Challenges to effective cancer control in China, India, and Russia

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Cancer is one of the major non-communicable diseases posing a threat to world health. Unfortunately, improvements in socioeconomic conditions are usually associated with increased cancer incidence. In this Commission, we focus on China, India, and Russia, which share rapidly rising cancer incidence and have cancer mortality rates that are nearly twice as high as in the UK or the USA, vast geographies, growing economies, ageing populations, increasingly westernised lifestyles, relatively disenfranchised subpopulations, serious contamination of the environment, and uncontrolled cancer-causing communicable infections. We describe the overall state of health and cancer control in each country and additional specific issues for consideration: for China, access to care, contamination of the environment, and cancer fatalism and traditional medicine; for India, affordability of care, provision of adequate health personnel, and sociocultural barriers to cancer control; and for Russia, monitoring of the burden of cancer, societal attitudes towards cancer prevention, effects of inequitable treatment and access to medicine, and a need for improved international engagement.

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Introduction

Cancer is a burgeoning health problem worldwide, and poses an increasing risk of human affliction and economic threat, particularly to emerging countries. China (1 350 695 000 people), India (1 236 686 732 people), and Russia (143 533 000 people) together account for nearly 40% of the world's population,[1] and have in common vast geographies, rapidly improving economies, increasing numbers of elderly people, adoption of westernised lifestyles (eg, changes in diet and decreased physical activity), populations in rural regions and of low socioeconomic status who often face suboptimum health care, serious contamination of the environment, and rising incidences of oncogenic communicable infections.[2–4] Table 1 shows comparisons of some key general and cancer-related demographics between the three countries, by contrast with those in the UK and the USA.[1,5–9] Although the incidences of most cancers are low in China, India, and Russia, the mortality burden from cancer is higher than in the UK and the USA; mortality-to-incidence ratios are 0·70, 0·69, and 0·60 for China, India, and Russia, respectively, compared with 0·40 in the UK and 0·33 in the USA. Despite each country's growing economy, the present financial burden per patient with cancer in China, India, and Russia is US$2202, $641, and $3784, respectively, compared with $37 836 in the UK and $86 758 in the USA (table 1).[6]

This Commission aims to first describe the status of overall health care and of cancer control for each country, and then emphasise specific issues and obstacles that are relevant to each: for China, access to care, contamination of the environment, and traditional medicine coupled with cancer fatalism; for India, affordability of care, provision of adequate health personnel and infrastructure, and sociocultural barriers to cancer care; and for Russia, monitoring of the burden of cancer, societal attitudes and political will towards cancer prevention, effects of inequitable treatment and access to medicine, and a need for greater international engagement.

We have endeavoured to report our findings in view of past and present improvements to health care and cancer control that are already benefiting the populations of China, India, and Russia. Our Commission has limitations; by focusing on important topics in each country we have been unable to be comprehensive in others; peer-reviewed, published evidence is often scant and at times we had to resort to an element of anecdotal evidence; and availability and access to each country's health records was often restricted. Despite these obstacles, we hope that our Commission initiates a strong debate among policy makers and other stakeholders and contributes to improved measures for cancer control in these three countries.

China

Background

China is geographically the third largest country in the world with 34 provincial divisions comprising 23 provinces, five autonomous regions, four municipalities, and two special administrative regions (figure 1).[10,11] It is the largest and most populous of the low-to-middle-income countries in the world, with a population of more than 1·35 billion people.[12] To address the issues that affect delivery of cancer care in China, the social, economic, and attitudinal aspects of the Chinese population must first be understood.

52·6% of the population live in urban areas, but governmental policy to accelerate urbanisation is poised

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	China	India	Russia	USA	UK
Size (km²)	9 596 961	3 287 263	17 098 242	9 826 675	243 610
Population	1·35 billion	1·24 billion	144 million	314 million	63·2 million
Total life expectancy at birth (years)	75	66	69	79	81
Total health expenditure (% of GDP)	5·2%	3·9%	6·2%	17·9%	9·3%
Health expenditure per person (US$)	278	59	807	8608	3609
Public health expenditure (% of total)	55·9%	31·0%	59·5%	45·9%	82·7%
Private out-of-pocket expenditure (% of private expenditure)	78·8%	86·0%	87·9%	20·9%	53·1%
Age-standardised incidence of cancer*	174·0	94·0	204·3	318·0	272·9
Risk of getting cancer before age 75 (%)	16·8%	10·1%	21·5%	31·1%	26·9%
Age-standardised mortality rate from cancer*	122·2	64·5	122·6	105·8	110·0
Risk of dying from cancer before age 75 (%)	11·5%	7·1%	13·7%	11·2%	11·3%
Mortality-to-incidence ratio	0·70	0·69	0·60	0·33	0·40
5-year cancer prevalence (thousands)†	5045·0	1790·5	1087·9	4775·2	827·1
Number of clinical trials in progress for cancer	979	479	445	10 420	2028
Financial burden per patient with cancer ($)	2202	641	3784	86 759	37 837

Data for country and population size from the World Bank.[1] Data for cancer from GLOBOCAN 2012.[5] The number of cancer trials was obtained by searching for the term "cancer" on the WHO trial search page.[7] Data for financial burden per patient with cancer was calculated by estimating the 2009 cost of all cancer cases divided by the estimated 2009 cancer cases by country (based on projections from 2002).[6] Data for health expenditure from the World Bank.[8] Data for life expectancy at birth from the World Bank.[9] GDP=gross domestic product. *Defined as the age-standardised incidence or mortality per 100 000 people per year. †5-year prevalence refers to the number of people living in each country who have been diagnosed with cancer in the past 5 years.

Table 1: **Size, population, life expectancy, and expenditure demographics for China, India, Russia, the USA, and the UK**

to increase this by 2·3% annually.[12,13] The proportion of the Chinese population older than 60 years is increasing without concomitant expansion and development of the social security system. The change in age distribution has resulted from slowing of the overall rate of population growth as a result of the one-child policy, together with an increase in average life expectancy from 46 years in 1950 to 75 years in 2010.[12] According to the Population Reference Bureau, the proportion of the population younger than 14 years is expected to fall from 40% in 1964 to 17% by 2035, with the proportion older than 60 years increasing from 6% in 1964 to 24% by 2035. At present, 12% of the population (162 million people) are 60 years of age or older compared with 18·4% in the USA and 22% in the UK.[14,15] However, in absolute terms people older than 60 years in China represent half of this age group in Asia and a fifth of this age group worldwide, on the basis of data from the Ministry of Civil Affairs of China.

China has experienced rapid economic growth (about 10% per year during the past decade), making it the world's second largest economy after the USA in terms of annual gross domestic product (GDP).[16] However, per-person GDP in China is $9100 compared with $49 800 in the USA, ranking China 127th in the world.[17]

China's present 5-Year Plan (2011–15)[18] outlines the country's goals in three key areas: rebalancing of the economy (encompassing environmental protection and social services within models for economic growth); reduction of social inequality by increasing of social safety nets, establishment of minimum wages, and increased investment in infrastructure and health-care insurance; and attention to environmental reforms from corporations and individuals.

Economic growth and urbanisation have brought sedentary lifestyles with increasingly westernised dietary habits, and increases in smoking rates, alcohol consumption, and environmental pollution. These changes have led to reductions in the incidence of communicable diseases, but have also increased the rates non-communicable diseases (eg, obesity, cardiovascular disease, diabetes, and cancer).[16] Furthermore, economic development with industrialisation and exportation of goods has caused substantial internal migration and urbanisation with subsequent increased social disparities between urban, rural, and migrating populations in China. About 11·8% of the Chinese population lived below the poverty line in 2009 (poverty being defined as the number of people living on less than $1·25 per day[19]),[20] and roughly 26% of urban and 44% of rural people live without access to basic sanitation.[16] These geographical and socioeconomic disparities, together with the lack of an equitable national social-support system, account for the high variance of health outcomes between different regions within China.

WHO estimates that 80% of all deaths in China are now due to non-communicable diseases and injuries, with cancer being the second most common cause of death after cardiovascular disease.[21] The rise in cancer mortality has been most pronounced in rural areas of China.[16,22] Annual mortality from cancer is 167·6 per 100 000 population,[23] constituting about a fifth of all deaths in China and a quarter of all cancer deaths

worldwide.[16] In absolute terms, there are 2·82 million new cancer cases and 1·96 million deaths in China from cancer each year.[5] The all-cancer mortality-to-incidence ratio for China is 0·62 (with variation across different registries), compared with 0·59 in Latin America, 0·43 in the European Union, and 0·35 in the USA.[5]

In China, the most common types of cancer for men are lung, gastric, liver, oesophageal, and colorectal cancer, and among women are lung, breast, gastric, colorectal, and liver cancer.[5] During the past few years, mortality from cancers of the liver, stomach, and oesophagus has remained high, whereas mortality from lung, colorectal, and breast cancer has risen.[23] The most common causes of cancer-associated disability-adjusted life-years lost in China in 2010 were lung and liver cancer.[24]

To enable the establishment of effective policies for cancer control in China, accurate data for the incidence, geographical distribution, and mortality rates of cancer must be known. To this end, the Chinese National Central Cancer Registry (NCCR) was established in 2002,[23] and five successive annual reports from it have been published since 2008. Incorporating data from more than 200 registries across China, the NCCR is estimated to contain information for roughly 13% of China's population (200 million people), which contrasts sharply with the 96% coverage of registries in the USA and nearly 100% coverage in the UK.[23] The low proportion of the population represented in the Chinese NCCR might not provide an accurate estimate on which health-care policies can be established. For example, Shi and colleagues[25] recorded a higher burden of cervical cancer than was reported in the registry data, suggesting that inclusion of high-income areas in the NCCR might not be indicative of the actual incidence in the country. Investigators of another study[26] compared mortality data from cancer registration and the Chinese national death survey to establish the representativeness of cancer registry estimates in China. Although cancer registry data are representative at the overall country level and for urban areas, mortality might be overestimated in rural areas; most rural cancer registries were in high-risk cancer areas, particularly for oesophageal and gastric cancer.

Cancer registration is difficult in developing countries, partly because of shortages of medical facilities and personnel. Although 100% coverage is not imperative for cancer registries, the quality of information, coverage, and the adequacy of the reference population are factors that need consideration before extrapolation to the entire population.[27] To obtain accurate estimates of cancer burden, representative capture and recording of cancer cases are needed across the country. Specific registry features that are needed include expansion of population coverage to improve representation of ethnic minorities and underserved populations (eg, rural residents, especially those from lower socioeconomic classes), and collaboration with cancer surveillance organisations for development of a national cancer surveillance plan.[28]

Figure 1: **Geographical divisions in China**
Eastern China has a GDP of US$5464, 5·22 registered doctors and nurses per 1000 population, and 3·96 hospital beds per 1000 population. Central China has a GDP of $2630, more than 3·3 registered doctors and nurses per 1000 population, and more than 3·3 hospital beds per 1000 population. Western China has a GDP of $2354, 3·76 registered doctors and nurses per 1000 population, and less than 3·35 hospital beds per 1000 population. Figure based on data from the China Health Statistics Yearbook (2011)[10] and Jian and colleagues.[11] GDP=gross domestic product.

Among low-to-middle-income countries, China has a relatively short history of national activities for cancer control. In recognition of the need to implement cancer control policies and provide efficient resources to improve cancer outcomes, the national Office of Cancer Prevention and Control was established in 1986. The first National Cancer Control Plan was published for the period 1986–2000, and showed that cancer mortality in high-risk rural areas (eg, a high risk of oesophageal cancer in the Lin County of Henan Province) decreased during a 5-year period.[29] After 2003, the Ministry of Health developed a second stage of the National Cancer Control Plan to cover 2004–10.[30] The stated aims of this programme were to implement health policies, integrate cancer control with prevention and treatment of other diseases, focus on rural regions and areas of high cancer incidence, and emphasise the government's leading role in these policies and their implementation.[31] A 1% yearly reduction in the prevalence of smoking in men for the past decade suggests that the National Cancer Control Plan might have been partly effective.[32] Additionally, the first medium-term and long-term national plan for control and prevention of chronic diseases for 2005–15 has mandated an integrated and comprehensive approach, including for cancer.[30]

In summary, economic development with transition from an agricultural to industrialised nation, adoption of

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For the **Population Reference Bureau** see http://www.prb.org

For the **Ministry of Civil Affairs of China** see http://www.mca.gov.cn

For the **US National Program of Cancer Registries** see http://www.cdc.gov/cancer/npcr/about.htm

For the **UK Association of Cancer Registries** see http://www.ukacr.org/registries

westernised lifestyles, increased environmental pollution, and an increase in the proportion of the population older than 60 years, together with geographical and socioeconomic disparities, are important factors that affect the burden of cancer in China. Furthermore, Chinese cultural traditions and beliefs affect, and might partly hamper, effective cancer control in terms of screening programmes, management of potentially curative cancers, and delivery of palliative care. Lastly, in a country with such geographical expanse, a nationwide one-size-fits-all cancer policy might not be possible. We believe that achieving an optimum cancer care service will require a substantial improvement in environmental pollution, and deep-seated traditional beliefs of healing among the Chinese people will need attention if outcomes are to be improved.

Access to cancer care in China

Access to affordable drugs and treatment

In 2011, China spent 5·1% of its GDP on health care (ranking 125th among countries of the world), which is low compared with high-income countries (eg, 10·6% of GDP for European Union countries).[8] Overall, China ranks 101st on the worldwide Human Development Index (including GDP per person, percentage of GDP spent on health, and private health expenditure) and 85th on the worldwide Health Index.[33,34] Thus, although health expenditure per person in China increased from $54 to $278 between 2002 and 2011, the investment in health care relative to GDP has increased by only 0·4% since 2002, and per-person spending remains low compared with the USA ($8607·9).[35] Overall, the cost of cancer care represents 0·11% of gross national income per person in China. By contrast, in the UK, Japan, and the USA the corresponding costs are 0·51%, 0·6%, and 1·02% of per-person gross national income, respectively.[36] These financial statistics emphasise one of the key obstacles to access of optimum care for and control of cancer in China.

In the past few decades, China has moved from a system of universal insurance to a largely privatised health-care system with most (79%) rural residents remaining uninsured.[37] During the same period the rate of out-of-pocket expenditure for urban residents rose from 20% to 60% since 1978.[38] To address inequality in health-care access, the Chinese Government has planned to commit about $125 billion by 2020 for the development of an affordable and accessible health-care system covering both urban and rural residents.[39] As a first step, China's total health-care expenditure has increased from $156 billion to $357 billion during the past 4 years,[40] and the percentage of the population enrolled in the national medical insurance system has risen from 29·7% in 2003 to near-universal coverage (95·7%) by 2011.[37] Although universal health coverage has been established in China, low reimbursement rates resulting in high out-of-pocket expenses still exist for patients with cancer. Under the national medical insurance policy, average inpatient reimbursement still does not exceed 70% for outpatients and 50% for inpatients.[37] In parallel with rising national health-care coverage, out-of-pocket expenses have fallen to about 35% of medical expenses.[40,41] However, China's out-of-pocket expenditure as a percentage of private health expenditure (78·8%) remains higher than that of high-income countries such as the USA (20·9%) and the UK (53·1%).[34] Thus, despite increased insurance coverage, the risk of catastrophic out-of-pocket expenditure (defined as payments exceeding 40% of a household's disposable income) has not been eliminated and drove 12·9% of households into poverty in 2011.[22] Patients with cancer are particularly at risk; investigators of a study[42] of patients with advanced non-small-cell lung cancer reported an average cost of care in the final 3 months of life to be $16 955, which far exceeds the finances available to most households in China, despite reimbursement of a substantial portion of these costs by insurance providers.

The foundation of China's medical insurance system consists of three principal medical insurance schemes: the Urban Employee Basic Medical Insurance and Urban Resident Basic Medical Insurance, which cover employees in urban sectors, and the New Cooperative Medical Scheme, which covers rural residents.[43] To supplement shortfalls in overall medical insurance coverage, so-called supplemental medical schemes exist for specific groups of patients (eg, Enterprise Supplementary Medical Insurance, Commercial Health Insurance, the Civil Servants Medical Subsidy, and Medical Security).[43] Reimbursement policies and rates vary by province and city, and the process to obtain reimbursement also varies widely because funds acquired by the insurance plans are pooled at regional levels and thus affect the reimbursement process. This aspect is particularly relevant to cancer drugs, which are often expensive compared with other drugs.

The cumbersome and slow process of regulatory approval for drugs in China further aggravates the issue of access to expensive drugs. Many new cancer drugs—already approved by the US Food and Drug Administration, the European Medicines Agency, or other agencies in high-income countries—are either delayed in approval, not approved, or have restricted approval compared with western nations. An example of delayed approval is bevacizumab for metastatic colorectal cancer, which was approved in China 6 years after its initial approval in the USA. Lenalidomide, an effective drug for myeloma, was approved by the US Food and Drug Administration in 2008, but was only approved for use in China in 2013. The bivalent and quadrivalent vaccines for human papillomavirus (HPV), which have been used since 2006 in more than 140 countries around the world for primary prevention of infection and cervical cancer, are not yet available in mainland China because of the lengthy process for drug approval.[44]

In 2009, to ensure access to essential medicines for poor and uninsured patients, China released the National

Essential Drugs List. This list is a catalogue of drugs that are priced at the manufacturer's cost without additional fees for profit and has higher reimbursement rates available under the national insurance system than for other drugs.[45,46] As of 2012, only 24 anticancer drugs (and only one opioid analgesic) were included in the list.[46] In addition to the national list, each province has its own Reimbursement Drug List, citing drugs that are reimbursed by public medical insurance plans. This list is issued by the central government and is then adjusted by local governments.[47]

Although anticancer drugs listed in the Reimbursement Drug List and linked to standard treatment guidelines are easier to procure and are more affordable,[48] patients still need to contribute to the drug's cost—an amount that varies from one region to another.[47] Innovative drugs are often unavailable through the National Essential Drugs List or local Reimbursement Drug Lists, so patients have to cover the full cost of these expensive drugs.[46,49] There is a possibility that hospitals stock only imported drugs instead of cheaper domestic drugs. Additionally, some patients might be overtreated through off-label use of anticancer drugs. Such off-label use could be common; in a 2011 study, Wang and colleagues[50] noted that of 2591 medical orders for 1122 patients in a major Chinese hospital, about 40% of orders for anticancer drugs were off label, although the therapeutic schedules were fairly standard. As in many other countries, there are shortages of anticancer drugs in China. Injectable cyclophosphamide, a low-cost drug used for treatment of many cancers, is only produced by two or three domestic manufacturers. Melphalan, a cheap (but effective) drug for multiple myeloma, is almost out of stock in the market.[51] Many factors are associated with drug shortages in oncology, but the most important are economic incentives for profitable production of these drugs.[52]

In the European Union, drug costs are not a key contributor to overall costs of cancer treatment.[53] Hospital inpatient care accounts for more than half of cancer-related health-care costs (56%), followed by drug expenditure (27%), outpatient care, primary care, and emergency care.[53] However, because inpatient care includes drug costs for inpatients in some countries, but not in others, numbers are difficult to compare. In China, drug costs account for 51·5% of outpatients' and 42% of inpatients' medical expenses; examination and treatment accounted for 29·7% and 26·7%, respectively, of treatment costs in public hospitals, and physical examination and treatment accounted for 29·7% and 26·7%, respectively.[54]

An incentive system applied to Chinese hospitals aims to make them market oriented, and government subsidies to public hospitals are now less than 8%.[54] However, to ensure that basic health services remain affordable, the government has set prices for many services below their true cost, whereas high-technology examinations are often expensive, and profit margins for drugs are permitted.[55] For example, inpatient nursing fees (which cover the technical labour services of nurses) range from ¥10 to ¥36 ($1·6 to $5·9) per day.[56] As a result, poor quality of services, overprescribing, and excessive testing have become widespread.[55]

The result of this complex system of drug reimbursement is that in China, unlike in the USA, drug use is driven by affordability rather than clinical benefit. Some patients do not have access to drugs with proven benefits, or are forced to use generics produced in China or India that are often much cheaper than the branded equivalent, but can be of questionable quality.[43,57] Findings from a survey by Kantar Health[58] in 2010 showed that only 30% of patients with breast cancer with tumours overexpressing HER2 (also known as ERBB2) had access to the monoclonal antibody trastuzumab, which has level 1 evidence for survival benefit in early and metastatic disease. Trastuzumab, and other highly beneficial monoclonal-antibody anticancer therapies, are used in only 45% of eligible patients in China compared with 80% of eligible patients in the USA, western Europe, or Japan.[58] Many new agents (eg, lapatinib, amrubicin, eribulin, and everolimus) can only be obtained from outside mainland China.[57]

To address this issue, China's Ministry of Health has identified specific priority diseases for further reduction of co-payments.[39] By 2013, 20 priority diseases (including eight cancers) had been identified, for which 70% of inpatient medical care expense is now covered.[59] The cancers included in this programme are childhood leukaemia, breast cancer, cervical cancer, chronic myeloid leukaemia, lung cancer, oesophageal cancer, gastric cancer, and colorectal cancer.[59,60]

Another component of poor access to optimum drugs for patients with cancer in China is a fragmented and inadequate localised system for the provision of palliative care. In a global study by the International Observatory on End of Life Care,[61] four levels have been used to describe the capacity for development of hospice and palliative care: no known hospice or palliative care activity; capacity-building activity (but no services yet); countries with localised provision of hospice palliative care (including China, Russia, and Brazil); and countries where hospice and palliative care activities are approaching integration with the general health system. In countries with localised provision, in many instances palliative services are mostly inaccessible to large parts of population.

