

REGIONAL REPORT

Health status and epidemiological capacity and prospects: WHO Western Pacific Region

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Background This article on the state of epidemiology in the WHO Western Pacific Region (WPR) is the first in a series of eight articles commissioned by the International Epidemiological Association (IEA) to identify global opportunities to promote the development of epidemiology.

Methods Global mortality and disease data were used to summarize the burden of mortality, disease, risk factor and patterns of inequalities in the region. Medline bibliometrics were used to estimate epidemiological publication output by country. Key informant surveys, Internet and literature searches and author knowledge and networks were used to elicit perspectives on epidemiological training, research, funding and workforce.

Findings The WPR has the lowest age-standardized disability-adjusted life-years (DALY) rate per 1000 of the six WHO regions, with non-communicable disease making the largest percentage contributions in both low- and middle-income countries (LMICs, 68%) and high-income countries (HICs, 84%) in the WPR. The number of Medline-indexed epidemiological research publications per year was greatest for Japan, Australia and China. However, the rate per head of population was greatest for Micronesia and New Zealand. The substantive focus of research roughly equated with burden of disease patterns. Research capacity (staff, funding, infrastructure) varies hugely between countries.

Epidemiology training embedded within academic Masters of Public Health programmes is the dominant vehicle for training in most countries. Field epidemiology and in-service training are also common. The Pacific Island countries and territories, because of sparse populations over large distances and chronic workforce and funding capacity problems, rely on outside agencies (e.g. WHO, universities) for provision of training. Cross-national networks and collaborations are increasing.

Conclusion Communicable disease surveillance and research need consolidation (especially in eastern Asian WPR countries), and non-communicable disease epidemiological capacity requires strengthening to match disease trends. Capacity and sustainability of both training and research within LMICs in WPR are ongoing priorities. China in particular is advancing quickly. One role for the IEA in building capacity is facilitating collaborative networks within WPR.

Keywords Western Pacific region, capacity, funding, workforce, epidemiology

Introduction

In this article, the first in a series commissioned by the International Epidemiological Association (IEA) for all World Health Organization (WHO) regions, we overview the state of health and of epidemiology in the WHO Western Pacific Region (WPR). The purpose of these articles is to take stock of the state of epidemiology for: strategic planning purposes of the IEA, possible use by government and non-government organizations (NGOs) involved in epidemiological training and research, and the general interest of readers of this journal.

There are 37 countries in the WPR, of which 7 are classified by the United Nations on the basis of socio-economic and human development as least developed countries [Cambodia, Kiribati, Lao People's Democratic Republic (Lao PDR), Samoa, Solomon Islands, Tuvalu and Vanuatu], two are landlocked developing countries (Lao PDR and Mongolia) and 17 are Small Island Developing States of the Pacific.¹ China makes up 74.7% of the total population of the WPR, and therefore greatly influences overall regional statistics.² Australia, Brunei Darussalam, Japan, New Zealand, the Republic of Korea and Singapore are the high-income countries (HICs) of the WPR.³ A total of 26.5% of the world's population live in the WPR.²

This article summarizes the descriptive epidemiology of mortality, disease burden, risk factor contribution and inequalities using the most recent global data. We then quantitatively examine the Medline-indexed journal articles by country (groupings) and the topic of focus (communicable diseases, maternal and perinatal conditions and nutritional deficiencies, non-communicable diseases and injury groupings) to compare with the burden of disease data. Next, we provide overviews of epidemiological training, research, funding and workforce in the WPR. In the absence of readily available and comparable data on the latter, these overviews are necessarily narrative and informed by a survey of key organizations and stakeholders followed up by invited comments on a draft of this article. We conclude with suggestions on addressing the challenges facing epidemiology in the WPR.

Descriptive epidemiology

We sourced life expectancy estimates for the WPR for 2008 from the *World Health Statistics 2010*.² We calculated pooled WPR under-five mortality rates using Rajaratnam *et al.*'s⁴ estimates for 2010. The latest WHO Global Burden of Disease outputs (2004 estimates and 2030 projections) were used to describe morbidity and risk factors in the WPR.⁵ Health inequalities within countries were assessed using publications identified by a Medline search using the MeSH term 'health status disparities' and countries in the WPR either included as a MeSH heading or appearing in the title or abstract of the article, plus literature known to the authors or suggested during consultation.

Mortality and morbidity

The median estimated life expectancy at birth across countries in the WPR is 70 years, slightly below the global country median of 71 years (Figure 1). The Marshall Islands have the lowest life expectancy (59 years), followed by Nauru (60 years) and Cambodia, Lao PDR and Papua New Guinea (all 62 years). China (including its special administrative regions Hong Kong and Macao) has a life expectancy of 74 years. Japan is the country with the highest estimated life expectancy at birth (83 years) in the region (and globally), followed by Australia (82 years), New Zealand and Singapore (both 81 years). Regarding trends, Rajaratnam *et al.*⁴ found that over the 1970–90 period, adult mortality has increased yearly in Papua New Guinea and Fiji, and decreased by at least 2% in Australia, Malaysia (female mortality only), New Zealand (male mortality only) and the Republic of Korea.⁶

The median estimated under-five mortality across countries in the WPR during 2010 is similar to the global median (19 vs 21/1000, pooled estimates using data in⁴ Figure 1). The highest under-five mortality rate is in Papua New Guinea (83), followed by Lao PDR (68), Cambodia (60) and Kiribati (46). China's rate is 15/1000. The lowest under-five mortality rates are observed in Singapore and Japan (both 3/1000, the lowest reported worldwide) and Australia (4/1000). By 2009, the WPR 'Countdown to 2015'

