 per cent).

The contributions of the three broad cause-of-death groups to the survival gaps illustrate the potential progress in longevity to be achieved by reducing cause-specific rates of death to equal those in the "longest-lived" populations. For example, the results shown in figure III.1 for Africa as a whole indicate that if age-specific Group I mortality rates were to fall to equal those in the "longest-lived" populations, the region would achieve a 17.0-year increase in life expectancy at birth, from 55 years to 72 years. In developing Oceania, the longevity gains to be attained through reductions in Group I mortality are somewhat smaller compared to Africa: life expectancy would be extended by 7.8 years if the region were to reduce Group I mortality rates to equal those in the "longest-lived" populations. But the region stands to achieve an even larger improvement in longevity through reductions in mortality due to the non-communicable diseases included in Group II. By lowering Group II death rates to equal those in the "longest-lived" populations, developing Oceania would attain an additional 8.4 years of life expectancy at birth.

Figure III.1. Years of life expectancy at birth to be gained by reducing cause group-specific death rates to equal those in the "longest-lived" populations, 2005-2010



In Asia, Group I and Group II causes each accounted for approximately 45 per cent of the 12-year survival gap, while the remaining 10 per cent of the gap was due to Group III injuries. Of the four regions of Asia, the largest survival gap was in South-central Asia where life expectancy at birth (64.5 years) lagged nearly 17 years behind the "longest-lived" populations. South-central Asia was also the only region of Asia where Group I causes accounted for more than half of the survival gap (9.1 years; 54 per cent). In South-eastern Asia where the survival gap was nearly 5 years smaller than in South-central Asia, the share of the gap that was due to Group I causes fell to 42 per cent, while that due to Group II causes grew to 47 per cent. Notably, the size of the total survival gap in South-eastern Asia was nearly identical to that of Northern Africa, but the distribution across the three cause groups differed somewhat. South-eastern Asia stood to gain 5.1 years of life expectancy at birth by reducing Group I mortality rates to equal those in the "longest-lived" populations, compared to Northern Africa's 4.3 years. Furthermore, while Northern Africa would gain 7.0 years of life expectancy at birth with similar reductions in mortality from Group II causes, these causes accounted for only 5.7 years of the total survival gap in South-eastern Asia. In both Western Asia and Eastern Asia, with survival gaps of 9.7 years and 7.4 years, respectively, Group I causes accounted for less than one quarter of the total gap while Group II causes were responsible for more than two thirds.

In the Latin America and Caribbean region the composition of the Caribbean survival gap differs substantially from that in South America and Central America. The Caribbean lost 5.6 years of life expectancy (57 per cent of the total gap) due to excess mortality from Group I causes, while these causes were responsible for gaps of 2.7 years and 2.1 years, respectively, in South America and Central America. Group II causes accounted for an additional 3.4 years of the Caribbean survival gap, which was identical to that in Central America. In South America 4.4 years of the 8.4-year total survival gap (52 per cent) was due to Group II NCDs. The survival gap due to injuries in South America (1.3 years) was nearly double those in the Caribbean and Central America.

Nearly the entire survival gap between the "more developed regions, excluding Eastern Europe" as a group and the subset of countries that were "longest-lived" in 2005-2010 was attributable to excess mortality from Group II NCDs. These causes accounted for 87 per cent of the gap, or 1.5 years of life expectancy. Less than 3 per cent of the total 1.7-year survival gap was due to excess mortality from Group I causes, while the remaining 10 per cent was due to Group III injuries.

Figure III.1 again highlights the predominant role played by excess mortality from Group II causes in Eastern Europe's survival gap. NCD mortality was responsible for 74 per cent of the total survival gap: the region would gain 8.6 years of life expectancy if Group II death rates were to fall to equal those in the "longest-lived" populations. It would gain and additional 2.2 years of life expectancy with a reduction in mortality from Group III causes. Deaths resulting from injuries accounted for 18 per cent of Eastern Europe's survival gap.

Each region must address the specific causes of death most responsible for its survival gap in order to advance further through the demographic and epidemiologic transitions. Those causes vary widely across the less developed regions.

C. SURVIVAL GAPS DUE TO SPECIFIC CAUSES OF DEATH

Each population has a unique epidemiological profile rooted in differing degrees of exposure to risk factors related to, *inter alia*, geography, economics, culture surrounding risk behaviours (e.g., smoking, alcohol consumption or unhealthy diet), policies that impact health and the quality and accessibility of the health care system. As a result, the specific causes of death responsible for the survival gaps vary considerably across regions, even those with survival gaps distributed similarly across the three broad cause groups. To explore this, the survival gaps are further decomposed to show the contributions of several of the specific major causes of death to differences in life expectancy between each of those regions and the "longest-lived" populations.

It is possible to pursue varying degrees of specificity in disaggregating causes of death. With too narrow a specification the results become difficult to compare meaningfully across regions, but with too broad a specification, the results lose their relevance with respect to identifying the interventions necessary to achieve continued or future progress. To summarize the results of the decomposition exercise, the cause disaggregations shown in table III.1 have been utilized. These causes represent the most common causes of death within each major cause group globally and are defined narrowly enough as to retain their relevance for the discussion of health policy interventions.

TABLE III.1. SPECIFIC CAUSES OF DEATH SELECTED FOR ANALYSIS OF SURVIVAL GAPS

Group I causes	*Group II causes*	*Group III causes*
HIV/AIDS	Cardiovascular diseases	Road traffic accidents
Tuberculosis	Heart diseases	Other unintentional injuries
Malaria	Stroke	(includes poisonings,
Diarrhoeal disease	Cancers	falls, fire and
Pneumonia	Diabetes mellitus	drownings)
Other communicable diseases	Chronic obstructive pulmonary disease	Suicides
(includes other STDs,	Other non-communicable diseases	Homicides
pertussis, polio, measles,	(includes non-malignant	Other intentional injuries
tetanus, meningitis, hepatitis	neoplasms, endocrine disorders,	(e.g., war)
A and B, tropical-cluster	neuropsychiatric conditions, sense	
diseases, leprosy, dengue,	organ diseases, digestive diseases,	
Japanese encephalitis,	genitourinary diseases, skin	
trachoma, intestinal	diseases, musculoskeletal	
nematode infections and	diseases, congenital anomalies	
upper respiratory infections)	and oral conditions)	
Perinatal conditions		
(includes prematurity and		
low birthweight, birth		
asphyxia and birth trauma,		
neonatal infections, and		
other infections related to the		
neonatal period)		
Nutritional deficiencies		
(includes protein-energy		
malnutrition, iodine		
deficiency, Vitamin A		
deficiency and iron-		
deficiency anaemia)		
Maternal conditions		

Source of categories: World Health Organization. Global Burden of Disease: 2004 Update.

Three Group I causes of death have received an unprecedented level of attention from the international community since they were identified as key targets for action under the Millennium Development Goals (MDG) framework: HIV/AIDS, tuberculosis and malaria. MDG6 calls for the international community to "combat HIV/AIDS, malaria and other diseases", and the indicators identified to monitor progress toward the goal include: HIV prevalence; the incidence and death rates associated with malaria; and the incidence, prevalence and death rates associated with tuberculosis, among others. Decomposing the survival gaps into the portions contributed by HIV/AIDS, tuberculosis and malaria reveals the challenge that these diseases continue to pose to improvements in longevity, especially in regions of sub-Saharan Africa. Figure III.2 displays the number of years of the survival gap that is due to those three Group I causes of death for each region the world along the primary y-axis (left side of the chart), as well as the proportion of the total survival gap in each region attributable to these three causes taken together along the secondary y-axis (right side of the chart).

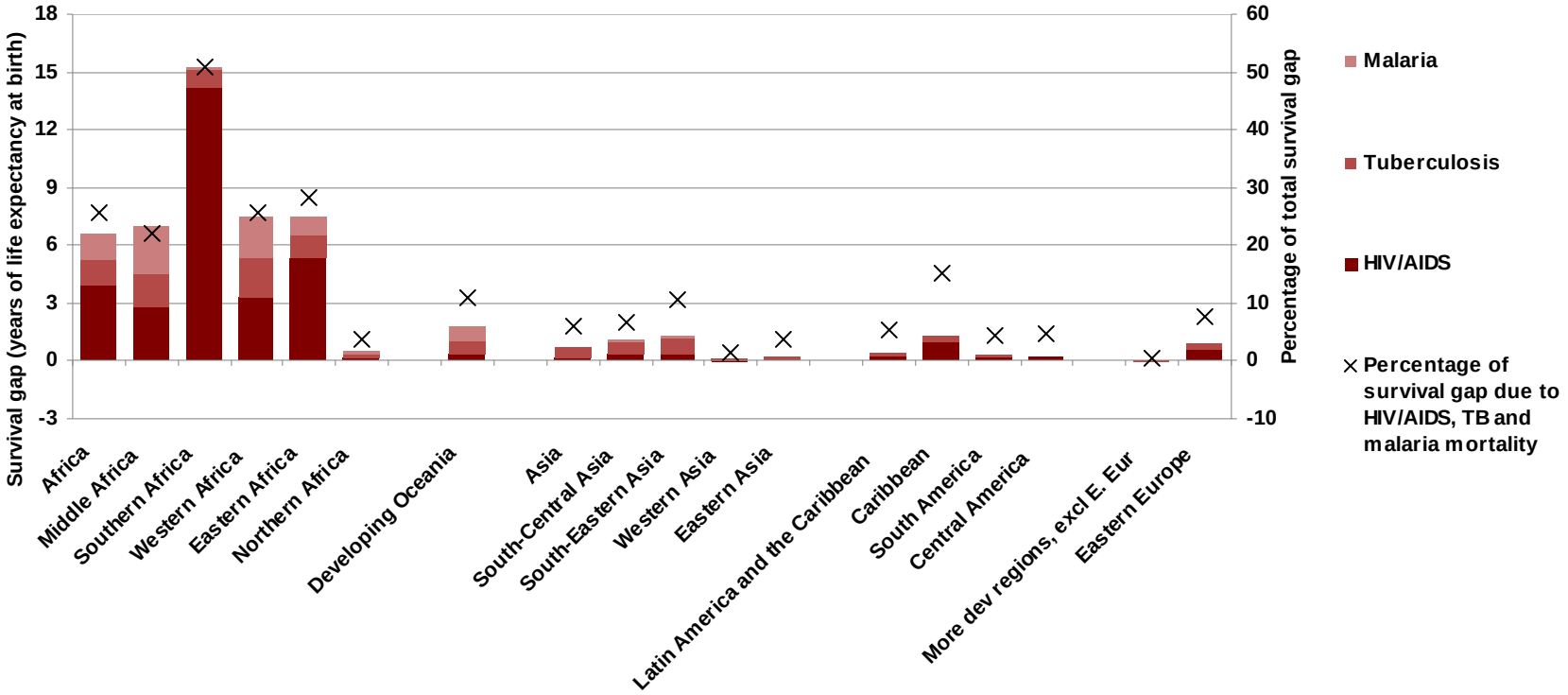
HIV/AIDS was the single largest cause of the survival gap in Southern Africa: reducing death rates from HIV/AIDS in the region to equal those in the "longest-lived" populations would result in a 14.2-year gain in life expectancy at birth. HIV/AIDS was also the leading Group I contributor to the survival gap in Eastern Africa, responsible for 5.3 years of the shortfall in life expectancy there. The disease had a smaller, although still profound impact on the survival gaps in Middle Africa and Western Africa, causing shortfalls in life expectancy of 2.8 years and 3.3 years, respectively.

In the regions outside of sub-Saharan Africa, the contributions of the HIV/AIDS epidemic to survival gaps were smaller. Survival gaps due to HIV/AIDS were smallest (0.0 years) in Western Asia and the "more developed regions, excluding Eastern Europe", where mortality rates due to HIV/AIDS were nearly identical to those in the "longest-lived" populations. Outside of Africa, the gap attributed to HIV/AIDS was highest (1.0 years) in the Caribbean, reflecting the impact on mortality especially in populations where adult HIV prevalence exceeds one per cent, including the Bahamas, Barbados, the Dominican Republic, Haiti, Jamaica, and Trinidad and Tobago.

Synergies between HIV/AIDS and tuberculosis mean that the survival gaps associated with the two diseases tend to be correlated. Figure III.2 shows that the largest survival gaps due to tuberculosis mortality occurred in Africa, where the disease produced disadvantages in longevity ranging from 1.0 year to 2.0 years across the four regions highly affected by HIV/AIDS. The survival gaps due to malaria deaths were also largest in Africa, especially Middle Africa and Western Africa where the disease accounted for 2.4 years and 2.2 years, respectively, of the deficit in life expectancy relative to the "longest-lived" populations. Only one region outside of Africa, developing Oceania, experienced a sizable survival gap due to malaria. If developing Oceania were to reduce malaria death rates to equal those in the "longest-lived" countries (i.e., to eliminate malaria mortality) the region would increase life expectancy at birth by 0.8 years.

Taken together, HIV/AIDS, tuberculosis and malaria accounted for just over half of Southern Africa's total survival gap and around one-quarter of the gaps experienced in Middle Africa, Western Africa and Eastern Africa. While the proportional impact of the causes was smaller outside of Africa, the three diseases targeted under MDG6 accounted for more than 10 per cent of the survival gaps in developing Oceania, South-eastern Asia, and the Caribbean. Continued efforts to achieve progress toward the MDG6 targets is needed in order to shrink the survival gaps by advancing the demographic and epidemiologic transitions in these regions.

Figure III.2. Number of years and percentage of survival gap in selected regions due to excess mortality from HIV/AIDS, tuberculosis and malaria, 2005-2010



A second set of Group I causes of death exacts a substantial impact on survival gaps throughout the less developed regions both because of the large numbers of deaths caused and because mortality is concentrated among young children and deaths that occur at younger ages impact the level of life expectancy at birth more so than deaths that occur among adults. These causes that primarily impact mortality in children include diarrhoeal diseases, pneumonia, and perinatal conditions (figure III.3).

In many of the world's regions, perinatal conditions were the leading Group I contributor to the survival gap. As populations progress through the epidemiologic transition, reductions in deaths due to perinatal conditions tend to be the slowest amongst all Group I causes of death. In Africa on average, perinatal conditions were responsible for 3.3 years of the total survival gap, with values for five African regions ranging from 1.7 years in Northern Africa to 4.1 years in Middle Africa. Among developing Oceania, regions of Asia, and regions of Latin America and the Caribbean, survival gaps attributable to perinatal conditions ranged from 0.8 years in Central America to 2.6 years in South-central Asia.

Throughout the less developed regions, continued progress to reduce mortality from diarrhoeal diseases and pneumonia is needed in order to advance further through the demographic and epidemiologic transitions. Reducing mortality rates due to diarrhoeal diseases to equal those in the "longest-lived" populations would advance life expectancy at birth by more than 3 years in Middle Africa and by between 2 and 3 years in Western Africa, Eastern Africa and South-central Asia. Interventions to reduce mortality from diarrhoeal diseases include promoting breastfeeding, improving access to safe water and improved sanitation, vaccinating children against rotavirus, which is estimated to be responsible for approximately half of diarrhoeal disease deaths worldwide (Tate and others, 2012), and delivering prompt and appropriate treatment to children who become ill (UNICEF and WHO, 2009).

