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THE GOAL OF THE SECTION OF CANCER INFORMATION (CIN) IS TO PROVIDE A DEFINITIVE REFERENCE SOURCE FOR INFORMATION ABOUT WORLDWIDE CANCER STATISTICS. CIN WORKS TO FULFIL A SERIES OF LINKED OBJECTIVES TO ACHIEVE THIS GOAL. THE PRIMARY OBJECTIVE PERTAINS TO THE COLLECTION, ANALYSIS, AND DISSEMINATION OF INFORMATION ON THE GLOBAL CANCER BURDEN. THIS IS ACCOMPLISHED THROUGH COLLABORATION WITH AND PROVISION OF SUPPORT TO CANCER REGISTRIES WORLDWIDE AND THROUGH HOSTING THE SECRETARIAT OF THE INTERNATIONAL ASSOCIATION OF CANCER REGISTRIES (IACR).

Information obtained from registries is published in the serial reference volumes Cancer Incidence in Five Continents (CI5) and International Incidence of Childhood Cancer (IICC), and in online global cancer statistics tools, including GLOBOCAN, which are available within the CIN web site CancerMondial (<http://www-dep.iarc.fr>). The 10th volume of CI5 (<http://ci5.iarc.fr/>) and the 2012 version of GLOBOCAN (<http://globocan.iarc.fr>) were both published in 2013.

The second objective of CIN is to conduct a research programme in the descriptive epidemiology of cancer, including geographical analyses, time trends, and the estimation of the future burden of the disease for adult and childhood malignancies. These studies are international collaborative efforts aimed at presenting the key indicators

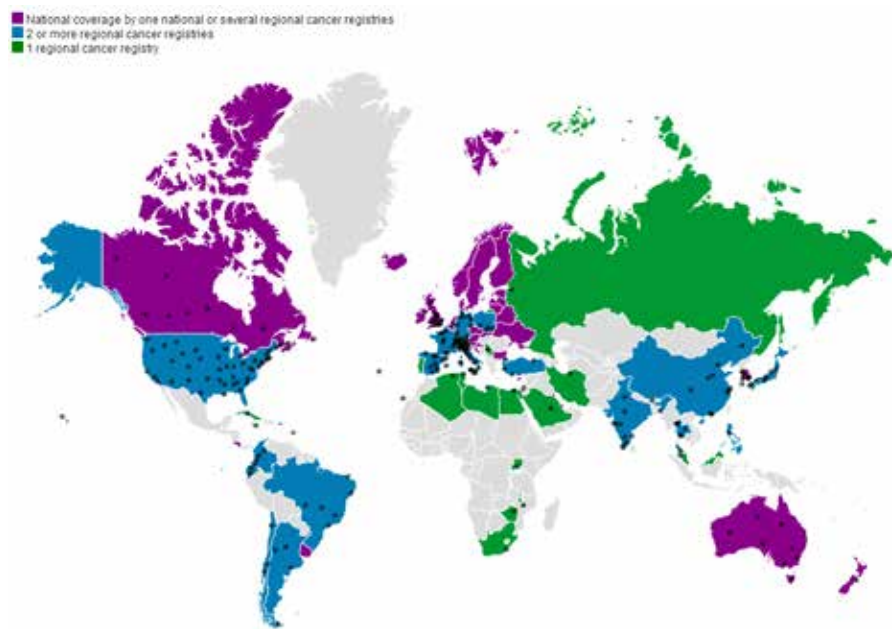
of the cancer burden at global, regional, or national levels. The data are analysed and interpreted so as to enhance our understanding of cancer incidence and mortality and the prospects for cancer prevention and control within the communities under study. New components of the research programme include the development of novel indicators to present the global burden of cancer, such as disability-adjusted life years (DALYs) and analysis of the fraction of cancers worldwide attributable to specific causes of cancer.

To improve the availability of global cancer information, CIN has a third objective: to increase population coverage by high-quality cancer registries, particularly in developing countries. To achieve this, CIN leads the Global Initiative for Cancer Registration (GICR, <http://gicr.iarc.fr>), which involves collaboration with many international partners. Through GICR, CIN is building a network of regional cancer registry resource centres (Hubs). The Regional Hubs offer a means for providing support to cancer registries worldwide in terms of development, staff training, promotion of common standards for coding and classification, and ensuring effective use of data produced. In 2012, the CIN programme was peer-reviewed and evaluated as of outstanding quality and a perfect fit with the mission of IARC. In the 2012–2013 biennium, CIN has had 58 peer-reviewed papers published.