An important milestone in the initiative for management of cancer pain in China was the official introduction of WHO's three-step analgesic protocol to Chinese professionals in 1991.[62] However, in mainland China, palliative care is still a fairly new and developing specialty. Essential drugs that can alleviate pain are frequently not used. For example, morphine tablets (a basic drug for alleviation of cancer pain) are not only effective and safe, but are also economical. However, of 27 808 Chinese hospitals, only 57% were able to provide

morphine for patients according to nationwide statistics in 2008,[63] and only one opioid analgesic was included in the National Essential Drugs List in 2012.[46]

Other traditional factors consistent with the culture and conditions in China result in Chinese families frequently not disclosing patients' diagnosis and disease details, making appropriate communication regarding end-of-life care between physicians and either patients or their families difficult.[64] Courses about palliative care are not mandatory for students enrolled in the medical universities of China. Medical students can select optional courses about palliative care for terminal patients in only a few medical universities.[63]

Access to infrastructure for cancer care

China has more than 100 000 district or level one hospitals, and almost 7000 subspecialty hospitals,[16] which translates to a physician distribution of 1·47 per 1000 population and a hospital bed coverage of 3·81 per 1000 population, compared with 2·24 physicians per 1000 population and 3·6 beds per 1000 population in upper-middle-income countries.[65,66] In the 1950s, China began to establish cancer hospitals in each province and in some major cities.[67] To further increase availability of medical services, the State Council's 2010 working plan called for the establishment of an additional 830 county hospitals, 1900 village hospitals, 1256 urban community health-service centres, and more than 8000 village health-care clinics.[68]

Today, China has more than 200 cancer hospitals, with more than 30 tertiary-level hospitals for cancer that provide the highest level of care.[10] In addition to these cancer hospitals, which offer expertise in various cancer disciplines, many general hospitals have oncology departments. Overall, although the number of beds for cancer care doubled from 2005 to 2010 (now totalling 134 395 nationwide[41]), they are unevenly distributed across the country, with twice as many beds available in urban areas (6·24 per 1000 inhabitants) as in rural areas (2·8 per 1000 inhabitants).[66]

Because patients with cancer are free to choose their health-care provider in most public Chinese hospitals regardless of location, patients tend to gravitate to large tertiary care hospitals in urban areas.[69] This trend leads to overcrowding of renowned inner-city facilities, prolongs time to diagnosis and treatment, and increases the likelihood of out-of-pocket expenses for patients.[70] The average annual out-of-pocket expense at these facilities is $15 076, which few households can afford.[47] Even in community-based health-care facilities, many patients have difficulty covering expenses for cancer care that should otherwise be funded by their local hospital. Under the present system, local health-care authorities are supposed to provide a substantial share of the local hospital's operating budget, but this obligation is difficult for resource-poor communities. In response to insufficient funds and resources, local providers generate revenues by providing investigations and procedures that are affordable for affluent patients in their communities, and generally provide fewer and lower-quality services to poorer people—a model that aggravates existing disparities in access to care.[16]

Apart from infrastructure and financial support, adequate cancer care in China is hampered by a lack of oncologists. Although 435 870 physicians graduated in China in 2010, there remains a substantial shortage of cancer specialists,[66] with only about 25 600 physicians registered as oncologists.[41] An aim of the central government is to subsidise an additional 3000 physicians to ensure staffing of at least one licensed physician per township clinic, an important measure that will, however, increase the number of oncologists only marginally, if at all.[68] Recent surveys suggest that most oncologists have a sound knowledge and awareness of advances in modern cancer treatments,[58] but qualified staff for cancer care are not evenly distributed across the country, with rural areas having difficulty attracting and retaining qualified personnel.[16] Aggravating this shortage of cancer specialists, most physicians in tertiary care hospitals are subspecialised as tumour-specific oncologists, thus potentially reducing the doctor-to-patient ratio for specific cancer types. Additionally, streamlined and effective cancer care is hampered by a lack of structure in many programmes, with poor or absent communication between specialists. For example, pathology and imaging reports are generally read and reported in isolation from the clinicians managing the patient, which could adversely affect optimum decision making.[57] As is the case in most low-income and middle-income countries, doctors, nurses, and other personnel for cancer care are overwhelmed by the number of patients needing care. Up to 100 patients are seen daily in outpatient departments, which is equivalent to a consultation time of about 3 min per patient.[71] In the past 10 years, the real incomes and social positions of Chinese doctors have fallen, by contrast with their high workloads and massive clinical responsibilities, particularly with the transition to market-oriented health-care reform.[72] For patients, care delivered under time and resource constraints, together with high expectations of physicians in specialised cancer hospitals, frequently leads to disappointment among family members towards medical personnel. Poor outcome of family members coupled with high out-of-pocket expenses often leads to violence against doctors and other medical personnel. In 2006, 9831 cases of such violent incidents against doctors were reported, and 5519 incidents resulted in serious injury.[73] Between 2006 and 2010, the Chinese Ministry of Health reported a rise in major events involving physical violence in Chinese health facilities from 9831 to 17 243.[74] *Yi Nao* gangs (criminals specialising in medical or hospital disturbances) conspire with families willing to take violent measures

against medical personnel for a substantial cut of any subsequent compensation.[75]

Key challenges for improvement of capacity and technical qualifications for overall health and cancer care include not only more health institutions and health professionals, but also balanced distribution of trained staff across the nation and the creation of equitable resources and funding for control and delivery of cancer care in all regions.[18]

Disparities in access

In addition to a general lack of human and other resources in cancer care, China's vast population, large geographical span, and diverse cultures and socioeconomic groups create wide disparities in cancer care within the country. Remarkable progress has been made towards upgrading the health-care system generally, but elimination of disparities remains a crucial step for China. The country has a fairly wealthy eastern coastal region, a poor rural western region, and an intermediate central region (figure 1).[11,76] Substantial social and health inequalities exist across these differing regions.[11] Awareness of such inequalities will hopefully lead to improved quality of care for patients with cancer in poorer regions of China, and ultimately an increase in the number of cancer survivors.

For example, there are 8·5 doctors or nurses per 1000 people in eastern China, compared with 2·8 per 1000 people in rural western China.[10] Inaccessibility for geographical reasons also contributes to poor overall health and cancer outcomes. In western China, 47% of poor people live within 2 km of a medical clinic, compared with about 65% of poor people in the northwest and central metropolitan areas.[77] The Ministry of Health plans to attract more physicians to underserved regions, with the intention of training 5000 physicians specifically to support western and central China, and to improve the quality of physicians in more remote primary care facilities.[78] Despite improvements in life expectancy in poor and remote areas of China, the more developed eastern and northern areas continue to profit most from the recent progress that has been made.[79] The goal of major health-care reform therefore needs to focus on grassroots medical networks, which can penetrate lower-tier socioeconomic populations and remote geographical regions.[68] If this issue is addressed from the grassroots level, patients with cancer in such regions will be more likely to have access to essential drugs, therapies, and screenings.

In addition to regional differences within the country as a whole, important disparities also exist between rural and urban areas within regions. In China, an urban area is defined as an area where economics, politics, and culture do not centre on agriculture.[11] Between 1980 and 2011, the urban population increased from 191 million to 691 million,[80] with recent estimates that 48·7% of the population of China live in rural areas. Although the number of impoverished people in rural China has fallen (from 250 million in 1978 to 36 million in 2009) and the proportion of people living on less than $1 per day has decreased from 46% in 1990 to 10·4% in 2005,[81] substantial disparities remain. Urban residents continue to have an advantage compared with rural residents in terms of longer life expectancy, better education and employment, higher socioeconomic status, and better access to health services—and in turn, improved access to cancer care.[82] Similarly, urban residents are likely to have cancer diagnosed at an earlier stage, leading to a wider variety of effective treatment options and better cancer outcomes.

Common cancers occurring in developing countries (eg, liver, cervical, oesophageal, and gastric cancer) remain common in rural China, whereas those related to westernised lifestyles (eg, lung, breast, and colorectal cancer) are rapidly increasing in urban areas. Because of disparities in access to optimum cancer care, mortality rates are increasing faster in rural than in urban areas, and rural rates have now surpassed those in urban areas.[22]

Despite health insurance coverage increasing from 21·0% to 97·4% between 2003 and 2011, and the raising of the medical reimbursement ceiling from $8035 to $9642, poor urban and rural patients continue to be disadvantaged in many ways. They are twice as likely to experience catastrophic health expenditures and are seven times more likely to be impoverished by medical expenses than are richer patients; inpatient reimbursement rates remain low in rural areas (43·7% in rural areas compared with 54·6% in urban areas).[22,37,39,83–85] Because cancer drugs (especially brand-name and new drugs) are particularly expensive and are often not covered by insurance, catastrophic health expenditure is an urgent issue for oncology. To address this difficulty, the Urban and Rural Social Medical Aid system was established to help patients who are severely ill, have low incomes, or belong to families with special financial difficulties.[86]

China has a large population of rural migrants and migrant workers (about 170 million people, or 9% of the national population), known as the floating population,[87] which creates additional challenges for provision of optimum health care.[80] After moving to urban areas without gaining permanent urban residency, migrants live and work in poor conditions, which results in an increased risk of occupational diseases and poor access to cancer care compared with non-migrant urban residents.[88] They are also far less likely to get optimum medical attention because their workplaces are far away from their place of registration. Only 19–45% of migrant workers within China have access to health insurance because their insurance providers are remote to their place of residency. Often the reimbursement from insurance available to these workers is variable and limited by pooling of funds at a local level. These obstacles are mostly responsible for reports that up to 53% of so-called migrant patients do not have access to a doctor when they become ill.[89] Because migration from rural regions to urban areas will probably persist and increase, medical insurance

needs to be linked to place of residency for these workers to access affordable health and cancer care.[39,84] The Urban Employee Basic Medical Insurance policy is one step forward in this respect, covering urban employees and retirees, some urban residents with flexible employment, and some migrant workers.[43] For disadvantaged groups, Social Medical Aid is also a minimum provision. However, migrant workers need flexible insurance, particularly for cancer care. People with slowly progressing life-threatening diseases such as cancer usually want to go home and need some family care. If mobility is needed for migrant workers, but health insurance is not mobile, cancer care will be hindered.

The environment and cancer in China

Economic growth and environmental pollution

The association between environmental pollution and economic development can be generally depicted by an inverted U-shaped curve, or an environmental Kuznets curve.[90,91] This curve shows an initial worsening in environmental conditions with economic development, followed by improvement as the economy grows and stabilises at a higher level.[90]

China's economic policy of "growth-at-all-cost"[92] in the past 30 years has resulted in inefficient use of natural resources, serious environmental pollution, and resultant damage to the population's health with concomitant increased costs.[93] In particular, the combination of increased production and consumption of raw materials and low efficiency of resource use has resulted in a substantial generation of waste products. The release of chemical toxins into the environment by industrial plants causes air and water pollution, resulting in water from half of sites sampled in the seven main rivers in China being unsafe to consume.[94] Additionally, biomass fuel and coal are burned for cooking and heating in almost all rural and many urban households,[95] leading to air pollution well in excess of recommended standards for health in many cities. The severe deterioration of the environment across China has severely affected human health, and is a major source of morbidity and mortality.[24,96]

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Pollution and cancer

Contamination of the environment is strongly associated with the occurrence of cancer.[97] Factors that have been directly implicated in the risk of developing cancer include radiation factors (eg, ionising and non-ionising radiation), carcinogenic chemicals (eg, asbestos, dioxins, and other pollutants), and biological carcinogens (eg, some viruses and bacteria).[98] The massive amounts of outdoor and indoor air pollution, together with contamination of soil and drinking water, have increased exposure of the Chinese population to many environmental carcinogens.[99,100] Modifiable environmental risk factors account for nearly 60% of cancer deaths in China, with chronic infection accounting for 29·4% of cancer deaths (31·7% in men and 25·3% in women), and tobacco accounting for 22·6% of cancer deaths (32·7% in men and 5·0% in women). Cancers of the bladder, nasal cavity and larynx, lung, and skin, and mesothelioma, leukaemia, and angiosarcoma of the liver, are all associated with occupational exposure to carcinogens.[101] Other examples of cancer that have been linked to specific exposures include brain cancer (non-ionising radiation), leukaemia (exposure to 1,3-butadiene), lung cancer (air pollution), and prostate cancer (exposure to pesticides and polyaromatic hydrocarbons).[97]

WHO estimates that 19% of all cancers worldwide are attributable to the environment (including work environment), with 1·3 million deaths annually.[102] In China, the increase in cancer rates has been strongly linked to environmental pollutants, particularly in rural areas;[103] the physical and psychological effects of contamination of air, water, and food have substantially and negatively affected the nation's health.[104,105]

Indoor and outdoor air quality

The expansion of economic and industrial development has resulted in tremendous increases in energy consumption, emission of air pollutants, and the number of poor-air-quality days in megacities and their immediate vicinities.[106] China has severe air pollution, defined as contamination of the indoor or outdoor environment by any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere. Long-term exposure to combustion-related fine-particulate air pollution is an important environmental risk factor for mortality from cardiopulmonary disease and lung cancer.[107] According to data from GLOBOCAN 2012, lung cancer represents 21·3% of all cancers and 27·1% of all cancer-related deaths in China, making it the most common cancer in terms of both incidence and mortality for women and men. The increased risk of lung cancer in eastern China compared with western China is probably attributable to both higher rates of smoking and worse air pollution; these risks are particularly high in some rural communities.[108]

Outdoor air quality in Chinese cities is among the worst in the world and is a widespread health hazard.[95] The average annual concentration of particulate matter measuring less than 10 μm in ambient air meets grade I (the best) air-quality standards in only 3·1% of all Chinese cities, whereas 11·0% of cities have grade III–IV (the worst) concentrations.[109] In one study[109] of 113 major cities, 0·9% met grade I national air-quality standards, 83·2% had grade II air quality, and 15·9% had grade III air quality. The worst air pollution occurs in large cities such as Beijing, where the concentration of fine particles reached 886 μg/m³ in January, 2013, which is 35 times higher than the WHO-recommended standard for acceptable daily exposure.[110] During June, 2013, Beijing's air was heavily polluted for 6 days consecutively.[111] Several Chinese cities, including Chongqing and Shanghai, have reached similar

extreme concentrations during the past 2 years.[111] By comparison, most European countries did not reach concentrations of greater than 100 μg/m³ on a single day in 2011, and none exceeded values greater than 200 μg/m³.[112]

In addition to outdoor air pollution, cooking and heating with coal and other biomass fuels on open indoor fires or traditional stoves results in indoor concentrations of air pollutants that are 100 times higher than is acceptable.[113] Every year, smoke from cooking fuel accounts for an estimated 2 million premature deaths worldwide, more than the deaths from malaria and tuberculosis combined.[114] Overall, about 60% of the 264 million rural households in China rely on wood or agricultural residues for indoor and outdoor cooking, and another 58 million households use coal to cook.[115] In western and northern China, almost all rural households depend on solid fuels.[115] Consequently, exposure to indoor smoke pollution is highest for women and young children.[113] Mu and colleagues[116] reported that, among non-smoking Chinese women, lung cancer was strongly associated with several sources of indoor air pollution, including heavy exposure to environmental tobacco smoke at work (adjusted odds ratio [OR] 3·65, 95% CI 1·57–8·48), high frequency of cooking (adjusted OR 3·30, 95% CI 1·32–8·22), solid fuel use for cooking (adjusted OR 4·08, 95% CI 2·17–7·67), and heating with a coal stove (adjusted OR 2·00, 95% CI 1·24–3·23). This association results in higher rates of lung cancer in Chinese women (21·3 per 100 000) than in women from European countries (16·4 per 100 000 in Germany and 11·4 per 100 000 in Italy), despite a substantially lower rate of smoking in adult women in China (3·7%) than in either Germany (25·8%) or Italy (19·2%).[117–119]

Findings from a national study[120] suggested that tobacco smoking is responsible for 32·7% of all cancer deaths in Chinese men and 5% of cancer deaths in Chinese women. Although smoking prevalence in China is predicted to slowly decrease on the basis of findings from the 1996 and 2002 national smoking surveys, the burden of tobacco-related cancer will still continue to increase.[120] Programmes and initiatives for tobacco control urgently need to be strengthened to reduce the burden of smoking-related cancer in China.[120] The WHO Framework Convention on Tobacco Control officially took effect in China in 2006.[121] China is required to meet the framework's commitments, including a comprehensive ban on all tobacco advertising, promotion, and sponsorship in the media, and ensuring that all indoor public places are free of secondhand tobacco smoke before 2011.[121] Although China has made considerable efforts to implement the Framework Convention, there is still a huge gap between China's present status and the framework's requirements.[122] Some obstacles have hindered the implementation of the requirements—eg, a low budget for tobacco control (0·5% of the total budget for disease prevention and control) compared with the high profits of the tobacco industry.[122]

Overall, ambient air pollution ranks fourth and household air pollution ranks fifth as risk factors for loss of age-standardised disability-adjusted life-years.[24] Recently, China has banned the household use of coal in cities, but alternative sources of energy need to be offered to rural households in view of the persistently high rates of coal use, especially in undeveloped rural areas.[123]

Water pollution

China faces severe issues in the quantity and quality of water supply.[124] A rapidly growing economy and burgeoning population has been accompanied by severe deterioration in the quality of water in China's rivers and lakes.[92] Vast discharges of industrial and domestic waste water, indiscriminate disposal of solid waste, extensive use of fertilisers and pesticides, and large-scale livestock breeding have rendered many water sources unfit for human consumption.[94] Industrial water demand has decreased by about 30% and domestic water use has roughly doubled in the past 15 years; as a result, the main environmental pollutants of concern have changed from heavy metals and toxic organic chemicals generated by industrial plants to pollutants from non-point sources (ie, from many different unidentifiable sources),[94] including widespread natural and human-made pollutants that ultimately deposit into lakes, rivers, wetlands, coastal waters, and groundwater. Municipal sewage plants have the capacity to treat only 52% of waste water generated in urban areas.[125] Doubling of China's levy rates for waste-water dumping could save about 17 000 lives every year, but would need an additional $500 million annually for treatment of waste water.[124,126] 90% of river water around urban areas in China is estimated to be seriously polluted,[94] with only half of the 200 major rivers and less than a quarter of the 28 major lakes and reservoirs suitable for drinking water.[127] Chemicals draining into waterways increase algal growth beyond natural amounts, which, in turn, stimulates the formation of highly carcinogenic compounds.[126] Increased concentrations of nitrates, nitrites, and humic acids (complex organic molecules formed by the breakdown of organic matter in soil), and increased chemical oxygen demand, are positively correlated with mortality from liver[128] and oesophageal[127] cancer. The deterioration of water quality in China is estimated to have increased rates of death from cancers of the digestive tract by 9·7% for each grade of deterioration on a six-grade scale;[126] 11% of all gastrointestinal cancers in China are now believed to be due to contaminated drinking water.[129]

In addition to poor water quality, the quantity of China's water is inadequate. On a per-person basis, China has a fifth of the supply of the USA and less than a quarter of the global average supply per person.[23] Furthermore, China's water resources are unevenly distributed geographically; the heavily populated northern river basins supply 44% of the population and 65% of cultivated land with less than 13% of the available national water

supply.[127] Beyond these regional differences, disparities in access to clean water exist between rural and urban areas. Rural China has poorer waste-water management than have urban regions, with only 3% of rural villages having effective waste-water handling, and less than 30% of the rural population having access to modern water-based sanitary facilities. Overall, in rural areas more than 30 000 children die each year from diarrhoea resulting from consumption of polluted water.[130] Two-thirds of the rural Chinese population (ie, 300–500 million people) live without running water,[94] and many researchers believe that the increase in cancer rates in rural areas reported during the 1990s was caused by reductions in the quality of water in lakes and rivers used for drinking water.[92]

Food contamination

By contrast with many western countries, contamination of food with harmful chemicals or biological agents is an important health problem in China.[131] Findings from a 2011 study[132] showed that about 10% of Chinese rice might be polluted with the heavy metal cadmium, which has been discharged into the environment in industrial waste water from mines. Other heavy-metal contaminants—eg, copper, zinc, and lead—are also reported in food crops grown around mining areas and pose a substantial health risk to the local population through the consumption of contaminated rice and vegetables.[133] A known human carcinogen and contaminant is aflatoxin, a toxic metabolic byproduct of some species of fungi, consumption of which has been implicated in increased risk of hepatocellular cancers.[134,135] High temperatures, humidity, water stress, and insect damage can all increase the risk of aflatoxin contamination of grains.[136] Additionally, the use of N-nitroso compounds (eg, nitrosamines and nitrosamides) in the preparation of salted fish has been associated with an increased incidence of nasopharyngeal carcinoma.[137,138] Careful inspection of food during pre-harvest, storage, processing, and distribution stages is needed to ensure proper safety for consumers and handlers. Carcinogenic pollutants in food probably add substantially to the growing burden of cancer in China.

The illegal use of pesticides and veterinary drugs, and the illegal addition or misuse of chemical substances, is believed to contribute substantially to the burden of food-borne diseases and has gained increasing attention from health authorities and the public.[104]

Another urgent issue for China's food safety is the illegal use of food additives in food processing.[139] In 2008, melamine adulterated milk formula (including powdered and liquid milk) caused illness in 300 000 infants and at least six deaths.[131] Di(2-ethylhexyl)phthalate, a plasticiser classified by the US Environmental Protection Agency as a class-B2 human carcinogen, is widely used and has been detected in water, air, soil, and food products in China. The estimated daily intake of this chemical among the Chinese population exceeds the standard maximum allowable intake in both the USA and the European Union.[140] Other reports of food contamination and adulteration include the use of waste oil as cooking oil, Sudan dye (a group of possibly carcinogenic industrial dyes banned in China and other countries) in chicken, clenbuterol-tainted meat, salted duck eggs containing cancer-causing dye, dyed bread, and excess iodine in milk powder.[131,141,142] Many small food-processing plants have substandard environmental policies and are inadequately supervised by China's food-safety administration. The contribution of food contamination will probably continue to increase cancer risk in China.

Cancer villages

Although a direct link between specific carcinogens and cancer incidence is difficult to establish, the existence of so-called cancer villages provides important circumstantial evidence for this link. The term cancer village refers to towns and villages where cancer incidence and mortality are particularly high, and therefore justifies the potential causal association with environmental pollution.[143] Overall, Chinese media have reported up to 459 cancer villages within 29 of the 32 provincial units in mainland China.[144] An analysis[145] of news reports about 74 cancer villages showed that 70 villages had high prevalences of cancers that are directly associated with water pollution. Most of these cancers were gastrointestinal and respiratory cancers (eg, liver, lung, oesophageal, and gastric cancer).

