

**United Nations Expert Group Meeting on Health,  
Mortality and Development**

New York, 10-12 November 2009

**Report of the Meeting**



United Nations



**Department of Economic and Social Affairs**  
Population Division

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New York, 2011

# DESA

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## PREFACE

The Population Division of the Department of Economic and Social Affairs (DESA) of the United Nations Secretariat is charged with estimating levels and trends of mortality for all the countries of the world. The work of the Population Division in this area has encompassed both the preparation of estimates of mortality indicators and the development of methods to estimate mortality, particularly when the data available are incomplete or deficient. As the number and diversity of data sources for the estimation of adult mortality levels increase, it is important to adjust or improve currently available methodologies to obtain accurate estimates. In addition, as the AIDS epidemic continues, accounting for its effect on adult mortality is essential. For those reasons, the Population Division has been devoting more attention to the evaluation and improvement of the methods used to estimate adult mortality.

The Population Division serves the Commission on Population and Development of the Economic and Social Council of the United Nations, which each year considers a special theme within the scope of population affairs. In its Decision 2008/101, the Commission decided to consider at its forty-third session in April 2010 the special theme “Health, morbidity, mortality and development.” To assist the Commission in its preparations for the forty-third session, the Population Division has compiled recommendations to improve global health.

As a part of these ongoing efforts, the Population Division organized an Expert Group Meeting on Health, Mortality and Development that was held at the United Nations Headquarters in New York from 10 to 12 November 2009. The purpose of the meeting was twofold. First, in preparation for the forty-third session of the Commission on Population and Development, the meeting brought together experts and officials of inter-governmental organizations to discuss the challenges in combating the major causes of death and improving health, including consideration of how to strengthen health systems. Second, building upon earlier United Nations Coordination Meetings on the Estimation of Adult Mortality held in 2006 and 2008, the meeting focused on methodological issues in the estimation of adult mortality and initiated a comparison and review of adult mortality estimates for selected countries as produced by different institutions. The issues and recommendations discussed during the meeting are reflected in this report.

This report as well as other population information can be accessed via the Internet on the official website of the Population Division, [www.unpopulation.org](http://www.unpopulation.org). For further information concerning this publication, please contact the Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, NY 10017, USA; telephone number +1 212-963-3179; fax number +1 212-963-2147.



## Explanatory Notes

The following acronyms are used in the report:

ACT	Artemisinin Combination Therapies
AMI	Acute Myocardial Infarction
DALY	Disability-adjusted Life Year
DCPP	Disease Control Priorities Project
DDM	Death Distribution Methods
DESA	Department of Economic and Social Affairs
DHS	Demographic and Health Surveys
DOTS	Directly Observed Treatment Shortcourse
GBD	Global Burden of Disease
GGB	General Growth Balance
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
IGME	Inter-agency Group for Child Mortality Estimation
IHME	Institute for Health Metrics and Evaluation
LF	Lymphatic Filariasis
MDA	Mass Drug Administration
MDGs	Millennium Development Goals
MVA	Manual Vacuum Aspiration
NTDs	Neglected Tropical Diseases
ORT	Oral Rehydration Therapy
SEG	Synthetic Extinct Generations
TB	Tuberculosis
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNICEF	United Nations Children's Fund
UNPD	United Nations Population Division
VR	Vital Registration
WHO	World Health Organization
WHS	World Health Statistics



## **UNITED NATIONS EXPERT GROUP MEETING ON HEALTH, MORTALITY AND DEVELOPMENT**

### **A. OPENING OF THE MEETING**

Ms. Hania Zlotnik, Director of the Population Division, welcomed the participants and emphasized the importance of the Expert Group Meeting in the context of preparations for the upcoming forty-third session of the Commission on Population and Development, which was to be held on 12-16 April 2010. The theme of the Commission was to be “Health, morbidity, mortality and development,” marking the first time in over a decade that the Commission had taken up these topics.

Ms. Zlotnik noted that in recent years, most consideration of health on the United Nations agenda had occurred in the context of the Millennium Development Goals (MDGs). Yet the MDGs highlighted only a small part of the total health burden in the world. At the upcoming Commission, she wished to bring focus to other diseases that constituted a major portion of the disease burden, namely the neglected tropical diseases (NTDs) and noncommunicable diseases. Highlighting the fact that professionals in the health sector were extremely busy and in very high demand for the many different conferences focusing on health-related matters, Ms. Zlotnik commented on how difficult it had been to gather participants for this Expert Group Meeting as compared to meetings on fertility and migration.

In the context of declining mortality and fertility, increasing survival to older ages, and the changing epidemiological profile of the burden of disease from primarily infectious diseases to primarily noncommunicable diseases, health systems would have to adapt to new challenges. The Population Division looked forward to the input of the gathered experts, particularly on policy advice to put before the Commission in its report. Guidance was needed particularly on how to advise Governments on the means to influence behaviours that affected health. Often, the decisions that had the largest impacts on health were taken in spheres outside of health ministries.

Ms. Zlotnik urged that amid the current intense focus on global health, it remained imperative to keep the importance of reproductive health and fertility in mind. The forty-second session of the Commission on Population and Development had examined the contribution of the Programme of Action of the International Conference on Population and Development to the internationally agreed development goals, including the MDGs. It found that family planning had a large impact on the survival of mothers and children, particularly by lengthening intervals between births. In 2011, the Commission was to take up the issue of reproductive health more generally.

Lastly, Ms. Zlotnik commented briefly on the second segment of the meeting that focussed on the estimation of adult mortality. She was very grateful that representatives from both the World Health Organization and the Institute for Health Metrics and Evaluation were able to participate in this process.

## PART 1: HEALTH

### B. GLOBAL BURDEN OF DISEASE AND DISEASE CONTROL PRIORITIES

The first substantive session of the meeting focused on the initiatives that aimed to quantify the burden of disease globally and to identify cost-effective interventions to address that burden. Mr. Colin Mathers, Department of Measurement and Health Information Systems of the World Health Organization (WHO), described the Global Burden of Disease project (GBD), a standardized framework for integrating all available information on mortality, causes of death, individual health status, and condition-specific epidemiology to provide an overview of the levels of population health and the causes of loss of health.

The original GBD 1990 study was undertaken from 1991-1996.<sup>1,2</sup> From 2000-2004, WHO carried out updates and extensions of the GBD, including morbidity and mortality estimates for the WHO member States. The most recent updates included estimates of morbidity and mortality for 2004<sup>3</sup>; burden of diseases projections to 2030<sup>4</sup>; a volume on global health risks<sup>5</sup>; and a report on causes of death among children, expected to be published in 2010. Meanwhile, between 2007 and 2010 a complete update of the GBD for 2005 was being undertaken by a team led by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, with funding from the Bill and Melinda Gates Foundation.

Mr. Mathers described the disability-adjusted life year (DALY), which was the primary metric of the GBD and provided a common measure of population health for each member State. For each country and health condition, the DALY summarized both the years of life lost due to mortality and the equivalent years of healthy life lost due to disability from that condition. Based on analysis of more than 10,000 datasets, the GBD estimated that while ischaemic heart disease and cerebrovascular disease were the two leading causes of death worldwide in 2004, they ranked only fourth and sixth respectively in terms of burden of disease (DALYs) because they tended to affect people at older ages, thereby causing fewer years of life lost compared to other fatal conditions that tended to affect young people. Accordingly, lower respiratory infections and diarrhoeal diseases, which caused large numbers of child deaths, were the two leading causes of DALYs in 2004. The third leading cause of DALYs, depression, was non-fatal but was responsible for many years of healthy life lost due to disability, and thus inflicted a large burden of disease globally. In addition to numbers of deaths and DALYs, the GBD produced internally consistent estimates of incidence, prevalence, remission and case fatality for each health condition.

Controversies surrounding the GBD project included the uncertainty of the estimates given the gaps in knowledge and information, as well as criticisms of the methods of disability weighting, age weighting, and health state valuation. While early critics had questioned whether DALYs were the proper metric for setting health priorities, in general the method had become widely accepted. Mr. Mathers emphasized that while the GBD project strove to take all data sources into account—including vital registration, child and adult mortality information from surveys, and epidemiologic data sources such as disease registries—data for many countries and health conditions remained inadequate. There was a need for long-term improvements in death registration in most countries of the world. In addition, most African countries lacked data on causes of death, necessitating a high degree of reliance on cause of death models to estimate the burden of disease in those populations. Even in other regions with sufficient mortality

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<sup>1</sup> World Bank (1993). *World Development Report 1993: Investing in Health*, volume 1. Washington, D.C.

<sup>2</sup> Murray, C. J. L., and A. D. Lopez, eds. (1996). *The Global Burden of Disease*. Cambridge, Massachusetts: Harvard University Press.

<sup>3</sup> World Health Organization (2008). *The Global Burden of Disease: 2004 Update*. Geneva.

<sup>4</sup> Mathers, C. D., and D. Loncar (2006). Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Medicine*, vol. 3, e442.

<sup>5</sup> World Health Organization (2009). *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*. Geneva.

data, information on the burden of non-fatal conditions, such as mental disorders, was often problematic. As a result, there was a large degree of uncertainty surrounding the estimates produced for the GBD.

A complete revision of the GBD was underway that would utilize additional data and improved methodologies to generate new estimates of death, disease, injury, and risk factors for 1990 and 2005. Research teams were working on overall mortality estimates, cause-of-death estimates, estimates of years lived with disability, disability weights, and comparative risk assessments. In addition, the lists of causes and risk factors were being expanded for the new revision. In response to earlier criticisms surrounding the DALY methodology, the new GBD would focus on loss of health, rather than goodness of health, and probably would drop age weighting.

Mr. Mathers explained that in order to project selected indicators of the global burden of disease to 2030, mortality trends were modelled as functions of national income per capita, education, smoking intensity, time (as a proxy for technological progress), and trends in body mass index. Separate models were used for HIV/AIDS, tuberculosis, lung cancer, diabetes mellitus, and chronic respiratory diseases. The numbers of deaths from cancer, cardiovascular disease, and stroke were projected to continue to increase through 2030, even though the death rates from these causes would decline somewhat. Deaths from infectious causes were projected to decline with the exception of HIV/AIDS, for which numbers of deaths were expected to peak between 2010 and 2015.

Mr. Mathers then presented results of the recently published report *Global health risks*, which assessed the proportions of global mortality and DALYs that were attributable to 28 common risk factors. Estimates of the prevalence of each risk factor and the risk of disease associated with each risk factor were collected in a thorough review of the literature and input to an epidemiological equation to estimate the proportion of disease incidence that could be attributed to a given risk factor in a population. More complex calculations were required for exposures such as smoking, which had a long lag time between the initial exposure and the outcome. The study concluded that the six leading causes of attributable mortality—high blood pressure, tobacco use, high blood glucose, physical inactivity, overweight and obesity, and high cholesterol—all were related to cardiovascular disease. In fact, 75 per cent of deaths from ischaemic heart disease were attributable to only eight risk factors. The leading causes of attributable burden of disease (DALYs), on the other hand, were more diverse: childhood underweight; unsafe sex; alcohol use; unsafe water, sanitation and hygiene; and high blood pressure. In all, 44 per cent of deaths and 35 per cent of DALYs were attributable to the combined effects of 24 avoidable risk factors. These 24 risk factors were responsible for the loss of nearly 10 years of life expectancy globally.

Mr. Mathers concluded his presentation by recalling the importance of the GBD project for influencing global and national health policies. By measuring the average health of populations and loss of health by causes, the results of the GBD were among the many inputs into health priority setting and resource allocation processes. Indeed, the GBD supplied crucial inputs to the Disease Control Priorities Project (DCPP), which was to be explained in a subsequent presentation.

Mr. Prabhat Jha, Director of the Centre for Global Health Research, Li Ka Shing Knowledge Institute at the University of Toronto, made a presentation entitled *The disease control priorities project*, in collaboration with Mr. Dean Jamison, Professor of Global Health at the Institute for Health Metrics and Evaluation, University of Washington, who was unable to attend the meeting. Mr. Jha began with a brief history of the DCPP. The first wave of the project was initiated by the World Bank in 1989-1993 to provide the background documentation for the 1993 World Development Report, *Investing in health*. The second wave of the project was conducted over the period 2002-2007, supported by the National Institutes of Health, the World Bank, the WHO and the Bill and Melinda Gates Foundation. With a budget of US\$6 million over four years, this wave produced a two-volume report with inputs from 500 contributors. The

third wave of the DCPP, called the DCPNetwork, was to take place over 2009-2016 and was also to be financed by the Bill and Melinda Gates Foundation.