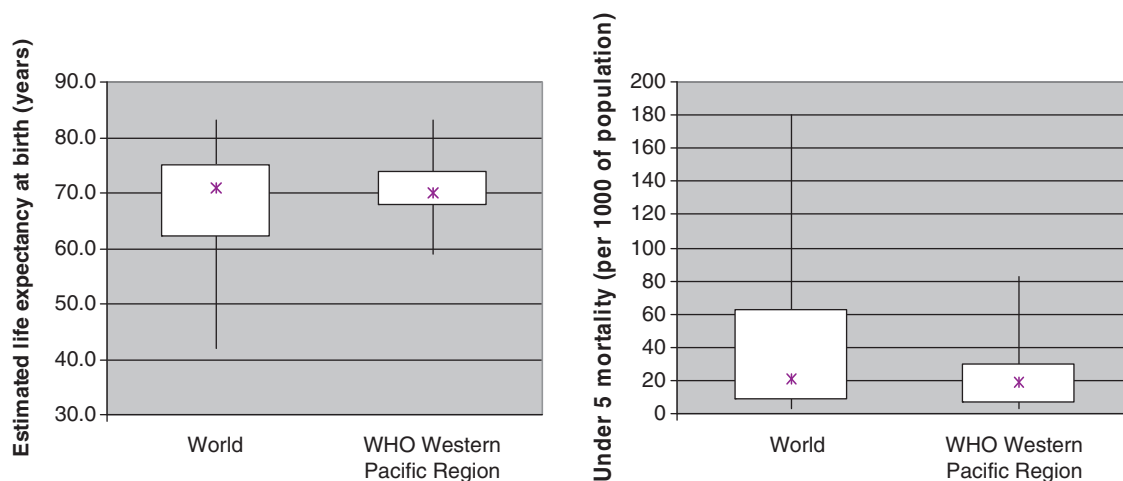


Figure 1 Median, inter-quartile and range of country life expectancy at birth (2008 data) and under-five mortality per 1000 of population (2010 estimates) for WPR and world. Data source for life expectancy at birth (2008 data): *World Health Statistics 2010*.² Note: Data were unavailable for the following countries of the WPR: American Samoa, Commonwealth of the Northern Mariana Islands, French Polynesia, Guam, New Caledonia, Pitcairn Islands, Tokelau and Wallis and Futuna. Data source for under-five mortality per 1000 of population (2010 estimates): Rajaratnam *et al.*⁴ Note: Data were unavailable for the following countries of the WPR: American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, French Polynesia, Guam, Nauru, New Caledonia, Niue, Palau, Pitcairn Islands, Tokelau, Tuvalu and Wallis and Futuna

priority countries China, Lao PDR and the Philippines were on track to achieving the Millennium Development Goal 4, but Cambodia, Papua New Guinea and Pacific Island countries and territories (PICTs) had made insufficient progress.^{4,7,8} New Zealand and the Republic of Korea are among the four HICs globally that have not reached rates of under-five mortality of <5/1000.⁴

The burden of disease as measured by age-standardized disability-adjusted life-years (DALYs) per head of population is lower in the WPR than in the total world (160 compared with 240/100 000; Figure 2). Within strata of the world's countries by income, the WPR countries have a favourable DALY profile compared with all other WHO regions (Figure 2). In particular, the WPR has a comparatively low burden due to communicable diseases, maternal and perinatal conditions and nutritional deficiencies. DALY rates for non-communicable conditions and injury are also less than in the total world, but the former still comprise 69% of the WPR's total burden of disease.

The total DALY counts (not rates) for the WPR are projected to fall by 1.4% from 2008 to 2030. This small decrease, despite population ageing and growth, is due to large projected falls in DALYs from communicable diseases, maternal and perinatal conditions and nutritional deficiencies (54%) and injuries (24%), offsetting a 14% projected increase in non-communicable disease burden. By 2030, it is projected that 83% of the disease burden in the WPR will be due to non-communicable disease, compared with 66% for the world as a whole.

Risk factors

One can assess the relative importance of risk factors by comparative risk assessment methods that quantify the percentage contribution of each risk factor to DALYs.³ This quantification requires estimates of the relative risk association of each risk factor with causally associated diseases and conditions, estimates of risk factor distribution and positing of a counterfactual or 'best achievable' risk factor distribution that each country or region could attain. (The counterfactuals are stated in the footnotes to Figure 3.) The 10 such leading risk factors as determined in low- and middle-income countries (LMICs) in the WPR, from highest to lowest, are: alcohol use (7.0% of all DALYs lost), tobacco use (4.5%), high blood pressure (4.4%), occupational risk (3.1%), high blood glucose (2.7%), indoor smoke from solid fuels (2.0%), overweight and obesity (1.9%), unsafe water, sanitation and hygiene (1.9%) and low fruit and vegetable intake (1.5%). This ranking varies notably from LMICs across the world, where risk factors such as underweight, unsafe sex and unsafe water, sanitation and hygiene make a much larger contribution to the DALY burden (Figure 3). Put another way, LMICs in the WPR have transitioned to environmentally conditioned behavioural risk factors being the major drivers of the DALY burden. Alcohol use is particularly important in LMICs in WPR.

The 10 leading risk factors in HICs in the WPR are: tobacco use (8.4% of all DALYs lost), alcohol use (6.9%), high blood pressure (5.7%), high blood glucose (4.8%), overweight and obesity (3.8%), physical inactivity (3.6%), high cholesterol (2.6%),