In the five regions of Africa, deaths due to pneumonia caused even larger survival gaps than those due to diarrhoeal diseases. Pneumonia was responsible for a 4.7-year survival gap in Middle Africa and a 3.7-year survival gap in Western Africa. In the three remaining regions of Africa and in developing Oceania, South-central Asia and South-eastern Asia, the survival gaps due to pneumonia mortality each exceeded one year. An estimated 156 million new episodes of pneumonia occur each year worldwide, of which 151 million are in less developed regions (Rudan and others, 2008). Children in developing countries face higher risks of mortality associated with pneumonia due in part to their increased exposure to malnutrition and poverty, as well as their inadequate access to health care. Several strategies have proven effective in reducing pneumonia death rates, such as vaccination against infection by streptococcus pneumoniae and Haemophilus influenzae type b, exclusive breastfeeding in the first six months of life, improvement of nutrition and prevention of low birthweight, control of indoor air pollution and provision of a healthy environment, prevention and management of HIV infection, and case management of pneumonia in the community, health centres and hospitals (WHO, 2010).

The three causes of death with disproportionate impact on mortality in childhood—perinatal conditions, pneumonia and diarrhoeal diseases—together accounted for nearly one third of the overall survival gaps in Africa, Asia and the Caribbean regions. Reducing death rates from these causes to equal those in the "longest-lived" populations would accelerate countries' progress through the demographic and epidemiologic transitions and advance life expectancy at birth by several years.

In 2008, an estimated 358,000 women died due to conditions related to pregnancy or childbearing (i.e., maternal conditions) (WHO and others, 2010). The impact of these deaths is evident in the survival gaps for women in many of the less developed regions. Figure III.4 shows the gaps in life expectancy at birth between women in selected regions and those in the "longest-lived" populations due to excess mortality from maternal causes. Survival gaps due to maternal causes were largest in Africa, where 58 per cent of maternal deaths in 2008 occurred. In Middle

Figure III.3. Number of years and percentage of survival gap in selected regions due to excess mortality from perinatal conditions, pneumonia and diarrhoeal diseases, 2005-2010

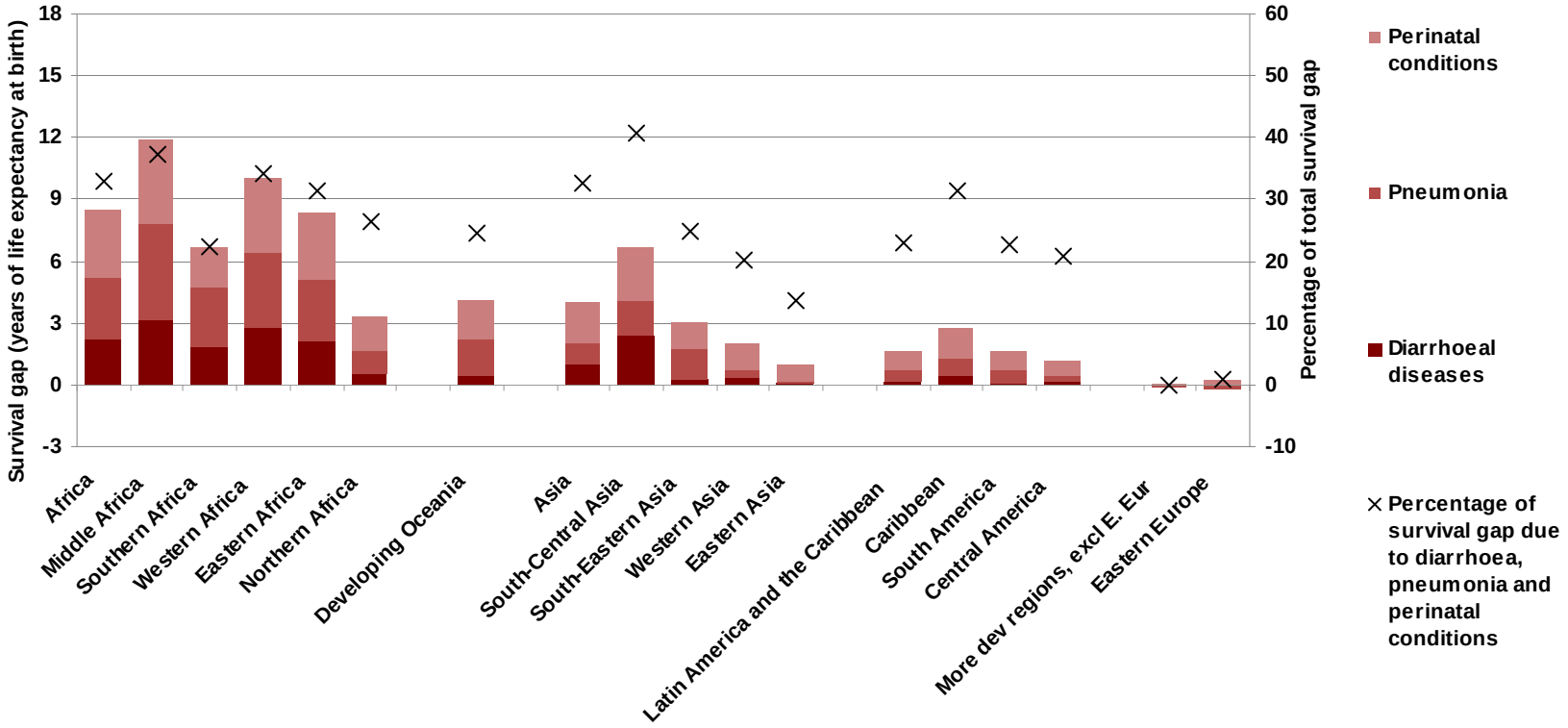
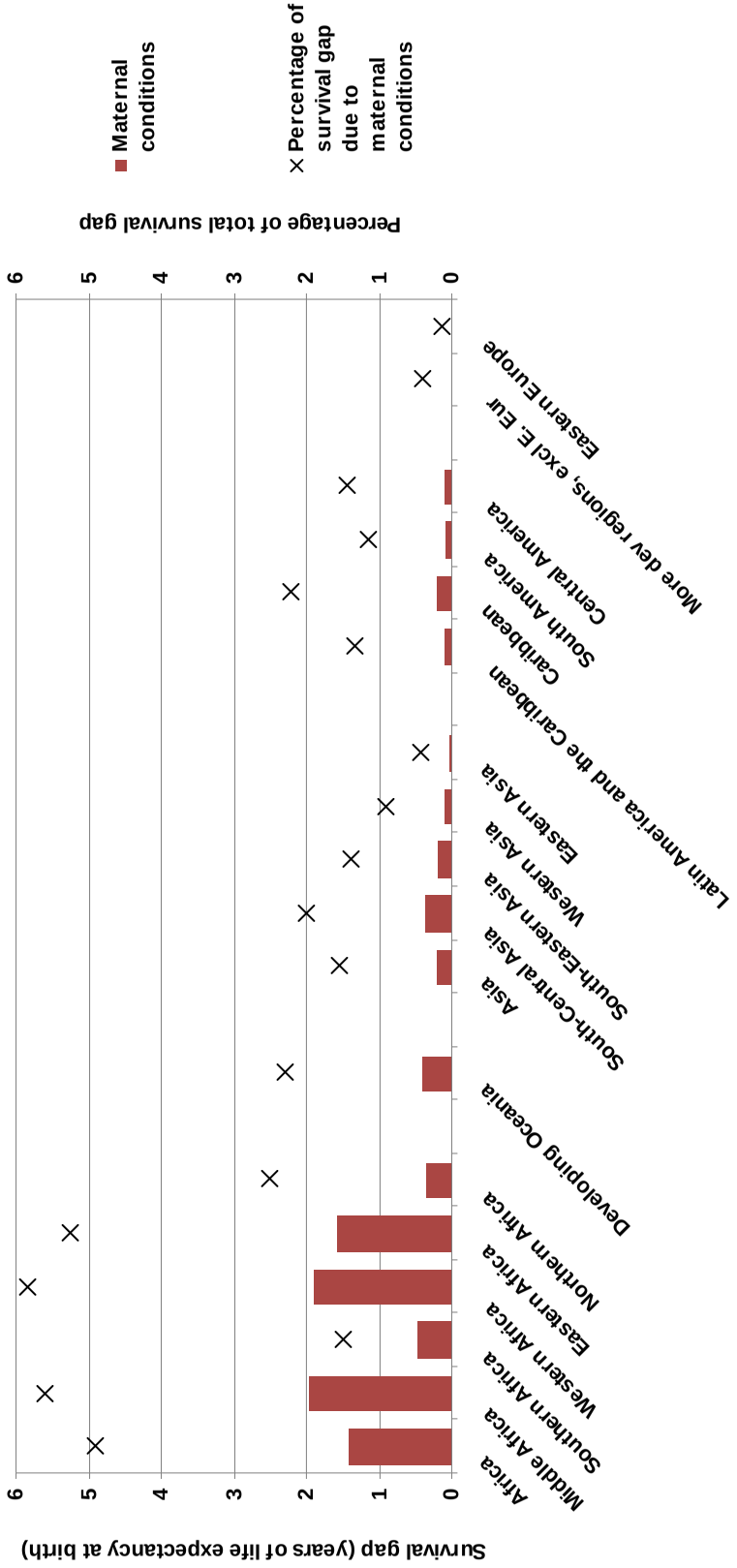


Figure III.4. Number of years and percentage of female survival gap in selected regions due to excess mortality from maternal conditions, 2005-2010



Africa, Western Africa and Eastern Africa these gaps approached 2 years and accounted for nearly 6 per cent of the total female survival gaps. Improving access to the full continuum of care related to reproductive health and maternal health can effectively reduce maternal mortality and advance countries through their epidemiologic transitions. The continuum of care includes adequate family planning to reduce unwanted pregnancy, antenatal care during pregnancy, management of normal delivery by skilled attendants, emergency obstetric services when needed, and timely post-natal care (WHO, 2005).

Four categories of Group II causes of death were responsible for more than 80 per cent of NCD mortality worldwide in 2008: cardiovascular diseases (including heart diseases and stroke), cancers, diabetes and chronic obstructive pulmonary disease. Figure III.5 displays the contribution of each of these causes to the survival gaps, as well as their collective share of the total survival gap for each region. In most regions heart diseases contributed the greatest number of years to the survival gap of the major NCDs. In Africa, the number of years of life expectancy lost due to heart diseases compared to the "longest-lived" populations ranged from 2.2 years in Southern Africa to 4.3 years in Northern Africa. Heart diseases contributed more than 4 years of the survival gaps in developing Oceania and Western Asia as well. Eastern Asia had the smallest survival gap attributed to heart diseases at 0.7 years, while Eastern Europe had the largest at 5.9 years. In the regions of Latin America and the Caribbean, heart diseases were responsible for less than 2 years of the overall survival gap. And while heart diseases contributed just 0.9 years to the survival gap in the "more developed regions, excluding Eastern Europe," this amounted to more than half of the total survival gap in the region.

Stroke was the single leading contributor to the survival gap in Eastern Asia of all of the major causes of death. If stroke mortality rates in Eastern Asia were to decline to equal those in the "longest-lived" populations, life expectancy at birth in the region would advance by 2.4 years. Among the other three regions of Asia as well as in Africa and developing Oceania, stroke was responsible for survival gaps ranging between one and two years. Latin America and the Caribbean had relatively less to gain from reducing stroke mortality rates to equal those in the "longest-lived" populations, ranging from 0.0 years in Central America to 0.9 years in the Caribbean. Stroke also factored little (0.0 years) into the survival gap in the "more developed regions, excluding Eastern Europe," but in Eastern Europe, stroke was second only to heart diseases in driving the gap in life expectancy compared to the "longest-lived" populations, contributing 2.4 years.

Because risk factors associated with the many varied types of cancers differ, the contributions of cancers as a group to the overall survival gaps experienced by the world's regions are somewhat more difficult to interpret compared to the other NCDs. In most of the developing regions shown in figure III.5, the net contribution of cancers to the survival gaps was negative, reflecting mortality risks due to cancer that were actually lower in these regions compared to the "longest-lived" populations. The negative survival gaps indicate that if cancer mortality rates were to change to equal those in the "longest-lived" populations (i.e., if cancer mortality rates were to increase) these regions would experience a decline in life expectancy at birth, ranging from -0.2 years in South America to -1.2 years in Central America. Among the less developed regions of the world, only Southern Africa and Eastern Asia experienced excess mortality from cancers that produced positive survival gaps relative to the "longest-lived" populations.