DCPP aimed to develop an evidence base and inform decision making by providing estimates of cost-effectiveness and impact of single interventions and packages of interventions. Project outputs suggested the best and worst buys for health and provided guidance for prioritizing interventions in a given health context. To illustrate, Mr. Jha posed the question, what would US\$1 million buy in terms of health in a developing country setting? DCPP analysis indicated that prevention and treatment of noncommunicable diseases through taxation of tobacco products could avert between 24,000 and 330,000 DALYs annually at a cost of between US\$3 and US\$50 per DALY. Treatment of acute myocardial infarction (AMI) with inexpensive drugs or a daily polypill, a single pill containing multiple drugs to treat risk factors for cardiovascular disease, were also deemed cost-effective in developing country settings. In contrast, bypass surgery for less severe coronary artery disease was not very cost effective, averting only a very small number of DALYs at a very high cost per DALY.

Mr. Jha summarized that, overall, the main messages to have emerged from the DCPP thus far were that immunizations and treatment of childhood diseases, tuberculosis, and AMI were all “good buys” for health in terms of their cost-effectiveness. With respect to health services, the study concluded that improving the provision of surgical facilities at district hospitals would have an important effect on health, pain management, and cancer outcomes in developing countries.

Mr. Jha stressed that the continued diffusion of new knowledge and technologies would be the drivers of future progress to address current global health challenges, such as noncommunicable diseases, HIV/AIDS, potential pandemics and neglected populations. Indeed, there was strong evidence that the diffusion of new knowledge and products (e.g., oral rehydration therapy (ORT), immunizations, and low-cost treatments), as opposed to increases in income and education alone, underpinned the enormous improvements in health observed over the 20<sup>th</sup> century.

Future work for the DCPNetwork was to address the insufficient attention as yet paid to the instruments of policy that aimed to improve health, including tax and other fiscal instruments, information and education campaigns, regulation and legislation, direct finance, and research and development. The DCPNetwork was also to focus on the platforms that carried interventions such as primary care facilities, hospitals, public health and inter-sectoral platforms. Additional work was to examine support systems such as disease and risk factor surveillance, education and training of health professionals, and monitoring and evaluation of interventions, expenditures and the consequences of ill-health. In addition, Mr. Jha said that the DCPNetwork recognized a need to address country applications. Two country applications were already underway, in South Africa and India, and additional country applications were to follow.

Mr. Jha informed participants that the results of the first wave of DCPP were particularly influential in India, yielding US\$1 billion in lending from the World Bank to India for various health projects. He and Mr. Ramanan Laxminarayan were engaged in the DCPNetwork country project in India, entitled *Choosing health: an entitlement of all Indians*, which aimed to create a blueprint for better health in India. It considered disease burden, cost-effectiveness and feasibility to produce recommendations for an entitlement package to ensure universal access to cost-effective interventions for all Indians. At a cost of US\$10 per person, the package—which included incentives for safe birth attendance, expansion of the number and types of vaccines provided to children, expansion of low-cost combination therapy for malaria, tobacco taxation and enforcement, low-cost treatments for those with heart disease, and interventions for epilepsy—could avert 80 million premature deaths over the next decade if implemented.

Mr. Jha concluded with a description of a study designed to investigate how to influence health policy change in India in line with the recommended entitlement package. Districts were randomized into intervention and control groups. District politicians in the intervention group received a bundle of multi-media materials explaining the entitlement package, including a book, a district report card detailing the burden of disease, a video clip and a speech. Mr. Jha's study team would then monitor changes in district health budgets and use of priority services in each of the districts to assess whether the intervention was successful in influencing health policy.

Participants expressed scepticism about the results of the cost-effectiveness analysis presented by Mr. Jha. Specifically, there was concern that the analysis did not account for the full benefit received from some interventions, such as improvements in water and sanitation. Treatment interventions, such as ORT for diarrhoeal disease in children, needed to be delivered for each incidence of illness in each child, whereas improved water and sanitation could have prevented the occurrence of diarrhoeal disease for both current and future generations. Mr. Jha responded that the analysis asked which were the "good buys" for health, given a modest and fixed health budget. For India, the package was developed as a guide for what could be accomplished by spending the next one per cent of gross national product on public health. Improved water and sanitation did not meet the cost-effectiveness criteria to be included in this package given this budget. He argued that it would be unethical to abandon what could be done today to save children, such as delivering immunizations, in favour of more long-term projects like water and sanitation. Mr. Jha added that the DCP analysis had not considered any broader societal benefit of improved water and sanitation. He suggested that a cost-benefit framework might someday be used to assess the full benefits of interventions like water and sanitation, and that other analyses could be undertaken to look at the extent to which these interventions protected people from poverty traps.

Some participants inquired whether cost-effectiveness could be assessed on the country level and whether findings from the India study, for example, could be extrapolated to other developing country settings. Mr. Jha said that local cost-effectiveness studies had been completed in Mexico, India, and several countries in sub-Saharan Africa. Mr. Laxminarayan added that heterogeneity in cost-effectiveness within India was also a concern. As a result, small differences in cost-effectiveness should not have been interpreted as meaningful. Only differences of orders of magnitude were significant.

Participants noted that many of the public health interventions mentioned by Mr. Jha fell outside the purview of health ministries, yet the India intervention package was addressed only to those ministries. Mr. Jha replied that cost-effective interventions that could be applied across sectors, such as to control tobacco through both packet warning labels from the health ministry and taxes levied through the finance ministry were not prioritized in the India package. Several participants agreed that it was important to engage multiple ministries to prioritize global health issues.

Participants requested clarification on the term "health platforms" and why these were identified as priorities for future work in the DCPNetwork. Mr. Jha explained that health platforms—which included primary care resources, hospitals, public health infrastructure, intersectoral programmes and support platforms—were the keys to addressing the question of how to deliver interventions. For example, district hospitals had been largely ignored in studies of intervention cost-effectiveness, yet these were a huge source of health spending in developing countries. Thus, in setting new spending priorities it was important to think about the facilities base and cross-interventions that addressed multiple causes of morbidity. Mr. Laxminarayan added that by framing the discussion around health platforms, they were better able to detect where lack of capacity, including insufficient human capital, restricted the ability to deliver interventions. The India package allocated nearly one third of its budget to catalytic health reforms, including human resources.

Concern was expressed about a perceived disconnect between the priorities identified by the global health community and the priorities of health care users. This phenomenon could be seen in the increasing funding for HIV/AIDS initiatives in Africa, without comparable resources being directed toward maternal health. Mr. Jha responded that in India, a portion of the package had been allocated for discretionary use according to local priorities. In addition, when priority setting was based upon disease burden, the DCPP provided good, practicable, cost-effective solutions.

Participants also asked what the India study had revealed about community-based interventions for maternal mortality, which had received less attention in the global health literature relative to more distal determinants of maternal mortality, such as gender and poverty. Mr. Jha described the Janani Suraksha Yojana (JSY) programme in India, which was established in 2004 and provided women with 2,000 rupees to deliver their babies in institutions. The programme had resulted in more women attending health centres, but because the money was paid only for delivery and not for remaining in hospital for observation, many women were discharged 24 hours postpartum, which was likely too soon to prevent certain causes of morbidity and mortality, such as sepsis. Thus it was not yet known what impact the programme had on maternal mortality.

### C. HEALTH SYSTEMS AND FINANCING OF GLOBAL HEALTH

The second substantive session of the Expert Group Meeting addressed strategies for reform and financing of health systems. Mr. Paolo Piva, Adviser in the Department for Health System Governance and Service Delivery at the WHO, gave a presentation entitled *Primary health care reforms: aligning health systems to needs and expectations*. He reviewed the history of international commitment to primary health care, starting with the Alma-Ata conference of 1978, where health was declared a fundamental human right and the attainment of the highest possible level of health was recognized as the most important worldwide social goal. Existing gross inequities in the health status of people were politically, socially, and economically unacceptable and were, therefore, of common concern to all countries. It was believed at the time that an acceptable level of health for all people could be attained by the year 2000 through fuller and better use of the world's resources.

Twenty years later, at an anniversary meeting in Almaty (Alma-Ata), universal access to quality care was identified as the bedrock principle of primary health care. Mr. Piva stressed that health was not a commodity that could be given to a country. As such, health action should not be imposed from outside a country, but rather should be generated from within. Growing social pressure from deprived populations made it a critical time to promote community-based primary health care and social mobilization to improve health.

Mr. Piva explained that people expected health systems to provide access to care that was effective, safe, and people-centred. They expected that the health of their communities would be reliably protected and promoted by health authorities. Most of all, they expected to have a say in what affected their own lives and those of their families. The realities, however, did not meet expectations. The rich consumed the most health care and public spending on health care benefited the rich more than the poor. Out-of-pocket payments and lack of social protection led to catastrophic expenditures on health care. It was estimated that 100 million people fell into poverty each year because of out-of-pocket health care expenditures. There was excessive specialization of health care providers, with a narrow focus on diseases rather than on the needs of individuals and families. Safety standards and medical errors remained concerns. Resource allocation was directed mainly to curative care, and there was little knowledge of how to mitigate the effects on health of other sectors. In sum, there was growing dissatisfaction of populations over unmet needs and expectations, along with growing inequities within and between countries. There was a growing call to scale up health systems and services to deliver health outcomes.

Mr. Piva described four sets of primary health care reforms that were proposed in response to persistent health inequities. First, universal coverage reforms were needed to ensure sufficient supply of care, eliminate barriers to access, and ensure social protection through pooled prepayment. He noted recent examples such as Thailand's universal coverage scheme and the health zone strategy in the Democratic Republic of Congo, in which local authorities and the Ministry of Health had taken the lead to refurbish the health system through policies that addressed the needs of the population. In addition, China was reversing its prior laissez-faire policy to extend coverage to 90 per cent of its population.

Second, service delivery reforms were necessary to orient systems to people's needs and expectations and make systems more socially relevant and responsive. In contrast, the current trends were toward hospital-centrism, commercialization and fragmentation. The envisioned reforms centred on trust and rights, with explicit entitlements to more than just minimal packages. Person-centred care, based on a personal relationship with regular and trusted providers, was comprehensive and integrated. The entry point to care was through close-to-client networks of primary care teams that had explicit responsibility for all members of a defined population and were well coordinated with other levels of care.

Third, beyond local action, public policy reforms were needed at the national level to correct underinvestment in effective public health policies. Intersectoral policy dialogue was necessary to ensure the inclusion of "health in all policies" with impact assessments and capacity building. Mr. Piva cited the examples of road policies in Ghana, anti-smoking policies in Turkey, and abortion policies in South Africa.

Fourth, leadership reforms were necessary to make health authorities more reliable and promote inclusive, participatory, negotiation-based leadership. Mr. Piva noted the value of activist government and the need to move away from a technocratic, command-and-control approach.

In 2009, the World Health Assembly passed a resolution on primary health care, including health system strengthening.<sup>6</sup> The assembly emphasized its commitment to the MDGs, the importance of equity in global health, and the need to build on inter-country exchange of experience and shared learning. Mr Piva highlighted the changing nature of the aid environment in light of the Paris Declaration on aid effectiveness.

Mr. Piva concluded by noting that the proposed reforms had numerous implications for both countries and global actors. Each country had to set its own context-sensitive priorities. Global players were expected to adopt the "International Health Partnership mindset" to support countries to move in the directions that the countries had set out, aligning with national plans and strategies and moving the focus away from inputs to context-sensitive change. Investments in information, financing, human resources, service delivery and governance were crucial to the success of the reforms.

Continuing the discussion of health systems reform, Mr. Andre Medici, Senior Economist (Health) at the World Bank, gave a presentation on *Reforming health systems for development*, with a focus on using burden of disease studies to reform health systems in developing countries. He noted that the burden of disease profile differed by level of development. Communicable diseases, malnutrition and maternal and child conditions were the main causes of mortality and morbidity in low-income countries, as in Sub-Saharan Africa, while chronic diseases were prevalent in high-income countries. Middle-income countries had a mixed burden of disease profiles, but chronic diseases tended to be more important than communicable diseases in these countries. Injuries were important in both developing and

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<sup>6</sup> WHA62.12

developed countries, but the burden of injuries tended to be higher in developing countries. Overall, DALY losses tended to be greater in regions with lower per-capita income.

Such differences in the epidemiological context according to development levels created differential complexity in the organization of health services. Low-income countries had generalized problems in all health dimensions: access to services and equity; financing; public health regulations and practices; access to technology; political economy; human resources; health infrastructure; supply chains; and externalities related to health. Middle-income countries faced particular problems in many dimensions that related to inequality and social exclusion, for example, higher out-of-pocket spending among the poor. Middle-income countries also faced large externalities affecting health, including crime and safety, water and sanitation, poverty and social exclusion, and risk behaviours. High-income countries generally had well-functioning health systems but faced new challenges in the area of political economy, environment, and risk behaviours.