Initiatives to counteract environmental pollution

Together, environmental, air, and water pollution in China are estimated to cause 2·4 million premature deaths every year from cardiopulmonary and gastrointestinal diseases, cancer, and other diseases or injuries.[95] The estimated financial cost of environmental pollution is about ¥512 billion (about $84 billion), which represents about 3% of China's total GDP.[92]

As a result of these statistics, environmental pollution has gained substantial attention in China. National policy now aims to improve resource use and for China to be perceived as an environmentally friendly country. China was able to reduce emissions of pollutants when it was a national priority, such as before the 2008 Olympics in Beijing.[95] The 12th National 5-Year Plan (2011–15) for environmental protection identifies four strategic measures for pollution control: total pollution control, environmental quality improvement, risk control, and balanced development. Under this plan, 60% of China's seven major water systems will have a goal for water quality between grade I and grade III, with an aim to reduce grade V or poorer systems to 15%. Additionally, 80% of cities above prefecture level will aim to have an air quality of at least grade II or better.[146]

China's Ministry of Environmental Protection has also devised a development plan for prevention and control of air pollution in major regions. The plan identifies 13 of the most polluted areas and aims to improve air

quality by focusing on several pollutants simultaneously, in an approach to control regional air pollution and atmospheric pollution.[147] States have been urged to monitor their own discharge of pollutants and to disclose the results to the public. Beijing, Shanghai, and Guangzhou have implemented stricter standards for vehicle fuel ahead of the planned government schedules.[147]

The Chinese Government spent $112·41 billion on water infrastructure between 2006 and 2010,[143] and committed more than $489 billion to improve prevention of pollution and treatment of contaminated air and water.[148] Furthermore, China has enacted a new Food Safety Law,[149] which includes 187 new national standards for food safety that encompass dairy products, mycotoxins, pesticide and veterinary-medicine residues, use of food additives, nutrition labelling, and frozen pastry and rice products.[139] These initiatives have already led to some progress in reduction of environmental contamination, as described by the 2011 Report on the State of the Environment in China.[143,150] 2587 environmental monitoring stations nationwide serve to monitor water pollution, air quality, concentrations of heavy metals, waste water, gas emissions, and sewerage treatment plants.[146]

In 2011, 45·0% of the monitoring sites had at least fairly good underground water quality.[151] Of 469 river sections and 26 major lakes, 61·0% and 42% met grade I–III standards, 25·3% and 50% met grade IV–V standards, and only 13·7% and 7·7% did not meet grade V standard.[151,152] The total chemical oxygen demand discharge and ammonia nitrogen discharge, which are the main pollutants of water, were reduced by 2·0% and 1·5%, respectively, between 2010 and 2011,[151] whereas the proportion of cities meeting the national air-quality standard increased by 10·6%.[109]

Access to running water increased from 30% of the population in 1985 to 77% in 2007, reaching nearly 94% for urban residents.[129] A total of $54 billion was invested between 1990 and 2005 in water supply and waste-water management in China's 661 designated cities; urban water industries now produce about 0·4% of annual GDP. Finally, companies engaged in environmental protection that have applied for public listings have been cumulatively valued at ¥9·97 billion (about $1·63 billion) and have successfully completed 916 pollution control projects.[150] Despite governmental spending on improvement of several aspects of environmental pollution and reports showing reductions in pollutant concentrations, outcomes such as reduced infant mortality and reduced prevalence of chronic conditions and cancers associated with pollutants need to be measured for these efforts to be effectively assessed. China seems to be turning a corner with respect to environmental pollution, but much still needs to be done, especially for rural people who have little access to running water, often use coal for heating, and are exposed to waste water and contaminated food from nearby industrial plants.

Chinese cultural traditions and cancer control

Ming and cancer fatalism

Culture and traditions are important aspects of society that affect cancer awareness and beliefs.[153] Officially, China is an atheistic nation, but statistics suggest that 100 million Chinese people belong to various religious faiths.[86] Most of these people practise Buddhism and Taoism, with a minority who are Christians or Muslims.[12]

Buddhism emphasises the cycle of life, with ageing, illness, and death believed to be natural and inevitable processes.[154] The mantra of Taoism (let it be) also portrays a belief in a natural lifecycle, in accordance with which followers perceive death to be a natural, preordained event that is impossible to alter.

The deeply engrained Taoist belief system, Ming, is responsible for cancer fatalism in China. Ming is believed to be an invisible force that governs everything in the course of human life, including birth, ageing, illness, and death. It affects the contradictory cognitive and behavioural strategies with which patients deal with cancer and survivorship.[155,156] When healthy, people perceive events in an open and optimistic manner, without concern for future illness, and acceptance of their daily existence. Cancer and other illnesses are believed to occur when an individual's state of harmony is in disequilibrium with regard to their physical, emotional, social, and environmental state. Some Chinese patients attribute most life events, including health and illness, as acts of Ming (otherwise known as fate).[157] This fatalistic attitude leads to difficulties in uptake of health-care interventions, particularly those targeted at primary prevention (eg, avoidance of unhealthy lifestyles or smoking).

Anecdotally, these attitudes are contrary to those of Chinese people living outside China, among whom optimism prevails, and who will try everything to cure disease. Liang and colleagues[158] reported that traditional cultural beliefs about cancer (eg, fatalism) were significantly associated with age at immigration to a new country. In their study of 438 Chinese-American women aged 50 years and older, women who held strong Chinese cultural views were more likely to have come to the USA in the later years of their life.

Furthermore, before and after a diagnosis of cancer, communication about treatment and prognosis is difficult because of beliefs among patients and their families that negative thoughts will merely provoke unnecessary worries and poor outcomes. Cancer and other illnesses are frequently taboo topics, which contributes further to an uninformed and misinformed public.[159] Both primary and secondary prevention of cancer are therefore thought to threaten the harmonious state of health, and are perceived as being harmful and unnecessary.[159,160]

Additionally, treatment of cancer is hampered by widespread perceptions that death is inevitable after cancer diagnosis and that the final outcome is predestined, irrespective of medical intervention.[160]

Cancer fatalism carries a sense of futility that is associated with fear and hopelessness.[161] Worldwide, cancer fatalism has been identified as a barrier to participation in vaccination for hepatitis B virus and HPV, and cancer screening, detection, and treatment, particularly in groups with low socioeconomic status (eg, African-American and Latin-American populations in the USA).[162] On the basis of their cultural beliefs, Chinese patients have an even greater acceptance of cancer fatalism, and are more likely to associate cancer treatment with misery and death than are western populations.[163,164]

Because of this fatalistic perspective, patients do not perceive cancer treatment as a method of changing the outcome of their disease. This attitude is thought to negatively affect cancer outcomes in China, because patient attitudes towards cancer are implicated in delayed presentation after development of symptoms, which can reduce the proportion of cancers diagnosed at an early stage and lead to an increase in mortality.[165] The effects of stigma and fatalism from traditional Chinese cultural beliefs about overall cancer awareness and diagnosis is understudied, but is probably responsible for the proliferation of traditional medicines, and nihilism about primary and secondary prevention of cancer.

Understanding of cancer fatalism and its role in China is important in the development of culturally sensitive approaches for promotion of vaccination, cancer screening, and cancer treatment, and to improve the relationship between doctors and their patients.

Traditional Chinese medicine

Traditional Chinese medicine (TCM) has a 5000-year history and is deeply embedded in both the rural and urban populations of China. It is intricately entwined with Chinese history, culture, and politics, and is promoted and institutionalised by the Chinese Government as a topic for research and as a point of pride.

3268 of China's 21 979 hospitals, 531 177 hospital beds, and 267 225 TCM doctors provide care to 397·7 million outpatients and 14·8 million inpatients, representing roughly 15% of all health care in China.[166] Virtually all Chinese physicians have some TCM training. More than 250 medical schools teach TCM, 20 universities teach TCM exclusively, and more than 130 000 TCM students graduate annually.[166] Graduates of TCM medical schools in China are accepted as being equally trained and credentialled as are those trained in western medicine, and can pursue residencies and fellowships with their degrees. Almost all general hospitals have departments of TCM and TCM therapies are used in cancer treatment. In China, the term integrative medicine is used to described the combination of TCM and modern western medicine in clinical practice. The Chinese Government has launched several initiatives to initiate research into and to modernise TCM (eg, the Program for Innovation and Development of Traditional Chinese Medicine, 2007).[167]

Most principles of TCM were derived from the philosophical basis of Taoism and Confucianism.[168] On these bases, diseases are believed to be caused by a disturbance in yin–yang (two opposite, yet complementary, interdependent, and exchangeable aspects of nature). TCM treatments aim to expel or suppress the cause of illness and to restore balance and health. The diagnosis that guides treatment is called *Zheng*, the hallmark of TCM theory.[169] This theory states that patients with the same disease can present with very different symptoms; conversely patients with different diseases can present with the same symptoms. TCM practitioners differentiate the illness on the basis of all symptoms and signs collected by four classic diagnostic methods: observation, inquiry, smelling or listening, and palpation.

Treatment in TCM is based on an understanding that the body has an innate intelligence and healing ability.[170] TCM consists of six primary branches that offer a holistic approach to health care: acupuncture, herbal medicine, massage (*tuina*), exercise (*tai chi*, *taiji*, and *qigong*), dietary therapy, and lifestyle.[171]

There is a widespread a-priori belief in the Chinese population that TCM is useful and beneficial because of its historical legacy in China.[172] Most Chinese physicians believe in the usefulness of TCM treatments (particularly herbal medicines and acupuncture) for symptom relief, reduction of side-effects, improvement of quality of life, and palliative care.[173,174] In oncology, TCM is believed to exert specific anticancer activity or chemosensitisation, to provide yin–yang balance, and to help in individualisation of anticancer treatment.[175,176] Chinese patients with cancer often believe that TCM can help to improve general wellbeing and relief of symptoms, and can even have curative effects. About 80% of patients with cancer are believed to have used TCM and 90% of oncologists have prescribed TCM herbs.[173]

Findings from preclinical studies in China have shown an association between some TCM medicines and apoptosis, autophagy,[177] suppression of tumour growth, and angiogenesis,[25] as well as inhibition of invasion and metastasis.[178–187] Although several case series or controlled cancer trials of TCM have been published in Chinese journals, high-level evidence for the clinical efficacy of TCM is still lacking. Findings from three systematic reviews[188–190] of the Chinese scientific literature (including 716 case reports with 1198 patients, 1217 case series with 92 945 patients, and 2964 clinical trials with 253 434 patients) showed reductions in side-effects induced by chemotherapy and radiotherapy, improvements in clinical symptoms, and improved quality of life associated with the use of TCM in cancer treatment.

Most clinical TCM research in China is focused on Chinese herbal medicines,[173] with many studies assessing pain control.[191] Other study findings have shown herbal medicines to improve side-effects associated with chemotherapy and radiation therapy (eg, diarrhoea, poor appetite, and radiation-induced pneumonitis).[192]

Although TCM is generally believed to be safe, herbal medicines can potentially cause adverse effects including abnormal liver-function tests, unexpectedly severe myelosuppression, haemostatic defects, impairment of renal function, and adverse drug interactions.[175] Because TCM often uses complex mixtures of plants, by contrast with isolated, bioactive, single natural products, some constituents in herbal composite prescriptions can contain carcinogenic compounds. Aristolochia, a prominent component of traditional Chinese medicine, has been used for centuries as an anti-inflammatory agent for arthritis and chronic skin diseases, a diuretic, an antibiotic, and a treatment for cancer.[193] However, aristolochia is associated with the development of aristolochic-acid nephropathy and upper-urinary-tract carcinomas;[194,195] the WHO International Agency for Research on Cancer classified it as a type 1 carcinogen in 2002. In addition to these adverse effects of TCM, specific harmful interactions with cancer treatments—including chemotherapy and targeted treatments—are possible and are understudied. For example, St John's wort (a popular herbal treatment for depression) has adverse effects on irinotecan chemotherapy, and patients are now instructed to refrain from combining these two agents.[196] Even with our existing knowledge of phytochemistry and pharmacology, identification of the individual effects and synergistic or antagonistic interactions of dozens of chemical constituents in herbal composite prescriptions is difficult.

Effects of culture and traditions on participation in screening and clinical trials

The notion of detecting hidden or asymptomatic disease with medical measures such as screening does not exist in traditional Chinese beliefs. Chinese patients often do not visit doctors for regular health screening, and instead present to a physician when symptoms arise. Overall assessment of wellbeing is focused on everyday life, without preoccupation of preventing future disease.[160]

Many researchers have described the Chinese population's reluctance to participate in cancer screening, both in people living in China and Chinese immigrants to western countries. According to findings from a 2001 intervention study[63] of screening for breast and cervical cancer, only 32% of non-English-speaking Chinese-American women had ever had a mammogram, compared with 86% of white American women. Screening rates for colorectal, cervical, and breast cancer were also significantly lower for non-English-speaking Chinese-American women.[160,197–202] Immigrant status, poor health communication, language barriers, and low rates of health insurance are all factors that might additionally contribute to low screening rates in emigrant Chinese women. Additionally, traditional cultural beliefs also present a substantial barrier to participation in cancer screening services.[203]

Barriers to screening are particularly prevalent in rural China, where cancer is a taboo subject—particularly breast and cervical cancer, which are associated with female sexual organs. Chinese women avoid participating in screening, and even those who have been screened are reluctant to speak openly about it.[203] Additionally, cancer centres in China focus mainly on treatment rather than prevention and early detection.[31] Many patients with cancer therefore present at later stages than in high-income countries, because presentation and diagnosis rely mainly on symptoms or the presence of palpable disease.[58] Wu and colleagues[200] reported that 75% of 400 women surveyed had never had a mammogram, with the most common reasons being low priority, feeling healthy, and lack of awareness of the benefits of screening for breast cancer. In another study,[203] only 19% of Beijing women aged 35 years or older had ever had a mammogram.

Selected sites for population-based screening are available in every province of China, although the national screening programme did not exist before 2009.[204] Cancer screening programmes are not available to the entire population, because some categories of screening only cover urban populations, subgroups with high rates of opportunistic screening, or employee-based screening through individual corporations.[25] For example, screening for cervical cancer covers only 23% of Chinese women.[205] Cancer screening is especially deficient in rural areas of China. Efforts to improve public education and awareness, to organise screening programmes, and to increase funding are underway.

In 2009, free screening for cervical and breast cancer was available for rural women under a government-sponsored 3-year programme. Overall, $11·3 million was invested to provide free screening for cervical cancer to 10 million women (6·7% of 150 million women who need screening) and screening for breast cancer to 1·2 million women, focusing particularly on under-developed regions in central and western China.[206] After 2 years of implementation, 473 000 rural women have been screened for breast cancer and 4·89 million rural women have been screened for cervical carcinoma.[18] Although this programme is a substantial step forward, the public health challenge to provide nationwide screening is enormous; 500 million women live in rural China,[204] and most do not have access to screening for either of these common cancers. A new project aimed to promote early diagnosis and treatment of cancer has started in 14 provincial-level regions, targeting lung, breast, colorectal, upper-digestive-tract, and liver cancer. The aim of the project is to develop efficient methods for cancer treatment through comparisons of cost and effectiveness of measures done at different disease stages—precisely the type of research that should be encouraged to enhance optimum cancer treatment in China. The project also includes a training programme to improve cancer prevention and cancer control in medical institutions.[207]

Public awareness of cancer should be a priority; in the interim, screening strategies should be targeted to high-risk groups, and culturally appropriate screening interventions based in the community that acknowledge Chinese beliefs need to be developed.[208] As public awareness increases, screening programmes should be made available in both rural and urban areas.

Scientific journals in western countries publish very few articles from Chinese researchers. China accounts for only 1·5% and 1·7% of publications for clinical research and randomised trials, respectively,[209] and only 3% of clinical trials sponsored by pharmaceutical companies are done in China. This figure is probably low because of a lengthy ethical approval process for new trials in China.[210]

Mentality and capability also pose barriers to the running and publishing of trials, for individuals as well as systems.[211] Chinese culture and traditional beliefs could also affect patient participation in cancer trials. Patient race and ethnic origin are important factors that can affect willingness to participate in clinical trials.[212] Lin and colleagues[213] noted many perceptual barriers to cancer screening and recruitment to clinical trials in immigrant Chinese patients with cancer in Manhattan (eg, the belief that screening for cancer can ultimately cause cancer). Despite the negative attitudes and numerous barriers to participation in clinical trials, after education and discussion with physicians Chinese patients became more receptive to recruitment.[214] Findings from a survey[215] of 578 patients with cancer and their relatives in China showed that most patients were willing to join a cancer trial at the suggestion of their doctor, or when it offered improved chance of access to therapy, although choice was affected by disease stage. With the support of the Chinese Clinical Trial Registry, the quality of clinical trials will be improved.[216]

Conclusions

Improvement of delivery and outcomes for cancer care in China needs consideration and integration of many key factors: disadvantaged populations (eg, those with low socioeconomic status), urban and rural communities, population size, rapid economic growth, environmental contamination, disparities in health-care access, and inherent traditional attitudes towards cancer. Cancer accounts for 21% of all-cause mortality in China and this proportion is increasing; allocation of government funding and methods to harness support and collaboration from non-governmental organisations are urgently needed (panel 1).[217]

National and regional policy implementation is needed to collect accurate and broadly representative data in cancer registries for common cancers (including stage of disease at presentation), with attention paid to areas with high incidence of late-stage diagnosis, rates of compliance with treatment recommendations, and clinical outcomes. This information would allow appropriate allocation of funding and resources to the areas of greatest need. Timely data collection (in view of trends of urbanisation) will allow policies to be developed to address the differing health insurance status of migrating workers, as well as strategies to address the differing socioeconomic profile of rural versus urban residents.

Education programmes are needed to enhance public awareness and to promote the benefits of prevention, early detection, and compliance with evidence-based treatments. Immunisation programmes related to prophylaxis of HPV and hepatitis B virus need to be expanded.

Fundamental prevention strategies for several common cancers include attempts to reduce known carcinogens in the air, water, and soil. To this end, incentive programmes for industries that avoid high-carbon-emission energy sources and promote safe handling of chemical byproducts, together with taxes to restrict organisations that pollute the environment, should be enhanced.

Religious and traditional beliefs are important factors that affect attitudes to cancer treatment and outcomes. Education of the community in schools, places of religious worship, and within other social groups might help to improve nihilistic attitudes towards cancer diagnosis and promote the quality-of-life benefits of early treatment. More information is needed to establish whether the delivery of palliative care to patients with advanced cancer is successful. Additionally, patients and their caregivers should be educated that measures are available to optimise symptom control, if intervention is introduced early. In view of the importance of Taoist and Confucian beliefs in Chinese culture, TCM approaches should be assessed together with conventional cancer care, in an effort to provide evidence for using a dual approach to management. If this approach provides objective benefits, it will probably be more acceptable to the community, and would also increase the pool of health-care workers available to manage the growing population of patients with cancer.

As with other emerging nations, the shortage of trained health-care workers and their availability in rural regions restricts the delivery of optimum care. Training of more health-care workers to meet the needs of local communities could improve education about prevention, screening, and initial diagnosis for health-care trainees. Additionally, incentivisation of medical staff who work in underserved areas might help mitigate disparities in care. Workers (so-called navigators) who can converse in the local dialect with knowledge of basic cancer facts might have more time to communicate effectively with patients with cancer and help them to navigate the many steps needed for optimum cancer outcomes. The alarming rate of violence towards health-care workers needs to be addressed, perhaps with distribution of literature, community and regional education meetings, and provision of non-medical (but trained) individual

navigators to spend adequate time with patients and their families. These approaches are probably more effective, particularly in the prevention of violence, than is law enforcement, which—although important in curtailing of violence in general—should be the last resort in situations where uneducated patients and families are faced with existential health threats and extreme emotional burden.

The benefits of a multidisciplinary approach to the management of cancer have been clearly shown in developed countries. However, this strategy might not be practicable in China. Establishment of alternative approaches needs programmes designed within the existing structure of health-care delivery. Methods that can improve communication between health-care workers to establish protocol driven management of patients with common cancers are needed. Within particular regions, local health authorities must establish best standards of care within the context of available funding, and assess prospectively whether equitable treatment is delivered. An evidence-based research approach is needed to establish guidelines for care for different cancers, tailored to local funding and health-care structures.

As with all countries, the cost of cancer care continues to compete with other medical problems, as well as other national needs. Improved communication between governmental departments and health-care insurance organisations is needed to reduce the substantial personal cost to Chinese patients with cancer. Differential funding might be needed to reduce the disparity in access to effective cancer treatment, which occurs across geographical regions and socioeconomic groups.

Lastly, health-care stakeholders in China need to fund and develop research programmes for cancer to identify the applicability of treatments that have largely been established in white populations in western countries. Toxic effects of treatment, genotypic behaviour, and pharmacokinetic handling of systemic treatments might differ between the Chinese population and other populations. Improved understanding of these factors could potentially affect both the optimum treatment for various cancers and the cost and resources needed.

Panel 1: **Summary and recommendations for cancer control in China**

National policies
- Timely and increased collection of population data, taking into account urbanisation trends

Prevention programmes
- Governmental directives to reduce environmental pollution

Religious and traditional beliefs
- Education to reduce nihilistic attitudes to cancer

Assess traditional Chinese medicines in the context of conventional therapies
- Involve traditional practitioners in delivery of cancer care and improve understanding of drug–drug interactions

Health-care training
- Equip local community health-care providers to communicate strategies for cancer prevention, screening, and treatment

Multidisciplinary approach
- Improve communication between health-care providers and patients and their caretakers

Research
- Promote local research to assess differences in cancer biology and response and tolerability to treatment

India

Background

The increasing population of India poses substantial challenges to the government's capacity to provide consistent health-care infrastructure and delivery of care. Although communicable diseases remain a common cause of mortality, non-communicable diseases (including cancer) now account for more than 50% of deaths in India. Although overall cancer incidence is lower in India than in most high-income countries, the relative mortality rates are higher. Overall, this disparity results in a substantial contribution to global cancer deaths because of the country's growing and ageing population, increasing westernisation of lifestyles, and increased levels of environmental pollution.[218] We examine some key obstacles to the structure and delivery of future optimum cancer-care in India, including affordability, provision of trained cancer personnel, and the effects of sociocultural barriers.