An examination of survival gaps contributed by specific types of cancers sheds some light on the variable risks that produce the cancer patterns shown in figure III.5. Figure III.6, which shows the survival gaps caused by selected cancers, reveals that, in general, cancers of the lung, bronchus and trachea, as well as stomach cancers, and colon and rectum cancers contribute most to the negative survival gaps. Cancers of the lung, bronchus and trachea, in particular, which are tied closely to tobacco use, contributed survival gaps of about -0.4 year in Middle Africa, Western Africa, Eastern Africa, developing Oceania, South-central Asia and Central America. Lung, bronchus and trachea cancers contributed

Figure III.5. Number of years and percentage of survival gap in selected regions due to excess mortality from heart diseases, stroke, cancers, diabetes, and chronic obstructive pulmonary disease, 2005-2010

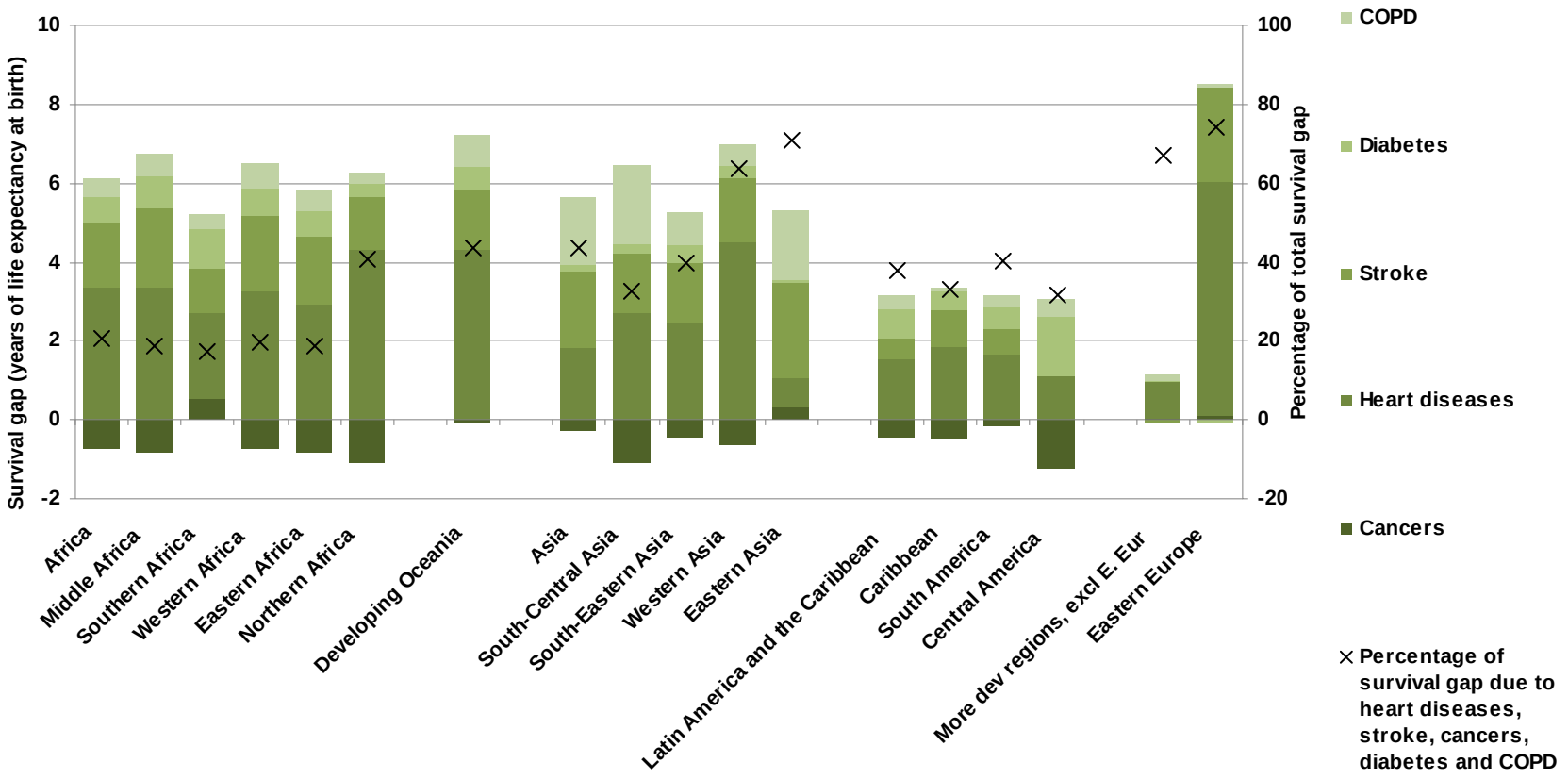
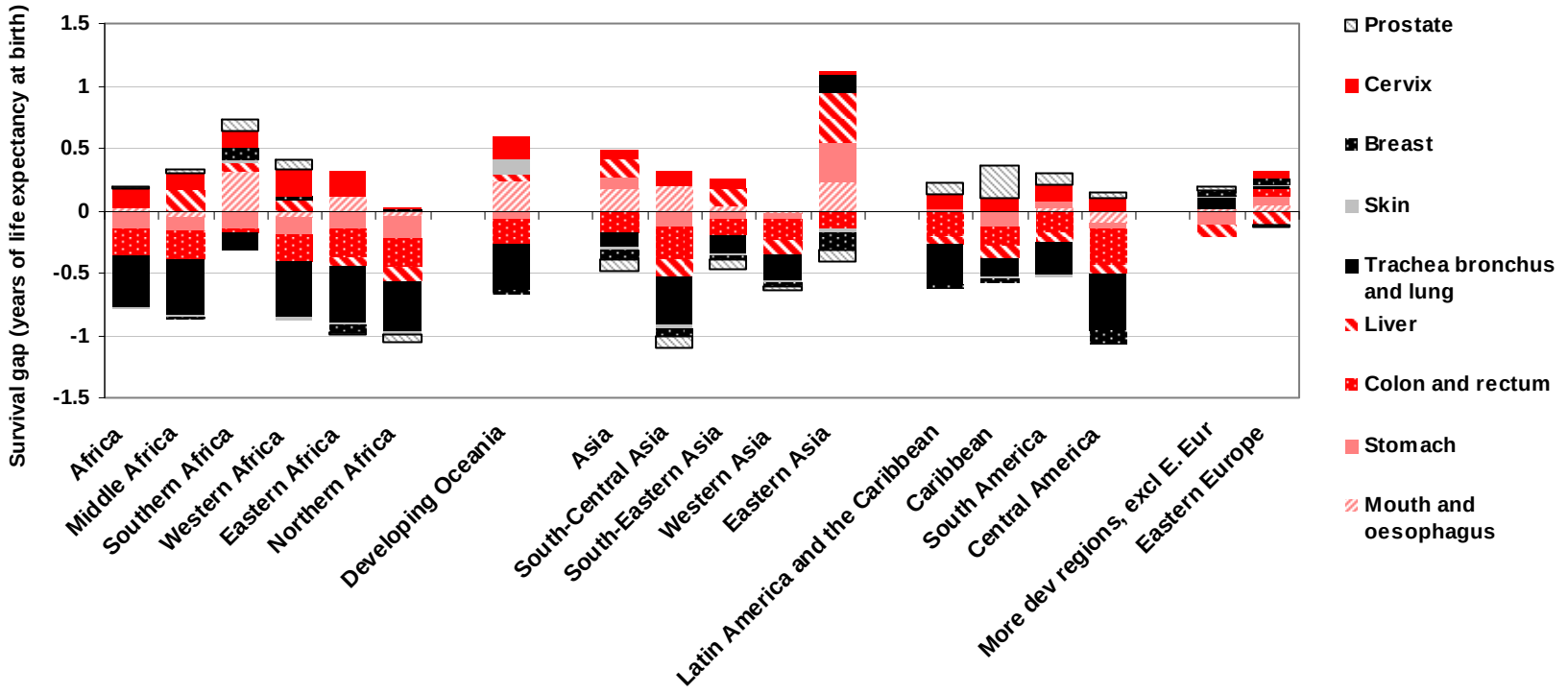


Figure III.6. Number of years of the survival gap in selected regions due to excess mortality from selected types of cancer, 2005-2010



positively to the survival gaps – indicating excess mortality relative to the "longest-lived" populations—in Eastern Asia, the "more developed regions, excluding Eastern Europe," and Eastern Europe.

Lower mortality rates from colon and rectum cancers compared to the "longest-lived" populations contributed survival gaps of around -0.2 years across the less developed regions. Stomach cancer also drove negative survival gaps in Africa, developing Oceania, all regions of Asia except Eastern Asia, the Caribbean, Central America, and the "more developed regions excluding Eastern Europe". Where stomach cancer was more common, such as in Eastern Asia, South America and Eastern Europe, the disease was associated with positive survival gaps of 0.33 years, 0.03 years and 0.08 years respectively.

Across most of the less developed regions, excess mortality associated with cancers of the cervix and prostate were associated with positive gaps in life expectancy relative to the "longest-lived" populations. Cervical cancer, which has been linked to human papilloma virus infection, caused survival gaps as large as 0.2 years in Western Africa and Eastern Africa. Survival gaps associated with prostate cancer were largest in the Latin America and the Caribbean region. Life expectancy at birth in the Caribbean would grow by nearly 0.3 years if prostate cancer mortality rates were to fall to equal those in the "longest-lived" populations.

While diabetes is a growing concern in many of the developing regions largely due to the rising burden of diabetes-associated disability, excess diabetes mortality risks do not yet figure prominently into the survival gaps in many regions (figure III.5). An exception was Central America, where diabetes was responsible for 1.5 years (24 per cent) of the total survival gap. In the remaining regions shown in figure III.5, populations stood to gain less than one year of life expectancy at birth by reducing diabetes mortality rates to equal those in the "longest-lived" populations.

The final category of NCD shown in figure III.5, chronic obstructive pulmonary disease (COPD), contributed most importantly to the survival gaps in South-central Asia and Eastern Asia. In South-central Asia, where indoor air pollution associated with cooking fuels was a common risk factor for chronic respiratory disease, reducing death rates to equal those in the "longest-lived" populations would improve life expectancy at birth by 2.0 years. In Eastern Asia, where tobacco smoking also exacerbated risk of chronic respiratory disease, reducing COPD mortality to the levels in the "longest-lived" populations would close the survival gap by 1.8 years.

Because the burden of mortality from Group I causes of death remains high in most regions of Africa, the proportional contribution of the five major categories of Group II causes shown in figure III.5 to the survival gaps was comparatively small: around 20 per cent in Middle Africa, Southern Africa, Western Africa and Eastern Africa; and around 40 per cent in Northern Africa. In developing Oceania and Latin America and the Caribbean as well as in the South-central and South-eastern regions of Asia, these five non-communicable disease categories accounted for around 30 to 40 per cent of the total survival gaps, while in Western Asia, Eastern Asia and the "more developed regions, excluding Eastern Europe", that proportion rose to around 60 per cent to 70 per cent. Of the world regions shown in figure III.5, Eastern Europe was the region with the greatest proportion of its survival gap attributable to the five major NCDs: if the region were to reduce death rates from these causes to equal those in the "longest-lived" populations, it would close nearly three quarters of its total survival gap.

Interventions to reduce mortality from NCDs and thus promote continued progress through the demographic and epidemiologic transitions hinge on both prevention and treatment. Tobacco use, alcohol use, unhealthy diets and physical inactivity have all been linked to heightened risk of morbidity and mortality from NCDs (WHO, 2011b). Multi-sectoral policies to reduce the prevalence of smoking, moderate alcohol and salt consumption, and promote healthy diets and physical activity can prevent the onset of and reduce mortality rates from many NCDs.

Treatment interventions that address proximate risk factors such as high blood pressure or cholesterol can also delay or prevent the onset of NCD morbidity and mortality. However, even with expanded prevention efforts, the incidence and number of deaths due to NCDs is expected to continue to grow as the world's populations age through their demographic transitions. According to WHO projections, the increase in the number of deaths due to NCDs attributable to population ageing will far outpace the reduction in NCD deaths anticipated to follow declines in age-specific risks (Mathers and Loncar, 2006). Thus while prevention and treatment efforts can slow the growth in the burden of NCDs, population ageing implies that the burden of the future will likely be greater than that of today. Hence, health systems will need to adapt accordingly to treat the growing number of patients afflicted with chronic illness.

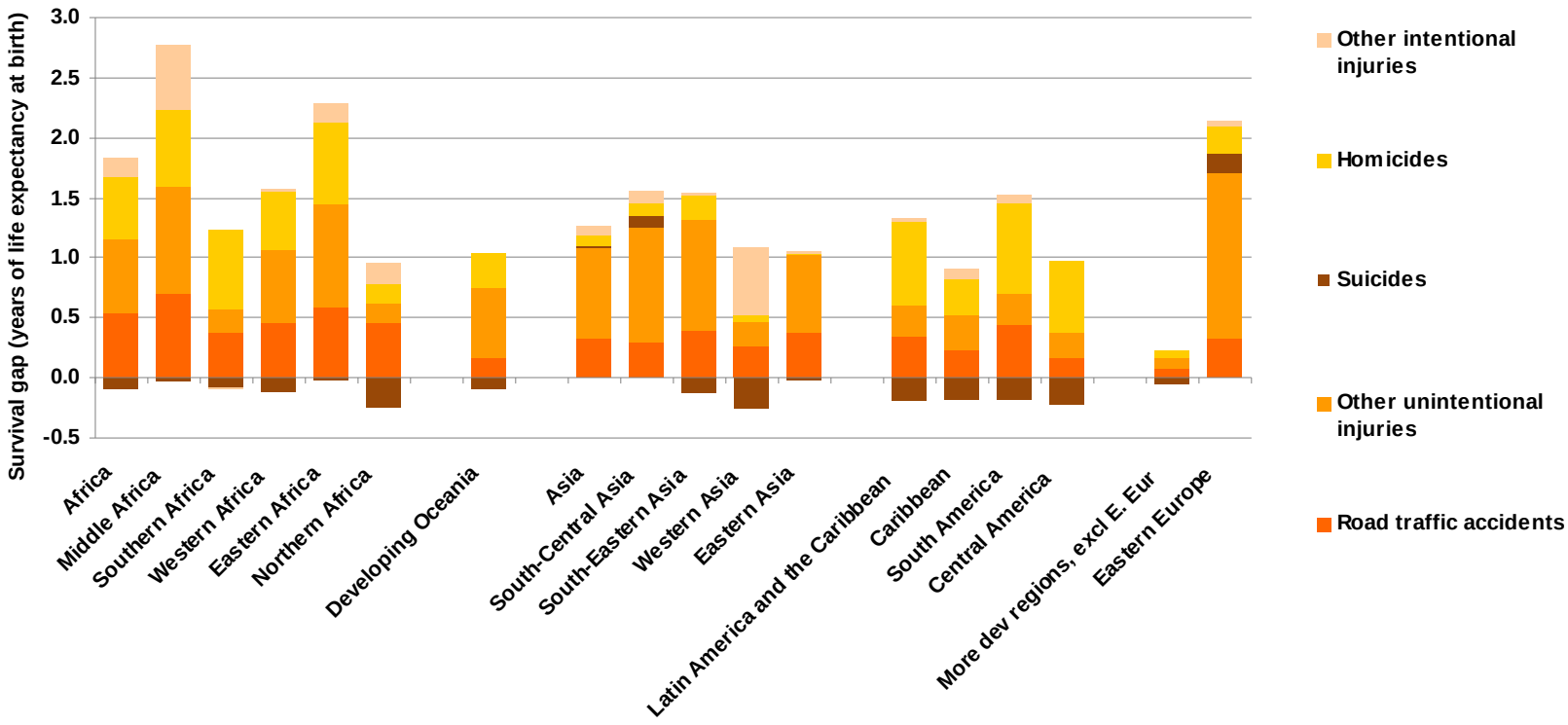
The capacity of health systems to respond to a growing burden of NCDs is convoluted by the fact that many of the medical interventions required to address such illness—e.g., surgery, chemotherapy, or insulin support—are expensive and not readily available to many patients in the less developed regions whose health systems were partly designed and built around the control of infectious diseases. The 2011 *Political Declaration on the Prevention and Control of Non-communicable Diseases* recognized that health systems in developing regions were increasingly tasked with diagnosing and treating NCDs and highlighted the need to strengthen those systems to address the growing numbers of patients in need of treatment interventions for NCDs.

Among the causes of death from unintentional injuries, road traffic accidents accounted for a large proportion of the resulting survival gaps (figure III.7). Across the five regions of Africa, excess mortality from road traffic accidents relative to the "longest-lived" populations produced survival gaps of around 0.5 years. The magnitude of the survival gap attributable to road traffic accidents was somewhat smaller in the other less developed regions, ranging from a low of 0.2 years in developing Oceania to a high of 0.4 years in both South-eastern Asia and South America. Other types of unintentional injuries—including, *inter alia*, poisonings, falls, fires and drownings—accounted for up to 1 year of additional survival gap in the less developed regions. Notably, in Eastern Europe other unintentional injuries accounted for 1.4 years of the survival gap, more than in any other world region. Poisonings, a large proportion of which were likely due to the overconsumption of alcohol, accounted for nearly 0.5 years of the survival gap attributed to "other unintentional injuries" in Eastern Europe (data not shown).