In Latin America and the Caribbean, health financing schemes differed according to the income level of the country. In low-to-middle income countries, out-of-pocket payments made up the bulk of health financing, with smaller roles for Government, private philanthropy, and social security. In middle-to-high income countries, social security played the largest role in health financing, with smaller shares for private health plans, direct government spending, and out-of-pocket payments. In the countries of the region with the highest incomes, social security and private health plans were equally important, again with a small share for out-of-pocket payments.

Mr. Medici then described the political context of health reforms. The term “health reform” covered a wide range of policies and many of these had been implemented in the last twenty years, with varying degrees of success. Many complaints against health reform in developing countries were led by health workers and health unions defending their own interests. In fact, many countries avoided the term “reform” because of its political sensitivity.

Mr. Medici distinguished between first-generation and second-generation reforms. First-generation reforms established entitlements; created institutions; defined financial mechanisms and mobilized funds; set up infrastructure, human resources and supply chains; and built partnerships and aligned public and private institutions and levels of government. Second-generation reforms tackled equity and access problems related to exclusion; improved quality of coverage and care; improved efficiency; enhanced public health systems and promotion and prevention strategies; and improved information systems and monitoring and evaluation processes. In Latin America and the Caribbean, seven countries had implemented first-generation reforms, while the rest had implemented only partial reforms or no reforms. In general, those countries that had implemented reforms achieved better health outcomes.

Burden of disease studies had a valuable role to play in informing health system reform. Such studies could motivate improved health information and surveillance for better monitoring and evaluation of health system interventions. They helped define needs on promotion, prevention and treatment, and guided the structuring of health packages and health systems according to epidemiological priorities. They could allow countries to structure tax incentives to fight priority diseases and reduce individual or collective risk. However, few developing countries were systematically developing burden of disease studies as part of their health information systems. Mr. Medici cited Chile’s use of a burden of disease study to define national health objectives and identify 56 priority interventions under its second-generation health reform.

In conclusion, Mr. Medici underlined several principles to be considered in second-generation health reforms. Integration of all health segments was needed to avoid transaction costs and improve efficiency. It did not matter whether services were public or private, as long as they were efficient and

cost-effective. Some countries needed more regulation of private providers while others needed better governance in state-provided services. He stressed that markets and regulation were not incompatible. Health markets were imperfect and deserved accurate regulation. Lastly, health promotion and prevention were essential public goods that required fundamental commitment from Governments.

Participants asked how health priorities should be set when resources for health were not sufficient to address the full spectrum of disease burden in a given country. Mr. Medici underscored that addressing human resources in the health sector needed to be a priority. He identified economic incentives or mandatory civil service for graduating doctors as good strategies to retain health workers in rural and poor areas.

Participants were concerned about how to reform a country's health system to be responsive to the burden of disease when adequate data were not available. Improved death registration was needed. Mr. Medici agreed that enhanced data systems were needed. He noted that Brazil was a good example of a country that was attentive to the burden of disease data, collecting data even at the sub-national level, and Uruguay was moving in that direction as well.

#### D. REPRODUCTIVE HEALTH

The meeting next turned to address challenges to delivering adequate reproductive health care to improve maternal health outcomes. Ms. Linda Bartlett, Associate Scientist at Johns Hopkins University, delivered a presentation on the burden and causes of maternal mortality around the world, including priorities for reduction strategies. She said that little progress had been made in reducing maternal mortality: from 1990 to 2005 the global maternal mortality ratio (MMR) was estimated to have declined only 5.4 per cent. It was projected to decline by 9 per cent by 2015, well short of the MDG 5a target of 75 per cent decline between 1990 and 2015.

Ms. Bartlett noted that 99 per cent of the 536,000 maternal deaths each year occurred in developing regions. Overall, 95 per cent of maternal deaths were concentrated in sub-Saharan Africa and South Asia. At the country level, India, Nigeria, the Democratic Republic of the Congo, Afghanistan and Ethiopia had the most maternal deaths. She emphasized that improvement was possible, as was evidenced by the successes achieved in Malaysia, Sri Lanka, Thailand, and in Matlab, Bangladesh, and the near eradication of maternal deaths in developed countries.

Research indicated that of the entire pregnancy, childbirth and postpartum period, the greatest risk for maternal deaths occurred the day of delivery. While this finding underscored the continuing need for skilled birth attendance, it was important that the strong focus on skilled birth attendance not distract attention away from those proven interventions that were not centred in facilities. Indeed, evidence showed that maternal deaths occurred both in facilities and at home, with the mix varying by country. For example, in Kabul, Afghanistan, 40 per cent of maternal deaths occurred with skilled birth attendance. In three districts of the United Republic of Tanzania between 44 per cent and 78 per cent of maternal deaths occurred in facilities. Often, in-facility deaths were the result of care that was delivered too late. One third of in-facility maternal deaths were attributed to sub-standard care.

Ms. Bartlett described the major causes of maternal death. Globally, haemorrhage was the most common cause, resulting in 166,000 maternal deaths each year, half of which were in sub-Saharan Africa and one third in South Asia. In Latin America and the Caribbean, hypertensive disorders were the leading cause of maternal mortality. The majority of causes of maternal death were direct and required minimal efforts for effective treatment and prevention.

Maternal deaths were most common among young women, women experiencing their first births, impoverished women, and women living in geographically remote areas. Data from Afghanistan showed that maternal mortality rates were more than twice as high in rural compared to urban areas. Ms. Bartlett posited that urban residence and high income were associated with better access to care and services.

Ms. Bartlett then described an argument by Mr. Jeremy Shiffman of the University of Syracuse to explain why safe motherhood initiatives had not been as successful as initiatives targeting child survival. According to this analysis, the safe motherhood movement lagged behind the child survival movement in terms of organization, measurement and philosophy. While both movements lacked politically empowered victims, the safe motherhood movement additionally lacked an enduring guiding institution, a strong leader, and a resonating set of ideas to attract sustained political support. Furthermore, the fact that maternal conditions caused fewer deaths than childhood illnesses, made it difficult to prioritize maternal health interventions. In terms of data, Ms. Bartlett emphasized that while maternal mortality was measurable with the appropriate survey instruments, survey sample sizes were often too small to yield precise estimates. Also problematic was that the maternal mortality ratio was not a well-understood metric among the general public. Ms. Bartlett said that, in addition, Shiffman's analysis concluded that the maternal health movement had been weakened by a rigid philosophy that characterized any maternal health service provision short of skilled birth attendance as unethical.

Ms. Bartlett stressed the need to strengthen evidence on clinical interventions to prevent maternal morbidity and mortality. Several packages of interventions had been identified for ante-natal care and skilled birth attendance, but other preventive and management intervention strategies were needed in settings where a large proportion of deliveries and maternal deaths occurred at home. Community midwives and community health workers could deliver these types of interventions. For example, misoprostol and oxytocin, which had been shown effective to address haemorrhage in facilities, could be administered in community settings. However, concern that the drugs would be used for illegal induced abortion was a major obstacle to community distribution.

Other proven clinical interventions included use of manual vacuum aspiration for post-abortion care to prevent sepsis and magnesium sulphate for treatment of preeclampsia or eclampsia. Active management of the third stage of labour was also effective to reduce mortality associated with postpartum haemorrhage. In terms of community interventions, iron and folate distribution to women needed to increase and there was a call for more methods to identify prolonged or obstructed labour outside of facilities. Ms. Bartlett closed by urging the United Nations system to work to generate political will, funding, and support to enhance safe motherhood initiatives and fill research gaps.

Participants noted that the level of maternal mortality reflected both the quality of the health system and the status of women in a given society. Political debate surrounding many of the issues raised in the presentation, such as the link between abortion and maternal health, was coloured by societal conceptions and ideals. These were the types of ideological issues that came to the fore at the Commission on Population and Development. Ms. Bartlett posited that with good data and programmes, it was possible to move beyond ideology. With proper programmes, misoprostol could be used in the community to prevent postpartum haemorrhage without concomitant increases in illegal induced abortion.

Participants also remarked that the issue of human resources seemed central to addressing maternal mortality, particularly given the large number of deaths occurring in facilities. There was a need to be explicit about the types of training and skills required to reduce maternal mortality. For example, it was unclear whether access to Caesarean sections or other surgical interventions was required to achieve safe motherhood. Ms. Bartlett responded that the expansion of midwifery was a promising strategy to enhance capacity to deliver maternal health care. Midwifery programmes in Afghanistan would soon be evaluated to assess the impact, if any, on maternal mortality rates.

## E. INFECTIOUS AND PARASITIC DISEASES

Communicable diseases continued to inflict a large burden of disease, particularly among poorer populations. This session of the meeting was dedicated to understanding the burden of infectious and parasitic diseases and priorities for prevention and treatment.

Mr. Ramanan Laxminarayan, Director of the Center for Disease Dynamics, Princeton University, presented an overview of the burden of infectious and parasitic diseases and proven interventions. Estimates from the GBD study corresponding to the year 2001 showed that sub-Saharan Africa experienced nearly 6 million deaths and nearly 1.8 billion DALYs from infectious and parasitic diseases in that year. The region with the second highest burden of mortality and morbidity from these causes was South Asia, with 3 million deaths and nearly 90 million DALYs attributed to infectious and parasitic diseases in 2001.

Mr. Laxminarayan identified immunizations as a critical component of infectious disease prevention programmes that required sustained support. While some Indian states, such as Bihar, Rajasthan and Uttar Pradesh had seen immunization rates increase between 1998-1999 and 2005-2006, some wealthier states had seen declines in immunization rates, producing a flat trend in deaths from vaccine-preventable diseases on the country level. It was not yet clear why rates of immunization were declining in India's wealthier states.

Mr. Laxminarayan explained that treatment for infectious and parasitic diseases produced benefits both to the individual receiving treatment and to the broader population by preventing transmission to others and avoiding the emergence of drug resistance. For example, there were significant benefits to treating multi-drug resistant tuberculosis in that the treatment prevented transmission of the disease to others.

Mr. Laxminarayan presented the results of an analysis undertaken to assess whether the economic benefits of increased treatment and other control measures for tuberculosis (TB) exceeded the costs associated with such an increase. The model estimated the economic burden of TB deaths and benefit-cost ratios for TB control for countries with high burden of TB. Three TB control scenarios were assessed in the analysis: 1) no Directly Observed Treatment Shortcourse (DOTS), meaning that treatment would continue as it existed before DOTS programmes were developed, characterized by variable rates of case detection and lower cure rates; 2) sustained DOTS, in which DOTS implementation was held constant at 2005 levels through 2015; and 3) the full implementation of the Global Plan to Stop TB 2006-2015, which included the expansion of DOTS coverage, programmes to address TB/HIV co-infection and multi-drug resistant tuberculosis, new TB diagnostics, drugs and vaccines, and expanded efforts in advocacy, communications and social mobilization.

The analysis revealed significant benefits to sustained DOTS and the Global Plan relative to a baseline of no DOTS, but relatively modest benefits for moving from sustained DOTS to the Global Plan. For countries of sub-Saharan Africa, the study concluded that the benefits of implementing the Global Plan exceeded the costs by a wide margin. Notably, despite having the greatest number of TB deaths, the benefit-cost ratios of implementing the Global Plan in Africa were lower than in Asia. This result arose from the moderate income growth projections for Africa as well as high prevalence of HIV co-infection.

Mr. Laxminarayan then turned to discuss some of the findings on cost-effectiveness of other infectious and parasitic disease interventions identified in the second wave of DCP. Recalling the discussion that had taken place on the first day of the meeting, Mr. Laxminarayan noted that water and

sanitation systems were quite expensive, and thus not very cost-effective for dealing with diarrhoeal diseases. ORT was often mentioned as a more cost-effective intervention (US\$1,062 per DALY averted), although purchased commercial packages were less cost-effective than solutions prepared in the home. Particularly given that most children had multiple diarrhoeal events between the ages of 0 and 4 years, commercial ORT could quickly become a very costly intervention. More cost effective interventions included the promotion of breastfeeding (US\$930 per DALY averted), hand pumps, stand posts and house water connections (US\$159 per DALY averted) and construction and promotion of basic sanitation (US\$141 per DALY averted). Water sector regulation was identified as the most cost-effective intervention to address diarrhoeal diseases (US\$47 per DALY averted).