NEW INFORMATION ABOUT THE GLOBAL BURDEN OF CANCER: 14 MILLION CASES WORLDWIDE IN 2012

CI5 and GLOBOCAN are now established as authoritative sources of information about the global burden and distribution of cancer and are frequently used and cited by cancer researchers and those involved in cancer control planning throughout the world. Work to produce the 10th volume of CI5 (CI5-X), in collaboration with IACR, commenced with the formation in 2011 of an International Editorial Board, which has met frequently by videoconference and has held three face-to-face meetings. After a general invitation to all population-based cancer registries to submit data, responses were received from 372 registries, providing data sets covering 521 populations.

Figure 1. Map showing locations of the 290 cancer registries (in 68 countries) providing data published in Volume X of *Cancer Incidence in Five Continents*.

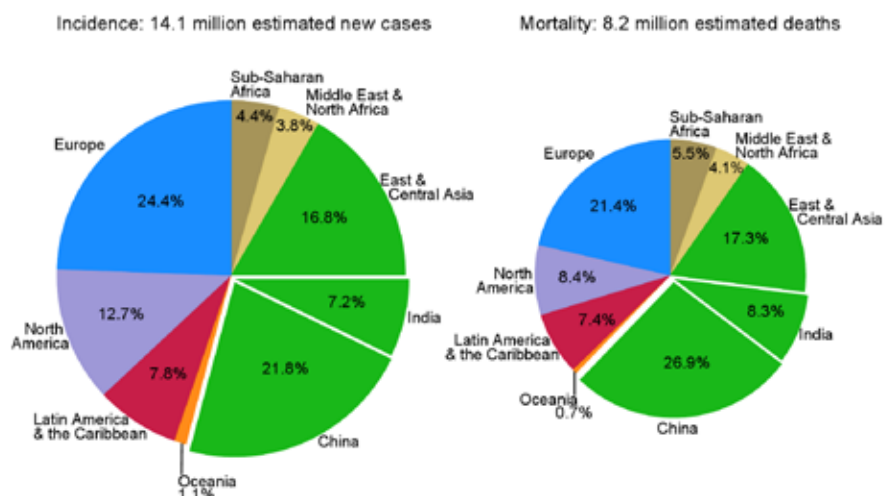


After review of all submissions by the Editorial Board, the resulting publication includes data sets from 290 registries that met the Board's quality criteria. These data largely cover incident cancer diagnoses in 2003–2007 and represent 424 populations in 68 countries. The new information contained in CI5-X significantly enhances the temporal and geographical availability of high-quality detailed cancer incidence data. IARC and IACR have also made preparations

to publish all the data submitted to CI5-X on a revised IACR web site (<http://ci5.iarc.fr/>).

Along with the preparation of CI5-X, and making use of data from this and several other resources, including the WHO Mortality Database, CIN has developed an update to GLOBOCAN to provide 2012 estimates of cancer incidence, mortality, and prevalence for 28 major cancer types in 184 countries around

Figure 2. Estimated global incidence and mortality with proportions by major world regions, for both sexes combined, 2012. (The area of the pie is proportional to the number of new cases or deaths. China and India are shown individually as part of Asia.)