The degree to which excess mortality due to intentional violence factored into the survival gaps experienced around the world differed markedly by region. In Southern Africa, for example, deaths due to intentional injuries were responsible for over half of the Group III survival gap, with homicides playing a particularly prominent role, accounting for 0.7 years of the difference in life expectancy relative to the "longest-lived" populations. The magnitude of the gap associated with homicides was similarly high in Middle Africa, Eastern Africa and South America. War-related mortality, captured under "other intentional injuries", also contributed to the survival gaps in some regions, namely Middle Africa (0.5 years) and Western Asia (0.6 years).

In most regions, lower age-specific suicide rates relative to the "longest-lived" populations produced negative survival gaps. Exceptions were South-central Asia and Eastern Europe, where excess mortality due to suicide contributed survival gaps of 0.1 years and 0.2 years respectively.

Figure III.7. Number of years of the survival gap in selected regions due to excess mortality from selected categories of injuries, 2005-2010



D. CONCLUSIONS

The preceding analysis identified the specific causes of death that impede continued progress through the demographic and epidemiologic transitions. These causes continue to challenge the world's regions as they strive to achieve or surpass the longevity enjoyed by the world's longest-lived populations, with life expectancies at birth greater than 80 years in 2005-2010. Results revealed great heterogeneity across the world's regions in terms of which specific causes of death were most responsible for the survival gaps, and thus great diversity in the types of health interventions needed to continue to advance the world's populations through the demographic and epidemiologic transition processes. Table III.2 presents the five leading causes of death with respect to their contribution to the survival gaps in each region.

In order for much of Africa to continue to realize the mortality reductions that characterize the demographic and epidemiologic transitions, continued progress is needed to address the communicable diseases. This means focusing attention not just on HIV/AIDS, tuberculosis and malaria, which have been the targets of large-scale national and international efforts related to MDG6, but also pneumonia and diarrhoeal diseases, which carry high risks of mortality for children and account for large percentages of the survival gaps in Middle Africa, Western Africa and Eastern Africa, in particular. Continued progress in preventing deaths from maternal causes is also needed to continue to advance life expectancy among women across these regions. But focusing attention on Group I causes of death alone ignores the substantial and growing risks of death due to Group II NCDs in Africa (Behrman and others, 2011). Excess mortality due to heart diseases and stroke in Africa has received comparatively little attention among the global health community, in spite of the fact that they outrank many of the major communicable diseases in contributing to shortfalls in life expectancy. That the survival gaps due to heart diseases in Africa were larger even than those in Asia and Latin America and the Caribbean, two regions that were further along in the demographic and epidemiologic transitions, further underscores challenge that NCDs present in advancing populations of Africa through their transitions.

The populations of developing Oceania and regions of Asia and Latin America and the Caribbean also experience a "double-burden" of communicable and non-communicable diseases, with both groups of causes contributing importantly to gaps in survival relative to the "longest-lived" populations of the world. In developing Oceania as well as South-central Asia and South-eastern Asia large portions of the survival gaps continue to be attributable to excess mortality due to pneumonia and diarrhoeal diseases at the same time that heart diseases, stroke and COPD are exacting an impact on survival deficits. In South-central Asia, for example, diarrhoeal diseases and COPD were each responsible for survival gaps of more than two years. To continue to achieve gains in longevity through the demographic and epidemiologic transitions, these countries need to address the prevention and treatment of NCDs among adults without detracting focus from interventions to reduce mortality due to pneumonia and diarrhoeal diseases, especially in young children.

Regions of Asia that have successfully reduced death rates from infectious diseases to close to the levels experienced in the "longest-lived" populations, including Western Asia and Eastern Asia, also experienced excess mortality from NCDs. In Western Asia, heart diseases were the chief source of the survival gap, while in Eastern Asia stroke and COPD were the leading contributors to deficits in survival.

Each of the three regions of Latin America and the Caribbean faces its own epidemiologic risk profile. In both the Caribbean and South America, heart diseases were the number one contributor to the survival gaps. The Caribbean region additionally counted HIV/AIDS among the leading challenges to progress in longevity. Central America is the only region of the world where diabetes and nutritional deficiencies rank among the top five causes of death contributing to

the shortfall in life expectancy at birth relative to the "longest-lived" populations. In both South America and Central America, excess mortality due to homicides was among the top five causes of death responsible for the survival gaps.

Among the more developed regions, the mortality risks posed by the NCDs constitute the biggest challenge to further improvements in longevity. Excess mortality attributable to heart diseases was responsible for the vast majority of the difference in life expectancy between the "more developed regions, excluding Eastern Europe" and the subset of countries or areas included among the "longest-lived" populations. Heart diseases were the most important contributor to the survival gap in Eastern Europe as well, though the size of the survival gap due to heart diseases in Eastern Europe was more than six times that in the "more developed regions, excluding Eastern Europe". Stroke and HIV/AIDS also stood out for their contributions to the shortfall in life expectancy at birth in Eastern Europe.

Notably, excess mortality due to perinatal conditions ranked among the top five causes of death contributing to the survival gaps in each of the regions included in this analysis. The magnitude varied across the regions with those regions with the lowest life expectancies at birth standing to gain the most by reducing the rate of death from perinatal conditions to equal that in the "longest-lived" populations. Even at advanced stages of the demographic and epidemiologic transitions, reducing mortality that is related to risks that occur in the late stages of pregnancy and in the period surrounding childbirth remains a formidable challenge.

The strength of the conclusions that may be drawn from the preceding analysis is limited by the degree of uncertainty surrounding the mortality estimates upon which the analysis relies. Many countries do not yet have adequate vital registration systems to provide reliable information on the numbers of deaths that occur. Among countries with good vital registration coverage, many lack accurate cause-of-death reporting from death certificates. Given the scarcity of complete and accurate mortality statistics, the estimates of age-specific all-cause mortality rates from the *World Population Prospects* are, for many countries, based upon mortality models. Likewise, the WHO has utilized cause-of-death models along with various assumptions in producing its estimates of the numbers of deaths by cause for numerous countries. Thus the extent to which the analysis accurately reflects the true magnitude of the survival gaps due to each cause is highly dependant on the validity of the models employed. Sustained improvements to vital registration systems are needed to better capture the mortality profiles of countries to accurately reflect the levels of mortality and the risks posed by the various causes of death.

TABLE III.2. LEADING CAUSES OF DEATH CONTRIBUTING TO THE DIFFERENCE IN LIFE EXPECTANCY AT BIRTH (SURVIVAL GAP) BETWEEN SELECTED REGIONS AND THE "LONGEST-LIVED" POPULATIONS, 2005-2010

Rank	*Cause of death*	*Survival gap (years*	*Rank*	*Cause of death*	*Survival gap (years)*	*Rank*	*Cause of death*	*Survival gap (years*	*Rank*	*Cause of death*	*Survival gap (years)*
					Less developed regions						
	Africa			*Developing Oceania*			*Asia*			*Latin America and the Caribbean*	
	Middle Africa						*South-central Asia*			*Caribbean*	
1	Pneumonia	4.7	1	Heart diseases	4.3	1	Heart diseases	2.7	1	Heart diseases	1.9
2	Perinatal cond.	4.1	2	Perinatal cond.	1.8	2	Perinatal cond.	2.6	2	Perinatal cond.	1.4
3	Heart diseases	3.4	3	Pneumonia	1.8	3	Diarrhoeal disease	2.4	3	HIV/AIDS	1.0
4	Diarrhoeal disease	3.1	4	Stroke	1.6	4	COPD	2.0	4	Stroke	0.9
5	HIV/AIDS	2.8	5	COPD	0.8	5	Pneumonia	1.7	5	Pneumonia	0.9
	Southern Africa						*South-eastern Asia*			*South America*	
1	HIV/AIDS	14.2				1	Heart diseases	2.4	1	Heart diseases	1.7
2	Pneumonia	2.8				2	Stroke	1.6	2	Perinatal cond.	1.0
3	Heart diseases	2.2				3	Pneumonia	1.5	3	Homicides	0.8
4	Perinatal cond.	2.0				4	Perinatal cond.	1.3	4	Stroke	0.6
5	Diarrhoeal disease	1.9				5	Tuberculosis	0.9	5	Pneumonia	0.6
	Western Africa						*Western Asia*			*Central America*	
1	Perinatal cond.	3.7				1	Heart diseases	4.5	1	Diabetes	1.5
2	Pneumonia	3.7				2	Stroke	1.6	2	Heart diseases	1.1
3	HIV/AIDS	3.3				3	Perinatal cond.	1.3	3	Perinatal cond.	0.8
4	Heart diseases	3.2				4	COPD	0.5	4	Homicides	0.6
5	Diarrhoeal disease	2.7				5	Pneumonia	0.4	5	Nutritional def.	0.4
	Eastern Africa						*Eastern Asia*				
1	HIV/AIDS	5.3				1	Stroke	2.4			
2	Perinatal cond.	3.2				2	COPD	1.8			
3	Pneumonia	3.0				3	Perinatal cond.	0.8			
4	Heart diseases	2.9				4	Heart diseases	0.7			
5	Diarrhoeal disease	2.2				5	Cancers	0.4			
	Northern Africa										
1	Heart diseases	4.3									
2	Perninatal cond.	1.7									
3	Stroke	1.4									
4	Pneumonia	1.1									
5	Diarrhoeal disease	0.6									
					More developed regions						
				More developed regions, excluding Eastern Europe			*Eastern Europe*				
			1	Heart diseases	0.9	1	Heart diseases	5.9			
			2	COPD	0.2	2	Stroke	2.4			
			3	Perinatal cond.	0.1	3	HIV/AIDS	0.6			
			4	Road traffic acc.	0.1	4	Road traffic acc.	0.3			
			5	Homicides	0.1	5	Perinatal cond.	0.3			

COPD: Chronic Obstructive Pulmonary Disease
Perinatal cond: Perinatal conditions
Road traffic acc.: Road traffic accidents

Annex I: Data and Methods

Much of the analysis presented in this report utilizes sex- and age-specific estimates of mortality rates by cause. To derive these estimates for the period 2005-2010, two data sources were used. Sex- and age-specific all-cause mortality rates corresponding to 2005-2010 were taken from the *2010 Revision* of *World Population Prospects*. The sex- and age-specific proportional distribution of deaths by cause corresponding to the year 2008 were accessed from the WHO's updated estimates of cause-specific mortality published in 2011. A time series of estimates of the proportional distribution of deaths by cause is not available, thus in calculating the cause-specific mortality rates for the period 2005-2010 the distribution of deaths by cause in 2008 is assumed to apply to the entire interval 2005-2010. Cause-specific mortality rates were calculated for each sex as follows:

$${}_nm_{x,i} = {}_nm_x \text{ x } {}_nD_{x,i} / {}_nD_x$$

where ${}_nm_{x,i}$ is the mortality rate due to cause i for ages x to $x+n$; ${}_nm_x$ is the all-cause mortality rate for ages x to $x+n$ from *World Population Prospects*; and ${}_nD_{x,i} / {}_nD_x$ is the proportion of deaths to age group x to $x+n$ that were due to cause i according to the WHO's estimates for 2008.

The assignment of deaths by cause is exhaustive, such that:

$${}_nm_x = \Sigma_i \, {}_nm_{x,i}$$

Two differences in the way the United Nations Population Division (UNPD) and WHO present their data have required attention while carrying out the above exercise. The first surrounds the delineation of childhood age groups. WHO's Child Health and Epidemiology Reference Group (CHERG) produced cause of death estimates (both sexes combined) for neonates (ages 0-27 days) and children (ages 1-59 months) for 2008, while in UNPD lifetables childhood mortality estimates correspond to the age groups 0-1 years for infants and 1-4 years for children. To apply the proportional distribution of deaths by cause from the WHO to the UNPD mortality rates for infants and children the following procedure was employed:

1) For each country, the proportion of deaths to children 0-4 years taking place within the neonatal period (P_{neo}) was calculated from the CHERG estimates of all-cause deaths to neonates (D_{neo}^{2008}) and all cause deaths to children ages 1-59 months ($D_{1\text{-}59mo}^{2008}$) corresponding to the year 2008.

$$P_{neo} = D_{neo}^{2008} / (D_{neo}^{2008} + D_{1\text{-}59mo}^{2008})$$

2) P_{neo} was multiplied by the number of deaths to children ages 0 to 4 years during the years 2005-2010 from *World Population Prospects: The 2010 Revision* to get the number of neonatal deaths during that period.

$$D_{neo}^{2005\text{-}2010} = (P_{neo} \text{ x } D_{0\text{-}4yr}^{2005\text{-}2010})$$

3) The number of neonatal deaths during 2005-2010 was subtracted from the total number of deaths among infants aged 0 to 1 year during 2005-2010 from World Population Prospects to get the number of deaths occurring to children ages 1 to 11 months during that period.

$$D_{1\text{-}11mo}^{2005\text{-}2010} = D_{0\text{-}1yr}^{2005\text{-}2010} - D_{neo}^{2005\text{-}2010}$$

4) The proportional distribution of neonatal deaths by cause from CHERG and corresponding to the year 2008 was multiplied by the number of neonatal deaths during 2005-2010 to get the number of neonatal deaths by cause for 2005-2010.

$$D_{neo,\,i}^{2005\text{-}2010} = (D_{neo}^{2005\text{-}2010} \text{ x } D_{neo,i}^{2008} / D_{neo}^{2008})$$

5) The proportional distribution of child (ages 1-59 months) deaths by cause from CHERG and corresponding to the year 2008 was multiplied by the number of deaths to infants 0-11 months during 2005-2010 to get the number of deaths to those aged 1-11 months by cause for 2005-2010. This procedure assumes that the distribution of deaths by cause is identical for the age groups 1-11 months and 1-59 months. The sum of cause-specific deaths for neonates and infants 1-11 months is the number of cause-specific deaths to infants aged 0-1 year, which corresponds to the infant age group in the UNPD life tables.

$$D_{1\text{-}11mo,i}^{2005\text{-}2010} = (D_{1\text{-}11mo}^{2005\text{-}2010} \text{ x } D_{1\text{-}59mo,i}^{2008} / D_{1\text{-}59mo}^{2008})$$

$$D_{0\text{-}1yr,i}^{2005\text{-}2010} = D_{neo,i}^{2005\text{-}2010} + D_{1\text{-}11mo,i}^{2005\text{-}2010}$$

$${}_1m_{0,i} = {}_1m_0 \text{ x } D_{0\text{-}1yr,i}^{2005\text{-}2010} / D_{0\text{-}1yr}^{2005\text{-}2010}$$

6) The number of deaths by cause to children ages 1-4 years was calculated by subtracting the cause-specific infant deaths from the estimates of deaths by cause to children ages 0-4.

$$D_{1\text{-}4yr,i}^{2005\text{-}2010} = D_{0\text{-}5yr,i}^{2005\text{-}2010} - D_{0\text{-}1yr,i}^{2005\text{-}2010}$$

$${}_4m_{1,i} = {}_4m_1 \text{ x } D_{1\text{-}4yr,i}^{2005\text{-}2010} / D_{1\text{-}4yr}^{2005\text{-}2010}$$

A second difference between the data compiled by the UNPD and that from the WHO concerns the countries or areas for which mortality estimates are produced. *World Population Prospects: The 2010 Revision* includes mortality estimates for regions that together represent 230 countries or areas, while WHO publishes estimates of deaths by cause for the subset of countries that comprise its 193 Member States. In combining the two sets of estimates through the procedure outlined above to produce the regional aggregates of the cause-specific death rates analysed in this report, countries or areas that were not among the 193 WHO Member States were assumed to have the same sex- and age-specific distribution of deaths by cause as the aggregate in the region for countries that were WHO Member States.