Both clinical treatments for individuals and public health interventions on the population level were considered in the second wave of DCPD cost-effectiveness analysis. Results revealed no systematic pattern of cost-effectiveness across these two categories. Case management of acute lower respiratory infection, at a cost of US\$398 per DALY averted, was not cost-effective. Interventions to improve nutrition among underweight children were more cost-effective, at a cost of US\$42 per DALY averted. A package of immunizations delivered as the traditional Expanded Programme on Immunization was the most cost-effective intervention to address conditions of childhood at a cost of only US\$7 per DALY averted.

Mr. Laxminarayan explained that a combination of low costs and high burden meant that several interventions for malaria were identified as highly cost-effective for sub-Saharan Africa. Preventive treatment in pregnancy with sulfa drugs or newer drugs, residual household spraying, and insecticide-treated bed nets all were estimated to have a cost of less than US\$25 per DALY averted.

In low- and middle-income populations with endemic TB, treatment for latent TB was not cost-effective, while management of drug resistant TB and DOTS for infectious or latent TB were estimated to be more cost-effective. A childhood vaccination for TB would have been the most cost-effective intervention in these contexts, at a cost of between US\$55 and US\$82 per DALY averted.

Cost-effective interventions to address HIV/AIDS in low- and middle-income countries included efforts like prevention of mother-to-child transmission and blood and needle safety. Condom promotion, treatment of other sexually transmitted infections, voluntary counselling and testing, and peer education programmes for high-risk groups were also cost-effective, although treatments of some opportunistic infections and antiretroviral therapy were not found to be cost-effective measures.

In general, interventions for dengue and hepatitis B in low- and middle-income countries were not cost-effective. Vaccination for hepatitis B came at a cost of more than US\$23,000 per DALY averted, and vector control to combat dengue cost around US\$2,000 – US\$3,000 per DALY saved. If a dengue vaccine were to become available, it was estimated that the cost would be around US\$1,440 per DALY averted.

Mr. Laxminarayan identified numerous challenges to expanding treatment for infectious and parasitic diseases, including financing, delivery, compliance, resistance, and the perceived impact on prevention. The challenge of emerging drug resistance had already been seen in the use of chloroquine for malaria. Combination drug therapies including the drug artemisinin (ACT) were needed to treat malaria while delaying the emergence of drug resistant parasites. However, because combination therapies were more expensive than monotherapies, scale-up was difficult. Mr. Laxminarayan advocated a global subsidy for ACT that would make them as cheap as chloroquine. The subsidy would work not only by discouraging monotherapy, but also by stimulating the market for ACT to allow for lower prices by ensuring stable demand. Mr. Laxminarayan stressed that regardless of the subsidy scenario or timing, the associated cost was always worthwhile in comparison to no subsidy as it would save lives and lower the

burden of malaria. He referred participants to his 2005 article in the journal *Health Affairs* for an analysis of how the subsidy would work relative to the current system. The Global Fund Board was to host the subsidy mechanism and had recently approved US\$230 million for a pilot programme in nine countries, which suffered 60 per cent of the global burden of malaria. If the programme worked, it was to be scaled up to all malaria-affected countries.

Continuing the discussion of infectious and parasitic diseases, Mr. Peter J. Hotez, Chairman of the Department of Microbiology, Immunology and Tropical Medicine, The George Washington University and of the Sabin Vaccine Institute, delivered a presentation entitled *The development impact of the neglected tropical diseases*. He noted that MDG 6 identified HIV/AIDS, malaria and “other diseases” as priorities on the global development agenda, but that while great strides had been made to address HIV/AIDS, malaria, and TB, the “other diseases” had been largely forgotten.

Approximately 1.4 billion people worldwide were infected with NTDs, and the most common type of infection were those caused by worms, including ascariasis, trichuriasis, hookworm, schistosomiasis, and lymphatic filariasis (LF).<sup>7</sup> Treating all of the NTDs together as a group for the purposes of advocacy gave them more weight than calling attention to the individual conditions.

Mr. Hotez urged participants to consider NTDs not only as occurring in settings of poverty, but as promoters of poverty themselves. The mechanisms linking NTDs to poverty included: 1) NTDs reduced productive capacity and worker productivity; 2) NTDs impaired intellectual and physical development in children; and 3) NTDs caused adverse pregnancy outcomes.

Mr. Hotez noted that NTDs were not acute, but rather chronic infections afflicting individuals over the course of many years. Because the NTDs caused chronic disabilities, the development impact of these diseases was large. For example, the severe disabilities caused by LF were estimated to result in losses of US\$1 billion in agricultural productivity in India each year. Those infected with LF lost an average of 68 working days per year due to LF-related disabilities, equivalent to a loss of 19 per cent of their productivity. An additional two NTDs, onchocerciasis and trachoma, reduced worker productivity by causing blindness. Moreover, fear of onchocerciasis infection sometimes led to the abandonment of otherwise productive farmland. In some farming communities where the prevalence of onchocerciasis infection grew to exceed 10 per cent, entire populations had fled in an effort to avoid further transmission of the disease. The corresponding economic rate of return associated with onchocerciasis control was estimated to be 18 per cent.

In addition to the morbidity caused by the NTDs, many of these diseases left those afflicted with increased susceptibility to other causes of morbidity and mortality. Some of the NTDs, such as opisthorchiasis and schistosomiasis, caused cancer. In addition, schistosomiasis was associated with a threefold increase in the efficiency of sexual transmission of HIV.

In many rural villages of impoverished populations the vast majority of children were affected by one or more NTD. Children tended to have more worms than adults, but it was not definitively known why this was the case. Treatment for worms was very effective at getting children back on track in terms of their growth and development. Mr. Hotez displayed a growth curve graph, which showed that if a child infected with intestinal worms and severely stunted by age 6 months received two days of treatment, by age 12 months she could catch up to her peer group in terms of growth. He estimated that an investment of US\$3.50 per child translated into an additional year of schooling gained.

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<sup>7</sup> Hotez, P. J., D.H. Molyneux, A. Fenwick, et al. Control of neglected tropical diseases. *N. Engl. J. Med.* vol. 357, pp. 1018-27.

There was strong evidence that the number of worms a child was infected with was inversely associated with the intelligence quotient of the child. A University of Chicago economist, Mr. Hoyt Bleakley, had estimated that hookworm infection in childhood led to a 40 per cent reduction in future earnings. Hookworm was also a significant problem among pregnant women, causing blood loss, increasing maternal mortality and enhancing susceptibility to malaria. In addition, hookworm infection during pregnancy was associated with low birth weight and increased perinatal mortality. Mr. Hotez said that an estimated one third of pregnant women in sub-Saharan Africa were affected by hookworm. There was a huge social stigma associated with the NTDs, especially for women, as in many populations NTD infection was grounds for marital abandonment or removal of children from a mother's care.

Mr. Hotez posited that the reason the NTDs did not resonate with policy makers was that they generally did not cause death and there was insufficient data available to estimate the burden of morbidity. The DALY computation procedure used in the GBD grossly underestimated the chronic effects of the NTDs. The procedure did not adequately consider the pain, inflammation, nutritional deficiencies and social stigma afflicting affected individuals, families and communities. Individual investigators in the field were making their own calculations of the burden of the NTDs. For example, Charlie King at Case Western University had calculated that schistosomiasis caused 75 million DALYs each year, whereas the GBD estimated only around 1.5 million DALYs due to schistosomiasis.

The beginning of NTD control was pioneered by Mr. Frank Hawking, who was interested in LF. He worked with diethylcarbamazine (DEC), which was mixed with salt to dose the entire population and halt LF transmission. This strategy was credited with the elimination of LF in Brazil and China. DEC could not be used to combat LF in sub-Saharan Africa because there was a severe toxic reaction to DEC in individuals co-infected with river blindness. An alternative drug, ivermectin, was effective and had been donated by Merck to combat both river blindness and LF. Z-packs (which contained zithromax) had also been donated en masse. At present, 42 per cent of the 1.3 million people at risk for LF were being treated through mass drug administration (MDA) strategies, many of them in post-conflict settings. Several countries had achieved success in combating other NTDs through MDA, including Morocco, which had nearly eliminated trachoma between 1997 and 2003, and Egypt, which had reduced the prevalence of schistosomiasis haematobium from almost 18 per cent in 1990 to less than 2 per cent in 2001. Mr. Hotez referred participants to his 2009 paper in the journal *Clinical Pharmacological Therapy* for more information on MDA.

Mr. Hotez explained that a similar level of drug coverage to that reached for LF had not been achieved for deworming medications to address soil-transmitted helminthiasis and schistosomiasis. Praziquantel (PZQ) was a relatively more expensive drug and was not yet being donated by drug companies, thus uptake had lagged. Rapid scale-up was needed because deworming medications were proven to improve child growth, physical fitness, cognitive function, school performance and attendance, and to reduce the prevalence of anaemia in children.

There was enormous geographic overlap in the NTDs and thus large economies of scale to delivering treatment. An effective strategy was to deliver treatments for multiple infections in one package, called the "Rapid Impact Package", which included treatments for ascariasis, trichuriasis, hookworm, LF, onchocerciasis, schistosomiasis, trachoma, strongyloidiasis, trematodiasis, taeniasis and scabies. The package could be delivered at a cost of US\$0.50 per person per year, including the costs of drugs, equipment, training, staff and delivery. The Just 50 Cents Campaign had been launched as a grass roots effort to deliver the package. The Bill and Melinda Gates Foundation and USAID were making major contributions toward the NTDs. The Gates Foundation had committed US\$34 million over five years to establish a global strategy and coordinated mechanisms to scale up NTD control and elimination efforts. The project aimed to leverage additional funding and to develop regional strategies, funding mechanisms, and country-level programmes to treat at least 230 million people over the grant period.

USAID, through the President's Global Health Initiative, was considering whether to commit US\$180 million over the next three years for NTD control.

Mr. Hotez posited that there was an important human rights dimension to the NTDs. Schistosomiasis, particularly in the Americas, was a legacy of the slave trade. Schistosomiasis could be eradicated in Haiti with treatment over five years at a cost of US\$20 million over that period. The cost seemed especially manageable when one considered that 20 million tourists visited the Caribbean region each year.

Mr. Hotez closed by noting that NTDs were not just a problem in developing countries. The United States had also neglected the infections of poverty. In the United States, these were not just diseases of immigrants. There was endemic transmission of parasitic diseases occurring in the country, particularly in regions south of the "Continental Poverty Divide", including Appalachia, the Cotton Belt, the Bootheel area of Missouri, the Mississippi Delta, the southern border regions of Texas and New Mexico, and the tribal lands of New Mexico and Arizona.

Discussion centred on the presenters' decisions to focus on disease-specific global health initiatives, rather than to emphasize the need to strengthen countries' health systems. There was concern that costing exercises failed to assess the efficiencies of interventions delivered through an existing health infrastructure or in combination with other interventions. Mr. Hotez agreed that one could not underestimate the importance of health systems, but he noted that systems building and reform was a long process and that proven interventions needed to be delivered in the meantime. Mr. Laxminarayan added that implementing interventions for single diseases could potentially enhance the overall health system, as was seen with the measles vaccination push in the United States. Better analytic tools were needed to measure the costs and benefits to building health systems.

Participants expressed interest in learning more about the gender distribution of infectious and parasitic diseases, particularly the NTDs. Mr. Hotez reiterated that women were disproportionately affected by the NTDs. Women in low-income countries were already iron deficient due to menstruation or pregnancy, but worms and schistosomes exacerbated this deficiency by causing blood loss. The pregnancy hazards of worm infections operated primarily through anaemia. Blood loss during birth compounded with blood loss from worms was associated with adverse health and mortality outcomes for mothers. In addition, the NTDs were associated with placental inflammation. When NTDs were co-endemic with malaria, anaemia was compounded. Studies in Nepal and Latin America conducted by research groups at Johns Hopkins University and McGill University showed that treatment of worms during pregnancy led to reductions in both maternal and infant mortality. He clarified that incidence of NTDs was similar in males and females, but morbidity was more severe among women. While occupational exposures were important for the gender distribution of disease in regional pockets, the global prevalence of NTDs was fairly equal in men and women. Mr. Hotez remarked that a forthcoming article in *PLoS* was to address the gender distribution of morbidity related to the NTDs.

The discussion turned to whether improved water and sanitation were considered effective interventions to address the NTDs. According to Mr. Hotez, when sanitation was the sole intervention, the impact on the NTDs in poor communities was meagre. In order for sanitation efforts to be effective, they needed to be combined with deworming efforts or overall economic development.

## F. CHRONIC AND DEGENERATIVE DISEASES

The final substantive session of Part I of the Expert Group Meeting addressed the burden of noncommunicable diseases and priorities for intervention.

