Global cancer incidence in older adults, 2012 and 2035

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Global cancer incidence in older adults, 2012 and 2035: A population-based study

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Population ageing has substantially contributed to the rising number of new cancer cases worldwide. We document cancer incidence patterns in 2012 among older adults globally, and examine the changing magnitude of cancer in this age group over the next decades. Using GLOBOCAN 2012 data, we presented the number and proportion of new cancer cases, and the truncated age-standardised incidence rates among adults aged 65 years and older for all cancer sites combined and for the five most common cancer sites by world region. We calculated the incidence in 2035 by applying population projections, assuming no changes in rates. In 2012, 6.7 million new cancer cases (47.5% of all cancers) were diagnosed among older adults worldwide, with marked regional disparities. Nearly 48% of these cases occurred in less developed regions. Lung, colorectal, prostate, stomach and breast cancers represented 55% of the global incidence, yet distinct regional patterns were observed. We predict 14 million new cancer cases by 2035, representing almost 60% of the global cancer incidence. The largest relative increase in incidence is predicted in the Middle East and Northern Africa (+157%), and in China (+155%). Less developed regions will see an increase of new cases by 144%, compared to 54% in more developed regions. The expected increase in cancer incidence at older ages will have substantial economic and social impacts globally, posing considerable and unique challenge to healthcare systems in every world region, especially in those with limited resources and weaker health systems.

Introduction

Due to ongoing demographic and epidemiological transitions, the global burden of cancer is rapidly increasing, with the 14 million new cancer cases in 2012 expected to rise to 24 million new cancer cases in 2035.[1] A key driver is the rapidly rising number of older people worldwide - the absolute number of people aged 65 years and older is expected to double in the next two decades in all world regions including those with limited resources at present.[2]

Cancer management in older people can be complex; comorbidity, polypharmacy and physiologic age-related changes can affect how and when cancer is diagnosed, whether or not treatment is offered and the individual tolerance to anticancer therapy.[3–5] Moreover, older people are often excluded from randomised controlled trials, and thus evidence relating to the efficacy of cancer treatment in this population is frequently absent or incomplete.[6] In addition, the survival gap between younger and older cancer patients is widening over time.[7] The growing cancer burden at older ages is likely to result in major economic challenges in the provision of clinical and health services that adequately meet these needs over the coming decades.

An in-depth global description of the burden of cancer at older ages is therefore long overdue; there are few reports on the epidemiology of cancer among older adults, and these have tended to be at the national level and mainly conducted in more developed countries.[8–11] This study, therefore, examines the current and future global patterns of cancer incidence among adults aged 65 and older by world region as a means to provide critical insight for policy makers into developing global cancer control policies in their region for this rapidly growing population.

Key words: neoplasms, epidemiology, older adults, population-based cancer registries

Abbreviations: ASR: age-standardised rate; GICR: Global Initiative for Cancer Registry; IARC: International Agency for Research on Cancer; ICD: International Classification of Diseases

Additional Supporting Information may be found in the online version of this article.

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Material and Methods

Data sources and statistical analyses

Cancer incidence estimates for 2012 in 184 countries were obtained from the GLOBOCAN database held at the International Agency for Research on Cancer (IARC).[1] Incidence data

What's new?

Population aging has substantially contributed to the rising cancer incidence worldwide. However, an in-depth global description of the burden of cancer at older ages is long overdue. This study examined the cancer burden in adults aged 65+ according to cancer sites and world regions. In 2012, 7 million new cancer diagnoses occurred among adults aged 65+, almost 50% of them in less developed regions. By 2035, older adults will represent about 60% of all newly diagnosed cases. The growing cancer burden among older adults will result in major societal and economic challenges for the provision of care and health services.

were available for 27 cancer sites plus all cancer sites combined, excluding non-melanoma skin cancer (ICD-10 C00-97, except C44), and for 10 age groups (0–14, 15–39, 40–44, 45–49,50–54, 55–59, 60–64, 65–69, 70–74, 75 and over) by sex.

Numbers of new cases among adults aged 65 years and older, as well as 0–64 and 75+ years old, and truncated age-standardised incidence rates (ASR per 100,000) for all cancer sites combined and the five most common cancers were reported for more and less developed regions, as defined by the United Nations[2] and for seven world regions: (*i*) Asia (eastern, south-east, south-central Asia excluding China and India), (*ii*) Europe (eastern, northern, southern and western Europe), (*iii*) Latin America and the Caribbean (central, southern America and the Caribbean), (*iv*) Middle East and North Africa (western Asia and northern Africa), (*v*) northern America (United States of America and Canada), (*vi*) Oceania (Australia, New Zealand and pacific islands) and (*vii*) sub-Saharan Africa (eastern, middle, southern and western Africa). In reporting the estimates, China and India, given their relative population sizes, were presented separately. The truncated ASR were calculated for the age group 65+ were compared to equivalent summary rates for ages 0–64, standardised using the world standard population of Segi, revised by Doll *et al.*[12] We also computed the number of new cancer cases occurring in adults aged 65 years and older as a proportion of the total cancer diagnoses by sex and world region. Lastly, we predicted the future number of new cancer cases for all cancer sites combined by world region in 2035 for the age groups 0–64, 65+ and 75+ by applying sex- and age-specific incidence rates in 2012 to United Nations population projections using the medium fertility variant for the year 2035.[2]

Role of the funding source

The funders had no role in study design, collection, analysis or interpretation of data or writing of the report. The corresponding author had full access to all the data and had final responsibility for the decision to submit for publication.