The cause-specific survival gaps estimated in part III of the report were calculated as follows. First, the cause-deleted lifetables were calculated for each cause using the procedure described in Box 4.2 of Preston and others, 2001. Then, the difference between the levels of life expectancy at birth in the "longest-lived" populations (e_0^*) and that in each of the world's regions (e_0) was decomposed by cause using the procedure outlined in Beltran-Sanchez and others, 2008:

$$e_0^* - e_0 = \Sigma^{n}_{i=1} \Sigma^{\omega}_{x=0,5} ({}_nL_{x,i}^* - {}_nL_{x,i})[({}_nL_{x,-i}^* - {}_nL_{x,-i})/2]$$

where ${}_nL_{x,i}^*$, ${}_nL_{x,-i}^*$, ${}_nL_{x,i}$, ${}_nL_{x,-i}$ represent the person-years lived between ages x and $x+n$ in the "longest-lived" populations (denoted with *) and each region in the life tables for cause i and cause $-i$, respectively using a lifetable with a radix of 1.

Annex II

Results of the Decomposition Analysis

Figure AII.1. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Middle Africa, by sex, 2005-2010

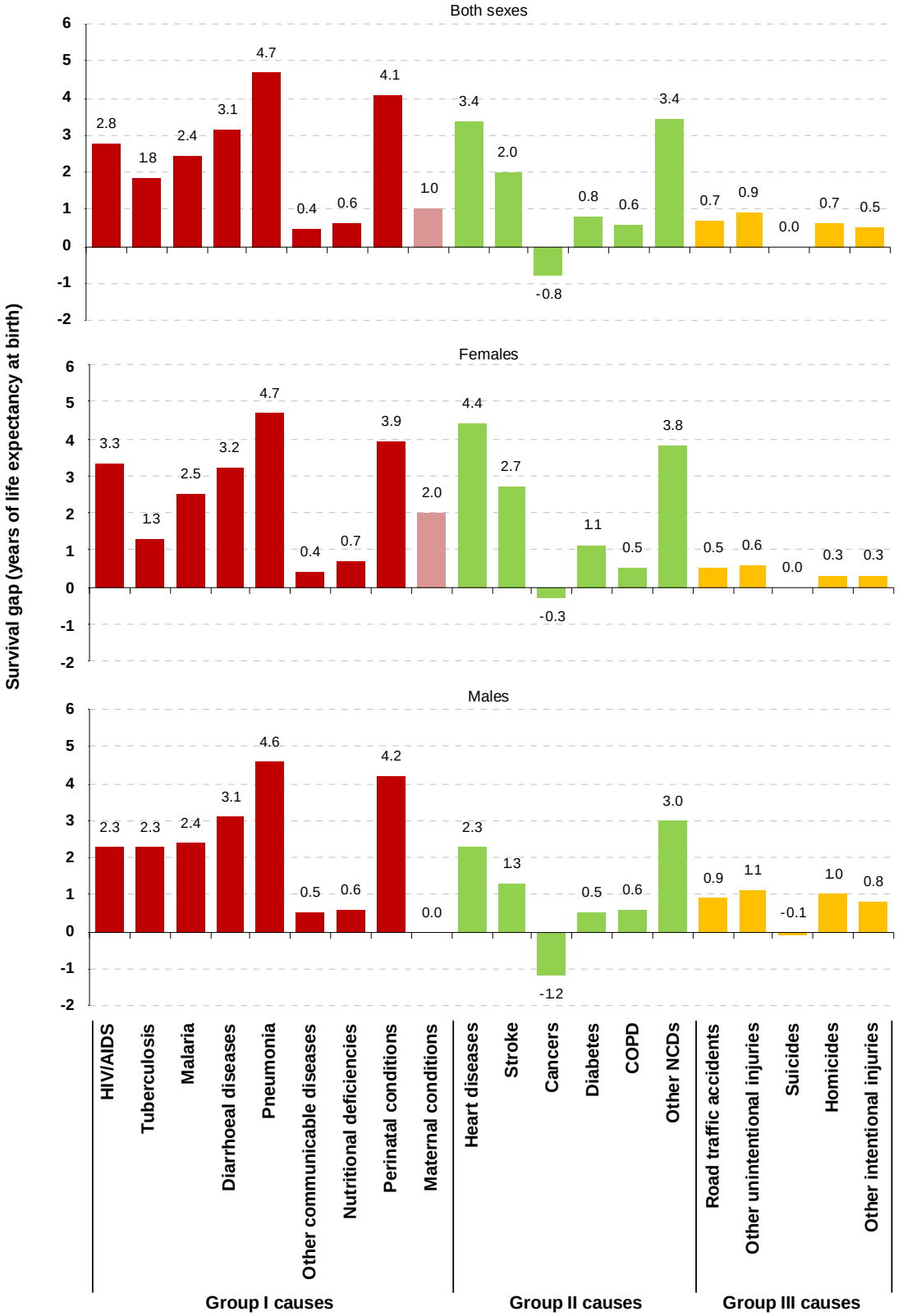


Figure AII.2. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Southern Africa, by sex, 2005-2010

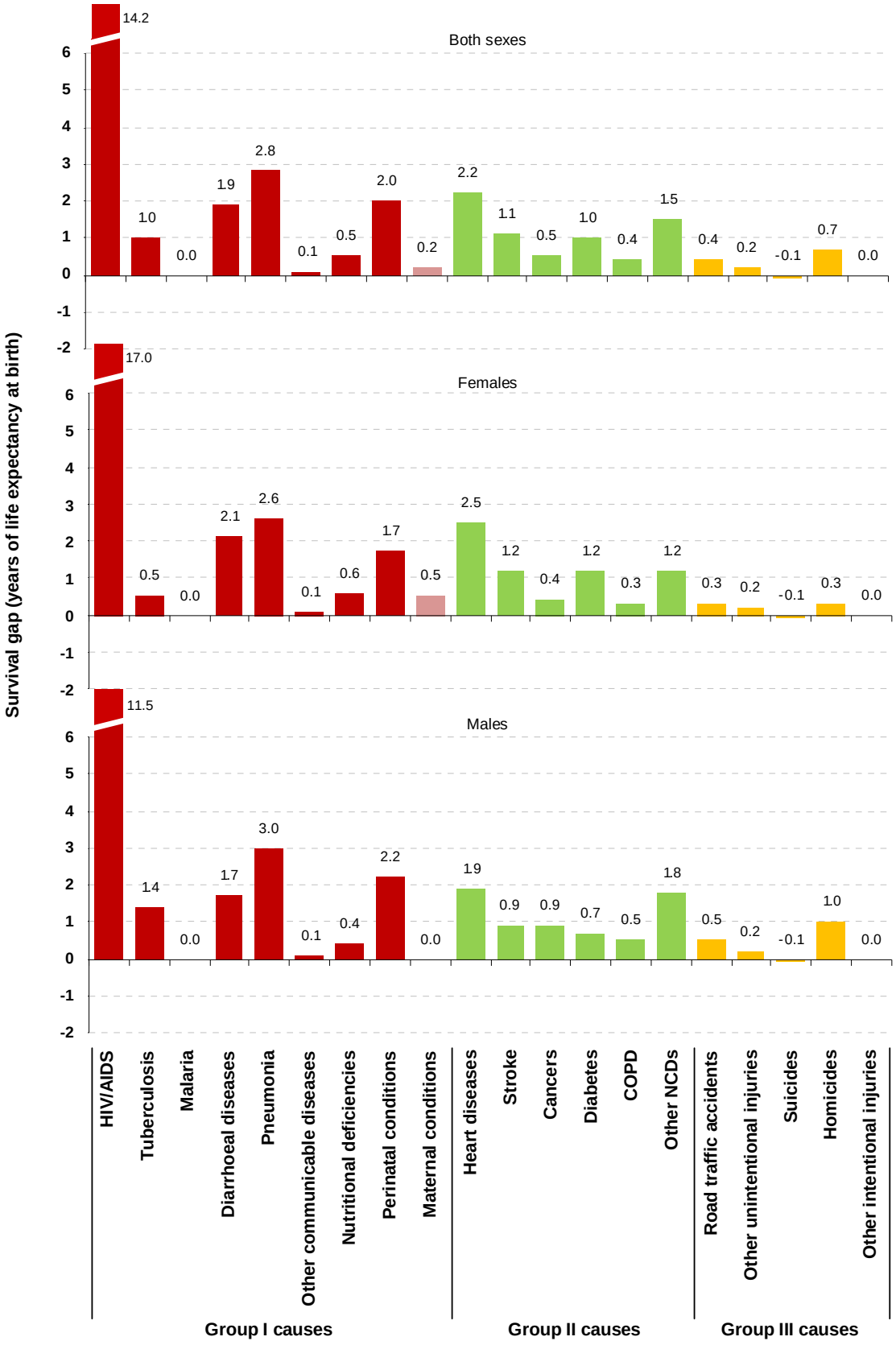


Figure AII.3. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Western Africa, by sex, 2005-2010

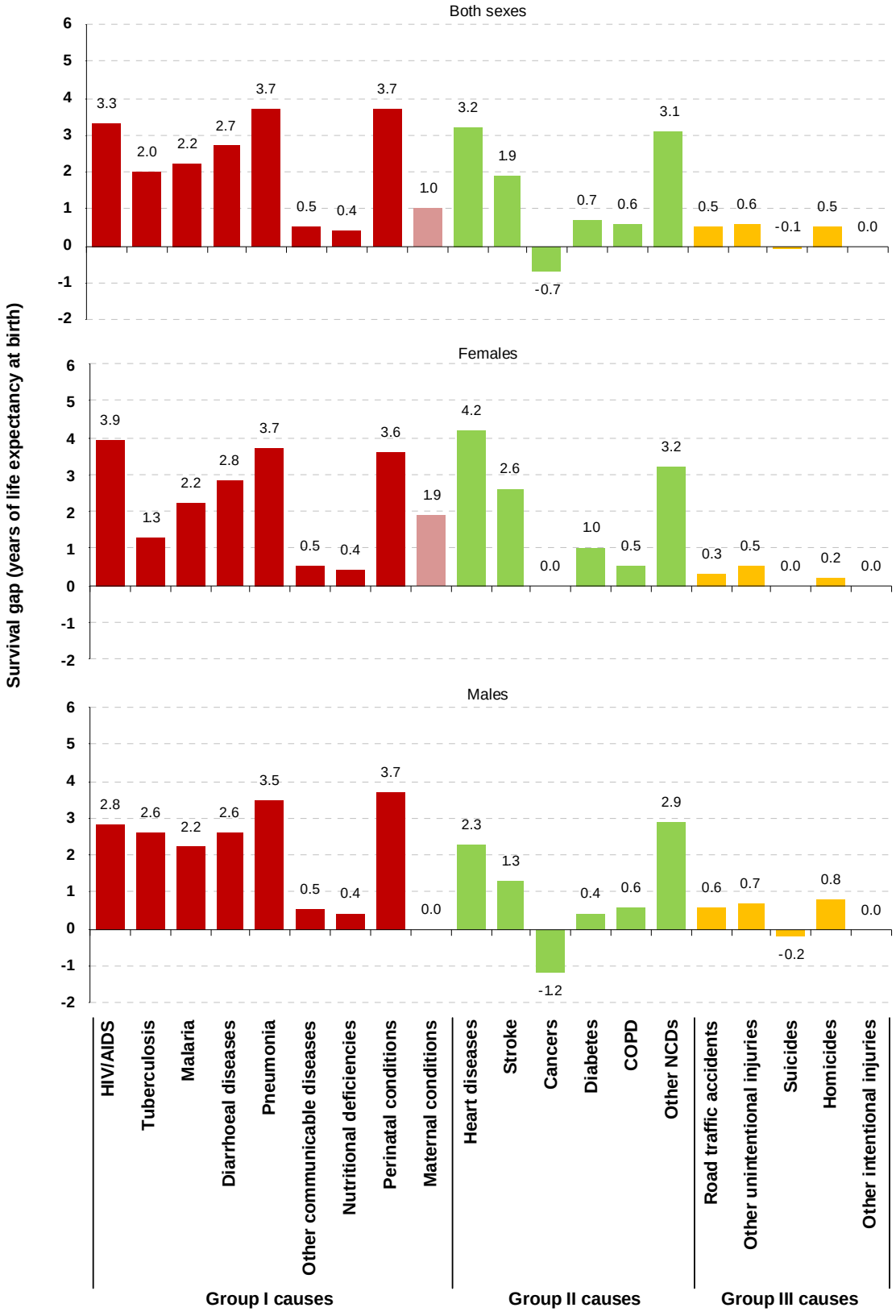


Figure AII.4. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Eastern Africa, by sex, 2005-2010