Mr. Prakash Shetty, Professor of Public Health Nutrition, Institute of Human Nutrition, University of Southampton, discussed the relationship between nutrition, lifestyles, obesity and chronic diseases. Overweight and obesity had become a global epidemic. They were prevalent in industrial, developing and transition economies around the world. Obesity increased the risk of co-morbidities including type II diabetes, gall bladder disease, insulin resistance, coronary heart disease, hypertension, and osteoarthritis, among others.

The determinants of the obesity and noncommunicable disease epidemics in developing societies were tied to the developmental transition. This transition encompassed the demographic transition from high to low fertility and mortality; the epidemiological transition from high infectious disease prevalence to predominance of chronic diseases; and a nutrition transition from a high level of undernutrition to a situation in which diet-related noncommunicable diseases predominated. These transitions occurred together with the phenomena of urbanization, migration and globalization.

The drivers of the obesity epidemic operated at both the macro level and the micro level. At the macro level, average caloric availability was increasing globally along with a drastic decline in real prices for food and agriculture. As national incomes rose, the composition of diets changed, with increases in consumption of fats, sugars and meat products and decreases in consumption of carbohydrates. In Asia, for example, increased vegetable oil consumption was a key component of the nutrition transition. Poor countries had access to higher fat diets at lower levels of gross domestic product than was the case for countries developing further in the past. Urbanization also drove changes in diet and levels of physical activity. As societies became more urban, occupational activity decreased and the amount of time spent in sedentary activities increased. There were few data, however, on levels of physical activity in developing countries.

The level of overweight and obesity among school-aged children was also a concern. Worldwide, around 10 per cent of children aged 5-17 years were overweight or obese, and the percentages were much higher in the Americas, Europe and the Near/Middle East. In the United States, changes had occurred in the patterns of transportation to school such that trips by vehicle had increased, while trips by walking decreased. Also, there was a positive relationship between the duration of television viewing and body mass index in children.

The determinants of energy balance and weight gain were extremely complex, as mapped in a recent Foresight Report on obesity in the United Kingdom. It was quite difficult to untangle the causes in order to identify where policy interventions might have an impact.

Mr. Shetty also discussed the relationship between social inequalities and risk of noncommunicable disease. In the Whitehall study of the British Civil Service, persons in lower-grade occupations had a higher risk of disease that was independent of biological and behavioural markers such as cholesterol, smoking, or blood pressure. Social support was another important protective factor.

Mr. Shetty went on to note that nutritional deprivation experienced by children early in life could have repercussions in terms of greater risk of chronic disease later in life. A link had been established between low birth weight and adult-onset cardiovascular disease. Also, undernourished children had an increased risk of obesity in adulthood. It was important to track the progress of low birth-weight and

undernourished children through adulthood to understand the implications. For example, low birth-weight infants in India showed elevated blood glucose by ages 7-11 years.

In conclusion, Mr. Shetty stressed that the epidemic of obesity and its co-morbid noncommunicable diseases was not confined to the industrialized world. Determinants of the emerging global epidemic were complex and included both macro-level and micro-level drivers. Hence, intervention strategies would need to address a complex range of individual and environmental determinants.

Participants were interested whether public health interventions to influence food intake were considered viable strategies to combat obesity and chronic disease. Mr. Shetty noted that such efforts were underway, such as the United Kingdom's Food Standards Agency initiative to reduce average salt consumption to below 6g per day. In addition, Poland had seen declines in cardiovascular disease following the abolition of government subsidies for margarine. For additional information on what some developing countries were doing to combat chronic diseases, Mr. Shetty directed participants to the Centers of Excellence programme, funded by the United States National Heart, Lung and Blood Institute and UnitedHealth.

Mr. Thomas Gaziano, Assistant Professor in the Department of Health Policy and Management, Harvard School of Public Health, then made a presentation entitled *The global burden of chronic diseases*. At the outset, he wished to dispel three myths. The first was the myth that chronic diseases were a problem only of affluent countries. Already by 2001, cardiovascular disease had become the leading cause of death in the developing world. About 28 per cent of deaths in low- and middle-income countries were the result of cardiovascular disease. Other causes of death such as injuries, respiratory infections, nutritional deficiency, and HIV/AIDS collectively still played a predominant role in certain regions, but it was clear now that even in these areas cardiovascular disease was a significant cause of mortality. The burden of cardiovascular disease was projected to grow: between 1990 and 2020, ischemic heart disease alone was anticipated to increase by 120 per cent among women and 137 per cent among men in developing countries, compared to age-related increases of between 30 per cent and 60 per cent in developed countries.

The emergence of high cardiovascular disease incidence reflected changes that had occurred to varying degrees in all regions of the world. The industrial and technological revolutions and their associated economic and social transformations had resulted in dramatic shifts in the diseases responsible for illness and death. Known as the epidemiological transition, these changes in morbidity and mortality were linked to changes in personal and collective wealth (economic transition), social structure (social transition), and demographics (demographic transition). The first stage of the epidemiological transition was dominated by starvation and infection. The main type of cardiovascular disease occurring during this stage was rheumatic heart disease. In the second phase of the transition, infectious diseases began to recede, reflecting improved public health measures such as clean water supplies and hygiene as well as improved nutrition. Hypertension was the first risk factor to emerge and thus this second stage was dominated by haemorrhagic stroke. The third phase saw the rise of degenerative and man-made diseases. In this phase, infectious diseases caused less than 10 per cent of deaths and lifestyle risk factors, such as obesity, dyslipidemia and diabetes mellitus type II, began to emerge. In the fourth stage, large public efforts were taken on to reduce the prevalence of risk factors and countries began to see declines in the cardiovascular death rates and further increases in life expectancy. While countries tended to enter the stages of the epidemiological transition at different times, the progression from one stage to the next tended to proceed in a predictable manner, with both the rate and the nature of cardiovascular diseases changing over the course of the transition.

Mr. Gaziano called attention to the younger age profile of deaths from cardiovascular disease in developing countries as compared to developed countries. For example, 40 per cent of cardiovascular deaths in South Africa took place between the ages of 35 and 64 years, as opposed to just 10 per cent in the United States. This would have profound economic effects over the next 25 years as workers in their prime would fall to cardiovascular disease.

Next, Mr. Gaziano emphasized the importance of prevention from a cost perspective. Taking the example of blood pressure, he said that blood pressure accounted for 10 per cent of worldwide health care expenditure but that the costs of blood pressure drugs were just the tip of the iceberg. In the United States the treatment and management of high blood pressure accounted for only 21 per cent of total health care costs related to blood pressure. The remaining costs were all due to treating the sequelae of high blood pressure including myocardial infarction and stroke. In developing countries, the fraction of costs related to management of high blood pressure would likely be lower because of lower drug costs.

There were several prevention opportunities to reduce the risk of morbidity and death from chronic diseases. Primordial prevention meant preventing risk factors from developing. Primary prevention referred to preventing risk factors from progressing into symptomatic disease. Secondary prevention consisted of treating symptomatic disease to prevent chronic suffering and death. Interventions could be applied at the individual level or the population level. Both treatments and population interventions (such as reductions in smoking) had contributed to lowering cardiovascular disease mortality in developed countries.

In evaluating the cost-effectiveness of prevention, it was crucial to take into account the level of risk as well as a range of expected outcomes. In an example of population-level intervention, the cost-effectiveness of salt reduction strategies ranged from cost-saving to US\$250 per DALY saved, depending on assumptions about the cost of salt reduction (from less than US\$0.50 to US\$1 per individual) and the effectiveness of blood pressure reduction (from 2-8 mmHg). In a second example he showed the importance of considering the risk profile of individual patients: for example, giving Lovastatin to patients after a myocardial infarction saved lives and reduced costs. However, giving the same drug to a 40-year-old woman with elevated cholesterol as her only risk factor was highly ineffective from a cost standpoint. He noted that accepted levels of risk for treatment were being revised continually based on new studies.

There was movement away from making treatment decisions based on individual risk factors, such as blood pressure or cholesterol levels, to assessing “absolute risk” that took multiple risk factors into account. Rather than making treatment decisions for high blood pressure, for example, based solely on an arbitrary cut-off, it was important to consider the added risk from other factors such as tobacco use, cholesterol, and age for an assessment of total risk of cardiovascular disease.

In resource-constrained settings, clinicians had to be given tools to accurately assess risk. Mr. Gaziano used the example of the Framingham risk score for cardiovascular disease. This framework assessed a patient’s age, blood pressure, total and HDL cholesterol, diabetes, smoking, and hypertension treatment status to produce a percentage risk of cardiovascular disease. The problem with using this risk score in developing countries was that cholesterol monitoring required costly laboratory tests. Mr. Gaziano and colleagues in South Africa had found that substituting measures of body mass index and waist-to-hip ratio instead of cholesterol testing gave almost equivalent predictive results. This permitted the development of a cardiovascular disease risk assessment that could be done without a clinic visit. Risk assessment could be conducted by community health workers, or individuals could even assess their own risk.

Lastly, Mr. Gaziano called attention to the “polypill”, a new pill that was being considered for preventing cardiovascular disease in developing countries. The polypill contained six drugs: three blood pressure medicines (a diuretic, a beta-blocker, and an ACE inhibitor), acetylsalicylic acid (ASA; aspirin), a statin, and folate. If given to all persons aged 55 or older, it could prevent up to 80 per cent of cardiovascular disease. However, the pill was still controversial. Data on the benefits of most of the included drugs were robust, and a single pill could improve treatment adherence. However, there were no trial data on a polypill and no long-term data on the use of three anti-hypertensives and, moreover, three large trials had shown no benefit of folate for prevention of cardiovascular disease. There was also concern that using such a pill for primary prevention could “medicalize” a large portion of society.

In summary, Mr. Gaziano reiterated that the chronic disease burden in developing countries was large and growing. Current resources devoted to cardiovascular disease in those countries were extremely scarce. However, reasonable population-based options existed to treat and prevent cardiovascular disease. One such measure was tobacco control. For other primary and secondary prevention, it was critical to base treatment on a proper assessment of risk.

Participants inquired as to how the costs of identifying myocardial infarctions were incorporated into the cost-effectiveness analysis for secondary treatments. Mr. Gaziano confirmed that adding these costs into the analysis would indeed make the treatments appear less cost effective.

To address the last topic of the chronic diseases session, Mr. Jha delivered his second presentation of the meeting, entitled *Global mortality from tobacco*. Mr. Jha noted that tobacco was a major cause of death and poverty and that taking tobacco seriously could save 115 million lives over the next few decades. He advocated a strategy that aimed both to help adults to quit using tobacco and to prevent kids from starting to smoke. Tripling the excise tax on cigarettes had proven to be the most effective tobacco intervention: doubling the retail price had been shown to lower consumption by at least 30 per cent while raising substantial tax revenues. Other worthwhile interventions included cigarette packet warning labels with a tax stamp to counter smuggling, an absolute ban on cigarette advertising, and a complete ban on public smoking. It was also important to monitor and report smoking mortality.

Mr. Jha cited data compiled by Mr. Richard Peto, who estimated that there would be one billion smoking deaths during the 21<sup>st</sup> century, and half would occur among today’s children who had not yet started smoking. For comparison, the 20<sup>th</sup> century had witnessed only 100 million smoking deaths.

In general, the news was good for men in developed countries who were seeing declines in tobacco-related mortality, though from relatively higher levels. However, women worldwide and men in low-income countries continued to experience large increases in smoking and smoking-related deaths. In India, one third of adult males smoked as did nearly 5 per cent of adult women. In developed countries, most smokers started by age 20 years, but in India the peak onset was around age 30 years. Smokers in India were distinguished by those who smoked regular cigarettes and those who smoked bidis, which contained less tobacco than cigarettes. While regular cigarette smoking increased with higher levels of education, the opposite relationship was observed for bidis.

Mr. Jha said that new data revealed that the health risks for Indian smokers were larger than previously thought. Seventy per cent of tobacco-related deaths occurred between the ages of 30 and 69 years. Even a few bidis or cigarettes per day were associated with large mortality risks. It was important to convey to Indian smokers that stopping smoking works, though less than two per cent of adults in India had quit smoking.

Mr. Jha described the Million Deaths Study, a study of health and mortality in India conducted by sample registration with the Indian Registrar General. The survey encompassed 1.1 million homes and

used RHIME forms (enhanced verbal autopsy) to record all deaths in those households. The study was to capture one million deaths between 1997 and 2014. To study tobacco-related mortality thus far, two physicians had classified 74,000 adult deaths over the period 2001-2003 according to the underlying fatal disease. A smoking history of the deceased was collected from living household members and those histories were then compared to the smoking histories of 78,000 living adults.