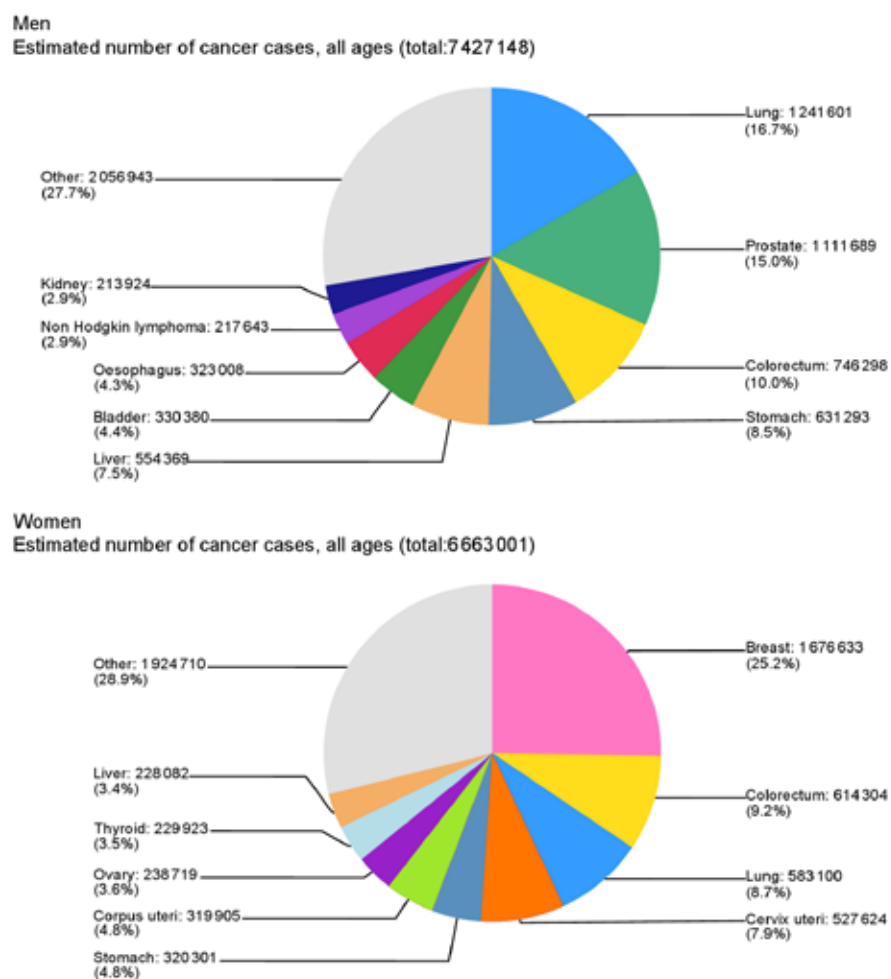


the world. These estimates make use of the best available data for any country. The GLOBOCAN 2012 web site now provides a grading of each country to evaluate the quality of the underlying source incidence and mortality data. An international GLOBOCAN Editorial Advisory Board was appointed to provide input on the selection and interpretation of source data. In 2012, GLOBOCAN estimates that there were 14.1 million new diagnoses of cancer (excluding non-melanoma skin cancer), 8.2 million deaths from cancer, and 32.6 million prevalent cases diagnosed within the previous 5 years. Of the new cancer cases, 8 million (57% of the worldwide total) occurred in developing regions of the world.

CIN ensures that the methodology used in producing the GLOBOCAN estimates is fully described and documented in peer-reviewed papers; for example, the procedures for estimating prevalence were published in Bray *et al.* (2013a). To generate prevalence estimates, these procedures made use of new sources of survival information as a result of more recent and extensive analyses, particularly in developing countries (<http://survcan.iarc.fr/>). Almost half of the global prevalence of cancer is in areas of very high development, comprising only one sixth of the world's population. Breast cancer is the most prevalent cancer in most countries globally, although cervical cancer is the most prevalent in much of sub-Saharan Africa and South Asia.

To provide more comprehensive insights into the global cancer pattern and its relation to economic development, CIN is using the Human Development Index (HDI) – a composite index based on life expectancy, adult literacy, and per capita gross domestic product – and has been looking at cancer profiles in countries at different HDI levels (Bray *et al.*, 2012). This analysis made extensive use of both CI5 and GLOBOCAN data and showed that cancers of the female breast, lung, colorectum, and prostate accounted for half of the overall cancer burden in the highest HDI regions; in medium HDI regions, cancers of the oesophagus, stomach, and liver were also very common; and in low HDI regions, cervical cancer was more common than

Figure 3. Estimated world cancer incidence proportions by major sites, for men and women, 2012.



either breast or liver cancer. In general, the analysis demonstrates that rapid societal and economic transitions in many countries mean that reductions in infection-related cancers are offset by an increasing number of new cases associated with reproductive, dietary, and hormonal risk factors.