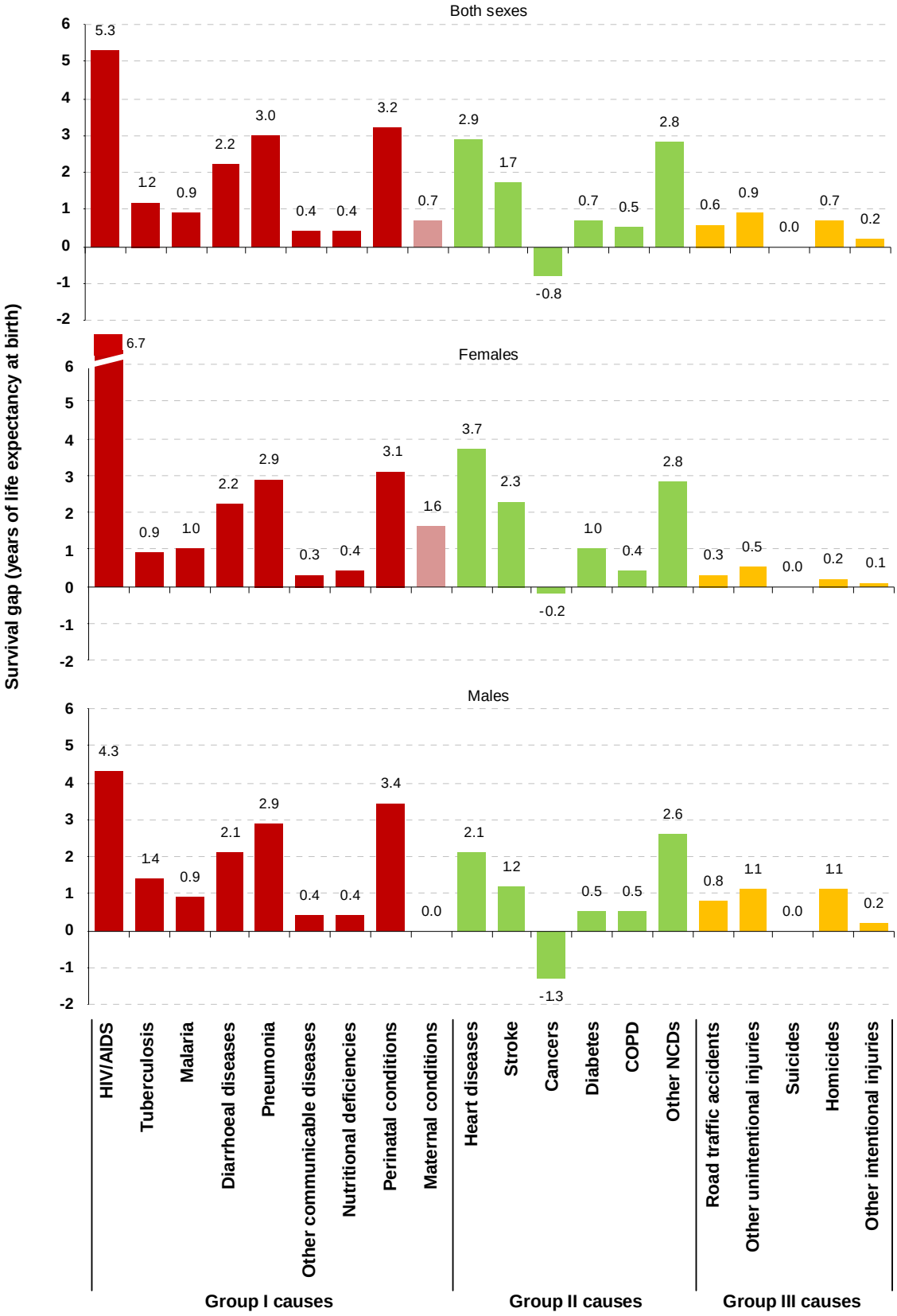


Figure AII.5. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Northern Africa, by sex, 2005-2010

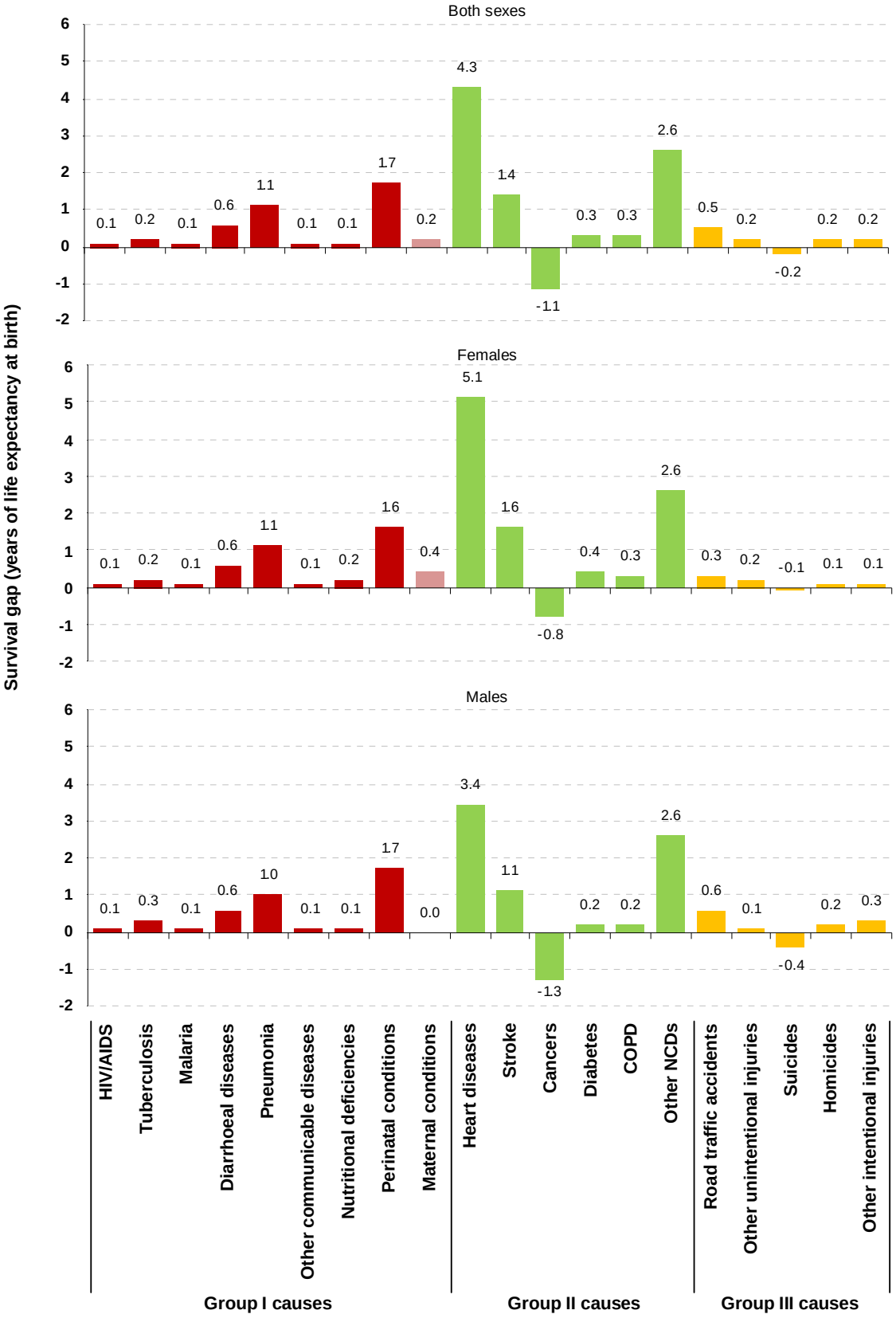


Figure AII.6. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, developing Oceania, by sex, 2005-2010

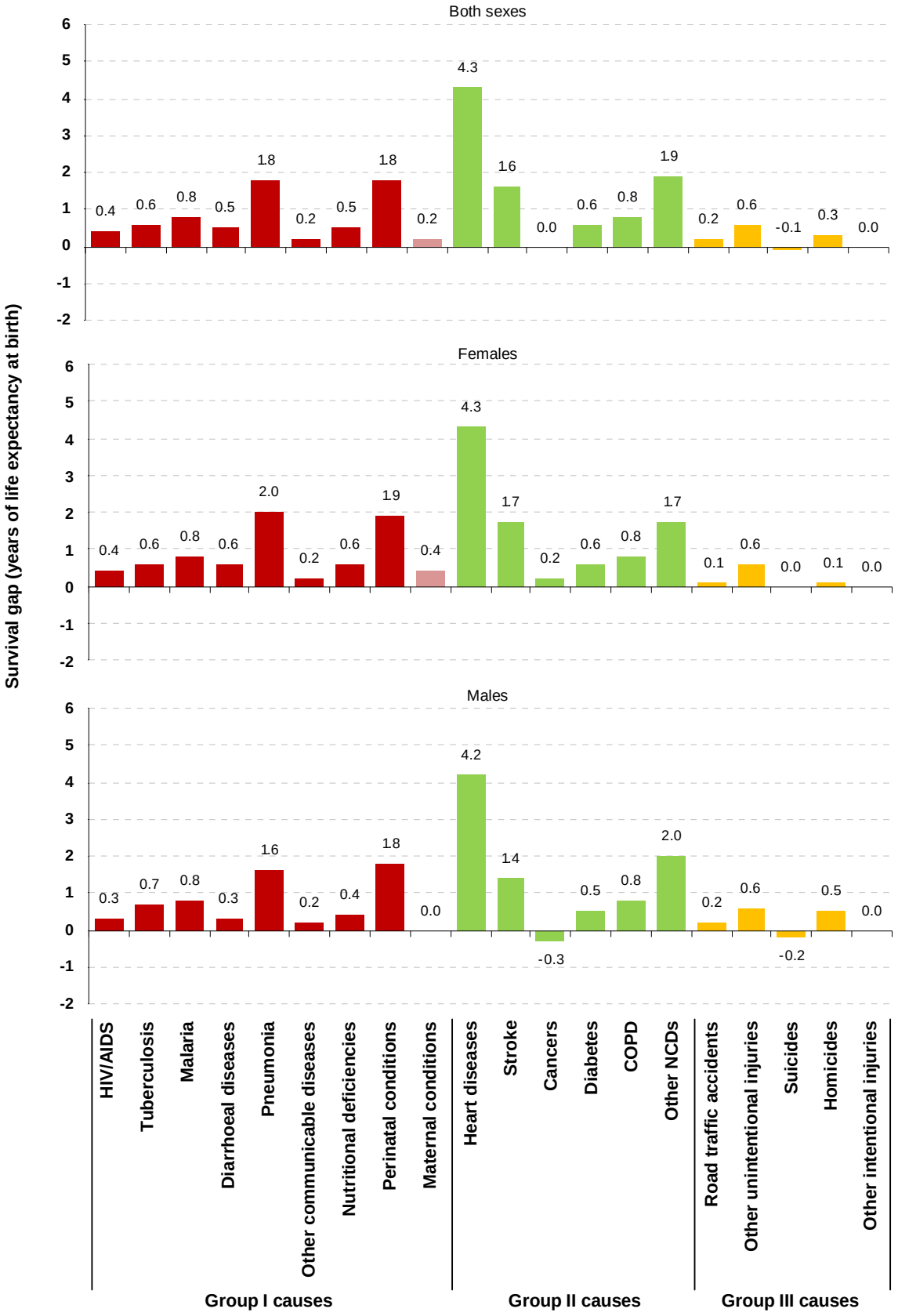


Figure AII.7. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, South-central Asia, by sex, 2005-2010

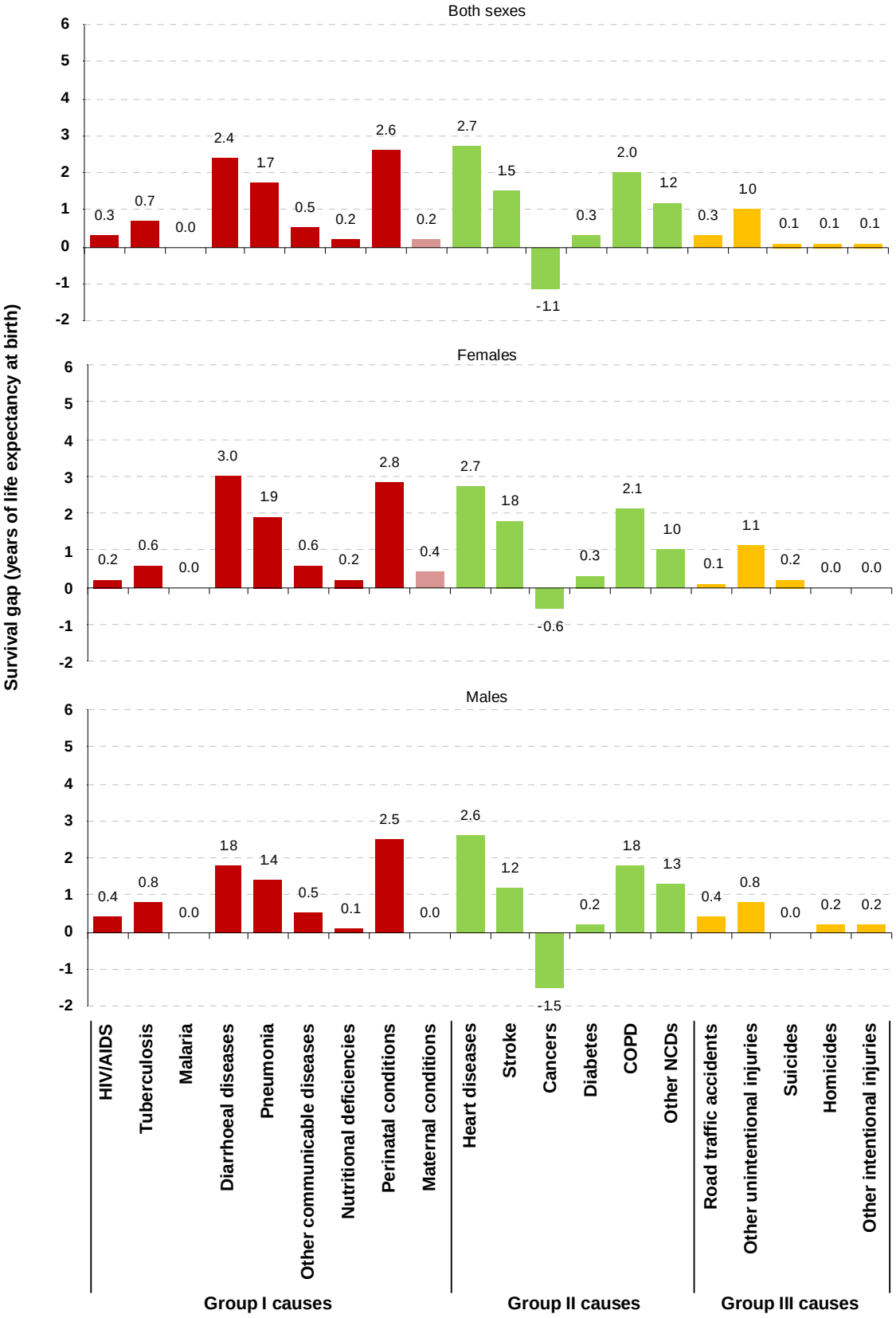


Figure AII.8. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, South-eastern Asia, by sex, 2005-2010