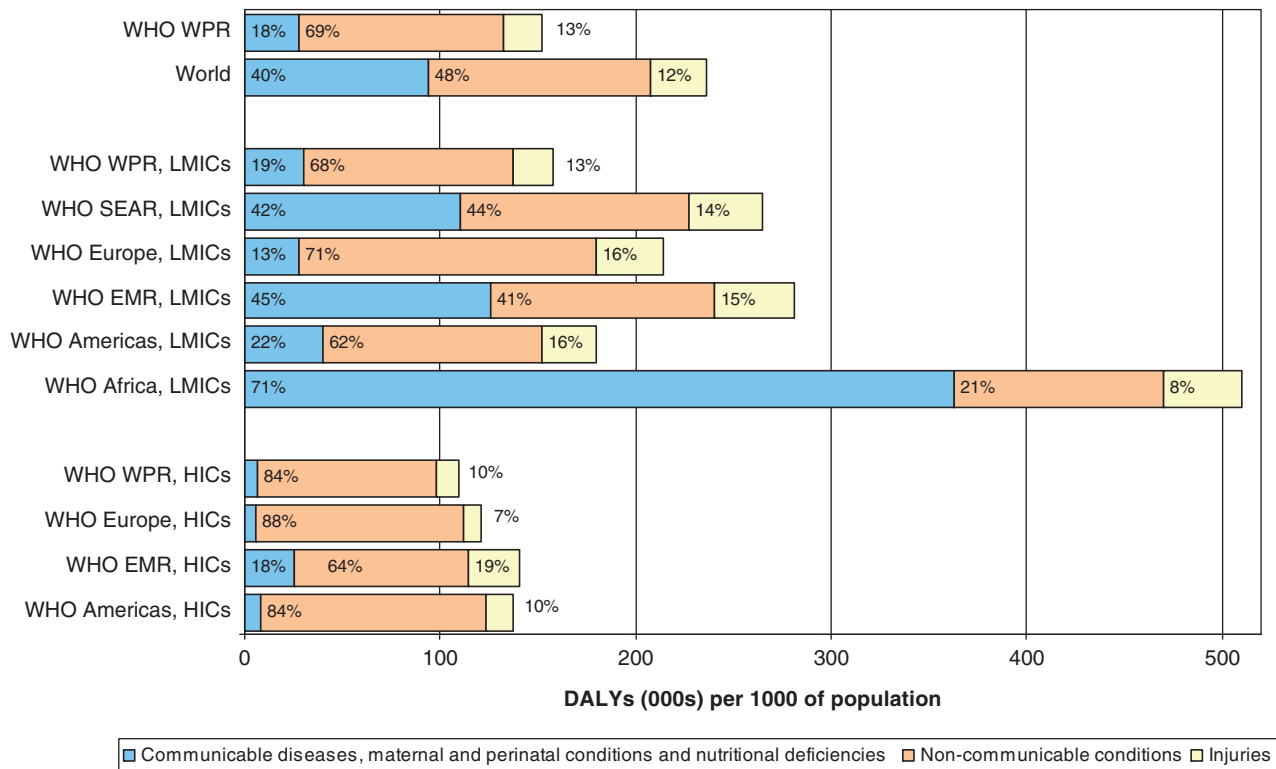


Figure 2 Age-standardized rates of DALYs per 1000 of population for WHO WPR and other WHO regions by income, 2004 estimates (labels are percentage of burden in region by income). Data source: *Global Burden of Disease: 2004 update*.⁵ Note: DALYs are age standardized, 3% discounted and age weighted. WHO Member States are classified as LMICs if their 2004 gross national income per capita was <US\$ 10 066 as estimated by the World Bank.⁵¹ LMICs in the WPR include: Cambodia, China (including Hong Kong and Macao), Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Lao PDR, Malaysia, Marshall Islands, Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu and Viet Nam. SEAR = WHO South-East Asian Region; EMR = Eastern Mediterranean Region; HICs = high-income countries. HICs in the WPR include: Australia, Brunei Darussalam, Japan, New Zealand, Republic of Korea and Singapore. The WPR countries that were not included in this analysis are: American Samoa, Commonwealth of the Northern Mariana Islands, French Polynesia, Guam, New Caledonia, Pitcairn Islands, Tokelau and Wallis and Futuna; all of these countries are small LMICs

occupational risks (2.1%), low fruit and vegetable intake (1.3%) and urban outdoor air pollution (1.0%). This ranking, and the percentage contribution, is similar to that for HICs of the world. However, tobacco use contributes relatively less to the risk factor-associated burden of disease in HICs of the WPR than in those of the world (8.4% vs 10.7%), as do obesity and overweight (3.8% vs 6.5%), illicit drug use (0.7% vs 2.1%) and unsafe health-care injections (0.6% vs 1.8%).

Inequalities

Income inequality within countries appears less among the WPR (median Gini index 37.9 for 14 WPR countries with data⁹) than the world (39.6 for 142 countries with data). Comparable data across countries for health inequalities within countries are not readily available. The WHO Global Health Observatory provides under-five mortality, measles immunization coverage and births attended by skilled

health personnel by geographical residence, education level of mother and wealth, but these are only available for 5 of the 37 countries of the WPR (i.e. Cambodia, Lao PDR, Mongolia, Philippines and Viet Nam). Regarding under-five mortality, inequality by household wealth is similar in Viet Nam (ratio lowest to highest wealth quintile: 3.3), the Philippines (3.1) and Cambodia (3.0).

Motivated by the Millennium Development Goals, the 'Countdown to 2015' collaboration has systematically collated trend data on inequality in maternal, newborn and child mortality within countdown priority countries, by asset wealth using Demographic Health Surveys and Multiple Indicator Cluster Surveys.^{7,8} They determined the 'coverage gap' (i.e. 100% minus actual coverage, hence the gap compared with full coverage) of eight health interventions in four domains (family planning, maternal and newborn immunization, treatment of sick children) and for each quintile of wealth within countries. In Cambodia, this coverage gap was 37.3% overall, but