A novel measure of the global cancer burden now being estimated within GLOBOCAN is disability-adjusted life years (DALYs) (Soerjomataram *et al.*, 2012a,b). DALYs integrate the commonly used measures of the burden (incidence, mortality, and survival) with measures of disability due to cancer and are calculated by adding the years of life lost (YLL) due to premature mortality and the years lived with a disability (YLD) in survivors. The global DALY is estimated to be more than 169 million years of healthy life, indicating that an individual

loses on average about 2 years of healthy life after cancer diagnosis. Irrespective of a country's HDI, the number of years of healthy life lost due to cancer is large, with the highest relative contribution of YLL to the total DALYs estimated in low-resource countries (97%). Colorectal, lung, breast, and prostate cancers were the main contributors to the total DALYs in most world regions, accounting for 18–50% of the total burden of cancer. An additional large burden from infection-related cancers (liver, stomach, and cervix) was estimated at 25% and 27% in sub-Saharan Africa and East Asia, respectively. Results also showed consistently poorer prognosis after cancer diagnosis in low-resource countries, which highlights the need for global public health actions to be increasingly directed towards such settings (Table 1). Currently, plans have been made to extend the project to

study the impact of cancer diagnosis on healthy ageing, to incorporate DALYs in assessment of attributable fraction and effects of intervention, and to use DALYs to estimate the economic burden of cancer.

DESCRIPTIVE EPIDEMIOLOGY OF CANCER: MONITORING THE BURDEN OF CANCER AT THE REGIONAL AND COUNTRY LEVEL AND FOR SPECIFIC CANCERS AND DUE TO SPECIFIC CAUSES

REGIONAL SURVEILLANCE

Building on CIN's global cancer surveillance activities, two papers have been published exploring in more detail regional patterns in Africa and Europe. The African analysis demonstrates how cancer is an emerging public health problem in the continent, with numbers expected to double in the next 20 years because of rapid population growth and ageing (Jemal *et al.*, 2012). Some specific cancers, notably those of the lung, female breast, and prostate, are being diagnosed with greater frequency due to changes in both lifestyle factors and detection practices associated with urbanization and economic development. The African analysis discusses opportunities for reducing the burden through resource-level-appropriate interventions, including implementation of hepatitis B virus (HBV) and human papillomavirus (HPV) immunization, tobacco control policies, and low-tech early detection for cervical cancer.

The European analysis provides an overview of cancer incidence and mortality in the 40 major countries of Europe and makes use of information from the European Cancer Observatory (ECO, <http://eco.iarc.fr>) launched in September 2012 (Ferlay *et al.*, 2013). This is a comprehensive web site combining all the information currently available in Europe on cancer incidence, mortality, survival, and prevalence as part of the EURO COURSE (<http://www.eurocourse.org>) project (Steliarova-Foucher *et al.*, 2012). The web site provides detailed estimates and country factsheets (EUCAN) for 2012 as well as analytical and presentation tools for cancer registry data (EUREG), and will include a data download mechanism for research use (EUROCIM). All data

Table 1. Comparison of rates of DALYs by Human Development Index (compiled from Soerjomataram *et al.* 2012a)

HDI	DALYs per 100 000	YLLs per 100 000	YLDs per 100 000	Proportion YLLs/DALYs
Very high	2404	2041	363	84.9
High	2491	2295	195	92.2
Medium	2329	2207	122	94.8
Low	2433	2356	77	96.8

DALYs, disability-adjusted life years; YLDs, years lived with disability; YLLs, years of life lost.

on the ECO web site are based on data collected by 130 European population-based cancer registries and are added to the web site using a semi-automated system of reception and processing of data through the Registries Portal at <https://cinportal.iarc.fr/>.