Analysis revealed that among women aged 30-69 years, the risk of tuberculosis death for smokers was three times that of non-smokers. A similarly high relative risk was found for deaths from respiratory diseases. For all causes of death combined, the risk of death for female smokers was double that of non-smokers. Among males, the relative risks associated with smoking tended to be slightly smaller than those estimated among females. Among males aged 30-69 years, the study measured about a six year loss of life associated with smoking. Risks of death were discernibly different for smokers compared to non-smokers even by age 50. Both bidis and cigarettes were harmful, with eight or more cigarettes per day associated with the greatest risk of death.

In addition to India, increasing tobacco-related morbidity and mortality in China was a matter of great concern. Despite a plateau in smoking uptake in the 1990s, cigarette production in China had increased since 2000. An estimated 300 million male smokers were currently alive in China and 100 million of them were likely to be killed by smoking.

Mr. Jha then turned to discuss the results of the Million Women Study, a longitudinal study of health and mortality in the United Kingdom, which had recorded 45,000 deaths through seven years of follow-up thus far. Smokers in the study tended to start early, by age 19 years. They smoked an average of 15 cigarettes per day. Results demonstrated that any amount of smoking was harmful, even as little as five cigarettes per day and even with low tar cigarettes. The Million Women Study was the first large prospective study to show the full effects of prolonged smoking in women.

Mr. Jha explained that smoking was an important source of social inequalities in mortality. It was estimated that if smoking were eliminated as a cause of death, mortality differentials by level of educational attainment in the United States and Poland would be more than halved.

Research showed that by quitting smoking, smokers could realize substantial health benefits. The probability of death from lung cancer was significantly smaller if smoking ceased by age 50 years. If cessation occurred by age 30 years, the risk of lung cancer death for former smokers was similar to that of persons who had never smoked. Mr. Jha concluded his presentation by inviting participants to view additional information on tobacco-related morbidity and mortality on his institution's website ([www.cghr.org/tobacco](http://www.cghr.org/tobacco)).

Participants inquired about the roles of second-hand smoke and solid fuel smoke exposure in contributing to smoking-related morbidity and mortality in India. Mr. Jha replied that while it had not been studied in India, evidence from other populations suggested that morbidity and mortality from second-hand smoke would be a fraction of that from active smoking. He added that the detrimental effects of smoking seemed to be independent of the effects of solid fuel smoke exposure.

Participants also questioned the feasibility of public smoking bans, particularly given powerful objections from tobacco companies. Mr. Jha explained that numerous public smoking bans had been instituted successfully in spite of the tobacco lobbies. Furthermore, contrary to the popular assumption that enforcing smoking bans would be especially challenging in developing countries, new evidence from Delhi indicated that smoking restrictions were very effective, perhaps in part reflecting strong cultural norms that discouraged offensive behaviours.

## G. SUMMARY AND CONCLUDING REMARKS

Mr. Philip Guest, Assistant Director of the Population Division, thanked participants for their presentations and discussion. He noted that a key objective of the meeting was to gather substantive information for the report that was to serve as the background documentation for the 2010 Commission on Population and Development, which was to address the topic, “Health, morbidity, mortality and development”. Mr. Guest expressed satisfaction that this goal had been met. The presentations had been purposely selected to fill in the gaps in the expertise of the Population Division. He expressed his appreciation for participants’ expertise, analysis and candid discussion.

Mr. Guest informed participants that the second half of the expert group meeting would continue with methodological papers on the estimation of adult mortality. All were welcome to attend. The third and final day of the meeting would focus on harmonizing adult mortality estimates for selected countries.

Ms. Zlotnik added her thanks and expressed that she found the meeting to be extremely interesting. The presentations and discussion had shattered her ideas about how to advise governments on their health policies. It was important to focus attention on the poorer countries which were facing not only communicable diseases, but also the growing iceberg of noncommunicable diseases. She urged that Governments needed to take courageous positions to address the growing epidemic.

## PART 2: ADULT MORTALITY

### H. OVERVIEW

Mr. François Pelletier, Chief of the Mortality Section of the Population Division, opened the second part of the meeting with a brief overview of the collaboration between United Nations agencies that had occurred over the last few years. Within the United Nations system, both the Population Division (UNPD) and the WHO were responsible for producing life tables and corresponding mortality estimates for all countries of the world. Mr. Pelletier noted that this task was quite challenging, highlighting the fact that for many countries there was a lack of reliable data to generate life tables. He also pointed out that the different data sources that were made available were not always consistent with one another and that different methods could be used to derive estimates. Bearing this in mind, he was not surprised to see that differences in the mortality estimates produced by the two agencies had been identified, but he believed that these could be substantially reduced by engaging in a process of methodological discussions and data sharing. A collaborative process on adult mortality estimates had been initiated in 2006, with roots in the Interagency Group for Child Mortality Estimation (IGME) involving UNPD, WHO, UNICEF, and the World Bank. The first coordination meeting on the estimation of adult mortality had been convened in 2006 and a second had taken place in 2008. Both of the meetings had focused on methodological aspects of adult mortality estimation. This meeting would begin similarly with a discussion of methodological issues. The final day of the meeting was to be devoted to a discussion of some 30 countries for which UNPD and WHO adult mortality estimates differed, with the objective of determining the quality of and harmonizing the estimates. By harmonizing estimates, Mr. Pelletier hoped to avoid confusing users of the data with inconsistencies between the agencies.

Mr. Pelletier welcomed both Ms. Mie Inoue and Mr. Mathers from WHO. He acknowledged the valuable long-time collaboration with Ms. Inoue, who had been responsible for producing the WHO life table estimates for many years. Mr. Pelletier also welcomed Ms. Julie Rajaratnam and Mr. Haidong Wang, both of whom were researchers at IHME. He was very pleased to see that representatives of IHME were joining the meeting. IHME was invited share information on the methodological enhancements they had been working on. While IHME was not prepared to share their adult mortality estimates at the present meeting, Mr. Pelletier looked forward to seeing their new estimates in the near future.

### I. METHODOLOGICAL ASPECTS TO THE ESTIMATION OF ADULT MORTALITY

Ms. Mie Inoue, Department of Measurement and Health Information Systems of the WHO, described the methodologies that WHO used to generate life tables at the country level. She explained that since 1999, WHO had produced annual life tables for its member States (193 member States at present). Each year, the World Health Statistics (WHS) publication contained estimates of life expectancy at birth, infant mortality, under-five mortality and adult mortality, among other measures, corresponding to the years 1990, 2000 and the most recent year available. For WHS 2009, the most recent year for which estimates were available was 2007. Prior to publication in WHS, life tables and corresponding mortality estimates were distributed to member States for comments and feedback.

As a starting point, each year the WHO requested its member States to provide their cause of death data. When countries did not have an appropriate focal point, regional WHO offices were sometimes contacted. Available data on the death rate by age and sex, adult mortality ( $_{45q15}$ ) and child mortality were collected.

Ms. Inoue next described the process of moving from the empirical data to the life table estimates. Empirical data sources included vital registration (VR), sample VR, surveys and censuses.

Completeness of VR was assessed using demographic techniques such as Growth Balance Equation, Bennett-Horiuchi and Variable-r. After adjusting for completeness, AIDS-free estimates of child mortality or adult mortality were used as inputs to the modified logit model utilised by WHO to generate life tables. IGME estimates were used for child mortality, while a projection of mortality was used as an input for adult mortality. This projection procedure entailed taking the trend of  $l_{60}$ , calculated from VR life tables and adjusted as necessary, and fitting a weighted OLS regression against time. If no trend was available, the annual rate of change was estimated from an empirical source or from the latest revision of *World Population Prospects* from the Population Division. AIDS deaths were then added to yield the life table estimates. Projections from the last available data point using the modified logit model permitted production of estimates for the most recent year needed for WHS. This was a benefit even for developed countries with complete VR, given that completely up-to-date VR data was supplied by only about 10 countries.

Estimates of AIDS mortality by age and sex were provided by UNAIDS. For countries with more than 5 per cent of deaths due to AIDS, the numbers of AIDS deaths were subtracted from child and adult mortality estimates. For the most recent life tables, new estimates not yet available to the public had been obtained from UNAIDS.

The modified logit system began with the original Brass method relating the logit of one  $l_x$  at a given time to the logit of another  $l_x$  at an earlier time. The modification corrected for both the child mortality and adult mortality biases contained in the original Brass method. The modified logit model was fitted to 1,802 life tables from the WHO mortality database. The choice of the standard was the mean of the 1,802 life tables.

Where the only input for a given country was the child mortality rate, the modified logit equation was used to relate child mortality to adult mortality, and this procedure was performed separately for males and females. Ms. Inoue showed that by plotting the observed life expectancy at birth against the predicted life expectancy at birth using the modified logit and the Coale-Demeny model life tables, it was clear that the modified logit produced a more linear relationship.

For the latest round of estimates currently being prepared for WHS 2010, 51 countries had complete VR with trend data and an additional 59 countries had incomplete VR with trend data. For 57 countries, child mortality was the only input used. Global life expectancy at birth for both sexes combined was 67.8 years. No major methodological changes were made between WHS 2009 and the forthcoming WHS 2010, thus any differences were the result of new data. Overall, WHO preliminary estimates of the total numbers of deaths for 2008 were similar to the average annual deaths over the period 2005-2010 estimated by UNPD. The largest difference between the two sets of estimates was for the Eastern Mediterranean region (UNPD estimates were 7.7 per cent lower than WHO estimates), which was driven primarily by differences in the mortality estimates for Iraq.

Looking to the future, Ms. Inoue identified the need to consider migration in the completeness assessment as a priority. In addition, further analysis was needed in order to adequately use adult mortality estimates derived from surveys. She welcomed suggestions for the development of the modified logit model and stressed that because the deadline for the final estimates for *World Health Statistics 2010* was not until the end of January 2010, there was still time to incorporate suggestions and additional data sources into the current round of estimates.

Participants expressed interest in the WHO country consultation process and how disagreements were handled. Ms. Inoue responded that often any differences between country estimates and WHO estimates were attributed to differences in the reference period. Mr. Mathers added that discrepancies sometimes arose when the country assessed the VR to be more complete than was indicated by the

WHO's assessment. In the future, the WHO aspired to conduct a more systematic review of its estimates, similar to what UNAIDS was doing in consultation with each country.

Participants were concerned that continuing to produce two sets of life table estimates, one from WHO and the other from UNPD, could be confusing. Mr. Pelletier explained that WHO and UNPD estimates were produced for different purposes. UNPD produced five-year estimates for the purposes of population projections and published the revisions every two years. In contrast, WHO produced single-year estimates that needed to be consistent with estimates of deaths by cause and revised annually. He stressed that it would take time to harmonize the estimates between WHO and UNPD. Mr. Mathers added that the present meeting was part of the process of harmonizing the work of the two agencies.

Participants also requested clarification on the methods used by WHO. Specifically, participants asked how VR trends were projected to derive estimates for the most recent year and whether the standard employed with the modified logit model was global or country-specific. On the procedure for projecting from VR data, Ms. Inoue clarified that the modified logit was used to project  $l_5$  and  $l_{60}$  to the year 2008, using the latest available VR  $l_x$  as the standard. She agreed that mortality at the oldest ages was a concern because ages 80 years and up were extended by the Coale-Guo method. She underscored that an improved extension method was needed for developed countries.

Ms. Julie Knoll Rajaratnam, Assistant Professor with the Institute for Health Metrics and Evaluation at the University of Washington, then presented IHME's methodology for evaluating the completeness of death registration. She noted that the methodology was built over the course of the past three years involving many colleagues, some of whom no longer worked with IHME.

Ms. Rajaratnam began with a conceptual overview of death distribution methods (DDM). Deaths by age and sex recorded in vital registration or censuses were utilized as inputs. The distribution of deaths recorded in those sources was compared to the distribution of population by age and sex from two censuses. The methods produced an estimate of the completeness of death recording relative to population recording. The inverse of the estimate of relative completeness was used as a correction factor to adjust death rates upwards.

Three DDM methods were widely used, namely the General Growth Balance (GGB) method developed by Hill in 1987, the Synthetic Extinct Generations (SEG) method developed by Bennett and Horiuchi also in the 1980s, and a hybrid approach referred to as GGB-SEG, developed by Hill and Choi in 2004. None of these methods assumed a stable population, but they did assume that the population was closed to migration and that there was no misreporting of age at death or age at census. An additional assumption common to the methods was that the level of completeness was constant over age. The SEG method further assumed that coverage was constant over both censuses.