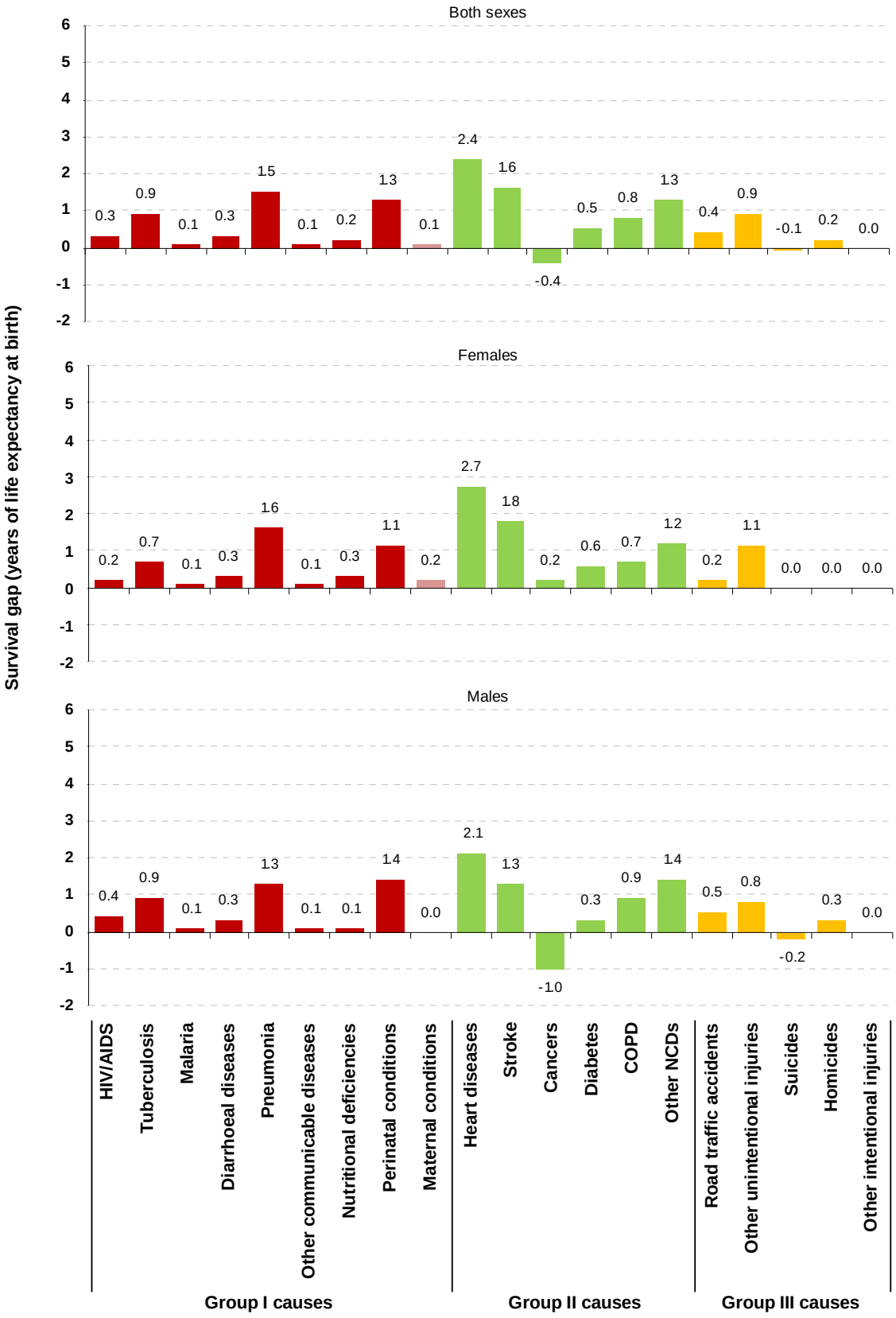


Figure AII.9. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Western Asia, by sex, 2005-2010

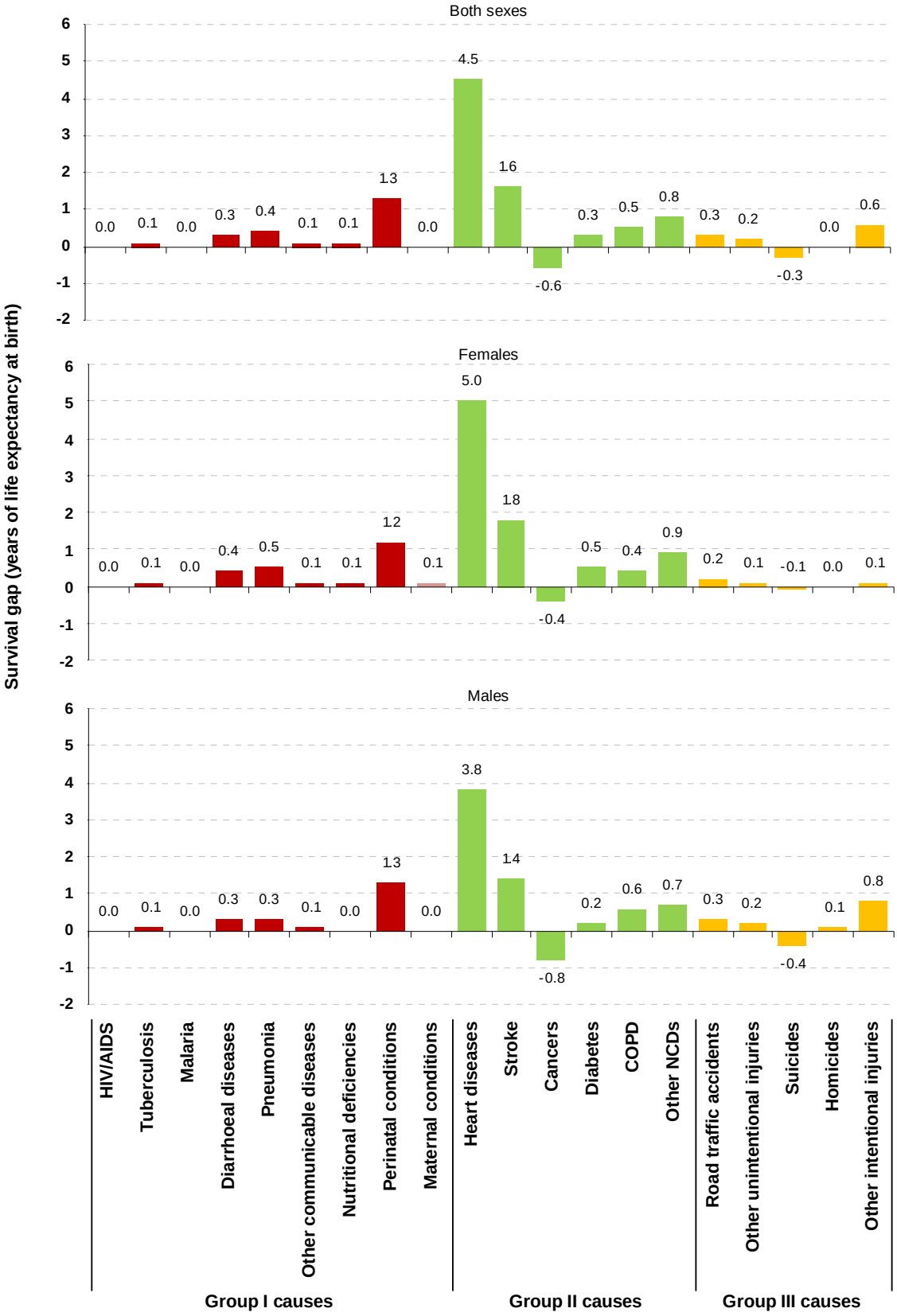


Figure AII.10. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Eastern Asia, by sex, 2005-2010

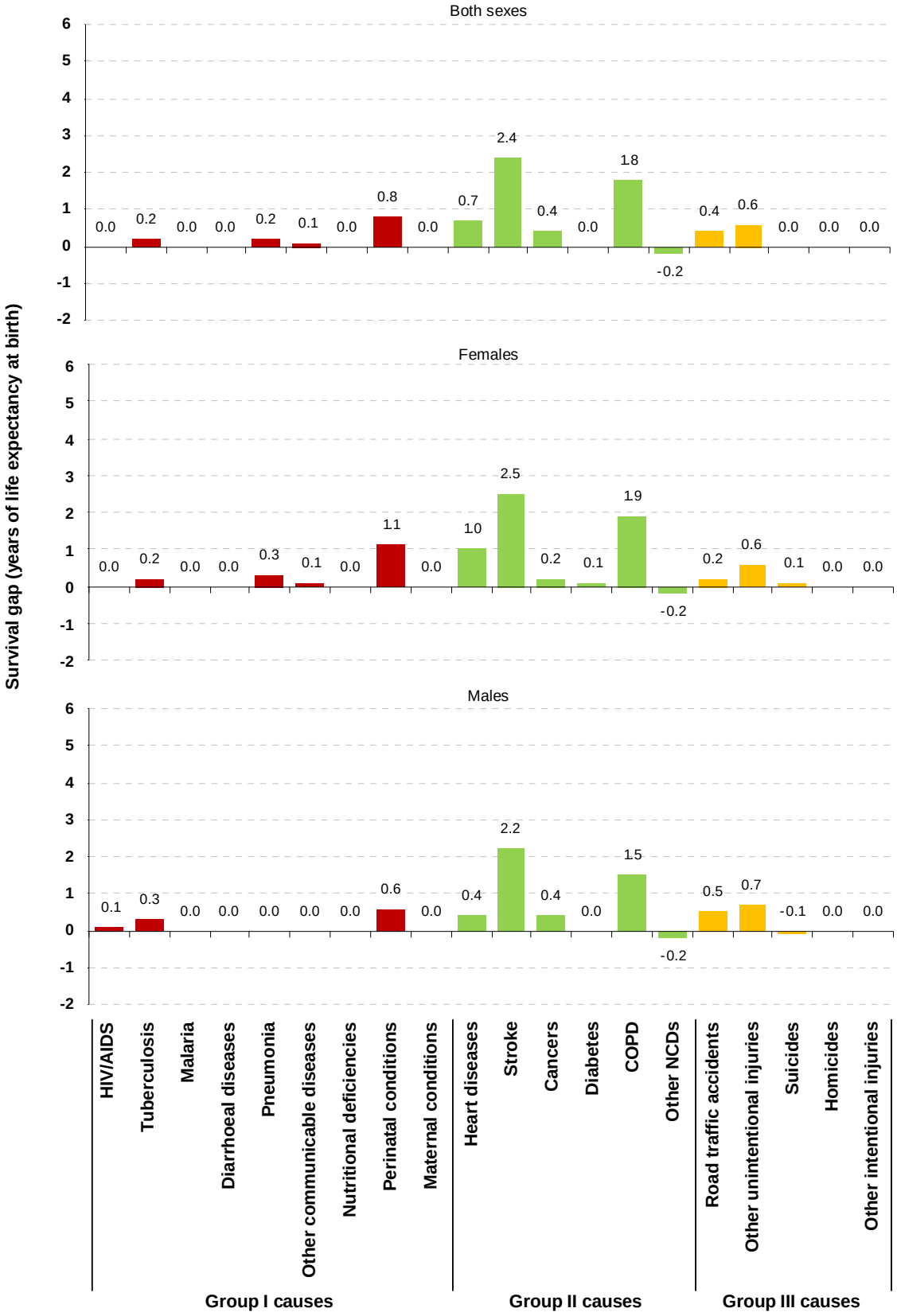


Figure AII.11. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, the Caribbean, by sex, 2005-2010

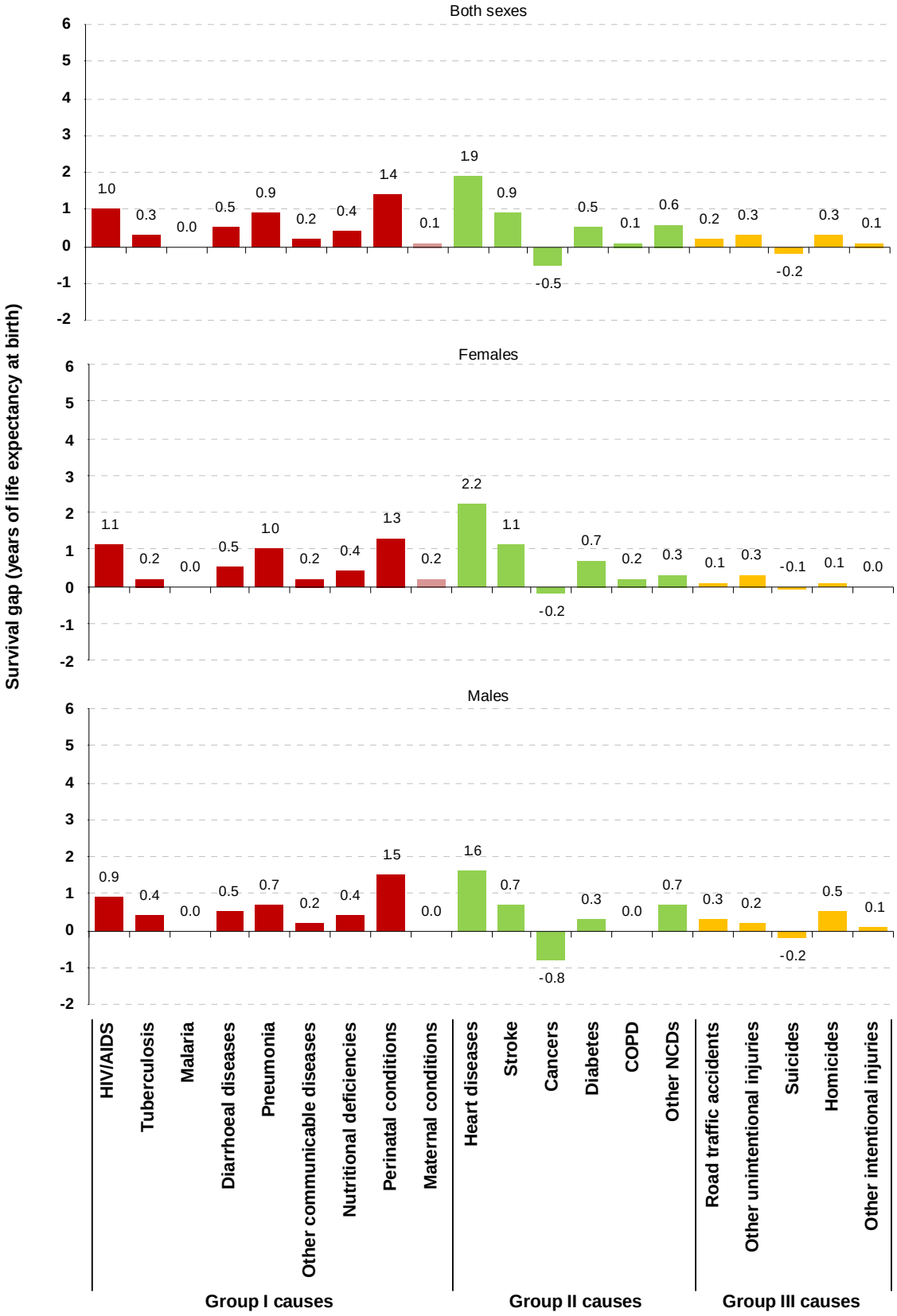


Figure AII.12. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, South America, by sex, 2005-2010