India is home to 1·24 billion people, and after China is the second most populous country. India accounts for 17·7% of the global population but, at 3·286 million km², only occupies 2·1% of the world's land surface area.[219,220] India is a pluralistic, multilingual, and multiethnic society. India's GDP grew by 6% per year during the past two decades, and was $1·873 trillion in 2011, making India the third largest purchasing power globally;[219] per-person GDP was $1489 in 2009–13.[221] India is divided into 28 states and seven union (federal) territories, with 27 cities having populations of more than 1 000 000 people. India's population density in 2012 was 367 per km², compared with 32 per km² in the USA. Although the number of Indians living in cities grew by 31·8% between 2001 and 2011, according to the 2011 census, nearly 70% still live in rural areas.[12]

For the **Indian 2011 census** see http://www.censusindia.gov.in

The median age of the Indian population is 26·5 years (compared with 40·3 years in the UK and 37·2 years in the USA),[12,222,223] with a 1·08 male-to-female ratio. Life expectancy in India is about 64 years for men and 68 for women.[224,225] The 74% literacy rate of the population is skewed in favour of men (82·1%) compared with women

(65·5%), according to data from the 2011 census. For such a large country health expenditure is low, with only about 3·9% of GDP spent on health care and 0·6 physicians and 0·9 beds per 1000 population, compared with 2·42 physicians and three beds in the USA and 2·77 physicians and three beds in the UK per 1000 population, respectively.[222,223,226]

The Indian Council of Medical Research has collected data about cancer incidence through several population-based cancer registries for the past 30 years. Although these registries cover only 7% of India's cancer population, they provide the best available information to understand the effects of cancer on national morbidity and mortality rates, and for future planning of health expenditures on cancer.[227] In India, an estimated 2·5 million people live with a previous diagnosis of cancer.[228] Although the age-standardised rate of cancer is 92·4 per 100 000 men and 97·4 per 100 000 women, the age-adjusted incidence for all types of cancer in India in urban areas ranges from 92·1 to 126·1 per 100 000 for men and from 107·8 to 142·0 per 100 000 for women.[5,229] The lowest incidences (36·21 per 100 000 men and 45·02 per 100 000 women) were reported in the rural region of Barshi, whereas the highest rates (103·0 per 100 000 men and 113·9 per 100 000 women) were reported in Delhi.[229] The most common sites of cancer in men are the oral cavity, lung, oesophagus, and stomach; in women, the most common cancers are cervical, breast, and oral-cavity cancers.[230] In urban registries (with the exception of Chennai), breast cancer is the most common type of cancer among women.[231] The age-adjusted rate of breast cancer in India is 30–35 per 100 000 women per year, and its incidence is increasing; the number of new cases in Mumbai is expected to double by 2021–25 compared with 2001–05 (table 2).[232] 50% of all cancer deaths in India can be attributed to oral and lung cancer in men, and cervical and breast cancer in women, with 40% of all cancers attributable to tobacco use.[228]

More recently, the Indian Council of Medical Research initiated the Cancer Atlas project, which provides data for regional differences and enables the analysis of trends in cancer incidence over time.[233] The registry also showed that the Aizawl district in the northeastern state of Mizoram has the world's highest incidence of cancer of the lower pharynx in men (11·5 per 100 000 men) and of tongue cancer (10·2 per 100 000 people), whereas other areas of India have regional variations in cancer incidence.[233] These variations in cancer incidence are affected by cultural differences (eg, patterns of tobacco use), social norms (eg, age at first childbirth), and sociodemographic trends (eg, relative wealth), and might also be affected by biological factors such as diet and genetic mutations (figure 2).[233,234–244]

	2001–05* (reported)	2021–25* (predicted)
Number of cases	1337	2664
Incidence per 100 000 women	27·3	..
Increase from 2001–05 (% change)	..	1327 (99%)†
Number of cases, ages 0–49 years (% of total)	534 (40%)	840 (31·5%)
Number of cases, ages 50–74 years (% of total)	698 (52·2%)	1545 (58%)
Number of cases, ages ≥75 years (% of total)	105 (7·8%)	280 (10·5%)

Comparison of observed and predicted mean annual cases of breast cancer in Mumbai, India, for 2001–05 and 2021–25, assuming continued linear trend. Data modified from Dikshit and colleagues[232] by permission of the authors. *Mean annual cases. †90% of increase in incidence is estimated to be due to population ageing.

Table 2: **Reported and predicted incidence of breast cancer in Mumbai, India**

Cancer is an important cause of adult deaths in India, with about 6% of all deaths (0·55 million) attributed to cancer each year.[245] This number will probably increase substantially because of changing population demographics and lifestyle factors.[245] Importantly, 71% of cancer deaths occur in patients in their prime productive years (ie, between 30 and 69 years of age).[245] Mortality is twice as high among the least educated (106·6 per 100 000 population) than among the most educated (45·7 per 100 000 population) groups.[245] Despite the incidence of cancer in rural areas being half of that in urban areas,[246,247] age-standardised mortality rates for cancer were similar in rural and urban areas, suggesting substantially higher mortality from cancer for patients living in rural areas than for those living in urban areas.[245] This distribution is probably due to a combination of factors (eg, socioeconomic status, diagnosis at a more advanced stage of disease, and a lack of facilities for cancer treatment in rural India).

In response to the increasing burden of cancer, the Indian Government launched the National Cancer Control Programme in 1975.[248] The goals of the programme included primary prevention through health education, secondary prevention through early detection and diagnosis, support of existing facilities for cancer treatment, and improvements in the delivery of palliative care.[249] The programme's achievements include the development of the National Cancer Registry Programme (which identified the magnitude of the burden of cancer in India), emphasis of the lack of human resources for cancer, and provision of necessary data to enable the establishment of facilities for treatment and rehabilitation to address this need. Data from the registry have enabled government policy makers to recognise the effect of cancer on the nation's health,[250] resulting in the formation of 27 regional cancer centres in India.[251] Additional funding has been provided to more than 80 public hospitals to establish oncology services. At a local level, programmes for cancer control are now operational in 21 states throughout the country.[252] To enhance collaboration between all medical institutions, the ONCONET-India project was initiated by the National Cancer Control Programme. The project provides telemedicine services between regional cancer centres and to four peripheral medical centres to enable prompt referral of patients and consultative communications between specialists

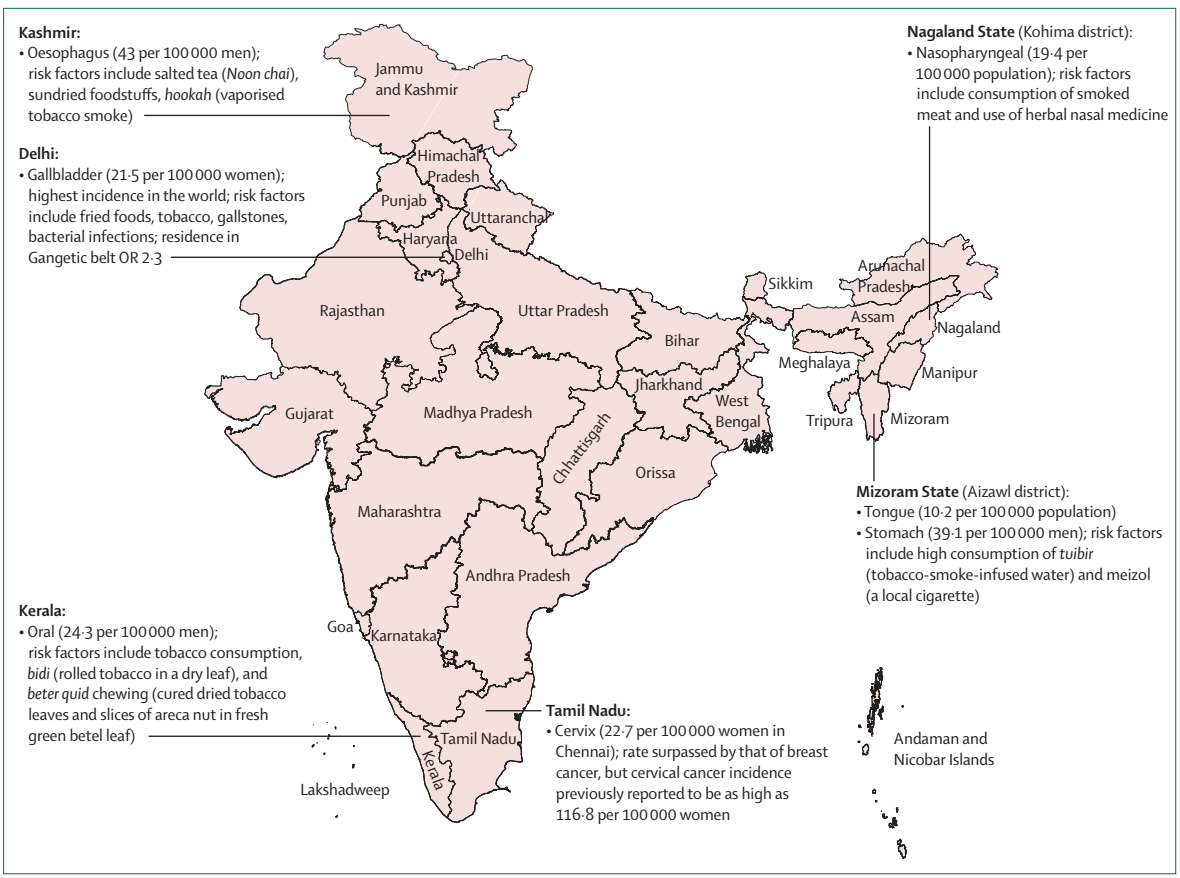

Figure 2: **Geographical distribution of cancer in India**
Figure based on data from Nandakumar and colleagues,[233] Kataki and colleagues,[234] Chelleng and colleagues,[235] Phukan and colleagues,[236,237] Randi and colleagues,[238] Jain and colleagues,[239] Mir and colleagues,[240] Ali and colleagues,[241] Coelho and colleagues,[242] Swaminathan and colleagues,[243] and Gajalakshmi and colleagues.[244]

(eg, review of pathology reports). Continuing medical education to general physicians and junior staff is also provided through this mechanism.[228] The potential benefit of this programme will further expand through use of telemedicine between regional cancer centres and the 300 or more general or multispecialty hospitals across India.[253]

Beyond the cancer-specific National Cancer Control Programme, cancer care is further supported by a broader strategy. The National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke[254] is the Ministry of Health's top priority for response to the increasing burden of non-communicable diseases in India. This initiative earmarked 7·32 billion Indian rupees (about $118 million) for cancer control for 2010–12 on a cost-sharing basis between the federal centre and the states. In the future, the programme will expand five-fold from the existing 100 districts to the entire country, with a goal of 25% reduction in premature mortality from non-communicable diseases by 2025.[255] Strategies are urgently needed to formulate treatment policies that are not merely based on international guidelines from high-income countries, but are tailored to specific settings in India. We discuss specific barriers that must be overcome to improve prevention and early detection, enhance prompt treatment, and provide cost-effective palliative care for patients with advanced stage disease.

Affordability of cancer care

Cancer treatment

The delivery of health care in India is financed by the public sector, private and employer-funded insurance, personal out-of-pocket fees, community-based and non-profit organisations, and by external funds from loans and grants.[256–258] Data from WHO show that in 2010 about $54 per person per year was spent on health care in India.[259] The government spends only about a third of this amount ($16), which is equivalent to only about 3·9% of India's GDP (table 3).[259–261] The proportion of GDP spent on health care by the Indian Government is low when compared with both larger countries and economies (eg, China [5·2%], the USA [17·9%], and the UK [9·3%]) and smaller countries (eg, Afghanistan [10·4%], Nepal [5·1%], Bhutan [4·3%], or Maldives [6·2%]).[259] Private expenditure on health (distinct from out-of-pocket expenditure) as a percentage of total

	Total health expenditure, 2010 (US$)	Per-person health expenditure, 2010 ($)	Household out-of-pocket spending, 2010 ($), and % of total health-care spending	Governmental spending, 2010 ($), and % of total health-care spending	General government expenditure on health (% GGE)	General government expenditure on health (% GDP)
India	66 billion	54	33 (61%)	16 (29%)	4%	1%
Russia	75 billion	525	165 (31%)	326 (62%)	8%	3%
China	289 billion	221	82 (37%)	118 (54%)	12%	3%
Bhutan	79 million	108	13 (12%)	94 (87%)	10%	5%
Timor-Leste	64 million	57	6 (11%)	32 (56%)	5%	5%
France	304 billion	4691	344 (7%)	3652 (78%)	16%	9%
Denmark	36 billion	6422	842 (13%)	5465 (85%)	17%	10%
UK	217 billion	3503	350 (10%)	2938 (84%)	16%	8%
USA	2584 billion	8362	987 (12%)	4437 (53%)	22%	9%

Data from WHO.[259] GGE=general government expenditure. GDP=gross domestic product.

Table 3: **Health-care expenditure by country, according to payer and governmental expenditure on health**

expenditure on health is 71·8% (compared with 16·8% in the UK and 51·8% in the USA),[262] with state and central governments contributing only 12% and 6·8%, respectively.[263,264] The government's contribution to health spending is thus less than 1% of the country's GDP (table 3).[228,259] As a result of substantial household out-of-pocket costs, an estimated 3·1 million households (2·2% of the population) are impoverished yearly because of catastrophic health expenditure.[228,265]

There are three broad socioeconomic groups in India: the upper socioeconomic class (about 180 million people, or 15% of the population), who can afford the best standard of care and innovative drugs; a middle socioeconomic class of about 360 million people (30% of the population), who can co-pay a small amount for medical care; and the financially challenged majority of 660 million people (55% of the population), who might not even have sufficient income for their daily sustenance.[266] On the basis of these demographics, the World Bank classifies India as a lower-middle-income country.[219]

India's class structure affects the incidence of some cancers (eg, oral cancer) that occur more frequently in people with low incomes. For instance, 90% of rural patients with oral cancer are poor, and 3·6% of these patients live below the poverty line.[267,268] Investigators of a retrospective study[269] from southern India also reported that most patients with breast cancer were living in rural regions and came from low socioeconomic conditions. Data from a hospital-based cancer registry from northern India further lend support to these findings, showing that nearly two-thirds of patients with cancer belong to the lower or upper-lower socioeconomic class.[270,271] In response to these data, the Health Minister's Cancer Patient Fund was established in 2009 within the Rashtriya Arogya Nidhi by the Ministry of Health and Family Welfare, enabling 27 regional cancer centres to provide financial assistance of up to 100 000 rupees ($1637) to patients with cancer living below the poverty line.[272] Additionally, several state governments (in Goa, Jharkhand, and Nagaland) provide medical insurance for cancer care,[266] with a fixed amount provided for cancer treatment and the state government paying the insurance premium. In the Karnataka government's initiative, the Yeshashvini Co-operative Farmers Health Care Scheme requires individuals to contribute only about $2·76 per year for their health insurance, with the government meeting the balance of funds.[266] Although those with low socioeconomic status live on less than $1·39 per day, more than 2 million people have joined the scheme and are eligible for free medical treatment (including surgery) at designated high-quality hospitals. In 2006–07, 39 583 surgeries and about 50 000 free outpatient consultations were done under this insurance scheme within a 12-month period.[266] The uptake of this scheme refutes the view that voluntary medical insurance subscription is not feasible for people living below the poverty line.[266] Apart from the medical infrastructure provided by the government, medical care in India is also supplemented by non-governmental organisations.

The cost of care for patients with cancer in India is difficult to estimate because it differs substantially dependent on geographical location, socioeconomic status, and type and stage of cancer. A prospective study[273] in 2006 at the All India Institute of Medical Science in New Delhi aimed to evaluate the economic burden on patients from time of diagnosis of cancer to completion of radiation therapy. 95% of the 432 patients had head and neck, breast, or cervical cancer, representing the three most common cancers in India. The average total cost per patient was 36 182 rupees (about $596); 40% of this cost was incurred before being seen at the institute (39% on hospital costs and 23% on the cost of radiation therapy). The monthly per-person income for patients included in this study was 1749 rupees, or about $20. Thus, focusing just on costs to the patient during the period of radiation therapy with or without chemotherapy, the average weekly expenditure for cancer care accounted for 60% of the patients' income.[273]

A pressing issue regarding affordability of cancer therapy in India is the cost of cancer drugs. During the period between 1972 and 2005, there were no patent protection laws; as a result, the generic drugs industry in India grew tremendously, producing low cost drugs.[274] To comply with World Trade Organization directives, India issued patent laws in 2005, but restricted patents to newly developed drugs, with exceptions for compounds that have been shown to improve survival.[275] This law has allowed Indian companies that produce generics to win legal disputes with large pharmaceutical companies that initially developed the compound,[275,276] and the very low cost of these generics has made Indian generic companies the leading suppliers of most of the developing world's antiretroviral drugs for HIV treatment programmes.[274,276] Several cancer drugs are included in the approved generics list and are available at very low cost.[276] Although there is great debate as to whether the lack of patent protection will have implications for investment in drug research, provision of affordable cancer drugs in India will allow for more equitable access to cancer treatment and enhance outcomes for patients with cancer in India.

Cancer prevention

In view of the financial constraints of the Indian health-care system, the most cost-effective strategies for cancer treatment and prevention in India need to be identified. One important strategy is to decrease tobacco use. Results from recent surveys show that 274·9 million Indians (35% of the total adult population, plus 14·1% of school children aged 13–15 years) are tobacco users, mainly in the form of smokeless tobacco.[277,278] Measures to decrease tobacco and alcohol consumption (eg, through reductions in advertising and increases in taxation) are estimated to cost less than $100 (4400 rupees) per disability-adjusted life-year averted,[279] making these population-wide interventions highly cost effective in India.

The Indian Government has enacted a national tobacco-control law (the Cigarettes and other Tobacco Products [Prohibition of Advertisement and Regulation of Trade and Commerce, Production, Supply and Distribution] Act, 2003). India was among the first countries to ratify the WHO Framework Convention on Tobacco Control in February, 2004.[280] In line with the convention, the act legislates tobacco-control measures by addressing each of the seven principles covered by the convention. These principles encompass protection of public places from tobacco smoke exposure, tobacco labelling, advertising and sponsorship, education and public awareness, reduction measures for tobacco dependence, and public health policies with regard to commercial interests of the tobacco industry.[281]

To facilitate effective enforcement of the act, improve awareness, and meet the obligations of the WHO Framework Convention, the Indian Government launched the National Tobacco Control Programme in 2007 in 42 districts of 21 states or union territories of the country. As per the Constitution of India, the implementation of these laws and programmes mainly rests with the state governments. Dependent on the prioritisation of tobacco control by states, different levels of success have been achieved during past decade. However, implementation of these directives has been hampered by pressure from the tobacco industry, irregular taxation of tobacco products, cultural issues, and low exposure to antitobacco information.[282] Apart from the government's own machinery, recent advocacy by civil society and community led initiatives have bolstered the movement for tobacco control in India. Prioritisation of tobacco control and effective implementation remain serious challenges.

Additionally, cost-effective (ie, <4400 rupees or <$100 per disability-adjusted life-year averted) treatments and strategies for secondary prevention have been identified for three highly prevalent cancers. Strategies for secondary prevention include screening for breast cancer every 2 years between 50 and 70 years of age and treatment of stage I breast cancer, whereas cost-effective strategies include surgery with or without adjuvant chemotherapy and radiation therapy for cervical cancer, and treatment of colorectal cancer.[279] Additionally, screening for cervical cancer by trained health workers with the use of visual inspection with acetic acid is another inexpensive technique, with estimated costs of examinations ranging from $4·93 to $14·75.[283] If widely implemented, visual inspection with acetic acid could potentially save 22 000 lives every year in India.[284] Furthermore, clinical breast examination done annually for women aged 40–60 years in India is estimated to reduce mortality from breast cancer by 23·3%, which is similar to that achieved by twice-yearly mammographic screening (mortality reduction of 25·8% for the same age group), but at potentially half the cost.[285]

Taken together, these data show that high-level cancer treatment is unaffordable for most the Indian population at present. However, strategies implemented by the Indian Government (eg, programmes to subsidise treatment, provision of insurance at very low cost, and legislation to support production of generic drugs) could substantially improve the situation for patients. Implementation of cost-effective measures aimed at prevention, early diagnosis, and treatment of early stages of cancer for the entire population will probably further improve affordability of cancer care in India.

Provision of health-care workers for cancer control

India's existing health-care system is designed to prioritise infectious diseases, nutritional deficiencies, and maternal and child health. However, findings from a review[286] of the regional distribution of mortality rates of these three health problems suggested that services are inappropriately allocated. The north-central states have the lowest incomes and the highest infant mortality rates in the country, but also have the lowest numbers of

health workers.[286] The regions with the highest health standards (Kerala and Tamil Nadu) provide care to only 9·1% of the population, whereas the states with the lowest health standards according to Indian Public Health Standards (Assam, Bihar, and Jharkhand) are responsible for care for 13·1% of the population.[263]

Although increased life expectancy at birth and decreased infant mortality rates result from improvements in overall health in India, there has been very slow progress in the improvement of infrastructure and an ongoing serious shortage of human health-care resources.[287] In 1943, the Bhore Committee was established by the Indian Government to focus on improving the general health of the population. Important recommendations by the Committee included major changes in medical education to improve the quality and number of health-care providers. According to the Medical Council of India, since 1943 the number of medical schools has increased from 19 to 381, largely bolstered by privately operated institutions. However, health-care workers across India are unevenly distributed (figure 3),[286] because of the preference of health-care workers (including doctors) to work in areas with adequate facilities, high incomes, and good quality of life for their families, and the inability of the public sector to attract medical staff to rural centres.[286]

For the **Medical Council of India** see http://www.mciindia.org

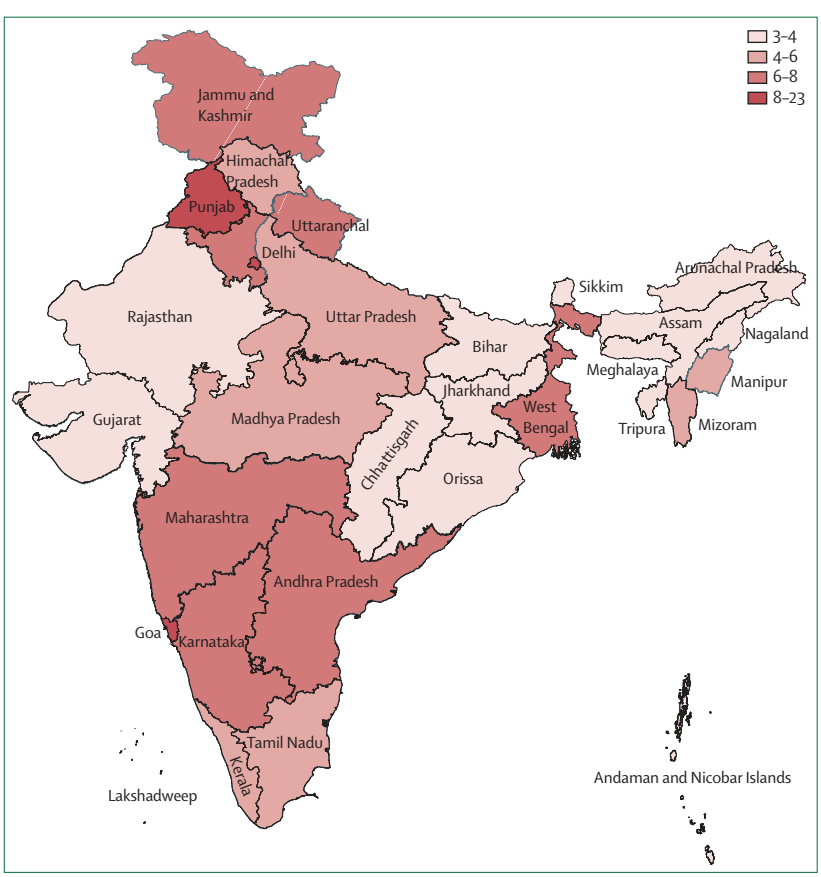

Figure 3: **Number of doctors in India per 10 000 population (2005)**
Figure reproduced from Rao and colleagues[286] with permission.