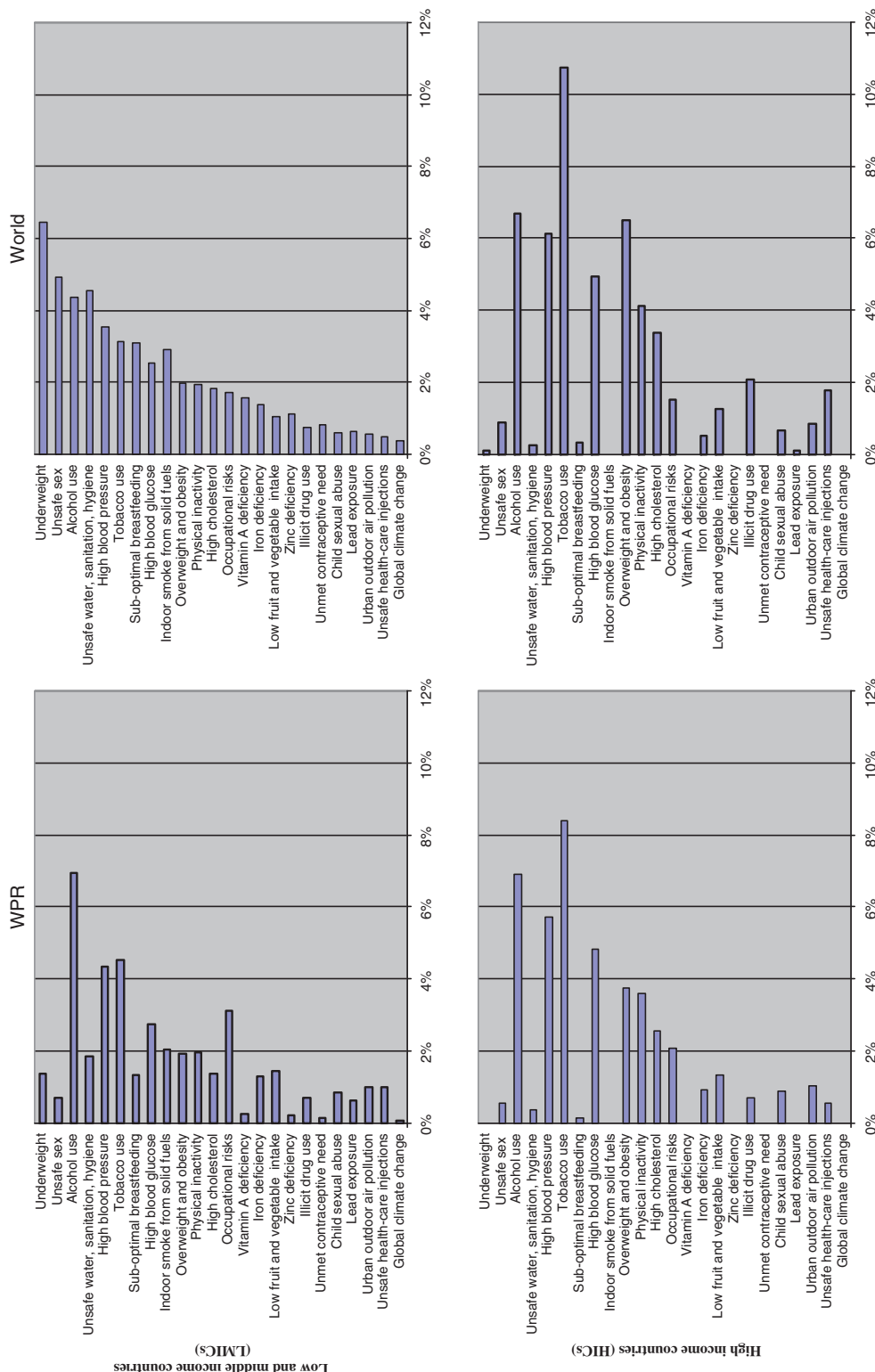


Figure 3 Percentage of DALYs attributed to the 24 leading risk factors (ranked by total world ranking, data not shown) within the WHO Western Pacific region and world each further stratified by income, 2004 estimates. Data source: *Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks*.³ Note: DALYs are age standardized, 3% discounted and age weighted. Occupational risk factors for injuries (indicator one); occupational carcinogens (indicator two); occupational airborne particulates (indicator three); occupational ergonomic stressors (indicator four); and occupational noise (indicator five). Risk factor counterfactual distributions are: underweight—same proportion of children below -1 standard deviation (SD) weight for age as the international reference group, all women of childbearing age with body mass index ≥ 20 kg/m²; unsafe sex—no alcohol use; no alcohol use; unsafe water, sanitation, hygiene—absence of diarrhoeal disease through water and sanitation; high blood pressure—mean of 115 mmHg and SD of 6 mmHg; tobacco use—no tobacco use; suboptimal breastfeeding—100% exclusive breastfeeding from 0 to 5 months and any breastfeeding from 6 to 23 months; high blood glucose—mean of 4.9 mmol/l and SD of 0.3 mmol/l; indoor smoke from solid fuels—no solid fuel or coal use; overweight and obesity—mean BMI of 21 kg/m² and SD of 1 kg/m²; physical inactivity—high activity level: minimum 3 days per week of vigorous intensity activity (minimum 1500 MET-min/week) or 7 days per week of any intensity activity (minimum 3000 MET-min/week); high cholesterol—mean of 3.8 mmol/l and SD of 0.6 mmol/l; occupational risks, occupational risk factors for injuries (indicator one) exposure corresponding to lowest rate of work-related fatalities observed: 1 per million per year for 16- to 17-year olds employed as service workers in the USA; occupational risks, occupational carcinogens (indicator two)—no work-related exposure above background to chemical or physical agents that cause cancer; occupational air-borne particulates (indicator three)—no work-related exposure above background; occupational risks, occupational ergonomic stressors (indicator four)—physical workload at the level of managers and professionals (low); occupational risks, occupational noise (indicator five)— <85 dBA on average over 8 working hours; vitamin A deficiency—no vitamin A deficiency; iron deficiency—haemoglobin distributions that halve anaemia prevalence in malarial regions and reduce it by 60% in non-malarial regions, estimated to occur if all iron deficiency were eliminated. [Note: The theoretical minimum haemoglobin levels vary across regions and age-sex groups (from 11.66 g/dl in children under 5 years in South-East Asian Region (SEAR)-D to >14.5 g/dl in adult males in developed countries) because the other risks for anaemia (e.g. malaria) vary]; low fruit and vegetables intake—600 g (SD 50 g) intake per day for adults; zinc deficiency—no zinc deficiency; illicit drug use—no illicit drug use; unmet contraceptive needs—use of modern contraceptives for all women who want to space or limit future pregnancies; child sexual abuse—no abuse; lead exposure—blood lead below 1 μ g/dl (note: theoretical minimum for lead is the blood lead level expected at background exposure levels. Health effects were quantified for blood lead levels >5 μ g/dl where epidemiological studies have quantified hazards); urban outdoor air pollution—mean concentration of 7.5 μ g/m³ for PM2.5 and 15 μ g/m³ for PM10; unsafe health-care injections—no contaminated injections; global climate change—average of 1961–90 climate conditions

was 21.5 percentage points worse in the poorest compared with richest quintile. The Philippines had smaller coverage gaps for the population overall (26.8%), but a similar equity difference between the wealthiest and poorest quintiles (22.3 percentage points). Unfortunately, equity data are only available for these two countries in the WPR.