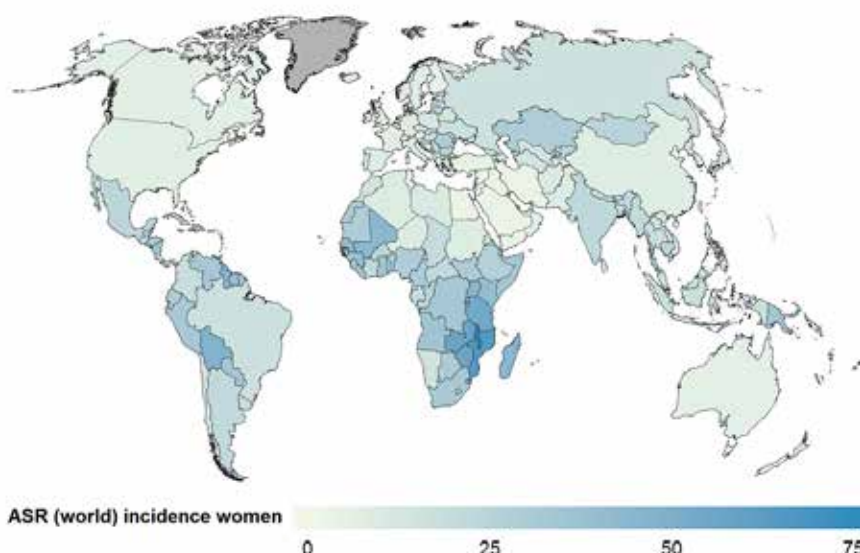
COUNTRY-LEVEL SURVEILLANCE

Several descriptive studies conducted during the biennium have focused on specific countries. They include an updated report on cancer mortality trends in Colombia in 1984–2008. This contrasted trends in the major causes of cancer death with those in other Latin American countries, and assessed the role of national health care reforms (Piñeros *et al.*, 2013). Another study examined the rising trends in breast cancer incidence in Mumbai, India, in 1976–2005, and predicted the cancer

burden in 2025 in support of cancer control planning; a near-doubling of incident cases to more than 2500 was estimated for 2025 (Dikshit *et al.*, 2012a).

Given that cancer mortality remains undocumented in various regions and subpopulations of India, IARC collaborated in a nationally representative survey of causes of death in 1.1 million households in 6671 randomly selected small areas (Dikshit *et al.*, 2012b). An estimated 556 400 cancer deaths occurred in India in 2010, 71% of them in persons aged 30–69 years. The high premature mortality burden from tobacco-related, cervical, and other treatable cancers emphasized the role of prevention and earlier detection in reducing cancer deaths, particularly in the rural areas of India presently underserved by cancer services. Other studies have included an analysis of

Figure 4. Distribution of estimated age-standardized (World) incidence rates (ASR) per 100 000, for cancer of the cervix, 2012.



testicular cancer incidence in Croatia (Sincic *et al.*, 2012), reporting a 7% per annum increase, one of the largest recorded in Europe and worldwide, and an analysis and elucidation of the reasons for the declining incidence rates of hepatocellular carcinoma in urban Shanghai, China (Gao *et al.*, 2012). Various collaborative studies are in progress, including an analysis of breast and cervical cancer incidence trends in Chennai, India, and cervical cancer mortality trends in Argentina, by region and level of human development.

CANCER SITE SURVEILLANCE

Several descriptive studies have examined specific cancers at the global level. Collaborating with the Section of Environment and Radiation (ENV), we examined melanoma incidence in 39 countries worldwide (Erdmann *et al.*, 2013). While incidence continued to rise in most European countries (at every age), rates were observed to stabilize in Australia/New Zealand, North America, and Norway (at younger ages and among recent cohorts). An age-period-cohort modelling approach to the analysis of cervical cancer trends in 38 countries globally (in collaboration with the Infections and Cancer Epidemiology Group [ICE]) showed that declines in risk over (screening-related) calendar time were observed only in higher-income countries, whereas increasing risk in successive (HPV-related) birth cohorts was seen in most European countries, Japan, and China (Vaccarella *et al.*, 2013). The study underscored the importance of strengthening screening efforts and implementing HPV vaccination programmes, notably in those countries where such cohort effects arise. Another study, part of a continuing series of urological site-specific papers in collaboration with the American Cancer Society, assessed prostate cancer incidence and mortality rates in 40 and 53 countries, respectively (Center *et al.*, 2012). An elevated incidence was seen in more developed countries, while mortality was higher in South America, the Caribbean, and sub-Saharan Africa. In further contrast, incidence increased in most high-income countries, whereas mortality increases were mainly confined to low-resource settings.