Health-care providers in India are a diverse group, and include trained doctors, practitioners of ayurveda, yoga, unani, siddha, and homoeopathy (AYUSH), nurses, dentists, midwives, pharmacists, technicians, community health workers, accredited activists for social health, registered medical practitioners without formal medical training, and traditional medicine practitioners and faith healers (who use charms and perform rites to treat illnesses).[286] Census estimates are dependent on citizens' self-reporting of information (eg, occupation). As a result, information about the size and distribution of the health-care workforce is unreliable. Small health registries exist in some regions of India, but are not adjusted for migration and retirement. Furthermore, so-called double counting of workers registered in more than one state is not uncommon and the corollary is that some categories of health workers are not registered, leading to difficulties in assessing the adequacy of health-care personnel in a reliable manner for ongoing resource allocation.[288] By not counting some categories of health-care providers (eg, medical technicians), a grossly inaccurate assessment of India's health care arises.

Details about the distribution and qualification of health-care workers were provided by the Public Health Foundation in India,[289] which identified 2·2 million health workers in India, equating to an estimated 20 health workers per 10 000 population. However, when estimates were adjusted for educational qualification and population density across India, the availability of health-care workers fell to 11·9 per 10 000 population, which compares poorly with the WHO benchmark of 25·4 per 10 000 population.[289] Furthermore, disparities were recorded between rural and urban areas, with a third of the number of trained doctors in rural areas compared with urban regions (per 10 000 population); most health workers (70%) worked in the private or corporate sector, which is not accessible to patients of low socioeconomic status.[287] Another report[263] estimated the number of trained medical practitioners in the country to be about 1·4 million, with only 50% of physicians trained in modern western medicine. 37% of practitioners defined as trained physicians were estimated to have inadequate or no medical training, suggesting that the true number of qualified physicians is even lower, at 3·8 per 10 000 population.[288] The availability of nurses and midwives was similarly poor, with 4·9 and 2·5 per 10 000 population, respectively.[288] These figures further decreased to 1·7 and 0·6 per 10 000, respectively, when only qualified nurses and midwives were included.[288]

Data about the availability of health-care workers in cancer care are very scarce, with the available information suggesting that there are only about 1500 oncologists in all of India—ie, one per 16 000 patients with cancer.[253] By contrast, the USA is predicted to have about one oncologist per 100 patients by the year 2020.[253] Underlining

this lack of human resources in India, investigators of a prospective study[290] described delays in obtaining a diagnosis of breast cancer of 67·5 days and 53·7 days for rural and urban patients, respectively, measured from the time of first consultation.[290] Although this study pertains only to patients with breast cancer and therefore cannot be generalised to all patients with cancer, it suggests that one of the main reasons for delayed diagnosis and increased mortality is the lack of easy access to health care.

On the basis of these numbers, the shortage of trained primary care physicians and of medical specialists in community health centres has been calculated to be 2866 (12% of the projected requirement) and 12 301 (64% of the projected requirement), respectively.[291] In response to these needs, the Medical Council of India increased the number of postgraduate physicians from 3500 to 5500 in the year 2009, and added an additional 5000 places on training courses in February, 2010.[291] Modifications to medical graduate training were also done to increase the number of specialists, including oncologists, trained in India.[291]

The unequal distribution of these workers poses an even more substantial issue. For example, the distribution of health providers per 10 000 population ranges from 23·2 in Chandigarh (capital of Punjab and Haryana in the north) to 2·5 in Meghalaya.[286] Most doctors trained in western medicine live in the south of the country (eg, Goa and Kerala, with 41·6 and 38·4 per 10 000 population, respectively), with a resulting scarcity of trained personnel in the north.[286] Additionally, human health-care resources are substantially unequal between rural and urban regions. Within each geographical region, urban areas have a greater proportion of trained physicians than do rural areas (60% *vs* 40%), with a density of allopathic physicians in urban and rural areas of 11·3 and 1·9 per 10 000 population, respectively.[288] Similarly, four times more nurses and midwives work in urban than work in rural areas.[263] Compared with other nations, the proportion of India's population that resides in rural regions is one of the highest in the world. Inherent cultural attitudes towards health problems in rural areas further aggravate the issue of low distribution of health-care workers in these regions.[292]

Several factors explain the paucity of trained health workers in rural areas, including disinclination of physicians to work and live in low socioeconomic areas; lack of funding from the public sector to adequately staff rural facilities and provide necessary equipment; reluctance of junior medical officers to work in an isolated working environment with low salaries and inadequate supervision and training; and few private health-care institutions in rural areas where salaries are often less lucrative.[293–295] Cancer is a chronic disease that needs health-care providers at a local level, because people are treated during extended periods of time; as a result, disparities in provision of human health-care resources have particularly severe effects on cancer care.

In an attempt to increase the number of doctors in rural areas, both incentive schemes and compulsory service have been initiated. However, evidence from countries such as Mexico[296] and Ecuador[297] shows that increased numbers of doctors or compulsory employment in rural regions do not necessarily translate into improved distribution of care. Some states (eg, Tamil Nadu) have focused efforts on rural recruitment, training in rural health facilities, and hometown placement after graduation, similar to initiatives in other nations such as Thailand and Indonesia.[298] These schemes provide financial support during undergraduate training in medicine and nursing, with contractual obligations to work for up to 4 years within the public sector after graduation.[298] Financial incentives have been proposed, with higher salaries for doctors working in the most remote regions of the country. This approach has had some success in Thailand, where two-thirds of Thai provincial graduates continue in their rural placement region even after completing their compulsory contract.[299] International emigration of physicians further contributes to the shortage of health-care workers in India. Indian-trained medical graduates accounted for about 2·1–10·9% of the total workforce of four English-speaking countries (the USA, the UK, Canada, and Australia) in 2004.[300] Findings from an earlier study[301] showed that up to 50% of graduates from India's most prestigious medical colleges emigrated between 1989 and 2000. Higher incomes and better educational experience were cited as the main reasons for relocation. Investigators of a 2009 study[302] reported that Indian physicians were dissatisfied with specialised medical training in India, an important factor that would affect retention of graduates to work in oncology. In a survey of surgical oncologists administered at the annual meeting of the Indian Association of Surgical Oncology,[302] most respondents regarded teaching in oncology as poor in medical school (75%), residency (56%), and as practising physicians (71%). However, the value of government expenditure on specialisation for doctors that then emigrate to wealthy nations with better working conditions is questionable. Overcoming medical workforce shortages, particularly in oncology, will need efforts to reduce international emigration and strategies that can increase distribution of staff to rural areas.

Public health policy makers have also considered another approach to deal with the issue of health-care distribution in India. In 2011, more than 750 000 AYUSH practitioners were registered, and the development of a network between these health-care workers and trained physicians was proposed. The Task Force on Medical Education for the National Rural Health Mission recommended the creation of a short-term course in medicine to create a cadre of health professionals socially orientated towards primary health care.[263] A 6-month training course for nurse practitioners was also designed,

with particular emphasis on maternal and child health and family welfare. Another key strategy of the task force is to provide a community health worker who is an accredited social health activist for every village with a population of 1000 or more.[303] These workers must undergo training at district hospitals and receive performance-based incentives. Most of the activist workers are women, and their mission is to increase health awareness among the population, particularly with regard to attitudes and practice towards health-care programmes.[304] Such strategies, with particular emphasis on cancer control and prevention, have already been implemented in several regions of India. In a cluster randomised trial in Kerala,[305] non-medical university graduates received training to identify precancerous and malignant lesions of the oral cavity. Two manuals about visual inspection with colour photographs and descriptions of oral lesions were used for training. After screening of eligible participants at their homes, those with suspicious lesions were referred to a dentist or oncologist. Among those detected at screening, 63% of participants complied with referral to a specialist clinic. The mortality-rate ratio in the intervention group was 0·79 (95% CI 0·51–1·22) overall, with a significant benefit for high-risk individuals (ie, male tobacco or alcohol users; mortality-rate ratio 0·57, 95% CI 0·35–0·93). In a similar trial in Osmanabad,[306] auxiliary nurse-midwives were trained to obtain cervical cells for HPV and cytological testing and to visually inspect the cervix with acetic acid during a period of 3 weeks. The auxiliary nurse-midwives were supervised by trained doctors and the results were reviewed by pathologists. Women with a positive screening test were assessed and treated at specialty clinics. The hazard ratio [HR] for death from cervical cancer in the HPV testing group was 0·52 (95% CI 0·33–0·83), with no significant mortality reductions in either the cytological testing group or the acetic acid group. A second cluster randomised trial[284] exploring the use of visual inspection with acetic acid for early detection of cervical cancer was done in Mumbai. This study involved four rounds of cancer education and screening by visual inspection with acetic acid by trained public health workers at 24-monthly intervals. The quality of screening by health-care workers showed very good agreement with that of an expert gynaecologist (κ=0·84) and the screening group had a significant reduction in cervical cancer mortality (relative risk 0·69, 95% CI 0·54–0·88). These interventions suggest that individuals in the community without medical training can be trained to provide high-quality screening of at-risk populations in regions where health-care resources are scarce. These strategies do not replace the need for trained physicians in rural areas, but nonetheless have shown improved cancer outcomes in these selected settings. Patients with cervical cancer will therefore have an improved chance of diagnosis at an early stage, enabling them to have a wide variety of treatment options. More health-care professionals should use visual inspection with acetic acid for female patients in view of the time-effectiveness and cost-effectiveness of this method.

Another disadvantage of the distribution of health-care workers in India is that women are greatly underrepresented, providing only a third of the health workforce and only 17% of trained physicians, resulting in only 6·5 trained female doctors per 10 000 residents in urban areas and only 0·5 per 10 000 residents in rural regions.[286]

In summary, there is a severe shortage of health-care personnel, particularly highly trained doctors, throughout India. This deficiency is particularly problematic in rural regions and in the north of the country. The experiences from countries encountering similar issues conflict as to whether measures to forcibly direct physicians to work in poor economic areas will be effective as a long-term intervention. Importantly, findings from several studies in India show that provision of additional basic training to health personnel that live in rural regions (eg, nurses or midwives) can be extremely effective to provide grassroots medical services for cancer prevention and early diagnosis.

Sociocultural barriers to health and cancer care

There is a wide range of cultural and social traditions across India, with further diversity within states and regions of the country. Generalisations about social and cultural barriers to cancer care in India are therefore at risk of oversimplifying the situation.

Major sociocultural issues that affect approaches to health care in India include social taboos, castes, gender inequality, low regard for health as a priority, nihilistic approaches to cancer diagnosis (ie, cancer fatalism), blind faith in traditional methods of healing, religious dynamics, and widespread superstitions. Although these factors are more prevalent in rural India, they also exist in urban areas. Even as information technology is rapidly revolutionising attitudes to education and literacy in India, these measures have not as yet led to a similar modernisation in attitudes towards health.

Stigma and gender inequality in cancer care

Social taboos frequently prevent individuals from seeking conventional health-care assessments, and subsequently lead to advanced stages of disease by the time a trained doctor is seen, particularly for socially stigmatised diseases such as cancer. Patients can often keep a diagnosis of cancer secret, and go to extreme lengths to conceal a cancer diagnosis from family and friends, even at the cost of compromising treatment and outcomes. Even after confirmation of a cancer diagnosis, the desire of patients to maintain normality in their life can negatively affect their acceptance of recommended care, frequently leading to irregular attendance for medical follow-up, and ultimately impairing outcomes. Additionally, 53% of 500 survey respondents in India

believed that patients with cancer "brought it on themselves".[307]

Gender inequality exists in many parts of India, which results in neglect of many female health problems. Notwithstanding some changes in attitude towards the role of women in Indian society, the country remains patriarchal, with men having power and authority both in the community and in the family. Clinicians lend support to the view that management of health problems in women and elderly people is often given less priority than are health problems affecting men and young family members.[250] Findings from observational studies suggested that women with breast cancer frequently present with more advanced stage disease in India than in developed countries. Findings from several hospital-based registries and some studies based in rural settings showed that more than 50% of newly diagnosed patients presented with stage III or IV breast cancer.[308,309] This pattern contrasts with statistics from western countries (eg, the UK), where some registries show that less than 15% of patients present with advanced disease.[310] Investigators of other studies reported that up to 75–80% of patients with a range of different cancer diagnoses presented with late-stage incurable disease, resulting in an inevitably high mortality.[311,312] Among the many reasons for delayed diagnosis is patient illiteracy, which is especially prevalent in rural regions.[290] For example, when women were invited to participate in a screening programme for cervical cancer in eastern India, the literacy rate of the non-compliant women was significantly lower than that of the compliant attendees. Importantly, the decision to decline screening was made by the women themselves in only 50% of cases, suggesting that health decisions are often made by other members of the family and community. Common reasons given for non-participation also included the belief that undergoing a procedure was unnecessary in the absence of symptoms; fear of the possibility of a cancer diagnosis; fear of undergoing a gynaecological examination, even by a female health worker; and fear of the instrumentation procedure or possible sterilisation. Additionally, 40% of non-compliant women stated that they wanted to undergo screening, but were unable to do so because of their responsibility to do domestic chores and care for their family.[313]

A nihilistic attitude towards cancer can also cause individuals to not present for medical review. For example, non-compliant women in a screening study[313] of cervical cancer stated that a diagnosis of cancer was synonymous with death and that the need for a diagnostic biopsy was sufficient reason to avoid attending. The influence of male partners and male elders in the family is also fundamental in non-compliance to medical consultations. In one community-based study from Karnataka,[314] 66·4% of rural and 37·9% of urban underprivileged women said that they needed the permission and consent of their male spouse or male elder to undergo testing. Although education programmes and campaigns for public awareness about cancer aim to change such beliefs, most Indians believe that cancer is generally incurable and that it should be kept secret from neighbours because of social stigma.[315] This attitude negatively affects uptake of and adherence to treatment recommendations even after a cancer diagnosis.

However, analysis from a cluster randomised trial[316] showed that participation in screening can be increased by implementation of comprehensive programmes for health education. In this trial, medical social workers first established rapport with opinion leaders in the community. The medical social workers then administered a baseline household survey to identify eligible women and developed area maps of the eligible households in the region. Participants randomly assigned to the intervention group were then personally invited by the medical social workers to attend screening procedures. As a result of this approach, the average compliance to three rounds of cancer screening was 71·4% for breast screening and 64·9% for cervical screening (with a compliance of 76% and 71·5%, respectively, for the first round of screening). Of the eligible population, 94% and 84% were screened at least once for breast and cervical cancer, respectively.[316] This finding compares favourably with rates achieved in controlled screening studies in other developing countries,[317] and with non-controlled screening programmes in developed nations.[318] Furthermore, compliance rates for completion of treatment were 95% for women with a diagnosis of breast cancer, and 86% and 81% for cervical cancer and a cervical precancerous lesion, respectively. The main risk factors for non-compliance in this study were older age, Muslim religion, low educational level, unmarried status, and speaking a language other than Hindi or Marathi.[316] Similar factors were also reported as reasons for non-compliance by investigators of a trial[319] of screening for cervical cancer in Maharashtra. Although the highly controlled settings of such studies make extrapolation of their results to programmes for general population screening impossible, the study findings suggest that a thorough and well-planned educational intervention can increase compliance even in illiterate and poor communities.

Last, but not least, faith in traditional and alternative forms of medicine is widespread among the Indian public. Homoeopathy is one of seven recognised national medical systems, with almost 250 000 registered homoeopathic doctors,[320] although findings from a large comparative study[321] showed that the effects of homoeopathy are consistent with a placebo effect. Because these traditional forms of medicine are given the same degree of credibility as is western medicine by the government and the community, many medically trained clinicians use traditional remedies as part of their treatment recommendations.[250] Additionally, religious faith is so pervasive that so-called healers can deceive vulnerable people. These medicine men frequently rely on chants, pujas (religious worship), and sacred powders

to cure patients with disease. Strong faith in these healers prevents establishment of modern scientific medicine in more remote rural areas in India.

Conclusions

An important priority for India (and many other low-to-middle-income countries) is to establish cancer registries and develop regional or national cancer plans. Furthermore, a concerted effort by public policy makers to change the funding of cancer control for poor people is needed. The percentage of GDP devoted to health care overall should be increased, with a greater proportion of the health-care budget allocated towards cancer control efforts. Of great need is a redistribution of resources to disenfranchised populations.

With better control of communicable diseases and improvements in living conditions and health care, life expectancy has increased in India. However, this improvement has been paralleled by an increase in the incidence of non-communicable diseases (ie, cardiovascular diseases, diabetes mellitus, chronic respiratory diseases, and cancer). Non-communicable diseases are estimated to account for 53% of all deaths in India, with cancer accounting for 6% of deaths.[21] With further improvements in life expectancy, the incidence of cancer will probably increase and will be an important cause of morbidity and mortality during the next three decades (panel 2).

The development of a minimum dataset to be administered at each level of health-care delivery—ie, subcentres, primary care, community-based care, and secondary and tertiary centres—would enable the appropriate allocation of public funding, and identify areas where private-sector health care is available to supplement public resources. The incidence of cancer and its stage at presentation will provide indirect evidence as to the effectiveness of preventive strategies (eg, tobacco education programmes and attempts to introduce basic health education at the community level).

Achievable priorities within a national cancer plan need to be established, focusing on prevention, screening and early diagnosis, the most cost-effective therapies relevant to the Indian population, and accessible palliative treatment for advanced-stage cancers.

Reduction of tobacco use in all age groups and detection and treatment of stage I breast cancer is highly cost effective for primary and secondary prevention of cancer. Access to basic surgery, use of generic pharmaceutical therapies, and timely radiation therapy will also probably be highly cost effective, translating to improved outcomes. However, most evidence-based guidelines for cancer care and cost-effectiveness analyses are derived from western countries, and therefore might not be applicable to the Indian population. Development of innovative approaches most suited to Indian populations without access to tertiary care centres or radiation facilities could be an important goal during the next decade. Such protocols need to be simple, affordable, safe, and with a minimum need for monitoring. With a large number of medical colleges in India, training of more physicians in basic oncology should be possible, enabling local doctors to follow up patients after referral to nearby regional cancer centres. This measure will help to reduce costs and allow patients to stay with their families.

Cancer of the head and neck and cervical cancer remain common in poor populations living in rural and urban India. Development of new strategies in collaboration with economists and lawmakers to prevent these cancers should be an important goal. High incidences of penile cancer in rural India and gallbladder cancer in northern India create a need for effective strategies to prevent these cancers. Innovative approaches accounting for existing Indian structures and available resources include an initiative educating non-medically-trained midwives in screening for cervical cancer. Providing people with the lowest incomes with basic health care will probably also achieve a large effect at low cost. In view of beliefs in traditional health-care approaches, AYUSH could have a complementary and palliative effect in patients who are symptomatic and need attention paid to their quality of life, although research into effectiveness is needed.

Education of rural and urban communities with regard to lifestyle modifications for preventable conditions is needed to overcome the deep-seated cultural beliefs preventing early intervention for potentially curable cancers.

The wide diversity in cultural attitudes and the variability in languages spoken in India suggests a need to train local health workers to disseminate information about cancer prevention and the benefits of early diagnosis. Collaboration between medically trained and traditional

Panel 2: **Summary and recommendations for cancer control in India**

National cancer data

- Minimum dataset collection in subcentres through to tertiary referral centres

Prevention, screening, and treatment

- Establish and assess effectiveness of prevention and screening programmes; assess and integrate traditional medicine; improve understanding of the biological interplay between western and traditional medicine

Education

- Lifestyle modifications; adapt programmes to local and regional traditional beliefs

Health-care training

- Integration of allopathic and traditional medicine

Governmental priorities

- Define priorities for public health; tailor affordable and equitable treatments across rural and urban regions

practitioners to demystify cancer could encourage patients to seek early medical attention and lead to improved compliance with recommended treatments.

The teaching of undergraduate health-care workers needs to be adapted, encouraging familiarisation with both modern and traditional medicine, to facilitate greater collaboration. The development of diagnostic and therapeutic interventions to meet the cultural and social needs of the Indian population should be done through national and local research.

Provision of research grants from governmental and non-governmental organisations to address uptake and compliance of affordable and proven therapies for cancer will probably serve a dual purpose of engaging local health-care workers in their own community (potentially lessening international emigration), and identifying strategies to enhance compliance with treatment. Initiation of research between modern medicine and traditional therapies could provide insights into effective interventions that are widely accepted in India. Research into the most common cancers in India should be promoted. Establishment of research groups, development of a reliable clinical databases, tumour banks, and simple clinical protocols, in addition to research to identify biomarkers for diagnosis, could be set as priority areas initially for a few cancers and in time could be adapted to other cancers. Gallbladder cancer in north India and gastric cancer in south and northeast India are examples that could be targeted first in this regard.

Communication between governmental and non-governmental stakeholders is needed to define policies for public health programmes, establish affordable and accessible programmes of tertiary education for health-care workers, tailor health-care programmes towards differing needs in rural and urban regions, and establish equitable infrastructure and staffing on the basis of population density and socioeconomic status across the states and regions in India.