As part of the work for the *2002 World Health Report*, inequalities in risk factors—not the burden of disease per se—were estimated by a measure of asset wealth across countries.¹⁰ Those living on <\$1/day in the WPR (excluding Australia and New Zealand) were estimated to have 1.7 times greater exposure to unimproved water and/or sanitation than those living on >\$2/day and 1.4 times the exposure to indoor air pollution (which was high for all due to China).¹⁰ There was relatively little difference in alcohol and tobacco consumption and female weight by absolute poverty.¹¹

Mortality differentials by socio-economic position and ethnicity have been quantified in some WPR countries. Socio-economic inequalities in mortality in New Zealand have been found to be increasing in relative terms over time¹² and are comparable to those in other HICs.¹³ In the Republic of Korea, socio-economic inequalities in mortality have remained persistent over time, but socio-economic inequalities in morbidity and risk factors have increased in relative terms.^{14,15} In China, socio-economic and rural/urban inequalities in mortality have probably increased during the period of socio-economic transition,^{16,17} but the extent of these inequalities is unknown. Socio-economic inequalities in mortality (and morbidity) in Japan are smaller than those observed in Western HICs, but appear to be increasing.¹⁸ In Australia, mortality burden attributable to socio-economic inequalities is large, with varying trends over time by socio-economic variable and cause of mortality.¹⁹

Using linked census mortality data, the Australian Bureau of Statistics estimated that over the period 2005–07, life expectancy at birth in Australia was 9.7 years (males) and 11.5 years (females) lower for Aboriginals and Torres Strait Islanders than non-Indigenous Australians.²⁰ These Australian Indigenous/non-Indigenous inequalities varied by territories and states with particularly large inequalities observed in the Northern Territories and Western Australia. Life expectancy gaps between Māori and non-Indigenous people in New Zealand increased from 7 to nearly 10 years in the 1980s and 1990s, associated with structural reforms (e.g. privatization of state industries) and high unemployment (e.g. 25% among Māori in 1992), but have fallen moderately since.²¹ In Yunnan Province of China, the life expectancy at birth of Indigenous people was 4 years less than that of Han Chinese in 2000, down from 5 years in 1990.²²

In summary, data on health inequalities within WPR LMICs are limited, but socio-economic inequalities in health in WPR HICs are well documented—and are comparable to those observed in HICs beyond the WPR. Indigenous/non-Indigenous health inequalities are pronounced in the WPR.

Peer reviewed epidemiological publications

The number of Medline-indexed journal papers with 'epidemiology' as a MeSH heading or 'epidemiol*' in the title or abstract, with countries in the WPR either included as a MeSH heading or appearing in the title or abstract of the paper, has increased from 7 per year in 1950–69 to 375 per year in 2006–09 in all LMICs in the WPR, with papers from China contributing much to the increase in recent years. (The exact search strategy for the bibliographical analyses is available from authors on request.) In all HICs in the WPR, it has increased from 22 per year in 1950–69 to 443 per year in 2006–09.

Figure 4 shows the number and rate per head of population of epidemiological publications (criteria as above) for 1990–09, by country (groupings). In absolute terms, the country of the WPR which appears in the largest number of papers (either as a keyword or in the title or abstract) over the 1990–2009 period is Japan, followed by China and Macao (China), Australia and New Zealand. However, expressed as per head of population, the highest epidemiological research activity is for Micronesia and New Zealand, followed by Australia and Singapore. The Philippines, China and Macao (China), Republic of Korea and Viet Nam have the lowest rates of epidemiological research activity.

Just under half (47.6%) of all epidemiological papers published on LMICs of the WPR between 1990 and 2009 are first-authored by someone with an affiliation with an institution from a LMIC in the WPR, with 75.0% of the China papers authored by someone affiliated with a Chinese institution. This percentage is 57.5% for HICs in the WPR.

Of the above publications, 36.8% were indexed as referring to conditions that according to the *Global Burden of Disease: 2004 Update* publication define one of: communicable diseases; maternal and perinatal conditions and nutritional deficiencies; non-communicable diseases; and injury.⁵ The percentage of these publication outputs that address communicable diseases, maternal and perinatal conditions and nutritional deficiencies in LMICs (41.1%) and HICs (28.5%) is higher than the percentile contribution of these conditions to the burden of disease (19.4% and 6.2%, respectively). Offsetting this, research outputs on injury (5.6% in LMICs and 6.2% in HICs) are proportionately less than the contribution of injury to the burden of disease (10.1% and 13.1%, respectively) and research on

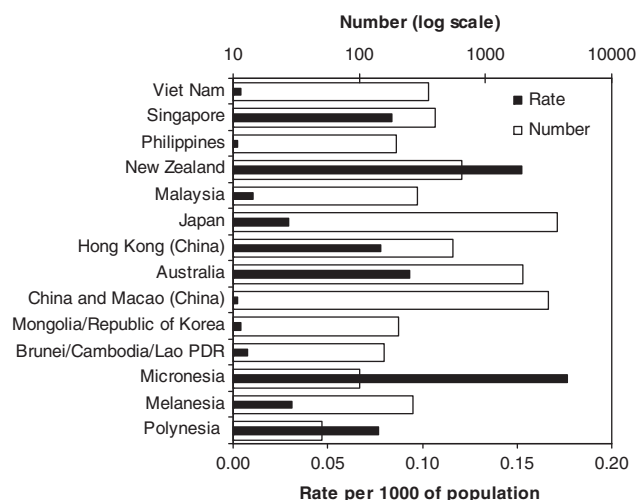


Figure 4 Epidemiological papers by country (groupings) for 1990–09: number; rate per 1000 of population. Note: An epidemiological paper (of the WPR) is defined as a medline-indexed paper with ‘epidemiology’ as a MeSH heading or ‘epidemiol*’ appearing either in the title or abstract of the publication, as well as a country of the WPR appearing either as a MeSH heading or in the title or abstract. Grouping of countries into regions in line with *United Nations Demographic Yearbook 2006*.⁵² Polynesia = American Samoa, Cook Islands, French Polynesia, Niue, Pitcairn Islands, Samoa, Tokelau, Tonga, Tuvalu and Wallis and Futuna. Melanesia = Fiji, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu. Micronesia = Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Kiribati, Marshall Islands, Nauru and Palau. Individual numbers of epidemiological papers, and rates per 1000 of population, are for Brunei Darussalam: 3 and 0.008, Cambodia: 116 and 0.008, Lao PDR: 39 and 0.006, Mongolia: 0.032 and Republic of Korea: 118 and 0.002. Population estimates are for 2008⁵³

non-communicable diseases (53.3% and 65.3%) is lower than its share of the burden of disease (67.5% and 83.7% in LMICs and HICs, respectively).