Ms. Rajaratnam noted that the age group selected for the method, referred to as the age trim, affected the results. Showing the application of the SEG method to data for Thai males for the period 1980 to 1990, Ms. Rajaratnam demonstrated that average completeness was estimated at 66 per cent when the age trim was 15 to 55 years, compared to 61 per cent when the age trim was 15 to 65 years.

To evaluate DDM performance, Ms. Rajaratnam asked two questions: 1) how well did the various methods perform in populations where the assumptions were violated; and 2) did particular age trims yield more accurate results than others? Three validation environments were constructed to address these questions. In the first, a simulated population was created by applying historical US death rates to Sweden's population in 1790 and projecting the population forward until it stabilized. Next, 77 different mortality, fertility and migration scenarios were defined and 2,000 unique combinations of census and VR systems applied to each of those scenarios with different levels of coverage and age misreporting. In total,

154,000 simulated population environments were created to which the three DDM were applied. This validation environment enabled assessment of both a systematic age misreporting component and a stochastic age misreporting component.

A second validation environment was created with data for US counties where completeness was assumed to be 100 per cent. Analysis was presented for counties with populations of 100,000 inhabitants or more. Ms. Rajaratnam said that this environment presented a good way to assess the effect of migration on the performance of the methods because US counties represented a range of migration scenarios.

The third validation environment assessed DDM performance for large, high-income countries, including OECD countries with populations greater than 5 million throughout the period from 1950 to 2000. The Republic of Korea and Germany were excluded. Like the second validation environment, this validation environment assumed 100 per cent completeness.

To test the performance of various age trims with the DDM, estimates of relative completeness for each method were generated using every possible age trim with a minimum of five contiguous age groups, beginning with age five as the minimum age and going up to age 80 as the maximum age. In all, there were 78 different age trims for each of the three methods, yielding 270 variants to test the DDM.

The median relative error in relative completeness was the performance metric used to evaluate the DDM. Performance was found to vary significantly across the different age trims. Based on a summary measure of performance in all three validation environments, for the GGB method, 40 to 70 years was the optimal age trim, while for the SEG method, 55 to 80 years was optimal. For the combined GGB-SEG, 50 to 70 years was the optimal age trim. Even with the best age trims, a large degree of uncertainty was observed, equivalent to 25 per cent of the actual estimate. Age misreporting was the most important factor influencing the degree of error.

The performance of the various DDM and age trims were ranked within each validation environment according to the median relative error in relative completeness. The method with the minimum average rank across the three environments was identified as the top performer. The completeness estimates from all three DDM tended to centre around the true completeness, thus there was little bias. However, the variance in the completeness estimates for a given level of true completeness was large, thus the degree of uncertainty in the estimates was high. There was greater uncertainty in the estimates of completeness for US counties than for high-income countries. The amount of uncertainty increased as the true completeness increased.

Ms. Rajaratnam qualified that the sources of the errors from each of the methods had not yet been fully disentangled. Simulations showed that stochastic age misreporting had an important effect, but the effect of systematic age misreporting was especially large. Age heaping, however, had little effect since 5-year age groups were used. The degree of error caused by migration was relatively small when compared to the error caused by age misreporting, probably because the optimal age trims were at higher ages, which were less likely to be affected by migration.

Ms. Rajaratnam presented an application to Belize, a country with a long history of vital registration. The three DDM methods were applied with censuses paired in both 10- and 20-year blocks. The three methods yielded varied estimates of completeness, with the differences between methods becoming wider going farther back in time. She hypothesized that age reporting might have improved in Belize over time, thereby yielding more consistent estimates for the more recent periods. It was noted that uncertainty intervals associated with each of the point estimates of completeness were wide.

As a final step it was necessary to derive a trend line of completeness estimates. Ms. Rajaratnam explained that while the level of completeness was determined from the various DDM estimates, the trend was determined by combining the DDM trends with the trend in estimates of completeness of the under-five mortality rate ( $q_5$ ) using a smoothing function. This procedure also enabled the derivation of estimates for the most recent period that did not yet fall between censuses.

Ms. Rajaratnam concluded with the recommendations that users employ optimal age trims and acknowledge uncertainty when using DDM to estimate completeness. It was extremely important to remain mindful that age misreporting had the greatest potential to bias the results. In light of the weaknesses of DDM, she recommended also considering alternative means of measuring completeness, such as directly with a survey through a capture re-capture analysis.

Participants inquired as to whether the migration effect illustrated using US counties was representative of what would be observed in comparisons across countries. Ms. Rajaratnam replied that she had examined the performance of the DDM at different levels of migration and determined that the performance of the best methods was comparable. The effect of migration was not as large as the effect of age misreporting and older age trims performed better at all levels of migration.

Concern was expressed about the wide “window” in the smoothing function presented by Ms. Rajaratnam. Where there was a systematic trend in completeness, it was not clear whether it was appropriate to smooth it away. Ms. Rajaratnam clarified that she had not used a Loess function, but rather another similar smoothing function. She conceded that the smoothing probably dampened the fluctuations in completeness levels within the window. She posited that the problem would be greatest for a country like Belize where the completeness estimates were U-shaped.

Lastly, participants were interested in how age misrepresentation had been tested in the simulation environments. By considering both age exaggeration and age under-representation in the same scenario, the true bias might be averaged over. In addition, it was problematic that the optimal age trims included ages 40 or 50 and above, when in developing countries these were precisely the age groups affected by age exaggeration.

Mr. Haidong Wang of the Institute for Health Metrics and Evaluation, University of Washington, made a presentation entitled *An improved model life table system: semi-parametric method*. He described a model life table system that was currently under development at the IHME. The new system was to be implemented with a program called MORTMatch, with the aim to improve upon the modified logit life table system previously employed for the Global Burden of Disease (GBD).

Mr. Wang explained that as part of the GBD estimation process, it was necessary to estimate a “mortality envelope” for each country, that is, an estimate of total deaths by year, age and sex from all causes that could be apportioned to cause-specific estimates. Available data from vital registers and surveys were assembled, assessed and adjusted for incompleteness or biases, and then synthesized. Then, several indicators were used as entry parameters into the new model system, called MORTMatch. These parameters were the under-five mortality rate ( $q_5$ ), a measure of adult mortality ( ${}_{45}q_{15}$ ), and HIV seroprevalence levels with an eight-year lag. A fourth entry parameter, the ratio of  ${}_{45}q_{15}^{\text{male}}/{}_{45}q_{15}^{\text{female}}$ , was currently under evaluation.

One objective of the MORTMatch model was to incorporate more high-quality and recent life tables from high-mortality populations than had been used in developing the modified logit life table system. Another objective was to have more straightforward input parameters than those used with the modified logit system.

The database or life tables for MORTMatch included a total of 8,134 country-years. Of these, 632 life tables were from Africa or low-income and middle-income countries of Asia. The majority of the empirical life tables (5,362 country years) came from the Human Mortality Database, with 50 additional life tables from other sources including the Indian Sample Registration System; the demographic surveillance system in Matlab, Bangladesh; historical life tables from Chile; and United States county life tables grouped by HIV prevalence. The other major source of life tables was those developed by IHME using death distribution methods (2,722 country years).

Life tables were constructed using the observed age-specific mortality rates, with two exceptions. First, for country-years that represented less than 20 million person-years, weighted 5-year moving averages were used instead of the observed mortality rates. Second, age-specific mortality rates from the death distribution analysis were adjusted for incompleteness of adult death reporting.

The process of generating a life table from MORTMatch depended upon the input data. In the first scenario, at least one life table within a radius of 10 years from the same country as the country-year of interest could be found in the MORTMatch database. In this case, 10 life tables were matched out of the database with priority given to life tables from the same country. The matching was done using Mahalanobis distance. Then a standard life table was generated from the matched life tables and the Brass relational model was applied. Validation of this method using life tables from the Human Mortality Database showed very good results up to age 70 years. Above age 70 years, relative error increased but the errors were smaller compared with the original modified logit model.

In the second scenario, no life tables from the same country within a 10-year radius could be identified. In this case, a number of life tables were matched out of the database, and the mean of the matched survival function was used as the standard. Various options for computing life tables were under consideration, including a simpler modification of the existing model life table systems, as well as more complex modelling procedures, using “bend factors” to better account for deviations from linearity. Mr. Wang said that a graphical user interface, programmed in Stata, would enable users to input parameters and perform matches.

Continuing the discussion of methodologies for the estimation of adult mortality, Ms. Rajaratnam gave a second presentation entitled *Measuring adult mortality using sibling survival: a new analytical method and new results for 44 countries, 1974-2006*. She explained that due to major gaps in the availability of vital registration data, particularly for Africa, Southeast Asia, and the Middle East, it was necessary to find alternative methods for estimating adult mortality. The use of survey data to measure adult mortality had been limited largely because adult deaths were rare events and therefore large sample sizes were required to generate reliable estimates.

Sibling histories presented an opportunity to capture more information on adult deaths from a survey, especially in settings with a recent history of high fertility. A sibling history obtained information on all the siblings of a respondent, including sex, whether the sibling was alive or dead, current age if alive, and if the sibling had died, the date of death and age at death. This was essentially a complete birth history of the mother of the respondent and allowed the direct computation of death rates. Unfortunately, the death rates computed directly from the sibling histories were frequently implausibly low. Also, because the Demographic and Health Surveys (DHS), in which sibling histories had mainly been collected, only interviewed female respondents aged 15-49, there was a limited pool of older siblings and it was difficult to get stable estimated rates further back in time.

Furthermore, the sibling histories were subject to two major source of bias. There was a selection bias, as families that had experienced high mortality were underrepresented in the sample. There was also the possibility of recall bias, if deaths were omitted from the respondent’s report.

To address these sources of bias, Ms. Rajaratnam and colleagues had developed the corrected sibling survival method (CSS). This method made use of the observed, generally consistent age patterns of mortality across contexts. Namely, patterns in the shape of log death rates between the ages of 15 and 60 were consistent regardless of the level of mortality. The CSS method used logistic regression to estimate the probability of dying for a given country, sex, age group and time period. The regression model was applied to multiple surveys pooled together. It could be applied to a single population with multiple surveys over time, or to any grouping of populations where at least some of the populations had multiple surveys over time. In the model, the probability of dying was regressed on dummy indicators for age group, dummy indicators for country-time periods, and on a continuous variable expressing time prior to the survey (TiPS).

Ms. Rajaratnam said that it was possible to make the model more flexible to account for different age patterns of mortality. Additional sets of dummy variables could be included for contexts where the age pattern would be expected to be different. HIV/AIDS was a major reason to do this, but other reasons such as conflict/war or high injury rates could also result in different age patterns of mortality.

The TiPS variable was intended to account for recall bias and took advantage of overlapping recall periods from successive surveys. It captured the difference between deaths reported in the more recent periods of older surveys and the older periods of more recent surveys. An exponentiated coefficient approximated the annual incremental reduction in observed probability of death due to omitted deaths. It could only be estimated if there was sufficient overlap of observations from different surveys for the same year.

The model also addressed the under-representation of high-mortality families. Families with higher mortality were less likely to be sampled, causing estimated death rates to be biased downward. To adjust for this selection bias, a set of weights was applied that had been derived by Gakidou and King (2006). This adjustment increased the weight of observations from high-mortality families. The weights were derived by dividing the total number of siblings by the number surviving at the survey date. That is, the weights were the inverse of the probability of surviving to the time of the survey. The Gakidou-King weights were multiplied by the survey sampling weights to arrive at the final weight for each observation.

The model had been applied to 85 DHS from 44 countries, using data from respondents aged 15-49 that referred to the period up to 15 years before the survey. The model also incorporated historical HIV seroprevalence data from UNAIDS, data on war deaths from the Uppsala Conflict Data Program, and child mortality estimates from Murray and others (2007).

The effects of including the Gakidou-King weights to correct for selection bias raised estimated  $q_{15}$  by an average of 28 per cent. The correction ranged from 6 per cent to 66 per cent. For recall bias, it was found that, on average, for each year prior to the survey there was a decrease in the estimated death rate of 2.1 per cent for males and 1.4 per cent for females. The effect varied widely, ranging from -0.8 per cent to 7.7 per cent. Ms. Rajaratnam assessed that the adjustments resulted in plausible trends in adult mortality for many African countries.

In closing, Ms. Rajaratnam noted that further research was needed on the correction for recall bias. The TiPS variable assumed that the recall pattern was consistent across settings and over time. This was a strong assumption, and there was some evidence from countries with multiple surveys that it did not always hold. In addition, it would be desirable to have data from a broader pool of respondents, namely males and older respondents.