Russia

Background

The dissolution of the Soviet Union and the formation of the Russian Federation in 1991 brought substantial social and economic instability to the region. The Russian economy experienced tremendous difficulties as it moved from a centrally planned Soviet economy to a free-market-based system. GDP fell at an accelerating rate and overinflation was a major issue. However, since 2000, the Russian economy has had sustained growth because of implementation of key economic reforms (tax, banking, labour, and land codes) and tight fiscal policy.[322] Russia's gross national income per person in 2012 was $12700, classifying the country as high income.[323] In 2012, when the global economy was losing momentum, growth in Russia remained solid and reaffirmed the country's position as an emerging economy.[323] Health expenditure has increased during the past two decades, rising from $113 per person in 1995 to $807 per person by 2011.[323] Nevertheless, there is substantial socioeconomic inequality in Russia; the wealthiest 1% of people own 71% of all private resources in the country, compared with 37% in the USA.[324] Although health expenditure has grown in parallel with the economy, per-person expenditure remains low compared with other high-income countries where average spending is $4607 per person.[323] Moreover, the proportion of public funding as a share of total health expenditure decreased from 73·9% in 1995 to 59·7% in 2011.[323] This decrease in public funding is accompanied by the concomitantly increased burden of out-of-pocket expenses for patients (table 1).[34,323]

At 17 098 242 km², Russia is the largest country in the world, covering more than an eighth of the planet's inhabited land area. The country extends across the entirety of northern Asia and much of eastern Europe. The Russian Federation comprises 83 federal areas, including 46 oblasts (provinces), 21 republics, nine krais (territories), four autonomous okrugs (autonomous districts), one autonomous oblast (the Jewish Autonomous Oblast), and two federal cities (Moscow and St Petersburg).[325]

Unlike most western countries, economic growth in Russia has not been matched with an improvement in life expectancy.[326] On the contrary, life expectancy among men has fallen from 64 years in 1965 to 63 years in 2011, whereas that of women has increased from 72 years to 75 years (table 4).[225,327,328] Early mortality among men and women is mostly attributable to injuries and violence (frequently associated with alcohol, which contributes to 12% of mortality), and a growing burden of non-communicable diseases.[21,329,330]

During the past two decades, the total population of Russia has fallen from 149 million to about 144 million due to high mortality rates coupled with low fertility.[1] If these trends continue, the population is expected to fall by another 30% during the next 50 years, which will threaten the demographic, social, and economic prosperity of the region.[331–333] As a result of the enormous regional socioeconomic differences within Russia, life expectancy and mortality vary greatly by region. Life expectancy can vary by up to 18 years between regions with high life

	China	India	Russia	Japan	USA
Male life expectancy, 1965 (years)	50	47	64	68	67
Male life expectancy, 2011 (years)	74	64	63	79	76
Female life expectancy, 1965 (years)	53	45	72	73	74
Female life expectancy, 2011 (years)	76	68	75	86	81

Data from the World Bank[224,225] and Shkolnikov and Meslé.[327]

Table 4: **Life expectancy in China, India, and Russia compared with Japan and the USA**

expectancy (eg, Republic of Ingushetia, Dagestan, and Moscow) and low life expectancy (eg, Republic of Tyva, Koryak Okrug, and Komi-Perm Autonomous Okrug).[334]

Russian women live about 12 years longer than do Russian men.[224,225] This gap in Russia is much wider than in other European countries, where it ranges between 5 and 7 years.[222,223] Two major factors behind this large gender gap are smoking and alcohol consumption, because these behaviours are very different between men and women.[333] Although Russian women outlive Russian men, they generally have worse health than do women in eastern and western Europe.[333] The gender gap in life expectancy has led to instability in marriage and a high proportion of widows.[333] The percentage of widows in Russia aged 30–44 years is about four times that of the USA.[333]

Non-communicable diseases are the most common cause of death, illness, and disability in Russia, accounting for 82% of mortality (1718 300 deaths) in the country in 2008.[21] Overall, mortality from non-communicable diseases is higher in Russia than in other high-income countries (1109 deaths per 100 000 men and 562 per 100 000 women in Russia, compared with 441 per 100 000 men and 309 per 100 000 women in the UK, and 458 per 100 000 men and 326 per 100 000 women in the USA).[21] In 2011, cancer accounted for 15% of all deaths in Russia.[335]

The Russian health-care system is challenged by a tense economic and political environment, and the growing burden of non-communicable diseases including cancer. We discuss the aspects of cancer management that need to be prioritised in Russia.

Monitoring the burden of cancer

Cancer statistics in Russia

The National Cancer Registry is jointly managed by the Department of Health Statistics and the Ministry of Health, where the Ministry of Health collects information annually about cancer incidence and mortality based on data obtained from many hospitals and treatment centres in the country. Two cancer centres, NN Blokhin Russian Cancer Research Center and Herzen Moscow Research Cancer Institute, both in Moscow, independently review the data and publish the findings.[336] The data collected include patient demographics, tumour characteristics, lifetime risk, trends in incidence and mortality, and the stage of cancer at diagnosis. Information about survival by stage is not available. Concerns have been raised about these statistics: the methods used to obtain the data are not transparent, data are accumulated from both electronic and paper records, and the comprehensibility of the information is not clear (in view of the variability in quality of these services across the country). National statistics might therefore not be comprehensive and could show trends in subregions of the country rather than provide accurate data for the whole country.[337]

For Russia, we relied on the available data and mainly present information about incidence and mortality from 2012 statistics published by the Herzen Moscow Research Cancer Institute and data from GLOBOCAN 2012.[336,338] For the GLOBOCAN 2012 data, historical statistics for incidence and mortality from previous years were projected to the 2012 population, which although an imperfect method, contrasts with data from the Herzen Moscow Research Cancer Institute, which do not include information about incidence and mortality by sex for different cancer subtypes.

525 931 new cases of cancer were registered in Russia in 2012 (240 938 men and 284 993 women).[336] These numbers were slightly higher than were the projected estimates from GLOBOCAN 2012, which estimated that there were 215 400 new cases among men and 243 000 new cases among women.[339] In total in 2012, 2 995 566 patients with cancer were registered, which constituted 2·1% of the country's total population, and 20% of patients were from rural areas. 51% of patients had been registered as oncological patients for 5 years or more; this measure (which shows cancer survivorship) varied between regions, ranging from 27% in Chechnya to 60% in the Zabaykalsk region.[336] In 2012, 25% of all cancers in Russia were diagnosed at stage I, 25% at stage II, 22% at stage III, and 21% of patients had metastatic disease at diagnosis (stage IV).[336] The highest percentage of stage IV cancer was recorded in the Republic of Kalmykia (37%), the Chukotka Autonomous Okrug (36%), and the Republic of Sakha (34%).[336]

In 2011, 289 535 cancer deaths were detected in Russia, accounting for about 15% of all national deaths (1 925 720).[335] The overall mortality rate at 1 year was 26%, and varied considerably according to geographical region, ranging from the lowest rate of 12% in Chechnya, to 18% in the Moscow region, and 40% in the Republic of Sakha (the highest rate).[336] Cancer mortality for men was consistently higher than in women (176·3 per 100 000 men *vs* 91·3 per 100 000 women).[339] The mortality-to-incidence ratio for all cancers was 0·60 in Russia, compared with 0·33 in the USA and 0·40 in the UK (table 1).[5,339] The chance of dying from cancer was higher for men than for women in Russia (mortality-to-incidence ratio 0·72 for men *vs* 0·49 for women), was double the US ratio (0·36 for men), and was also higher than the ratio in Europe (0·44 for men).[5,339]

The three most common cancers among Russian men in 2012 were lung cancer (incidence 51·4 per 100 000), prostate cancer (30·1 per 100 000), and colorectal cancer (30 per 100 000).[339] However, these statistics varied by region (table 5).[336] For example, in St Petersburg, the most common cancers among men were lung cancer (16·6%), prostate cancer (12·2%), and gastric cancer (9·7%).[340] Presumably, this difference is mostly due to socioeconomic, lifestyle, and environmental factors.[340]

Breast cancer is the most common cause of cancer among women in Russia; annual incidence and mortality

	Total number of registered patients	Proportion diagnosed at stage I (%)	Proportion diagnosed at stage II (%)	Proportion diagnosed at stage III (%)	Proportion diagnosed at stage IV (%)	Proportion with unknown stage at diagnosis (%)	Mortality at 1 year after diagnosis (%)
All cancers							
Whole country	507 310	25·1	25·3	21·5	21·2	6·8	26·1
Central	141 456	25·6	26·0	21·1	21·4	5·9	24·4
Northwest	47 086	24·5	25·3	23·9	18·3	8·0	26·6
South	54 181	26·8	25·4	17·8	21·8	8·2	25·0
North-Caucasus	22 103	19·4	26·2	23·0	20·9	10·5	25·2
Privolzhskii	108 904	25·5	25·6	21·7	21·0	6·2	27·0
Ural	42 505	25·5	26·2	22·7	20·6	4·9	25·2
Siberia	70 539	24·4	23·9	22·3	21·9	7·6	28·9
Russian Far East	20 536	24·1	21·9	20·7	26·0	7·2	27·9
Lip							
Whole country	2789	53·0	31·8	10·4	3·9	0·9	5·2
Central	526	52·5	32·1	12·0	3·0	0·9	5·2
Northwest	155	45·8	36·8	8·4	5·2	3·9	9·5
South	328	50·9	33·2	10·1	5·8	0·0	4·0
North-Caucasus	181	49·7	34·8	9·9	4·4	1·1	2·5
Privolzhskii	792	56·3	30·7	10·0	2·7	0·4	5·0
Ural	236	59·3	26·3	8·5	3·8	2·1	4·8
Siberia	485	51·3	32·6	10·5	4·5	1·0	4·5
Russian Far East	86	45·3	29·1	16·3	7·0	2·3	14·1
Oral cavity							
Whole country	7544	10·9	25·5	33·6	28·1	1·8	37·0
Central	2316	8·7	24·1	33·9	32·0	1·3	38·6
Northwest	810	11·2	26·4	38·3	21·4	2·7	33·7
South	678	10·5	23·9	29·6	34·8	1·2	34·7
North-Caucasus	285	10·5	24·6	32·3	28·4	4·2	47·2
Privolzhskii	1509	13·3	29·8	30·9	24·9	1·1	35·6
Ural	594	17·2	26·1	28·8	26·9	1·0	35·1
Siberia	1020	9·0	23·4	37·4	26·6	3·6	37·8
Russian Far East	332	10·8	23·5	38·9	25·3	1·5	36·7
Larynx							
Whole country	4512	3·6	13·5	41·0	40·1	1·9	40·2
Central	1540	3·3	11·2	37·3	46·9	1·2	38·7
Northwest	397	4·0	12·1	46·9	33·2	3·8	43·9
South	488	2·0	12·1	30·5	54·7	0·6	38·5
North-Caucasus	207	2·9	22·2	47·8	23·7	3·4	37·6
Privolzhskii	893	5·2	19·1	45·5	29·7	0·6	40·2
Ural	282	6·4	16·3	35·5	40·1	1·8	35·0
Siberia	569	1·4	9·0	48·3	35·9	5·4	45·0
Russian Far East	136	4·4	9·6	43·4	41·9	0·7	45·2
Oesophagus							
Whole country	6970	3·6	25·0	36·2	29·2	6·0	59·4
Central	1829	3·6	24·2	35·3	31·9	4·9	61·5
Northwest	801	3·6	22·3	38·8	28·2	7·0	59·1
South	511	2·0	29·2	22·3	34·1	12·5	62·7
North-Caucasus	240	1·3	26·7	44·6	21·7	5·8	38·6
Privolzhskii	1769	3·5	26·2	40·5	25·7	4·1	63·1
Ural	516	5·4	32·6	34·5	27·1	0·4	53·1
Siberia	894	4·1	19·6	36·9	30·5	8·8	56·8
Russian Far East	410	4·1	23·9	29·8	32·0	10·2	60·1

(Table 5 continues on next page)

	Total number of registered patients	Proportion diagnosed at stage I (%)	Proportion diagnosed at stage II (%)	Proportion diagnosed at stage III (%)	Proportion diagnosed at stage IV (%)	Proportion with unknown stage at diagnosis (%)	Mortality at 1 year after diagnosis (%)
(Continued from previous page)							
Stomach							
Whole country	35597	9·3	19·4	26·6	39·3	5·4	49·8
Central	10626	9·7	20·5	26·3	40·0	3·5	48·3
Northwest	3635	10·4	19·3	29·6	35·3	5·4	49·5
South	2934	9·8	19·2	19·8	45·7	5·5	51·4
North-Caucasus	1274	2·7	25·2	31·2	36·1	4·8	43·3
Privolzhskii	7924	9·2	18·3	28·3	36·2	8·1	52·5
Ural	2827	9·7	22·7	29·5	37·9	1·2	46·4
Siberia	4934	9·5	16·7	24·9	41·8	7·1	51·7
Russian Far East	1443	7·6	16·1	21·6	47·1	7·6	52·0
Colon							
Whole country	32528	6·7	35·3	27·5	27·5	3·0	29·6
Central	9664	6·7	36·3	27·0	27·5	2·5	27·1
Northwest	3530	6·8	35·4	32·3	21·6	4·0	31·6
South	3352	5·9	39·3	22·5	28·2	4·1	26·7
North-Caucasus	1173	3·2	37·6	29·3	24·2	5·7	26·9
Privolzhskii	6738	6·9	33·8	27·7	29·5	2·0	32·5
Ural	2890	7·2	35·1	29·2	27·2	1·3	28·5
Siberia	4041	7·4	33·0	27·0	28·2	4·4	32·5
Russian Far East	1140	8·8	29·4	25·5	33·3	3·0	31·1
Rectum and anus							
Whole country	25571	9·0	38·6	26·0	23·2	3·3	25·8
Central	6937	8·9	38·9	26·5	22·6	3·1	24·0
Northwest	2646	10·4	33·0	31·3	21·5	3·8	26·8
South	2686	9·1	42·2	21·5	23·5	3·7	25·9
North-Caucasus	958	4·3	41·6	27·6	20·3	6·3	24·7
Privolzhskii	5700	8·6	40·1	24·6	23·0	3·7	26·9
Ural	2401	10·1	37·0	27·4	24·4	1·1	24·8
Siberia	3279	9·3	38·0	25·0	24·7	2·9	28·0
Russian Far East	964	8·3	35·2	25·8	26·8	3·9	26·6
Liver and intrahepatic bile ducts							
Whole country	5090	1·5	6·8	21·4	57·3	13·1	66·0
Central	872	2·8	10·3	27·4	50·9	8·6	61·4
Northwest	413	2·4	8·2	24·7	49·6	15·0	70·6
South	674	0·6	6·1	18·3	61·5	13·5	65·8
North-Caucasus	320	0·3	5·0	11·3	45·9	37·5	58·2
Privolzhskii	1119	1·8	5·2	14·5	61·9	16·6	62·2
Ural	487	1·0	9·4	28·5	50·1	10·9	64·5
Siberia	861	0·8	6·0	24·5	61·4	7·2	77·8
Russian Far East	345	0·9	2·3	22·3	68·9	4·6	70·6
Pancreas							
Whole country	13757	2·2	10·2	21·2	60·3	6·2	68·1
Central	3749	2·5	12·2	22·4	59·1	3·8	69·1
Northwest	1270	2·3	9·8	27·2	51·4	9·4	71·0
South	1679	4·4	12·8	14·3	55·3	13·2	68·4
North-Caucasus	566	0·7	10·8	19·6	60·2	8·7	59·8
Privolzhskii	2816	1·2	7·0	19·1	67·8	4·9	63·7
Ural	1135	2·3	11·3	27·5	57·1	1·9	66·9
Siberia	1922	1·5	8·9	20·7	62·2	6·7	73·3
Russian Far East	620	1·5	7·7	20·6	65·0	5·2	70·7

(Table 5 continues on next page)

	Total number of registered patients	Proportion diagnosed at stage I (%)	Proportion diagnosed at stage II (%)	Proportion diagnosed at stage III (%)	Proportion diagnosed at stage IV (%)	Proportion with unknown stage at diagnosis (%)	Mortality at 1 year after diagnosis (%)
(Continued from previous page)							
Trachea, bronchi, and lung							
Whole country	52 446	11·0	15·4	31·8	38·3	3·4	52·4
Central	12 921	11·5	15·4	30·1	39·4	3·5	51·7
Northwest	4214	11·7	14·9	34·5	34·0	5·0	53·7
South	5520	10·5	12·3	28·2	46·0	3·1	56·6
North-Caucasus	2617	5·3	16·7	34·6	39·3	4·2	51·1
Privolzhskii	11 423	11·8	17·1	33·1	35·1	2·8	51·5
Ural	4840	10·7	18·8	34·9	33·8	1·7	45·5
Siberia	8345	12·0	13·4	31·1	39·3	4·1	55·9
Russian Far East	2566	8·7	13·6	32·4	41·3	4·1	53·0
Breast							
Whole country	59 068	18·4	46·1	23·8	9·2	2·6	8·3
Central	17 780	16·0	44·2	23·2	10·0	6·5	8·2
Northwest	5870	23·4	42·6	25·3	7·2	1·4	8·8
South	5941	16·2	48·2	24·2	11·0	0·4	9·2
North-Caucasus	2481	12·6	43·5	31·0	11·2	1·6	9·4
Privolzhskii	12 094	19·3	48·9	23·3	7·8	0·7	7·9
Ural	4795	20·0	48·9	21·8	8·9	0·4	7·6
Siberia	7761	20·8	46·1	23·5	8·6	1·0	8·4
Russian Far East	2346	18·4	47·6	23·4	9·7	0·9	7·3
Uterine cervix							
Whole country	14 865	29·0	31·3	28·6	9·1	2·0	17·0
Central	3638	30·7	32·0	26·0	9·2	2·1	15·7
Northwest	1493	33·2	27·9	28·1	8·4	2·4	14·7
South	1755	28·7	32·1	28·8	9·4	1·0	18·1
North-Caucasus	646	18·4	25·9	48·5	6·3	0·9	20·4
Privolzhskii	2864	28·7	33·3	27·3	8·1	2·4	18·1
Ural	1353	30·7	27·3	30·5	10·9	0·4	15·6
Siberia	2378	27·2	30·8	30·2	9·2	2·6	17·2
Russian Far East	738	26·0	37·9	21·7	11·8	2·6	20·7
Uterine corpus							
Whole country	20 900	59·0	22·0	10·8	5·5	2·7	9·7
Central	6760	62·4	22·0	8·8	4·6	2·2	8·4
Northwest	1931	55·7	23·7	12·9	4·9	2·7	10·9
South	2115	54·7	23·7	9·3	6·1	6·2	9·8
North-Caucasus	756	46·3	34·3	12·4	4·0	3·0	9·9
Privolzhskii	4418	62·3	19·2	11·0	5·7	1·7	10·2
Ural	1710	61·6	20·8	11·2	5·6	0·9	9·1
Siberia	2497	52·9	20·8	15·1	7·7	3·5	12·2
Russian Far East	713	57·1	23·0	10·2	7·2	2·5	9·1
Prostate							
Whole country	28 560	9·0	39·3	31·8	17·8	2·1	10·3
Central	9082	10·7	41·3	28·8	17·7	1·5	8·1
Northwest	2321	7·2	46·1	28·5	15·1	3·1	10·6
South	2840	8·0	39·7	30·4	20·3	1·7	10·5
North-Caucasus	976	5·9	33·8	31·5	23·1	5·7	14·6
Privolzhskii	5933	10·3	31·2	39·6	16·8	2·0	11·6
Ural	2481	10·4	42·4	28·4	18·0	0·8	10·4
Siberia	4079	5·3	44·6	31·3	15·7	3·1	12·1
Russian Far East	848	8·0	28·2	34·2	27·7	1·9	12·0

Only selected cancers are shown. The total number of cases does not include post-mortem diagnoses. Russian Far East refers to the Far Eastern Federal District. Modified from Kaprin and colleagues.[336]

Table 5: **Adult morbidity and mortality from cancer in Russia, 2012, by cancer site**

are 45·6 and 17·2 per 100 000 people compared with 92·9 and 14·9 per 100 000 in the USA, and 82·1 and 15·5 per 100 000 in Europe.[339] After breast cancer, the second most frequent cancer in women is colorectal cancer, followed by endometrial and cervical cancer.[339] Cancer incidence for women also varies between regions (table 5).[336]

Diagnostic radiology and pathology services

Although accurate cancer diagnoses need high-quality radiology and pathology services, little information about the availability of diagnostic radiology for cancer care in Russia is available. WHO has no data for the number of MRI, CT, and PET scanners or mammography equipment per 100 000 people for Russia.[341] However, anecdotal evidence suggests that some regions of Russia have more CT and MRI machines per person than do the UK or France.[342] Nevertheless, press reports suggest that radiological capacity is not meeting demand, with issues including shortages of both equipment and workforce.[343,344] One report described that 6% of equipment purchased during 2006–07 was not in use at the end of 2007 because of a lack of necessary spare parts and consumables.[345] Although radiation oncology exists as a designated specialty in Russia, there is no established training programme or licensure procedure; many radiologists in their daily practice function as both radiologists and radiation oncologists.[346] To assess how inadequacies or shortages in radiology and radiation therapy affect cancer diagnosis and treatments, a thorough assessment of needs and available resources would be valuable.

Russian pathologists have traditionally been trained in post-mortem assessment; nowadays, many still focus on this role within the Russian health-care system.[347] As a result, funding and health regulatory standards for pre-mortem diagnostic pathology have been lacking.[347] Post-mortem pathological diagnosis for inpatients is discrepant with ante-mortem diagnosis in up to 15–25% of cases, increasing to 50–70% for outpatients.[348] In 2012, the head of Russian pathology services, Georgii Avraamovich Frank, emphasised the importance of pre-mortem diagnosis, and recommended restructuring the training of pathologists as a result of global trends in modern pathology.[349]

At present, high-quality pathological diagnoses can only be guaranteed in a few specialised medical centres in Moscow and St Petersburg where the necessary high-quality equipment and pathological expertise exist.[347] Only a few laboratories have extensive experience with immunohistochemistry, which is often necessary to establish a correct diagnosis and provide prognostic information.[347] In 2012, a diagnosis of cancer was confirmed by histopathological examination in only 86·7% of new cases, with wide variability by organ system. Although this figure was higher than in 2001 (77·5%), it is still clearly less than the target of about 100%.[336] For some cancers, diagnostic verification with pathology was low: only 44·2% for pancreatic cancer, 48·9% for hepatocellular carcinoma, and 65·3% for lung, tracheal, and bronchial cancer.[336] The rate of a morphological diagnosis also varies greatly between regions, from almost 100% (in the Republic of Mordovia and Kamchatka) to less than 50% (in the Republic of Tyva).[336] There is no consistent assessment about whether the diagnostic specimen and the definitive pathological sample are in agreement.

A troubling feature of pathological examinations in Russia is the separation of individuals who do cytological and histological examinations.[350] Concurrent analysis of cytological and histological specimens is often necessary, and improves the likelihood of arriving at an accurate diagnosis. In Russia, however, cytological specimens are assessed by clinical laboratory physicians, whereas histological material is usually reviewed separately, by pathologists.[350]

Diagnostic pathology slides from Russian patients self-referred for medical care are poorly prepared and stained, and are often inadequately labelled with patient identifiers, carrying the risk of assigning a diagnosis to the wrong patient (Sheikine Y and Tatishchev S, unpublished data). As a result, patients outside large metropolitan areas often seek opinions from expert pathologists in one of the major Moscow oncology centres; delays of up to 2 months for a pathological diagnosis are not infrequent. Such delays can delay treatment, worsen the stage of cancer at diagnosis, and lead to poor outcomes.[351–354]

Societal and political will regarding cancer prevention

With recognition of the burden of cancer in Russia, several new policies have been introduced to reduce cancer incidence and improve outcomes. Public health initiatives directed at alcohol and tobacco control are examples of such attempts. Another effort, as part of the National Priority Project Health, was started in 2009, and focuses on disease prevention with an aim to reduce cancer mortality.[345] Cancer prevention is recognised as one of the most effective strategies for cancer control and is intended as an important part of the initiative, but the logistics of how cancer prevention will be implemented under this programme are not well-described.[355]

However, the National Priority Project Health's programme does create a primary care infrastructure on which efforts for cancer prevention could be built.[345] Within the programme, 502 prevention clinics for adults and 193 for children have been opened since 2010.[356] Investment in health infrastructure was urgently needed; in 2008, 7·6% of hospitals had no running water, 29·7% had no hot water, 7·3% had no telephone connection, and 10·1% had no main sewerage systems.[357] Nonetheless, an assessment must be made to establish if cancer prevention is adequately emphasised in the clinics run by the National Priority Project Health, and how changes

could be made to guarantee that the effort is sufficient to affect cancer incidence. Vaccination and screening for HPV are not covered by the national health system, and at this time, screening for cervical cancer is not offered at the project's clinics. Furthermore, reports suggest that there is a lack of public awareness of the clinics, and attendance has generally been low.[356] Also, anecdotal reports suggest that waiting times in these clinics are long and burdensome, service is poor, and drugs are frequently unavailable.