Current status of training and research

We were unable to locate any previously published stocktakes of epidemiological training, research, funding and human resources in the WPR with the exception of a 1998 stocktake of epidemiological training in Australian and New Zealand universities.²³ The summaries below are based on knowledge of the co-authors, Internet searches of training, research, funding and workforce development institutions and a survey of selected key individuals and organizations in the WPR. Regarding the latter, 17 of the 44 invited people or organizations responded with text comments as per the questionnaire included in Supplementary Appendix 1.

Training

Academia, WHO, networks and collaborations

Universities are the main providers of epidemiological training in most LMICs and all HICs. University training is particularly well established in Australia, Japan and New Zealand and rapidly developing in China. ‘University-outreach’ is also a common model (by geographical necessity) in the Pacific. For example, the Fiji School of Medicine provides training to many PICTs. Government departments provide epidemiological training in some countries, often as a means to develop their public epidemiological workforce. For example, the Australian state of New South Wales offers service-based postgraduate epidemiological training through its Public Health Officer Training Program.²⁴ Also, the Chinese Ministry of Health sponsors 2-week training courses for senior physicians through the National Continuing Education Program of Clinical Epidemiology.²⁵

WHO is an important facilitator of training in LMICs, particularly in PICTs through activities such as the Pacific Open Learning Health Network online training, which allows workforce in remote areas to learn epidemiology principles without leaving their areas and jobs, and provides in-country field-epidemiology training.²⁶ Another example of WHO training is ‘training of trainers’ from Cambodia, the Lao PDR and Viet Nam in 2007,²⁷ which also identified the northern region of Lao PDR as particularly in need of training on the use of health data for decision making. Other international organizations and networks also play a role. For example, under the Pacific Public Health Surveillance Network umbrella, the Secretariat of the Pacific Community has held the Data for Decision Making (field epidemiology) training in the Federated States of Micronesia, Fiji, Guam, Commonwealth of the Northern Mariana Islands and the Solomon Islands²⁸ and facilitated lab-based influenza surveillance capacity building in 14 of its Member States in partnership with WHO, the US Centers for Disease Control and Prevention (CDC) and the Pacific Island Health Officers Association.

Training within a Masters of Public Health compared with specialized training

The Masters of Public Health (MPH) is the most common modality of postgraduate academic epidemiological training and is offered in all WPR countries outside PICTs. In China, six MPH programmes have been established, but are still in an ‘experimental’ stage. Australia has 19 MPH programmes spurred on by two decades of government funding that finished in 2010 (Public Health Education and Research Program).

Most identifiable specialist epidemiological training is through dedicated Masters of Epidemiology degrees, which are taught in Australia,²⁹ China, Japan and the Philippines, and advanced postgraduate

degrees such as the Doctors of Philosophy or Public Health. Some universities in LMICs and HICs offer 'sandwich' programmes, where students from LMICs train in HICs but remain affiliated with their home universities in LMICs, conduct research of interest to their home country and generally return to their home countries after completion of the training.³⁰ One example is the training offered collaboratively by Hanoi Medical University and the University of Umeå in Sweden since the 1990s with funding from the Swedish International Development Cooperation Agency.³⁰ Other specialist epidemiological training is through clinical or field epidemiology training programmes; for example, the Shanghai Regional Clinical Epidemiology Resource and Training for senior clinical epidemiologists conducted by the China Clinical Epidemiology Network (ChinaCLEN), a regional arm of the International Clinical Epidemiology Network (INCLIN).²⁵

WHO Member States in the Western Pacific and South-East Asian regions have agreed to capacity building in emerging disease control.³¹ Two-year Field Epidemiology Training Programs (FETPs), which are connected through the Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET), but operated independently by national health authorities to cater for the specific country's needs, are offered in both LMICs [i.e. China, Hong Kong (China), Malaysia, Philippines and Viet Nam] and HICs (i.e. Japan and Republic of Korea).^{32,33} For example, Malaysia's FETP complements national academic training, which often lacks focus on application,³⁴ and Japan's FETP focuses mainly on infectious disease control and on training health officials to bridge the gap between local and central health authorities.³⁵ Modified FETPs of 6 months to 1 year in duration have recently started operation in Cambodia, several Chinese provinces, Lao PDR and Mongolia, and the establishment of such a programme in Singapore is underway. Whereas FETPs in China, Hong Kong (China), Japan, Malaysia, Republic of Korea and the Philippines are well established, the newer Vietnamese and all Modified FETPs require further external assistance.

LMICs and HICs have successfully collaborated in the development and provision of in-country and in-service epidemiological research training in LMICs. For example, Vietnamese and Japanese epidemiologists have run such a research training programme at Vietnamese universities and teaching hospitals since 2001.^{36,37} This appears to be an effective and sustainable approach and model for building epidemiological research capability in some LMICs of the WPR.^{36,37}

The WPR is not particularly strong in epidemiological methods research and training. Many PhD students and practising epidemiologists in HICs travel to dedicated epidemiological method short courses in Europe and North America.