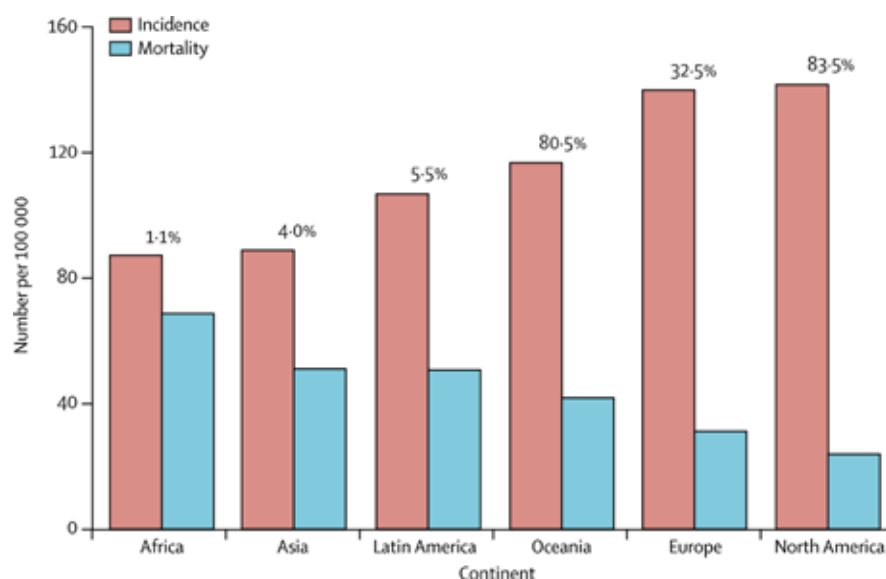
Several additional reports have been published on HPV-related cancers. A review estimated that 4.8% of the global burden of cancer could be attributed to HPV infection; this figure varied substantially, from 1.6% in North America to 14.2% in sub-Saharan Africa and 15.5% in India (Forman *et al.*, 2012a). Although cervical cancer accounted for most of this burden (86.9%), the residual burden (13.1%) represents a significant number of cancers of the oropharynx, penis, vulva, vagina, and anus. In collaboration with the United States National Cancer Institute, an international trend analysis in 23 countries revealed increasing oropharyngeal cancer incidence in developed countries, among men, and at younger ages (Chaturvedi *et al.*, 2013). The paper highlighted the importance of HPV infection as an explanatory factor, particularly among men. In a population-based study of incidence and survival trends in Norway in 1987–2007, parallel increases in incidence and survival for oropharyngeal squamous cell cancers were observed; the increased incidence was postulated to be a result of increasing prevalence of HPV-positive tumours (Nygård *et al.*, 2012). An overview of cervical cancer and other HPV-related diseases in central/eastern Europe and central Asia highlighted the elevated cervical

cancer rates in certain countries in both regions, and, in the absence of effective screening programmes, an increasing risk of death from cervical cancer among young women (Bray *et al.*, 2013b).

CHILDHOOD CANCER SURVEILLANCE

A recent review article highlighted specific pathological, etiological, and psychosocial issues of cancer in young people (Pritchard-Jones *et al.*, 2013). Age-standardized incidence rates in children (age 0–14 years) vary around the world between 50 and 190 per million and comprise mainly haematological malignancies, central nervous system tumours, embryonal tumours, and sarcomas. In adolescents (age 15–19 years), the haematological neoplasms remain common, and most are lymphomas. Other prominent groups are central nervous system tumours, bone tumours, malignant melanoma, thyroid tumours, and germ cell tumours. Overall incidence rates are 90–300 per million. Childhood cancer has been a paradigm of therapy success, with survival increasing from 30% in the 1960s to more than 80% today in the populations of high-income countries, even though the recent trends of cancer mortality in childhood populations have reached a plateau. There are very large geographical

Figure 5. Incidence and mortality rates in children aged 0–14 years according to continent of residence. The percentage of total population covered by cancer registration is also shown. Source: Sullivan *et al.* (2013); reproduced with the permission of the publisher.



differences in mortality from childhood cancer between developed and developing countries. The percentage of a population covered by cancer registries in each continent is associated concordantly with the incidence rates and inversely with the mortality rates of childhood cancer (Figure 5) (Sullivan *et al.*, 2013). This correlation provides evidence that effective paediatric cancer control programmes that include cancer registration help to improve outcomes (Magrath *et al.*, 2013).

Data on cancer incidence in children and adolescents (age 0–19 years) are being compiled in collaboration with IACR to produce a third volume of *International Incidence of Childhood Cancer* (IICC-3, <http://iicc.iarc.fr/>), planned to appear in 2014. Approximately 350 cancer registries submitted data, and it is estimated that about 250 peer-approved data sets will be included.