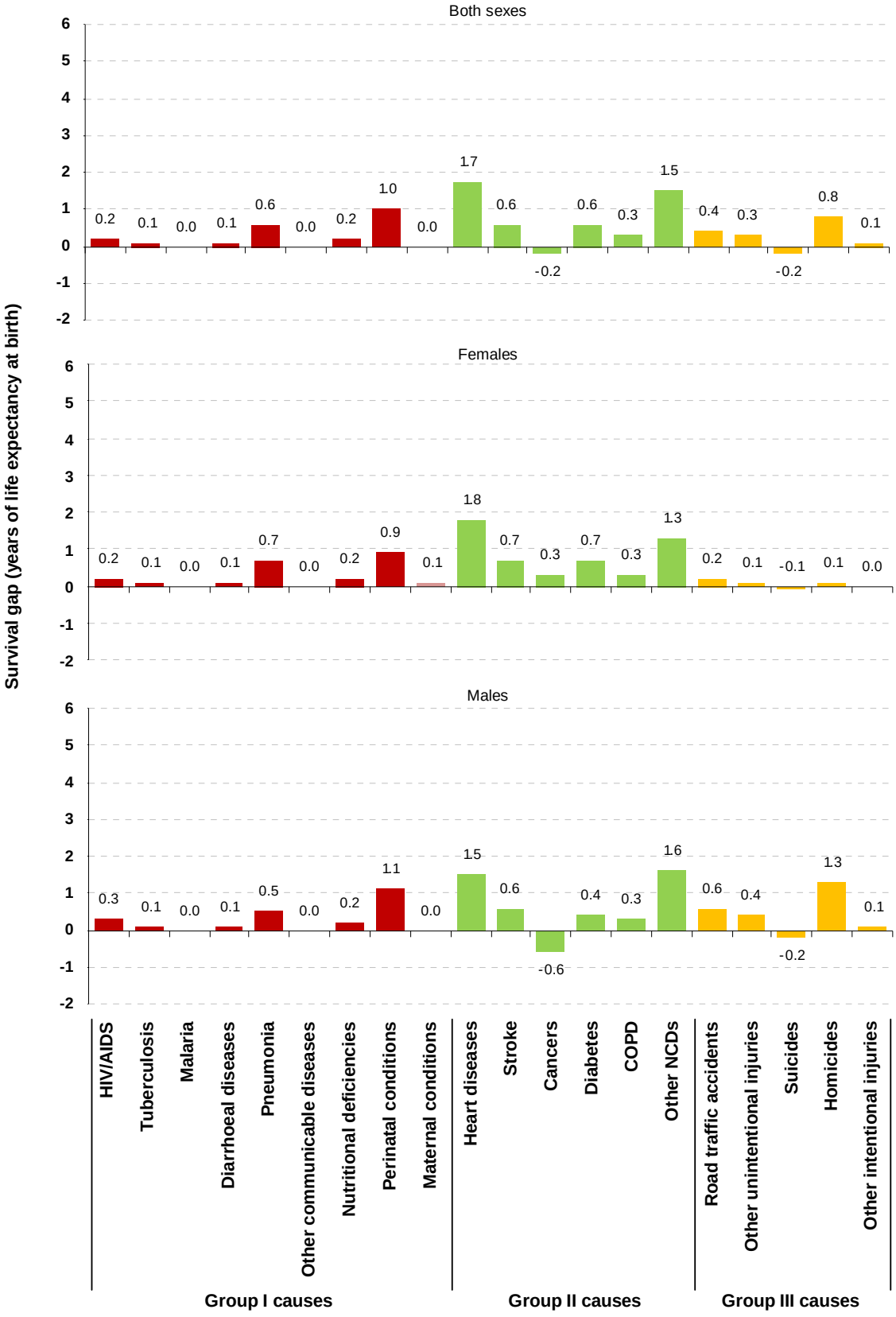


Figure AII.13. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Central America, by sex, 2005-2010

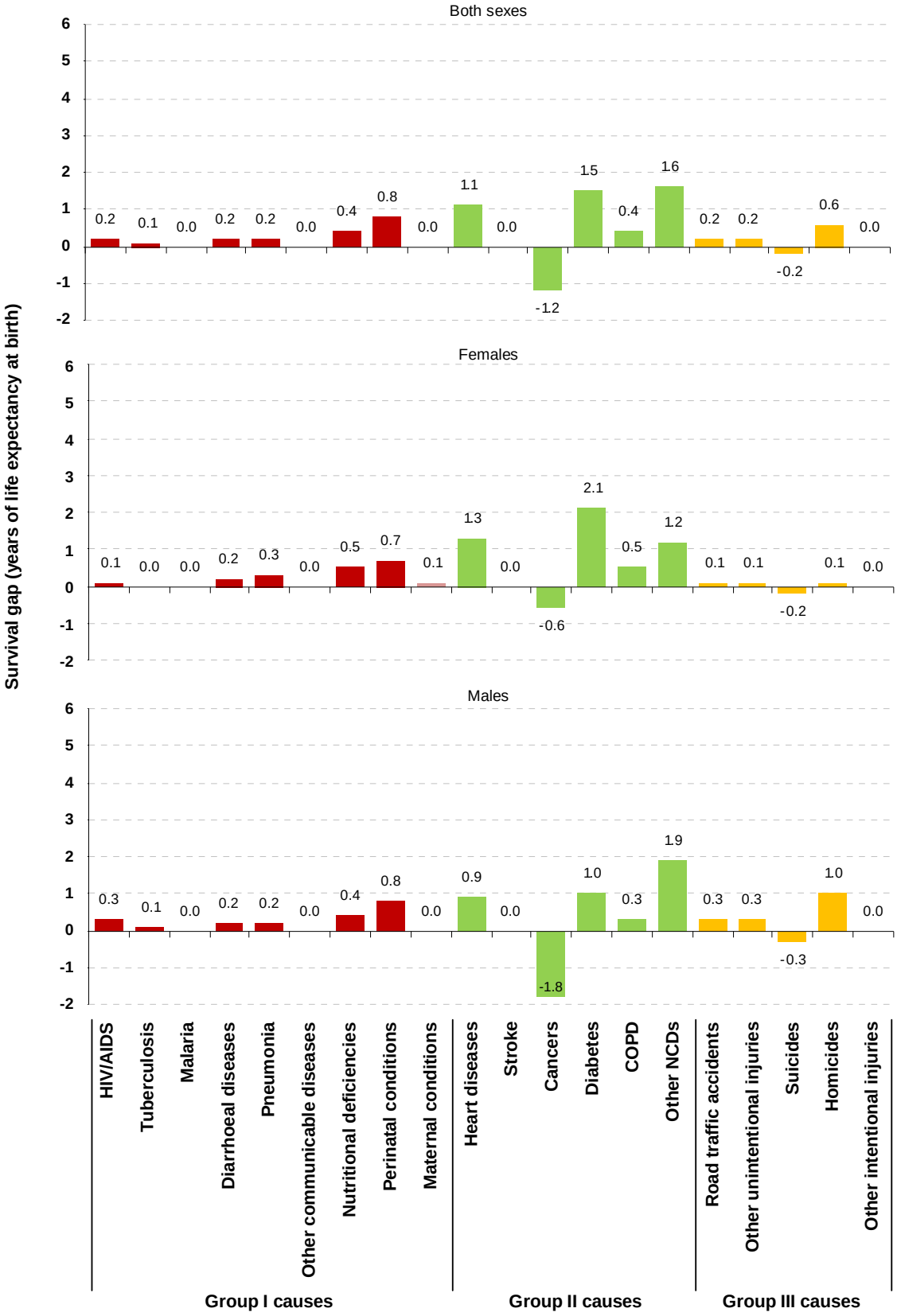


Figure AII.14. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, "more developed regions, excluding Eastern Europe", by sex, 2005-2010

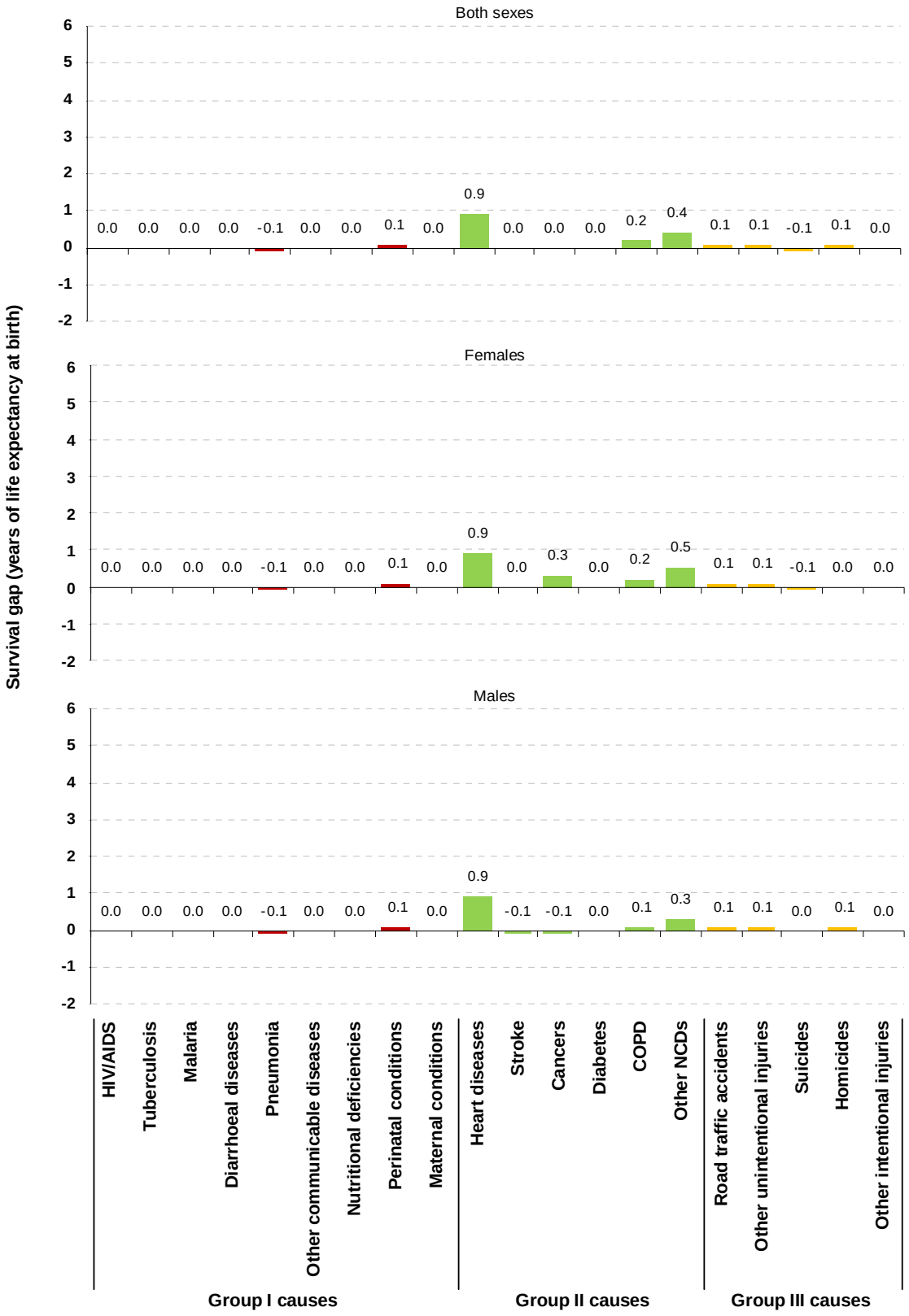
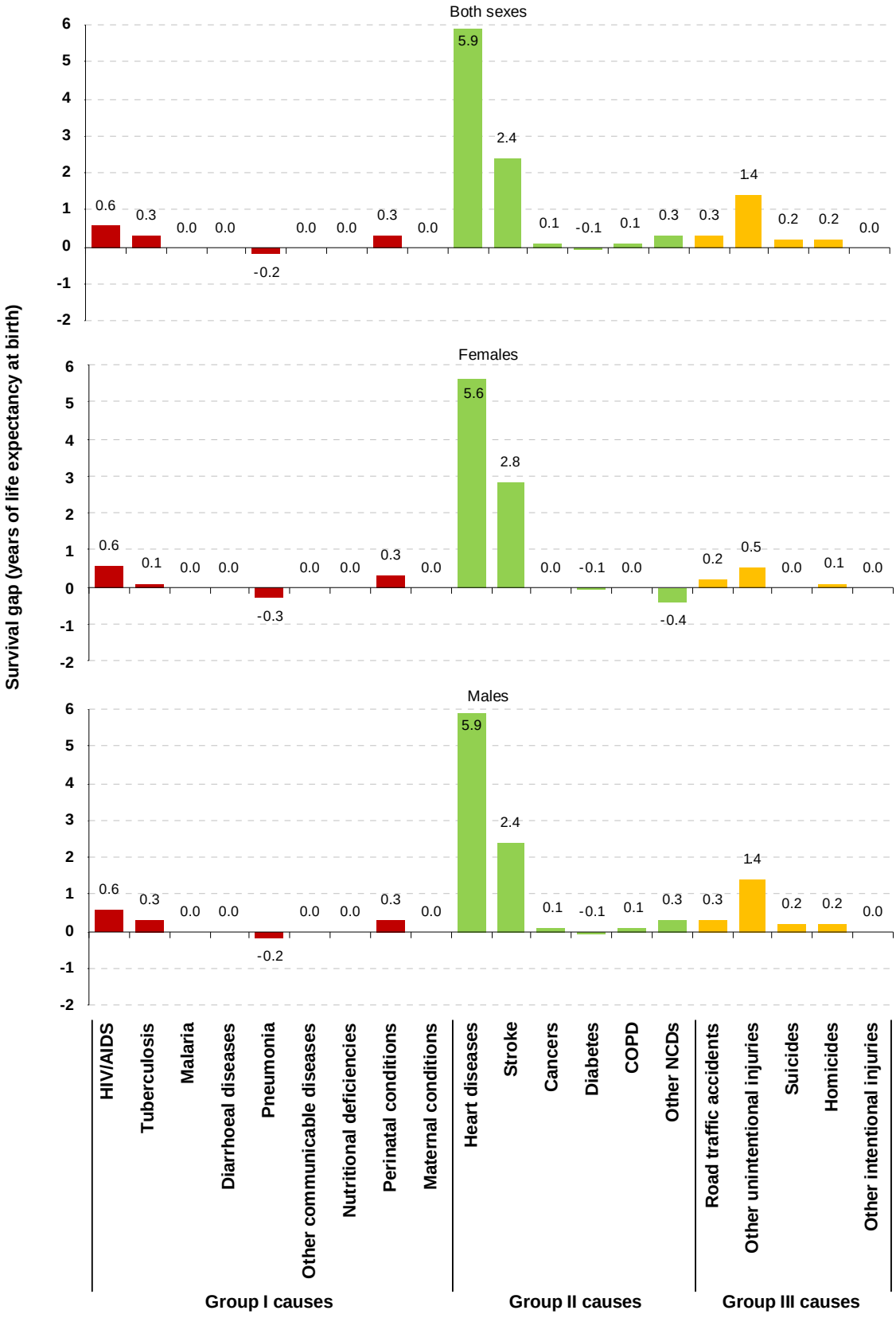


Figure AII.15. Years of life expectancy at birth to be gained by reducing cause-specific death rates to equal those in the "longest-lived" populations, Eastern Europe, by sex, 2005-2010



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