Capacity

Countries differ in their training needs and in the level to which their training needs are currently met. HICs have a sufficient number of training institutions and sufficient academic training, but continuing and advanced education for senior epidemiologists may be considered lacking. In LMICs, the number of training institutions is often insufficient, training sometimes of low quality and advanced training not available in-country. The PICTs subregion is a particularly challenging environment for training due to limited funding, relatively low population numbers and geographical distances. Students often go to Australia or New Zealand for (intermediate to advanced) training—and may not return. Basic in-country and online courses in epidemiology may be the only sustainable models, so long as computing resources and Internet connectivity is sustained and maintained. On the trainee side, a number of survey respondents commented on the lack of mathematical skills among potential trainees, pointing to the need for improved primary school, secondary school and undergraduate education across society before self-sustaining capacity can be achieved in epidemiology (and presumably many other professions).

Fit of training with current and future disease patterns

The predominance of non-communicable disease in both LMICs and HICs in the WPR and its projected proportionate increase in future decades point strongly to the need for associated epidemiological capacity. Events such as avian influenza and SARS have injected substantial communicable disease surveillance training in China and PICTs. There is the need to maintain this capacity, but also further develop the capacity in injury and non-communicable disease epidemiology, especially in China and other LMICs that have traditionally focused on communicable disease control.

Research institutions

The WPR as a whole is less active in epidemiological research than the European and (North) American regions (likely due to lesser funding and fewer population-based cohort studies), but comparable to the other WHO regions. Research activity in Australia, New Zealand and Japan is comparable to that in the HICs of the European region. The WPR makes a significant research contribution to emerging disease and viral epidemiology (China, Japan and WPR South-East Asian countries) and social epidemiology (Australia, New Zealand and Republic of Korea). More international, especially North–South and LMIC–HIC, collaborations are required.

In Australia and New Zealand, most epidemiological research is conducted by universities or institutes affiliated with universities and most universities

have research clusters that involve a substantial epidemiology component. Some research, especially field epidemiology, occurs in public health service arms of government-funded health services and (non-university) research institutes. Weaknesses include a lack of career structure and limited funding base (at least in comparison with other HICs in other WHO regions) to compete with the more expensive forms of epidemiological research (e.g. gene-wide association studies) that are funded in Europe and Northern America.

Epidemiological research in China is primarily conducted by academic institutions and by government agencies (principally the Chinese Academy of Medical Sciences and research institutes of China's national and provincial Centers for Disease Control and Prevention), the Public Health Agency of China and international organizations (e.g. World Bank). China's epidemiological research strengths include applied epidemiology, especially infectious disease epidemiology, and its large population size and wide disease spectrum (that has also attracted a number of senior international epidemiologists).

In Japan, all three schools of public health, approximately one-third of the 80 medical schools, and a small number of health-care schools conduct epidemiological research. Cancer and cardiovascular epidemiology are prevalent fields. The government does not have dedicated epidemiological research institutes, but establishes special research committees when a health problem such as Creutzfeldt–Jakob disease occurs.³⁸

In the PICTs, epidemiological research capacity is building and epidemiological research remains primarily externally driven and conducted by international organizations and overseas universities. Institutions conducting epidemiological research in the PICTs include WHO (Office of the South Pacific) and other international organizations (e.g. UNICEF), the Secretariat of the Pacific Community, Ministries of Health, universities in the PICTs (i.e. Fiji School of Medicine and University of Papua New Guinea) and further afield (especially Australia and New Zealand), US CDC and a range of NGOs. The small, but growing, pool of local researchers are well versed with local situations, resulting in the increased documentation of local knowledge, cultural ways and methods to promote health (e.g. traditional medicines) and the development of Pacific-specific methods of research that are acceptable within Pacific communities. Collaborative research projects between PICTs-based epidemiologists and those from other countries outside the subregion are needed to build local research capacity and capability.

Epidemiological research in Cambodia, Lao PDR, Malaysia and Viet Nam is often generated and led from a limited number of these countries or from outside the region. Stronger in-country leadership for the generation of epidemiological innovation and

primary knowledge is needed. North–South research collaborations are a good model, e.g. the well-established Viet Nam/Sweden collaboration on a longitudinal field site collecting epidemiological data.³⁹ An example of South–South collaboration is the China/Lao PDR/Vietnamese collaboration of the Mekong Basin Disease Surveillance Network.⁴⁰

Funding for epidemiological research

The principal funding organizations in Australia and New Zealand are government agencies, but there are other avenues for the funding, including NGOs, charities, directly from the Ministry of Health and (most importantly) directly from universities by way of staff activity. Epidemiological research in the PICTs is poorly funded with no dedicated funding bodies or programmes for epidemiology in place in PICTs. However, citizens of the New Zealand protectorates Cook Islands, Niue and Tokelau are eligible for New Zealand Health Research Council funding. Funding for some epidemiological research in PICTs comes from national governments (generally the national health authority), but larger research projects are donor funded. In China, funding has gradually increased and is principally awarded either through governmental research funding programmes or governmental projects. In Japan, epidemiological research is mostly funded through either specific studies (e.g. a specific cohort study) or through funds for researching specific diseases (e.g. prion diseases). In Cambodia, Lao PDR, Mongolia, Malaysia and Viet Nam, epidemiological funding is mainly through national grants and international and philanthropic organizations. TEPHINET has also received philanthropic funding (Rockefeller Foundation), but generally philanthropic funding is not as prominent in the WPR as in other regions. Development banks also commonly fund activities benefiting LMICs; for example, the World Bank recently contracted Massey University, New Zealand, to deliver veterinary and public health epidemiology training to 250 postgraduate students from LMICs in Asia, including China.

Regional and global institutions, networks and organizations active in WPR

Regional epidemiological infectious disease surveillance functions are run by WHO across the entire WPR, by the Pacific Public Health Surveillance Network (i.e. WHO, the Secretariat of the Pacific Community and partners) across PICTs⁴¹ and by the Mekong Basin Disease Surveillance Network across China, Lao PDR and Viet Nam.⁴⁰ WHO's STEPwise approach to non-communicable disease risk factor surveillance (STEPS) has built some capacity in non-communicable disease surveillance at country level,⁴² but regional surveillance functions for non-communicable diseases are lacking.