The European Network for Cancer Research in Children and Adolescents (ENCCA, <http://www.encca.eu/>) aims to improve the management of young people with cancer. CIN is involved in initiating the collection of additional data items with clinical relevance from its network of cancer registries. An extensive questionnaire, asking about current practices and opportunities for registries to expand activities in this direction, was launched in July 2013. The results will inform a standard data set that will be used to launch a call for enhanced data in 2014. Part of the questionnaire also addresses the objectives of another European project, PanCare Childhood and Adolescent Cancer Survivor Care and Follow-Up Studies (PanCareSurFup, <http://www.pancaresurfup.eu/>), aimed at improving the situation of survivors. Data on multiple primaries and late mortality are being collected to produce a baseline status report for Europe. Both projects will contribute to enhanced interpretation of differences in survival.

SURVEILLANCE IN INDIGENOUS POPULATIONS

The study of the distribution and determinants of cancer in indigenous populations is an overlooked area of scientific research. From a global perspective, there is a need to identify

the similarities and differences between indigenous populations across countries, highlighting disparities and the need for targeted interventions. As part of an IARC-Australia Fellowship, several studies have been completed that combine an extensive review of the literature and an original analysis of available data in different regions or for specific cancer types. This includes an assessment of cancer variations in indigenous populations across the Latin America and Caribbean region (Moore *et al.*, 2013b) and global inequalities in stomach cancer, which noted a rising incidence in certain indigenous groups. Similar exercises exploring childhood cancer profiles among indigenous populations worldwide and a review and analysis of the cancer patterns in the circumpolar region are under way, as is a report aiming to quantify differences in the cancer incidence and mortality rates in indigenous and comparable populations in Australia, New Zealand, Canada, and the USA.

The International Research Network Investigating Cancer among Indigenous Peoples (IRNCIP) has been established to facilitate global research on cancer in indigenous communities. The primary objectives of IRNCIP are to better understand cancer profiles among indigenous people in different countries, interpret results in the context of opportunities for cancer control, and promote awareness among health care providers and policy-makers of relevant cancer issues. This agenda may be further developed in the near future.

GLOBAL ATTRIBUTABLE RISK ESTIMATES

Estimates of the number of new cancer cases and deaths attributable to a risk factor are needed for priority setting and for monitoring the disease burden associated with the respective risk factor. In collaboration with ICE, we have estimated the population attributable fraction (PAF) for infectious agents and the corresponding global and regional burdens of cancers associated with such agents (de Martel *et al.*, 2012). In 2008, 2.1 million (16.4%) of the total 12.7 million new cancer cases globally were attributable to infections. This fraction is substantially higher in developing countries (23.4% of the total) than

in developed countries (7.5%). The most important infectious agents are *Helicobacter pylori*, hepatitis B and C viruses, and HPV, which together are responsible for 1.9 million cases of gastric, liver, and cervix uteri cancers, respectively. In collaboration with the Section of Nutrition and Metabolism, within a project funded by the World Cancer Research Fund, work has commenced to estimate the PAF for cancer associated with excess body weight. The project requires appropriate data input to derive robust results and also literature reviews to quantify the relative risks of cancers associated with each cancer site. Methodologies are also being reviewed and standardized analytical frameworks are being adopted to estimate both PAF and risk of disease in those exposed. Due to the considerable interest in developing a suite of global and regional PAFs associated with, for example, specific dietary exposures, tobacco smoking, occupational, and, possibly, generic risks or estimating the population impact of interventions (i.e. vaccinations and early detection), we are planning to extend this project to a range of other risk factors established as definite causes of cancer in collaboration with other Sections/Groups within IARC (ENV, Screening Group, Prevention and Implementation Group, Section of Genetics, and Section of IARC Monographs)

BRINGING MAJOR IMPROVEMENTS TO CANCER SURVEILLANCE IN DEVELOPING COUNTRIES

THE GLOBAL INITIATIVE FOR CANCER REGISTRY DEVELOPMENT (GICR)

Subsequent to an IARC Governing Council resolution (May 2009) supporting a special project to improve the coverage and quality of data from cancer registries in developing countries, IARC launched the Global Initiative for Cancer Registry Development (GICR) together with several international partner organizations. GICR was unveiled at the UICC World Cancer Leaders' Summit in November 2011.

The GICR has launched a network of regional registry resource centres (Hubs) as a means to expand the coverage and quality of population-based cancer

registries through increased and tailored support. IARC's role is to coordinate and support the operation of these Regional Hubs, which will become the focal contact points for technical queries from cancer registries, including issues related to the use of the CanReg5 software. Hubs also develop tailored training programmes; conduct advocacy activities in support of cancer registration; and help cancer registries make full use of the data they produce for cancer prevention and control policy and evaluation, and to enhance their output and research capacity. Site visits by IARC and Hub staff are a key component in the evaluation of cancer registry capacity within countries and a way to provide critical recommendations to enhance the operation of cancer registries and bring about improvements in capacity and quality.