Despite these flaws, prevention clinics are a good first step; although other competing health-care initiatives might affect the National Priority Project Health's budget, funding for disease prevention should be prioritised and cancer prevention efforts now need to be introduced.[345]

Policies and perceptions related to tobacco use

Lung cancer is the number one cause of cancer and cancer mortality among men in Russia, and overall mortality for all tobacco-related cancers (eg, bladder, head and neck, kidney, gastric, and pancreatic cancer) is higher in Russia than in the USA or the European Union.[339] An estimated 44 million people in the region smoke; 60·2% of men and 21·7% of women are smokers.[358] Tobacco companies increasingly target women with intense marketing campaigns advertising slim and ultra-slim brands, and smoking among women has increased sharply in urban areas.[359] Smoking rates are also high among teenagers and young adults.[358] Passive smoke exposure is common and 51% of respondents to a survey[358] reported passive smoke exposure in public places (79% in restaurants, 25% on public transportation, 30% at universities, and 10% in health-care facilities). In Russia, 35% of people also report passive smoke exposure in the workplace, compared with 24% in Brazil, 63% in China, 30% in India, and 8·6% in the USA.[277,360–363]

An estimated 330 000–400 000 people die from tobacco-related causes every year in Russia.[364] The World Lung Foundation[365] estimates that the loss in annual economic productivity from smoking-related premature mortality in Russia (not including smoking-related health-care costs, morbidity, or health costs from passive smoke exposure) is at least $24·7 billion, or more than 3% of GDP.

In recognition of the smoking issue, several attempts have been made to ban smoking in public places,[366] but restrictions on smoking are widely ignored, mostly because of insufficient enforcement coupled with very low fines for infringement[367] and challenges from the tobacco industry.[365,368] After years of campaigns by organisations such as the Russian Public Health Association, Russia finally signed the WHO Framework Convention on Tobacco Control in 2008.[366,369] However, the power of tobacco lobbies in policy processes in Russia has so far impeded a full implementation of the framework.[370] A recent draft for a new tobacco-control bill from the Ministry of Health and Social Development represents a good opportunity to effectively reduce the tobacco burden in the country.[371] The recent Tobacco Act showed promise of successful enforcement during the Sochi Winter Olympic Games, where a strictly enforced tobacco-free policy protected athletes, sports delegation representatives, volunteers, and spectators from exposure to second-hand smoke.[372]

Many experts believe that low taxes on tobacco are a key contributor to the high prevalence of smoking in Russia, which has not been adequately addressed.[359] Despite recent increases in tobacco taxes, the real price of cigarettes (dependent on purchasing power in the region) fell by 49·4% between 2000 and 2007.[365] Total tobacco tax in Russia represents 33% of the retail price for filtered cigarettes and 43% for non-filtered cigarettes, which is substantially less than the 67–80% taxation recommended by WHO.[373] A 70% tax on cigarettes in Russia could avert 2·7 million tobacco-related deaths, would save 77 billion rubles ($2·23 billion) in productivity loss, and generate 153 billion rubles ($4·42 billion) in excise tax revenue per year.[365]

The Global Adult Tobacco Survey, administered in 2009, provides comprehensive information about perceptions of tobacco control held by the Russian public.[358] The survey findings showed that most smokers expressed interest in stopping smoking (60%), but only 3·6% proactively planned to stop in the coming months and 10·8% within the year, despite 68% of people surveyed having been exposed to antismoking information in the previous 30 days.[358] Pro-smoking campaigns are prevalent, and 68% of respondents reported recent exposure to cigarette advertisement, sponsorship, or promotion. Although the combination of increased cigarette taxation and antitobacco media campaigns can reduce cigarette consumption (as in Uruguay and Brazil),[337] tobacco taxation in Russia is so low that the potential benefit of media campaigns is strongly negated by cigarette advertising.[374] The Global Adult Tobacco Survey also provided information about how often tobacco use is discussed in health-care settings; only 45% of smokers reported being asked about tobacco use when they sought care with a health-care professional, compared with 69% of smokers in the USA.[375]

The crisis of alcohol misuse in Russia

Russia has the most hazardous pattern of binge drinking and the highest consumption of alcohol per person in the European region, and is classified as "most risky" by WHO.[376–378] Low life expectancy in Russia is attributed to high rates of alcohol consumption.[329,369,376,379] An estimated 500 000 Russians die each year as a result of alcohol-related disorders, a substantial portion of the estimated 2·5 million deaths from alcohol that occur worldwide.[369,380]

Alcohol-related cancers—eg, cancers of the head and neck (ie, oral cavity, larynx, and pharynx), oesophagus,

liver, colon, rectum, and breast—are common in Russia.[339,381] In men, the incidence of head and neck cancer is 19·6 per 100 000 people compared with 16·6 per 100 000 in the USA.[382] The mortality-to-incidence ratio for head and neck cancer is almost three times higher in Russia than in the USA.[382] The annual incidence of oesophageal and gastric cancer among men is also higher in Russia than in the European Union or the USA.[382] Because the incidence of cancers of the head and neck and oesophagus is linearly correlated with duration of alcohol use and amount of consumption, alcohol use is a major predisposing factor for the high incidence of these cancers in Russia.[381] Heavy alcohol use has also been associated with gastric cancer in Russia.[383,384] Because both alcohol and tobacco use are often entwined in Russia, the synergistic effect of these two carcinogens is of particular concern.[381]

Cessation of alcohol and tobacco use decreases risk of head and neck cancer on a population level.[385] Moreover, reduction of alcohol consumption has been reported to decrease the rate of alcohol-related malignancies 10–15 years after a decrease in consumption.[386] These data suggest that initiatives targeting alcohol and tobacco use could be useful for cancer prevention.

Historically, legislative attempts to curb alcohol use in Russia were met with opposition, driven by concerns that alcohol restriction and taxation would adversely affect the economy. A strong industrial lobby, both domestically and internationally, opposes alcohol regulation and taxes. In the Soviet era, the production of spirits was a state enterprise and taxation on alcohol was low, leaving a legacy of low taxation after the establishment of Russian Federation.[369,387]

In the past decade, a decrease in annual alcohol consumption from 17·5 L/person per year of pure alcohol in 2003 to 13·5 L in 2010 has been reported, which could be partly attributable to new alcohol legislation.[388] This decrease in consumption has already reduced the incidence of alcohol-related violence and acute alcohol toxicity,[388] but the latent effect on cancer incidence is not expected for at least another 10–15 years.[386] Despite these improvements, continued efforts are needed to curb alcohol use,[389–391] because it remains prevalent among Russian adolescents. Rates of alcohol use among 15-year-olds are more than double those in the USA,[392–394] which is of particular concern because alcohol use in young people is associated with a five-times increased risk of alcohol dependence and misuse during later life.[395]

Very recently, new comprehensive taxation of alcohol was introduced for both domestic and foreign beer and spirits. Taxes on beer rose by 20% in 2012, and the finance ministry is anticipated to increase taxation by another 25% in 2013 and a further 20% in 2014.[396] Whether these new alcohol taxes will be effective is uncertain, because historically progress in reduction of consumption was frequently hampered by negative public opinion and insufficient enforcement.[397] Despite this concern, taxation can be an excellent approach to curb alcohol use, particularly in young adults, when effectively implemented and enforced.[398,399] However, a multifaceted approach seems best to reduce alcohol use in Russia.[398] Policy efforts must address the public's perception of alcohol and change attitudes towards drinking. Public health campaigns, which portray alcohol use negatively, can change public perceptions about alcohol use and decrease consumption.[400]

Environmental effects and cancer in Russia

The link between environmental pollution and cancer incidence is well-established. Exposure to environmental carcinogens occurs in many countries due to a lack of proper regulation to prevent pollution and little funding for remediation efforts. In the 1990s, 40% of Russia's territory was environmentally stressed because of deforestation, irresponsible energy production, pollution, and nuclear waste.[401] The term ecocide was used to describe the environmental contamination that occurred during the Soviet era and contributed substantially to poor health among the population. The extent of pollution in Russia needs to be systematically assessed to establish its effects on cancer trends. Available reports suggest that efforts to reduce pollution in the former Soviet Union are inadequate.[402]

The Chernobyl accident in 1986 has been linked to high incidences of cancer in areas including Belarus, Ukraine, and Russia, as well as countries beyond. Up to now, more than 4000 cases of thyroid cancer have been attributed to the Chernobyl nuclear accident,[329] and other malignant diseases (including leukaemia and solid tumours) have been implicated.[403,404]

Other areas in Russia have alarming rates of cancers related to environmental contamination. Workers from the Mayak nuclear facility have exhibited a dose-response association between exposure to external radiation and leukaemia and lung cancer.[405] A more recent effort is underway to characterise cancer mortality of employees in asbestos mines and mills. A study[406] funded by the Ministry of Health is following up the health of about 30 000 workers of the JSC Uralasbest mine employed between 1975 and 2010. The JSC Uralasbest mine produces 20% of the world's asbestos, and reports suggest that there are high rates of asbestos-related malignant disease in the region, making a comprehensive study important.[407]

Infectious causes of cancer

Cervical cancer is an important cause of morbidity and mortality among women in Russia. The incidence of cervical cancer in Russia is 15·9 per 100 000 women, exceeding the incidence in both the USA (6·6 per 100 000) and the European Union (9·6 per 100 000).[382] Cervical cancer is a common cause of cancer death among women in the region, and mortality (6·1 per

100 000) is higher than in the USA (2·7 per 100 000) or the European Union (2·8 per 100 000).[382]

Secondary prevention of cervical cancer by either Pap smear or visual inspection with acetic acid are successful interventions to reduce both incidence and mortality.[408–410] In Russia, screening for cervical cancer is available on request, but no national screening programme exists.[411,412]

In a survey[413] administered by WHO of about 2800 Russian women, 70% of those aged 18–69 years had undergone a Pap test in the past 3 years, but findings from other studies have shown that only 30% of women receive Pap smears.[411,412] If high-quality Pap screening is as comprehensive in Russia as the WHO study suggests, a lower incidence of cervical cancer than that actually recorded would be expected. To provide optimum diagnostic accuracy of cytology-based screening for cervical cancer high-quality smears and qualified cytopathology reports are needed, both of which are difficult to achieve in Russia.[414]

One approach to circumvent the issues associated with cytology-based screening would be to implement screening by visual inspection with acetic acid and nationwide HPV vaccination. HPV vaccination is uncommon in Russia, but in view of the burden of cervical cancer and data showing a high prevalence of HPV infection (33% of 1976 women screened in Moscow and Novgorod had high-risk HPV),[415] large-scale HPV vaccination should be considered for both girls and boys. In addition to prevention of cervical cancer, this intervention reduces the incidence of HPV-associated anogenital disease,[416] and economic models clearly show that it would be cost effective.[417]

Other infectious causes of cancer should be closely assessed in Russia. Rates of hepatocellular carcinoma are low and therefore hepatitis vaccination should be considered in selected populations at risk, an approach used in other countries.[418,419] This measure is already underway in some regions of Russia with the National Priority Project Health's programme.[420] Rates of gastric cancer are high in some regions of Russia (table 5), and in one study from St Petersburg from 2007 to 2009, *Helicobacter pylori* infection was present in 83% of patients with gastric cancer and 55% of healthy people, compared with an overall prevalence of 30–40% in the USA.[421,422] *H pylori* strains containing the *cagA* gene predominate,[423] which might account for the high incidence of gastric cancer because *cagA* is associated with carcinogenesis.[424]

Cancer screening and early detection

At present, cancer screening is recommended only for breast and prostate cancer in Russia. No national public health initiatives support screening for cervical or colorectal cancer. On average, 15·6% of all cancers are detected during screening exams, but regional statistics show that screening services substantially vary.[336] For example, only 1·6% of cancers were detected with screening exams in Adygeya Republic, whereas 41·0% were detected with screening in the Chukotka region.[336] These data suggest that present screening programmes are completely inadequate, and need to be prioritised in the country.

Screening for breast cancer

Russia has a high incidence of metastatic breast cancer at presentation compared with the USA, which has comprehensive national mammographic screening and widespread community awareness about seeking medical attention for possible breast-cancer symptoms. Of 59 068 women diagnosed with breast cancer in Russia, 9·2% presented with stage IV disease compared with 5% of patients in the USA.[336,425]

Little information is available about the extent of screening for breast cancer in Russia, but access to screening varies between regions. According to Zaharova and colleagues,[426] Moscow provides the best organised screening programmes, whereas other regions that have introduced screening programmes lag far behind. For example, a diagnostic mammographic screening programme for breast cancer that was started in the Khanty-Mansi Autonomous Okrug in 2007 reached only about 30% of eligible women in the first 2 years.[427] Overall, screening rates seem to be low, with findings from a survey of 1351 women showing that less than 20% of eligible respondents had undergone mammographic screening or received a clinical breast exam in the previous 3 years; screening is almost 50% lower in rural areas than in urban areas.[413] These rates are well below the recommended goal of more than 70% coverage defined by WHO.[413] Public awareness of the benefits of mammographic screening is also low; 16·1% of Russian women surveyed were unaware that mammographic screening reduces mortality and 32·1% did not know whether screening had any benefit at all.[428] By contrast, 92% of women in eight other European countries overestimated the mortality reduction from mammographic screening by at least one order of magnitude. These findings suggest a need to assess whether mammographic screening would benefit Russian women, and if so whether capacity for mammographic screening should be expanded. This issue is evolving, in view of the recent installation of 1500 modern mammography machines throughout Russia for screening for breast cancer.[429] Data about the effects of this effort are awaited.

Review of the scientific literature in Russia shows a lack of data about socioeconomic and cultural barriers to breast screening and breast health care. As programmes are expanded in the region, screening protocols for breast cancer need to be developed that meet local needs and take available resources into account.[430] Careful analyses need to be done to establish if mammographic screening at a national level would be effective, because in many regions other impediments can reduce its effectiveness

(eg, suboptimum diagnostic pathology, barriers to establishing timely diagnoses, and other competing comorbid conditions that could negate the benefit of screening).

Screening for colorectal cancer

Colorectal cancer is the second most common cause of cancer-related death in women after breast cancer, and is the third most common cause of cancer-related death in men after lung and gastric cancer,[339] with overall incidence and mortality increasing during the past decade.[431] Screening for colorectal cancer is not included in the National Priority Project Health, which provides guidelines for cancer prevention efforts in Russia,[432] although several screening approaches (including regular faecal occult blood test, sigmoidoscopy, and colonoscopy) are recommended in other countries.[433]

Worldwide, colonoscopy reduces both the incidence and mortality of colon cancer.[434] In the absence of public awareness and screening, about 25·6% of all new cases of colorectal cancer in Russia are stage IV at diagnosis, compared with 18·8% in the USA and 16·6% in Australia.[336,431,435] 1-year survival for colorectal cancer is also lower in Russia than in the USA or Australia (72·1% in Russia *vs* 82·3% in the USA and 82·2% in Australia), suggesting either more advanced stage at diagnosis or suboptimum treatment.[336,431,435]

Effects of inequitable treatment and access to medicine

As of 2011, Russia has 2090 oncology departments associated with tertiary centres (hospitals), 125 registered oncology clinics (serving major towns or oblasts), 6175 radiology departments, 50 radiation oncology departments, 287 cytological laboratories, 1495 pathology laboratories, 4100 endoscopy suites, and 1541 mammography units.[336] Overall, the number of oncology beds in hospitals is 2·4 per 10 000 inhabitants. Almost 1 million adults are admitted to hospital each year for cancer, and on average patients with cancer are admitted to hospital for 11·2 days.[336] In the same year, there were 6539 cancer specialists, 1653 radiologists, and 93 radiation therapists in Russia.[336] The exact number of providers that administer radiation is unknown. However, the available data do suggest that the oncology workforce might not be sufficient to meet the growing cancer demand.

Although information about the distribution of cancer services within Russia is scarce, health care varies between regions with access to care differing between rural and urban populations, different socioeconomic groups, and different ethnic groups.

Urban and rural differences

In many countries, distribution of cancer resources and access to optimum cancer care differ between urban and rural populations.[337] Similarly, the 26% of the Russian population who live in rural settings are generally more likely to be poor and less well-covered by health-care resources.[436,437] Historically, adequate health care in Russia was available only in a few major regional cities throughout the country, and cancer services are still most extensive in Moscow and St Petersburg. This unique centralisation of Russian health care for a country of its size is not optimum for delivery of cancer services, because less than 12% of the total population in Russia resides in Moscow and St Petersburg.[438] The accessibility of medical services in rural populations is still much lower than for urban populations.[436,439] In 2008, there were 12·1 physicians per 10 000 inhabitants in rural areas compared with 49·6 per 10 000 overall in the country. The number of hospital beds per person was 2·6 times lower in rural areas, which was exacerbated by closure of many rural hospitals.[437] Most importantly, because cancer care is concentrated in very few urban areas, the vast majority of oncology patients have delayed diagnosis and lack of timely intervention.

Data about cancer incidence from Arkhangelsk and Chukotka, two regions in Russia with low urban development, show that rural areas might be affected by different types of cancer compared with Russia overall.[339,440,441] Men from these regions had high incidences of lung, oesophageal, and gastric cancer, whereas gastric and cervical cancers were the most frequent cancers in women. The national cancer statistics also showed that patients with cancer in Siberia and the Russian Far East (ie, the Far Eastern Federal District), where urbanisation is less advanced, had a high percentage of stage IV disease and high 1-year mortality rates (table 5).[336] These data should be used to guide interventions—eg, preventive efforts for cervical cancer should target regions with high incidence (eg, Chukotka and the Russian Far East) and frequent presentation with advanced disease (eg, North Caucasus and Ural; figure 4, table 5).[336,440]

Similar to other countries,[337] barriers to obtaining an accurate diagnosis and lengthy delays in care occur more frequently in rural than in urban areas.[442–445] Delays to diagnosis and treatment are a major concern because they affect cancer stage and outcomes.[351–354,446]

Socioeconomic inequalities affecting cancer care

Although Russian citizens are provided free access to medical care at state and municipal medical facilities (article 41 of the Constitution of Russia 1991),[447] availability of services differs widely by region, and socioeconomic factors affect rates of screening for cancer.[448,449] In rural regions where poverty is more common, health-care workers are often in short supply. Poor people spend on average 1·5 times more of their household income on health care than do wealthier people,[450] and often cannot afford treatment at all.[437,439] By contrast, the wealthiest 10% of the population use medical services 1·52 time more frequently than do the 10% poorest of the population (35·9% of the wealthiest

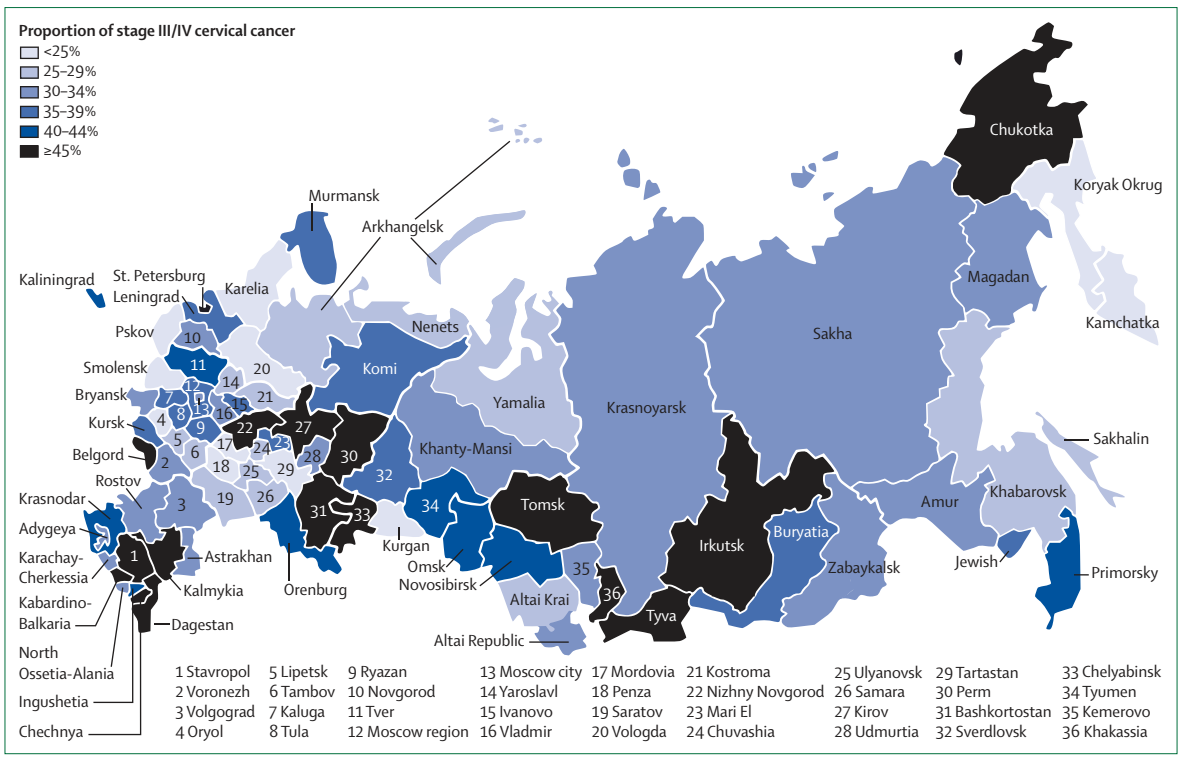

Figure 4: **Distribution of advanced cervical cancer by region in Russia**
Figure based on data from Kaprin and colleagues.[336]

accessed health services compared with 23·5% of the poorest in a 3-month period).[451]

Direct data to assess how these factors affect patients with cancer and their families are not available. In an attempt to ameliorate these issues, a 2011 health-care reform incentivises physicians to work in poor and rural areas with a one-off appointment allowance of 1 million rubles ($30 000).[452] Access to high-quality cancer services together with reductions in the prohibitive costs of care are urgently needed if patients from low socioeconomic backgrounds are to achieve improved outcomes.