Within WPR, the Australasian Epidemiological Association provides networking of epidemiologists

in Australia and New Zealand through a regular journal, annual conferences, an email newsletter and occasional workshops. National associations include the Chinese, Hong Kong and Japan Epidemiological Associations, which also provide networking opportunities for epidemiologists, regular journals and workshops.

The International Clinical Epidemiology Network, which builds epidemiological capacity through training, research and networking, runs ChinaCLEN (seven universities) and its South-East Asian regional arm (SEACLEN; one Malaysian, four Philippine and one Vietnamese universities).⁴³ One Australian and one Japanese university have also joined this network.⁴³

Workforce

Epidemiological workforce in the WPR is not currently monitored by international organizations or national governments and no strategic plan for developing the epidemiological workforce in the WPR and individual countries exists. However, systematic efforts to develop epidemiological workforce have commenced in Australia, including an analysis of national epidemiological training and workforce development needs^{23,44} and in the PICTs through the Pacific Public Health Surveillance Network.^{28,45}

Judging from the rate of IEA members per 100 000 of population, the epidemiological workforce capacity and capability in WPR (0.13) is less than those in the Americas (0.32) and Europe (0.31), comparable to the Eastern Mediterranean region (0.17) and higher than the African (0.06) and South-East Asian (0.04) WHO regions. PICTs are still building up their workforce and many countries of Melanesia and Micronesia face an intense shortage of epidemiologists. The Secretariat of the Pacific Community's approach to capacity building has proven a successful model—that is establishing awareness-raising programmes for epidemiology in the PICTs and training local epidemiologists, including through field work. A regional workforce that provides services to countries [a regional pool of experts (regional EpiNet team) supporting national and territorial response within the framework of the Pacific Public Health Surveillance Network] might need to be considered and has been endorsed by the Ministers of Health of the PICTs in 2005,⁴⁶ but will require a suitable sustainable funding mechanism.

In China, there is a shortage of epidemiologists in rural, remote and deprived areas, especially in Western China, but other areas are better resourced. Epidemiologists with medical training or with an integrated knowledge base (e.g. theory and practice and clinical and public health combination) are required.

Future challenges

Communicable disease control mechanisms and institutions are well established in the WPR, in both LMICs and HICs, but mechanisms and institutions for the control of non-communicable diseases, injuries, major risk factors (especially alcohol use, smoking and physical activity) and for researching and reducing health inequalities need to be strengthened. Non-communicable diseases currently constitute the largest burden of disease in both HICs and LMICs of the WPR and will grow further in percentage terms. For example, the Pacific Island Health Officers Association just declared an 'epidemic' of non-communicable diseases in the US-affiliated Pacific Islands.⁴⁷ This requires a re-orientation of training, research, funding and workforce towards non-communicable disease prevention. Within the region, training and research expertise in non-communicable diseases epidemiology are currently concentrated in HICs, but lacking in LMICs. The UnitedHealth and US National Heart, Lung and Blood Institute Collaborating Centers of Excellence to Combat Chronic Diseases, which include a centre in China, are an established model for increasing research capability and capacity in non-communicable disease epidemiology in LMICs.⁴⁸ The Global Alliance for Chronic Diseases is also likely to strengthen research on non-communicable disease epidemiology in LMICs.⁴⁹ To ensure that responses to emerging public health issues are timely and efficient both at country and regional levels, strategic planning on such issues could also be regional. Cohort studies on the causes of non-communicable diseases, injuries and risk factors in the region (and especially LMICs) are particularly needed, also to facilitate epidemiological workforce development.

For LMICs, the main challenge remains the lack of financial and human resources and the associated flow-on effects of limited training, research, funding and workforce in these countries. Additional, high-quality tertiary and field epidemiological training, through international research collaborations, which ensures technical support from other countries, is needed.

The PICTs, although not a large proportion of the population of WPR, provide a stark case example of challenges, including unstable governments, geographical remoteness and poor workforce retention. Patel argues that awareness raising will likely lead to a more country demand-driven response to epidemiological capacity needs, but that financial and human epidemiological resources should be pooled with the establishment of regional (rather than national) epidemiological mechanisms and institutions favoured.⁵⁰ Indeed, initiatives such as WHO's Pacific Open Learning Health Network are realizations of this strategic direction and now might be extended to offer advanced epidemiology courses. Strategies for

ongoing workforce development and retention strategies are both urgent and important.

In China, epidemiological training efforts need to focus not only on Centers for Disease Control and Prevention staff, but also on other health officials, as well as medical personnel and managers. China should strengthen infectious disease control epidemiology to prevent communicable disease epidemics such as SARS and H1N1, but also increasingly move towards focusing on prevention of non-communicable diseases (for example, the epidemic of tobacco use). Other training needs include data analysis skills, design of epidemiological research and academic publishing. Given China's geographical and population size, infrastructure enabling epidemiologists to cooperate across China needs to be built; the existing epidemiological societies of China and Hong Kong could play a key role in this regard.

In HICs of the WPR, epidemiology is an established discipline. Key challenges are to secure sufficient funding to address priority issues, strengthen international linkages, increase communication and collaboration across the WPR and, importantly, contribute more to the development of epidemiology in LMICs of the WPR. LMICs–HICs partnerships in epidemiological training and research have successfully been established in the WPR and provide inspirational models.^{36,37}

In summary, the WPR is diverse in its epidemiological capacity, but has substantial strengths upon which to build capacity to address the key disease burden challenges of the future and translate this into evidence-based policies.

Supplementary data

Supplementary data are available at *IJE* online.

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KEY MESSAGES

- This is the first of eight papers commissioned by the IEA on health status and epidemiological capacity and priorities in WHO Regions.
- Using DALYs as a metric, health status in the Western Pacific Region is better than other WHO regions.
- All of epidemiological research output, training and research infrastructure vary enormously across countries in the WHO WPR. However, all are improving over time.

- Communicable disease surveillance and research needs consolidation (especially in eastern Asian WPR countries), and noncommunicable disease epidemiological capacity requires strengthening to match disease trends.
- One role for the IEA in building capacity is facilitating collaborative networks within WPR.

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