Participants requested clarification on the methodologies employed by IHME. On measuring adult mortality using sibling survival, participants were curious about whether the World Health Surveys had been assessed, the potential impact of recall bias, the assumption of a linear TiPS factor over time, the choice of the age range for mortality estimates, and opportunities to validate the estimates. Ms. Rajaratnam responded that the World Health Surveys had failed to produce plausible estimates, likely because sample sizes were small and the questionnaire limited responses to eight siblings, which was insufficient for some countries. To address recall bias, the 15 years of data used were split into three five-year time periods. Ms. Rajaratnam planned to examine further the potential for recall bias in reporting of deaths close to the time of the survey. She was, however, comfortable with the assumption of a linear TiPS factor over time. Ms. Rajaratnam clarified that  ${}_{45}q_{15}$  estimates were calculated directly from the empirical data, using inputs above age 50, and that they were not derived from the  ${}_{35}q_{15}$  estimates. Lastly, she explained that there were not yet good data sources against which to validate mortality estimates obtained from sibling histories.

With regard to IHME's model life table system, participants inquired about the methods used to estimate mortality at older ages. Mr. Wang explained that for countries for which death distribution methods were used, old-age mortality was estimated using the Gompertz curve. He planned to use the Kannisto-Thatcher method to predict mortality at old ages.

Ms. Rajaratnam informed participants that once the results were published, the software developed to derive the mortality estimates would be made publicly available.

#### J. REVIEW OF ADULT MORTALITY ESTIMATES AT THE COUNTRY LEVEL

Mr. Pelletier opened the final day of the meeting by welcoming representatives of the WHO and IHME to join in the discussion of adult mortality estimates by sex for selected countries. He also thanked staff members of the Mortality Section and the Population Estimates and Projections Section of the Population Division for their work in preparing the materials to be discussed.

Mr. Pelletier noted that while the coordination meetings convened in previous years had focused on methodologies for mortality estimation, the present meeting aimed to focus on estimates derived for various countries for which the estimation of adult mortality levels had been particularly challenging. The objective of the discussion was to improve the overall quality of adult mortality estimates and to harmonize estimates across the different institutions.

To select countries for discussion, the Population Division analyzed differences in adult mortality estimates produced by the WHO and UNPD respectively. In comparing the sets of estimates from the two agencies, Mr. Pelletier was impressed at the degree to which estimates were already in agreement for most countries. Out of close to 200 countries, about 30 countries for which significant differences were encountered had been selected to be discussed and reviewed.

To facilitate the discussion, estimates of  ${}_{35}q_{15}$  and  ${}_{45}q_{15}$  from the WHO's *World Health Statistics 2009* and UNPD's *World Population Prospects: The 2008 Revision (WPP)* would be plotted together. Mr. Pelletier noted that the time points referenced by the two sources differed. The WHO had published point estimates for the years 1990, 2000 and 2007. Because the estimates referred to a single year, they did not reveal mortality crises that may have occurred during the years in between. In contrast, UNPD published estimates for five-year periods. While the data used for the discussion would include WPP estimates dating back to 1980-1985, only estimates from 1995 onward were published.

Mr. Pelletier then provided a brief explanation of the methods UNPD used to estimate adult mortality for WPP. For some countries, estimates of  $q_5$  were used to select a model life table. For other countries, empirical age-specific mortality rates were used to calculate adult mortality directly for one or more periods. For this second group of countries, to complete the population projection the “modified method” was used which entailed selecting a model life table and projecting into the future such that the age-pattern of mortality converged toward that model.

In addition to the adult mortality estimates produced by WHO and UNPD, the discussion would consider empirical estimates of  ${}_{35}q_{15}$  and  ${}_{45}q_{15}$  obtained from various sources. Mr. Pelletier noted that empirical data on adult mortality were not as abundant and readily available as data for the estimation of child mortality. The UNPD was continuing to gather empirical information on adult mortality for all countries. As such, the data presented were not to be considered comprehensive in scope. It had been hoped that IHME estimates of adult mortality could have been included in the discussion, but those estimates were unfortunately not yet ready to be shared. Mr. Pelletier looked forward to seeing those estimates at a later date.

Where possible, estimates of  ${}_{35}q_{15}$  had been calculated from sibling survival recorded in the DHS. The recommendation from DHS had been to estimate  ${}_{35}q_{15}$ , rather than  ${}_{45}q_{15}$ , from sibling survival data. Mr. Pelletier acknowledged that this recommendation was contentious. From each DHS with sibling histories, two estimates of  ${}_{35}q_{15}$  were calculated for each sex. The first estimate referred to the period zero to six years prior to the survey and the second referred to the period seven to 13 years prior to the survey. For comparison with the WHO and WPP estimates, points were plotted at the middle of the period.

Mr. Pelletier explained that countries identified for discussion had been categorized according to the method WHO had used in estimating adult mortality levels. The discussion would begin with those countries for which the child mortality estimate  $q_5$  was the only input. Starting with the  $q_5$  input, WHO then used the modified logit procedure to derive adult mortality levels, while UNPD usually employed Coale-Demeny or United Nations model life tables. Both agencies used their procedures to estimate non-AIDS adult mortality and then later added AIDS deaths for those countries highly affected by the HIV/AIDS epidemic. Mr. Pelletier noted that the greatest difference between mortality estimates between the WHO and UNPD for countries in this category occurred when UNPD was using the Coale-Demeny South model life table (which had the lowest level of adult mortality for a given  $q_5$ ) and the UN Far Eastern model life table (which had the highest adult mortality for a given  $q_5$ ). Estimates from the two agencies tended to be in agreement when the Coale-Demeny North and West model life tables were used. He further noted that Mr. Ian Timaeus had recommended several years earlier to use the South model life table for certain developing countries, but it appeared that this choice may have resulted in the underestimation of adult mortality for countries where the  $q_5$  had been declining to lower levels. Countries identified for discussion in the first category were Benin, Burkina Faso, Chad, Côte d’Ivoire, the Democratic People’s Republic of Korea, Kenya, Malawi, Myanmar, Saudi Arabia and Uganda.

The second category of countries identified for discussion included countries for which the WHO used both a  $q_5$  estimate and a  ${}_{45}q_{15}$  estimate in order to derive the life tables. This category included Bangladesh, China, Indonesia, Nepal, Pakistan, the Syrian Arab Republic, the United Republic of Tanzania, and Viet Nam.

The third category of countries to be discussed included those for which WHO relied on vital registration data constrained by various additional inputs or adjustments based on completeness in order to derive estimates of adult mortality. This category included Albania, Belize, Brazil, Egypt, Malaysia, the Philippines, Qatar, South Africa, Sri Lanka and Thailand.

The fourth and final category of countries identified for discussion included those that had experienced a mortality crisis between 1980 and the present due to war, civil strife, collapse of the health system or other crisis situation. This last category included Eritrea, the Democratic Republic of the Congo, Iraq, Liberia and Rwanda.

Participants engaged in a fruitful discussion of the adult mortality estimates for the selected countries. In some instances, it was determined that the agencies were relying on different sources of empirical data to inform their estimates. Participants agreed to share data when possible, given data use agreements. In other instances, agencies disagreed in their assessments of VR completeness or the quality of other empirical data sources. Acknowledging the complexity of producing life tables and mortality estimates for all countries of the world, participants stressed the importance of taking into account all relevant data, including contextual information that may help to understand and corroborate the levels and trends of mortality of a given country.

#### K. NEXT STEPS AND CONCLUDING REMARKS

Mr. Pelletier thanked participants for their active participation in the discussion. Thirty-three countries were examined and progress was made with the harmonization process. He recalled that each agency was assigned to look into what data they had and investigate whether those data could be shared with the other agencies, given data use agreements. In some cases, it could be possible to share aggregate summary statistics even if the micro data could not be shared. There was still time to incorporate empirical estimates into UNPD's next revision of *World Population Prospects*, which was to be completed in 2010. The next round of estimates from WHO and IHME were to be completed in the coming months.

Mr. Pelletier expressed his appreciation for this collaborative approach to reviewing adult mortality estimates and he noted that if a more informal collaboration was desired, participants could be in touch with each other.

10-12 November 2009

English only

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UNITED NATIONS EXPERT GROUP MEETING ON HEALTH,  
MORTALITY AND DEVELOPMENT  
United Nations Secretariat  
Department of Economic and Social Affairs  
Population Division  
New York, 10-12 November 2009

**Venue: One Dag Hammarskjöld Plaza**  
**2nd Avenue**  
**48th Street, 37th Floor (Conference Room 1DHP-3833)**  
**New York, NY 10017**

## ORGANIZATION OF WORK

### Tuesday, 10 November 2009

9:30-10:00     *Registration*

#### **PART 1: HEALTH**

**Chair: Philip Guest**

*Morning session:*     10:00-12:30

1. **OPENING OF THE MEETING:** Hania Zlotnik, Director, Population Division
2. **GLOBAL BURDEN OF DISEASE AND DISEASE CONTROL PRIORITIES**

(a) *Global burden of disease and risk factors*

**Colin Mathers, World Health Organization**

*Coffee break*

(b) *The disease control priorities project*

**Dean Jamison, IHME, University of Washington &  
Prabhat Jha, University of Toronto**

#### **Discussion and questions**

*Lunch break:*     12:30-14:00

*Afternoon session: 14:00-17:00*

**3. HEALTH SYSTEMS AND FINANCING OF GLOBAL HEALTH**

*(a) Primary health care reforms: aligning health systems to needs and expectations*

**Paolo Piva, World Health Organization**

*(b) Reforming health systems for development*

**Andre Medici, World Bank**

**Discussion and questions**

*Coffee break*

**4. REPRODUCTIVE HEALTH**

*(a) Why isn't safe motherhood a reality for all pregnant women?*

**Linda Bartlett, Johns Hopkins University**

**Discussion and questions**

**Wednesday, 11 November 2009**

*Morning session: 9:00-13:00*

**5. INFECTIOUS AND PARASITIC DISEASES**

*(a) Prevention and treatment of infectious and parasitic diseases*

**Ramanan Laxminarayan, Princeton University**

*(b) The development impact of the neglected tropical diseases*

**Peter J. Hotez, George Washington University Medical Center**

**Discussion and questions**

*Coffee break*

*Morning session: 9:00-13:00 (continued)*

**6. CHRONIC AND DEGENERATIVE DISEASES**

*(a) Nutrition, lifestyles, obesity and chronic diseases*

**Prakash Shetty, University of Southampton**

*(b) The global burden of chronic diseases*

**Thomas A. Gaziano, Harvard Medical School**

*(c) Global mortality from tobacco*

**Prabhat Jha, University of Toronto**

**Discussion and questions**

**7. SUMMARY AND CONCLUDING REMARKS:** Philip Guest, Assistant Director,  
Population Division

*Lunch break: 13:00-14:30*

**PART 2: ADULT MORTALITY**

**Chair: François Pelletier**

*Afternoon session: 14:30-17:30*

**8. OVERVIEW:** Francois Pelletier, Chief, Mortality Section, Population Division

**9. METHODOLOGICAL ASPECTS TO THE ESTIMATION OF ADULT MORTALITY**

*(a) Overview of procedures used by WHO to generate life tables at the country level*

**Mie Inoue, World Health Organization**

*Afternoon session: 14:30-17:30 (continued)*

(b) *Evaluating methods to estimate the completeness of death registration*

**Julie Knoll Rajaratnam, IHME, University of Washington**

*Coffee break*

(c) *An Improved Model Life Table System: Semi-parametric Method*

**Haidong Wang, IHME, University of Washington**

(d) *Measuring adult mortality using sibling survival: a new analytical method and new results for 44 countries, 1974-2006*

**Julie Knoll Rajaratnam, IHME, University of Washington**

**Discussion and questions**

**Thursday, 12 November 2009**

*Morning session: 9:30-12:30*

**10. A REVIEW OF ADULT MORTALITY ESTIMATES AT THE COUNTRY LEVEL  
(ALL DAY)**

Discussion will focus on adult mortality estimates by sex for selected countries.

**Representatives of WHO, IHME, the Population Division and others**

*Lunch break: 12:30-14:00*

*Afternoon session: 14:00-17:00*

**11. NEXT STEPS AND CONCLUDING REMARKS:** François Pelletier, Chief, Mortality Section, Population Division.

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UNITED NATIONS EXPERT GROUP MEETING ON HEALTH,  
MORTALITY AND DEVELOPMENT

United Nations Secretariat  
Department of Economic and Social Affairs  
Population Division  
New York, 10-12 November 2009

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