Since its launch, GICR has made significant progress with four Regional Hubs established in support of cancer registration in western, central, and south Asia, sub-Saharan Africa (in collaboration with the African Cancer Registry Network), East Asia and North Africa, and Latin America. Discussions are taking place to set up further Regional Hubs for the Caribbean and Pacific Islands. Regional Hubs do not have a uniform structure but adapt to regional circumstances: the two Asian Hubs have physical locations, the sub-Saharan Hub operates as a virtual network, and the Latin American Hub has a physical administrative base and several contributing centres.

During the 2012–2013 biennium, activities by GICR and Regional Hubs included regional training courses (see below); the establishment of collaborative research projects in Africa and in Asia; Collaborative Research Agreements (CRAs) between IARC and cancer registries (e.g. in Sri Lanka, Mongolia, and Indonesia); development and dissemination of advocacy material; presence on the Internet and among the cancer registration community through web sites, newsletters, and networking activities; and extensive interaction with relevant regional stakeholders. CIN staff made site visits to 12 countries in support of population-based cancer registration, providing recommendations to Bangladesh, Bhutan, Cambodia,

Figure 6. Inauguration of the IARC Regional Hub for Cancer Registration (Tata Memorial Centre, Mumbai, India), October 2012. From left to right: Dr C.P. Wild, IARC Director; Dr R. Badwe, Tata Memorial Centre Director; and Dr R. Dikshit, Regional Hub Principal Investigator.



Nepal, India, Indonesia, Jamaica, Lao People's Democratic Republic, Puerto Rico, Thailand, Uzbekistan, and Viet Nam.

Financial requirements for GICR increase with the many activities generated by operational Regional Hubs. Fundraising efforts are in progress to ensure adequate support to GICR, with an estimated requirement of US\$ 15 million over the next 5 years. The initiative's sustainability strategy focuses on strengthening the capacity of Regional Hubs, increasing regional expertise, and fostering support of cancer registration by national authorities, who should ultimately take responsibility for this fundamental element of cancer control. Progress of the GICR may be followed at <http://gicr.iarc.fr>.

CANREG DEVELOPMENT

CanReg is the cancer registration software package developed by IARC and used in more than 50 countries (mainly developing countries). The CanReg5 software is available for download for free in several languages (presently in English, French, Russian, Portuguese, Spanish, and Chinese) at <http://iacr.com.fr>. A handbook is also

available and is constantly updated. Technical support is available to registries using CanReg on aspects including installation and tailoring, data entry, and analysis.

More than a dozen updates to the software, some major, were released during the biennium. A special focus has been on improving the available analytical capabilities, for example by integrating functionality from R, freely available statistical software, and some powerful libraries. In collaboration with the Northern Ireland Cancer Registry, a tool to facilitate staging of cancer has been developed, which will ultimately be incorporated into CanReg. The first result is a web application available to authorized users via a web browser.

TRAINING ACTIVITIES

CIN is involved in many varied training activities, ranging from one-to-one mentoring of prospective CanReg5 trainers (eight people trained, from India, Rwanda, Argentina, Nigeria, and Kenya) to organizing major regional courses in cancer registration methods, organized jointly between CIN and the regional Hubs. During the biennium, CIN has hosted such courses in Mumbai, India;

Blantyre, Malawi; Bangkok, Thailand; Jakarta, Indonesia; Cali, Colombia (in Spanish); Buenos Aires, Argentina; and Izmir, Turkey, and has led the cancer registration module for the IARC Summer School. CIN has also provided specific CanReg5 training on courses in The Gambia and has developed a series of webinars on different aspects

of CanReg5 management, including installation and customization, data entry, and analysis (all materials are available at <http://gicr.iarc.fr/en/resources>).

A specialist training course, Paediatric Oncology for Cancer Registries, was held in collaboration with the ENCCA network (<http://www.iarc.fr/en/education-training/ENCCAcourse/index.php>) in November

2013. The course was designed to help cancer registry personnel understand medical practice, learn about the impact of known prognostic factors on survival and survivorship, and identify the relevant data sources required for collection of enhanced data sets in paediatric oncology.

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