Ethnic inequalities

Russia has more than 100 ethnic groups, representing only 0·2% of the population (about 250 000 people), but together they inhabit huge geographical territories.[453] Indigenous people in Russia have poor health outcomes with high rates of infectious diseases and maternal and child mortality.[453] Regions with the highest mortality are Siberia and the Russian Far East, whereas the country's most western areas (the so-called Russian heartland) have mortality rates above the national average.[334]

Epidemiological data for cancer incidence and outcome in indigenous people in Russia are scarce. Findings from a study[440] in the Arctic region showed different distribution of cancer compared with Russia overall, including increased all-cancer incidences and mortality rates among men and women. Similar to other regions of the world, poor health outcomes for indigenous people in Russia result from structural and socioeconomic factors—eg, living in remote areas with limited access to health services, low quality of public health services in indigenous settlements, and poverty.[337,454] Incomes of indigenous people are two to three times lower than the Russian national average,[455] and indigenous people often lack basic resources such as clean drinking water, adequate food, and proper housing. Additionally, indigenous people in Russia often live in areas with natural resources such as gas, and exploitation of these resources can lead to environmental pollution and contaminated soil, which are known to endanger health.[455]

Health funding inequities that affect access to cancer services

Cancer drugs are included in drug lists and standards of medical care. However, many patients with cancer have to procure funds for therapies themselves and there are drug shortages, even for patients who qualify for drug coverage under national programmes for drug reimbursement. In this setting, few data are available about overall access to cancer therapies across the country.

Historically, all cancer treatment was given in hospitals, even if admission to hospital was not clinically indicated. The infrastructure for outpatient oncology services still remains underdeveloped, with a rate of hospital

admission for patients with cancer of about 1 million per year.[336,437] Drug coverage is free for inpatients if needed drugs are listed on the essential drug list and are thought to be standard treatment, whereas outpatient medicines are not covered.[456] Despite the guarantee for inpatient drug coverage, 80% of inpatients are estimated to have to pay part of the costs of their medicines;[457] meanwhile, 75% of out-of-pocket expenses for outpatients are for outpatient pharmaceuticals.[437] Outpatient drug costs constitute a major difficulty for patients with cancer, because many oral drugs are increasingly becoming the mainstay of therapy for various cancers. Vulnerable groups can receive prescription drugs for outpatient care either free or at a discounted rate through the *Dopolnitelnoe Lekarstvennoe Obespechenie* (Additional Medicines Supply) programme.[437] The programme covers about 10% of the population, but not all who would benefit from outpatient drug coverage. As a result, pharmaceutical costs can act as a barrier for patients seeking treatment.[457,458]

Some hospitals and clinics cannot pay for drugs that are mandated by law to be available to patients without cost; out-of-pocket expenses for hospital-based treatment are also high.[456] Additionally, reports describe situations where informal payments, including bribery, are sometimes not only accepted, but demanded from patients and their care providers.[459] Informal payments are distinct from out-of-pocket expenses and are defined as payments made to individuals or institutions outside of official payment channels or for purchases meant to be covered by the health system.[460] Informal payments are very common in health systems worldwide, and can help patients to receive more expedited care, improved or increased care, or drugs that are in short supply or are costly.[460] Although informal payments are at times thought to be a form of corruption, they result from a system of poor health-care governance and have been described by physicians as necessary because of low pay and irregular salary payments.[460] In the most recent Russian Longitudinal Monitoring Survey from 2009,[437] 38·5% of inpatients and 28·6% of outpatients gave informal payments for their care. The percentage of informal payments for inpatients and outpatients in Russia has fluctuated in the past decade (figure 5).[437] The proportion of cancer care in Russia supported by informal payments is unknown.

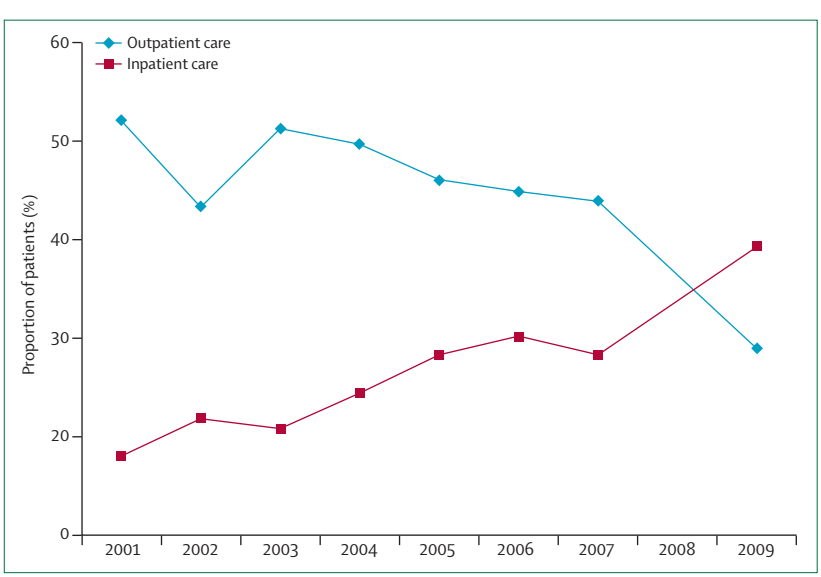

Figure 5: **Percentage of patients paying for necessary health care informally**
Figure reproduced from Popovich and colleagues[437] by permission of the European Observatory on Health Systems and Policies.

In an attempt to improve access to pharmaceuticals and innovative therapies for all Russian citizens, an essential drug list was created. In December, 2011, the amount of oncology drugs imported into the country increased—an encouraging sign that suggests improved access to modern treatments. To reduce drug shortages and high costs, attempts have been made to expand pharmaceutical development in Russia. At present, the generics industry largely relies on active pharmaceutical ingredients from India and China. Although the Russian Government plans to enforce regulations for good manufacturing practice, many companies receive certificates for good manufacturing practice of indefinite duration, with questionable quality assurance through inspections. A separate list of drugs, developed by the Ministry of Industry and approved by the Russian Government (List #1141-r, approved July 6, 2010) mentions 57 strategic drugs that should be produced in Russia.

Quality oversight of oncology drugs needs to be closely examined in view of reports of counterfeit drugs on the Russian pharmaceutical market. In 2008, findings from a survey[461] showed that up to 40% of Russians believe that they have been taking either substandard or counterfeit drugs. Although some state officials and local industry groups claim that the issue is minor and decreasing, in 2008 experts estimated that 10–12% of pharmaceuticals on the Russian market were counterfeited.[461] Antibiotics and hormonal therapies seem to be the most counterfeited drugs in Russia.[461] At this time, although the effect of counterfeit (or poor-quality) chemotherapies and other anticancer drugs is unclear, it should be investigated and regulatory measures implemented urgently if needed to protect patients.

Other factors

Access to medical literature and international engagement

The medical system in Russia inherited a legacy from the Soviet Union that discouraged international exchange of medical knowledge. More than two decades after the change in the political climate of Russia, lack of international engagement continues to affect oncology care.

Historically, access to foreign medical literature and academic publications was poor during the Soviet period, but has improved since academic medical research and

publications have received increased support.[462–464] The Russian Science Citation Index was created in 2005, and the online public-access catalogue contains almost 18 million publications from about 37 000 journals, 8188 of which are in Russian.[465] Before the index was established, access to online catalogues of Russian scientific literature was poor because less than 5% of Russian scientific journals are included in international databases.[465,466] A future step would be to encourage more Russian journals to translate publications into English, so that this research is available to the international community. Likewise, foreign literature published in English should be made available at academic institutions and be translated into Russian.

The academic environment

The Russian academic community has a rich history and intellectual culture. However, in recent years, Russian researchers trail the world average in both quantity and quality of international publications in clinical medicine.[467,468] The reasons are complex, but include poor financing and improper distribution of available funds, and insufficient personnel and poor quality of research infrastructure.[467,468] Favouritism and corruption have also been described,[468–470] which negatively affects academic medicine.

Postgraduate education in oncology

In Russia, postgraduate medical training is not structured and is suboptimum in content, volume, and duration.[347] Low wages force physicians to work in several jobs or leave hospital practice to seek employment in the pharmaceutical industry or abroad. Additionally, precarious employment increases corruption (eg, collection of informal payments from patients for services provided). Some Russians trained in western Europe, the USA, and Canada return home only to find that the credentialling requirements to obtain recognition of their foreign medical education are convoluted and not transparent, even to someone who speaks the language fluently, understands the local culture, and has experience of navigating government and administrative agencies.[471,472]

Graduate and postgraduate education in oncology and pathology (and medical education generally) in Russia is also severely hampered by the lack of up-to-date medical literature and journals.[464] Because of poor English skills, trainees cannot self-educate using western-derived material; most translated textbooks are outdated, with a lag time of 10 years for scientific knowledge.

Many have called for improved education in oncology for medical students in Russia.[473] For example, efforts are underway by the Russian Ministry of Health to create clinical practice guidelines based on the best available scientific evidence.[474]

The availability of radiation therapy in Russia has fallen since the Soviet era, despite increased need.[459] Only 30% of patients with cancer receive radiation therapy, compared with 70% in other developed countries.[346] This poor availability is due to lack of financial resources, equipment, training, and personnel.[346,459] Radiation therapy is largely viewed as a "palliative treatment that prolongs poor quality of life of the terminally ill."[459] Adequate training of radiation oncologists is needed. To increase capacity of radiation therapy in Russia, training programmes for radiation oncology need to be established throughout the country.[346]

Palliative care

Palliative care is a relatively new component of cancer care in Russia, because it did not exist in the Soviet health system. The first hospice in the region opened in St Petersburg in 1990, and palliative care has steadily grown since.[475] However, only 15% of patients with terminal cancer or HIV/AIDS have access to proper pain control.[476] Prescriptions for opioids are strictly regulated, creating a barrier to prescribers and patients, and training for palliative care is poor among students and physicians.[476,477] Although palliative care is referenced as a priority for patients with cancer, Russia has no national policy for palliative care.[476] Introduction of effective ambulatory palliative care would improve the quality of life for both patients with cancer and their families, and would be highly cost effective for many reasons (eg, reduction of the need for prolonged and costly hospital admissions for patients at the end of their lives, which also block beds for acute care).

Clinical trials in cancer

Clinical trial efforts for cancer are expanding in Russia. According to the WHO International Clinical Trials Registry Platform, 445 clinical trials of cancer are in progress (table 6).[1,7,478] However, compared with other high-income countries (eg, the UK and the USA), capacity for clinical trials could be substantially increased in Russia. Many Russian patients believe in new treatment modalities, with more than 80% willing to participate in clinical trials. Russia is emerging as one of

	Number of cancer trials*	Population in 2012†	Number of cancer trials per 10 000 000 inhabitants*
China	979	1 350 695 000	7
India	479	1 236 686 732	4
Russia	445	143 533 000	31
UK	2028	63 227 526	321
USA	10 420	313 914 040	332

We estimated the number of cancer clinical trials for each country by searching with the term "cancer" in reference 7. The number of clinical trials per 10 000 000 inhabitants as a metric for capacity was calculated by dividing the population in 2012 per 10 000 000 inhabitants with the number of cancer trials. *Data from WHO.[7,478] †Data from the World Bank.[1]

Table 6: **Number of cancer clinical trials done in China, India, and Russia compared with the USA and the UK**

the most strategic locations for global pharmaceutical companies to do clinical trial research,[479] and a growing number of international contract research organisations and pharmaceutical companies have opened or expanded offices in Russia.

The Russian Ministry of Health provides incentives for research through regulatory support for trials and increasing of the number of qualified investigative sites in the region. In the past, most cancer trials were done mainly at the NN Blokhin Cancer Research Center and Herzen Oncological Centre in Moscow, and at the NN Petrov Research Institute of Oncology in St Petersburg, supported by industry;[480] nowadays, infrastructure for clinical trials is rapidly growing, and more than 50 cancer centres have approval to run domestic studies and participate in international clinical trials. In the second quarter of 2012, the Ministry of Health issued approvals for 228 clinical trials, almost twice as many as in the second quarter of the previous year. A recent European Medicines Agency report described that Russia is fifth in the world in terms of patient recruitment, with 3·1% of patients (compared with the USA at 29·6%, Germany at 6·8%, Canada at 4·4%, and Poland at 3·9%).[481] In the future, barriers to trials supported by academia should be explored to foster a supportive environment for cancer trials throughout the country.[482]

Conclusions

Disease burden in Russia is shifting from infectious to chronic, non-communicable diseases. Cancer incidence in Russia is rising, but by contrast with other high-income countries, death rates are high in Russia; cancer is the second most common cause of death, contributing to 15% of annual national mortality.

Cancer control could be substantially enhanced in Russia through several strategic initiatives: increasing of health-care expenditure to about 10% of GDP, and increasing of the percentage of resources allocated to cancer control; improvement of investment in health-care infrastructure and delivery for prevention and treatment services for cancer; ensuring of equitable distribution of funding, specifically to indigenous populations and populations that are socioeconomically and geographically disenfranchised; establishing of a national cancer registry that meets international standards; promotion of antitobacco and antialcohol efforts; and improvement of professional training for cancer diagnostics and treatment services (panel 3).

The present national cancer registry provides information about cancer incidence, mortality, and stage at diagnosis.[336] However, it does not specify the percentage of the population that it covers, nor whether it is representative of minority, underserved, and remote populations. The annual publication by the Ministry of Health also does not present data about cancer incidence and mortality by gender for different cancer subtypes. Comprehensive and accurate statistics for cancer should additionally include data for survival by stage. Use of ethnic origin or indigeneity as a metric is important to collect data for distinct disadvantaged subpopulations. The goal of a national cancer registry should be to understand cancer trends in all subpopulations within a country to identify challenges that can be addressed to reduce cancer mortality. Assessment of capacity for radiology, radiation oncology, and oncology is generally needed to establish whether human and technical resources are adequate and well-distributed.

Complete clinical staging and high-quality pathology services are needed, and improvement of training and resources for pathology is a high priority. Because only 7·7% of health-care facilities use electronic medical records and less than 3% are equipped with the means to use telemedicine,[483] improvement of access to electronic medical systems, databases, and scientific literature could have a substantial effect. Telepathology can provide rapid consultation and second opinions in diagnostically challenging cases, and could be implemented both within Russia and in collaboration with foreign pathologists abroad. Additionally, telepathology can be used for educational purposes by medical students and pathologists in training, as well as by the practising pathologists to improve their diagnostic skills. Implementation of effective telemedicine services, however, needs initial upfront investment (eg, in equipment, storage and cloud servers, and high-speed networks for transmission of digitally scanned images). Another important aspect to enhance quality and enable international collaboration of scientific and clinical services is the legal framework for exporting patient material (eg, in the form of digital images) out of the country.[484]

There is a need to establish a comprehensive national cancer plan that takes into account the distribution and burden of cancer in the country. Primary prevention and early detection of cancer, together with prompt and optimum treatment, should be public health priorities to reduce cancer incidence and mortality in Russia. WHO estimates that about 50–60% of cancer mortality is avoidable by applying country-specific strategies for prevention and treatment.[485]

Lack of access to information, poor prevention and early detection, and suboptimum treatment result in diagnosis of cancer at a late stage, and therefore reduce survival. Interventions for prevention and early detection need a series of legislative actions, public awareness campaigns, and public health interventions. Some interventions can be accomplished by training of physicians and non-physician health workers about reduction of risk factors. Furthermore, a strict antitobacco and antialcohol policy is needed. Present regulations about tobacco and alcohol should be enforced, and more stringent measures need to be introduced. Additionally, infectious causes of cancer need close assessment. HPV-related cervical cancer, which is preventable, is a main cause of cancer mortality among women and urgently

needs to be addressed. In areas with a high incidence of cervical cancer, HPV vaccination and screening by visual inspection with acetic acid or expansion of existing Pap-smear screening programmes should be considered. Prevention of, and screening for, cervical cancer should be the top priority for cancer prevention in women. Environmental decontamination and remediation of polluted lands is also needed. From an economic standpoint, effective prevention and early detection yield benefits that far exceed costs.

Research is needed to assess cancer trends and care differences between rural and urban populations, ethnic minorities, and indigenous peoples, and to identify factors that increase the burden of cancer. Socioeconomic differences that affect access to cancer prevention need investigation. Reforms of drug reimbursement programmes and the National Priority Project Health have recently been implemented, but close assessment of these programmes from an oncology perspective is warranted. To support research in the region and promote international collaborations, changes need to be made at governmental and institutional levels. Many large cancer organisations are now expanding their educational efforts at an international level, and physicians and researchers in Russia should be supported to engage in these endeavours. The American Society of Clinical Oncology is working closely with the Russian Society of Clinical Oncology to organise meetings in the region. The American Society of Clinical Oncology and the European Society for Medical Oncology also provide grants for international physicians and researchers, and are taking steps to translate their publications to Russian.

Panel 3: **Recommendations for cancer control in Russia**

Improve characterisation of cancer epidemiology in the region

- Improve the national cancer registry by increasing collection of statistical data from all regions of the country; measure cancer outcomes by stage and cancer subtype for both sexes

Increase efforts for primary prevention

- Establish a comprehensive national prevention plan for cancer (including reduction in consumption of tobacco and alcohol)

Improve efficacy and coverage of cancer screening programmes

- Cancer screening programmes need to be organised at a national level, taking into account local needs and available resources

Enhance diagnosis and treatment of cancer

- Improve and standardise diagnostic services for radiology and pathology
- Provide increased patient access to surgical treatment, radiation therapy, and anticancer therapeutics

Reassess governmental policies

- Develop standardised national guidelines for cancer treatment, taking into account available resources and health insurance policies
- Develop a standardised training curriculum for oncologists, radiation oncologists, and pathologists

Final recommendations for China, India, and Russia

Both from a standpoint of human suffering and effects on future economies and prosperity, cancer control in China, India, and Russia is of paramount importance. To curb rising cancer incidence and disproportionately high mortality rates, steps common to all three countries need to be taken. Primary prevention, particularly reduction of tobacco use, is essential because of the mortality caused by lung and other cancers, and non-communicable diseases; tried-and-tested methods for public education and legislation should be used. Additionally, prevention of contamination and repair of polluted environments is essential, particularly in China. For cancer-causing infections, immunisation (eg, for HPV and hepatitis A and B), screening (eg, for *H pylori*), and treatment should be instituted. Early detection increases the proportion of cancers diagnosed at stage I and decreases the proportion diagnosed at stage IV, and urgently needs to be improved in all three countries. Conversely, cost-effective programmes for secondary prevention (eg, mammography and clinical breast examination for breast cancer; Pap tests and visual inspection with acetic acid for cervical cancer; and faecal occult blood testing and colonoscopy for gastrointestinal malignant disease) are also essential to reduce the number of cancers that develop. Cancer registries (which are fairly inexpensive) and comprehensive national cancer plans are required by governments and researchers to implement and assess the success of new strategies for cancer control. Reformed education, country-specific research, and improvements in health-care infrastructure are needed, as are twinning programmes for cancer centres. Treatment access for patients needs to be improved through better drug availability, treatment, and facilities for diagnosis, pathology, and imaging. Furthermore, clinical research should be supported, regulatory approvals for drugs should be improved, and quality control of generically available drugs needs to be enhanced. Successful strategies for primary and secondary prevention, and reductions in stage IV disease, will result in improved mortality rates and reductions in costs.

An integral component of optimum cancer care is delivery of palliative and terminal care. Because many patients will not be cured after a cancer diagnosis, it is essential that funding, resources, access to opioid analgesia, and community education continue to be developed for this group. Optimum management of symptom control includes attention to physical symptoms, but also support for emotional, spiritual, and social difficulties experienced by patients and their care providers, with attention to cultural differences in attitudes to death, which will vary between each country.

To achieve these goals, political and social will is necessary. Increased funding in terms of absolute dollar investment, increased percentage of GDP spent on health

care, and increased percentage of health-care spending allocated to cancer control need to be achieved. More equitable distribution of monetary resources, health-care workers, and general health-care infrastructure is needed, particularly for disadvantaged populations in rural communities, the urban poor, and indigenous peoples. For China, curbing of environmental pollution is paramount. The role of Taoist and Confucian beliefs in cancer attitudes are key considerations for health-care planning. In the case of India, the use of smokeless tobacco and smoking control is essential, because reductions in lung cancer, cancers of the head and neck, and other tobacco-related cancers are a major priority. New strategies to incentivise doctors and other skilled personnel to remain in India and practise in disadvantaged settings are needed. Control of drug availability, legislation to curb provision of illegal drugs, and improved oversight of quality control are also needed in India. As a priority, Russia needs to improve rates of alcohol and tobacco misuse, two leading causes of cancer-related and non-cancer-related deaths; in view of its high-income economy, funding for cancer control urgently needs to be addressed.

The intent of this Commission is to engender enthusiasm among policy makers and health-care stakeholders for change and improvements in China, India, and Russia; with the necessary will, substantial progress can be made relatively inexpensively. Our long-term hope is to help avert a potential worsening of cancer burden, increased human suffering, and future economic peril caused by cancer for these three important countries.

Contributors

PEG was the lead author of the Commission, wrote the abstract, introduction, and conclusion, and participated in the concept design, writing, and editing of all sections of the Commission. KS-W and AC participated in the writing, editing, and review of all sections. LF, JL, and KS-W were lead authors of the China section. ZC, YQ, ZS, Y-LW, DF, LWCC, JW, QZ, SY, GS, and JH were coauthors, participated in the concept development, writing, and editing, and approved the final version of the China section. YC-G, PERL, CSP, and AC were the lead authors of the India section. AP, RS, RB, SDB, RN, LK, PP, SS, PC, SI, SSS, RD, and ESPdC were coauthors, participated in the concept development, writing, and editing, and approved the final version of the India section. BLL-B, TB-C, and YS were lead authors of the Russia section. DA, VS, SO, DK, IT, ST, KDD, and SS were coauthors, participated in the concept development, writing, and editing, and approved the final version of the Russia section. MH participated in the writing and editing of all sections. CV and JS participated in the concept development, writing, editing, and management of all sections.

Declaration of interests

PERL has received travel grants from Roche, Sanofi-Aventis, and Novartis, and has also consulted for Novartis. All other authors declare that they have no competing interests.

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