Results

The global burden of cancer in older adults

In 2012, an estimated 6.7 million new cases of cancer were diagnosed in adults aged 65 years and older, representing 47.5% of the total number of new cancer cases worldwide (Table 1) while 8% of the world population was aged 65 years and older (Fig. 5). Most of the new cancer cases occurred in Europe (1.9 million, 29% of the world total) and Asia (2.8 million, 42%) including 1.5 million cases diagnosed in China (22% of the world total – Table 1) whereas people aged 65 years and older in these respective regions represented 22, 39 and 31% of the world older population, respectively. Nearly 48% of all new cancer cases among older adults occurred in less developed regions where more than 60% of older adults live. The geographical pattern of ASR is shown for both males and females in Figure 1. The truncated incidence rates among older males varied from 716 per 100,000 in sub-Saharan Africa to 2,544 per 100,000 in Oceania (Table 1), while in females, rates ranged from 337 per 100,000 in India to 1,540 per 100,000 in northern America. Overall, a nine-fold difference in rates among older adults was found across countries worldwide, from 261 in Niger to 2,226 in Denmark (Supporting Information Appendix pp. 2–5). For the purposes of comparison, a similar degree of variation was observed in the 0–64 age group, but with much lower ASR in the latter age group, ranging from 33 per 100,000 in The Gambia to 214 per 100,000 in the Republic of Korea (Supporting Information Appendix p. 6).

Geographical patterns of rates were very similar for both sexes, although incidence rates were consistently 15–90% higher in men compared to women (Table 1). When excluding sex-specific cancers – for example, prostate and testis cancer in males and breast, cervical, corpus uteri and ovarian cancers in females – the magnitude of sex difference was even higher (60–160% – Supporting Information Appendix p. 7).

The percentage of all new cancer cases that occurred among older adults ranged from 35% in sub-Saharan Africa to 60% in Oceania among males and from 22% in sub-Saharan Africa to 53% in Europe among females (Supporting Information Appendix p. 8). The lowest percentage within specific countries was observed in the United Arab Emirates for both males and females (12 and 5%, respectively), with the highest percentage in Japan, also in both sexes (76 and 67% among males and females), respectively.

Major cancer sites among older adults

Among older males, prostate cancer was the leading cancer globally (Fig. 2) and in all regions, except in Asia where lung cancer exceeded all other cancers (Fig. 3*a*). Lung and colorectal cancer were also common cancers in most regions. Liver cancer was frequent among older males in Asia, Middle East

Table 1. Estimated number of new cancer cases, age-standardised incidence rates per 100,000 inhabitants (ASR) for all cancers combined excluding non-melanoma skin cancer in adults aged 65 years and older in 2012 by sex and world region

	Males		Females			Total	
Region	Cases[1]	ASR	Cases[1]	ASR	M:F ratio[2]	Cases[1]	ASR
Asia (excl. China and India)	614,000	1,325	416,000	700	1·9	1,030,000	976
China	928,000	1,576	551,000	811	1·9	1,479,000	1169
India	172,000	570	114,000	337	1·7	286,000	445
Europe	1,086,000	1,261	855,000	1,102	1·1	1,941,000	1518
Latin America and the Caribbean	284,000	1,417	225,000	877	1·6	509,000	1115
Middle-East and North Africa	109,000	1,097	78,000	632	1·7	187,000	839
Northern America	510,000	2,381	439,000	1,540	1·5	949,000	1909
Oceania	51,000	2,547	34,000	1,387	1·8	85,000	1924
Sub-Saharan Africa	90,000	716	82,000	531	1·3	172,000	612
More developed regions[4]	1,960,000	2,206	1,524,000	1,190	1·9	3,484,000	1618
Less developed regions[5]	1,913,000	1,155	1,287,000	655	1·8	3,201,000	883
World	3,873,000[5]	1,511	2,811,000[5]	854	1·8	6,685,000[5]	1143

[1]Numbers are rounded to thousands.
[2]M:F Ratio = Male to female age-standardised incidence rates ratio.
[3]More developed regions comprise Europe, Northern America, Australia/New Zealand and Japan.
[4]Less developed regions comprise all regions of Africa, Asia (except Japan), Latin America and the Caribbean plus Melanesia, Micronesia and Polynesia.
[5]The estimated numbers of cancer cases for world do not correspond to the sum of the estimated numbers of cancer cases of regions because the world population may include some small country populations for which no estimates are provided.

and North Africa and sub-Saharan Africa, and stomach cancer was the second most diagnosed cancer in Asia. These five cancers represented over two-thirds of the total burden of cancer among those aged 65 years and older in all regions.

Among older females, breast cancer was the leading cancer globally (Fig. 2) and in most world regions, except in Asia including China and sub-Saharan Africa where colorectum, lung and cervical cancers were more common, respectively (Fig. 3*b*). Similar to males, liver was a leading cancer site in Asia, the Middle East and North Africa and sub-Saharan Africa, while colorectal cancer was one of the five main cancer sites in all regions. The proportion of the total burden of cancers in this age group explained by the top five cancers was less than among males but still represented between 46% in Middle East and North Africa, and 66% in China (Fig. 2*b*). For comparison, the five most common cancer sites for 0–64 and 75+ years old are displayed by sex in Supporting Information Appendix pp. 9–10 and pp. 11–12, respectively.

In terms of rates of the specific main cancer sites, Oceania, northern America and Europe had the highest rates of prostate and colorectal cancers among older males and the highest rates of breast and colorectal cancers among older females (Supporting Information Appendix p. 13). Asia (including China and India) had the highest rates of liver and stomach cancer among older females and males, whereas the lowest rates of lung, and colorectal cancers were observed in sub-Saharan Africa for both sexes. The magnitude of difference in rates across regions varied according to cancer site. The largest variation was for lung cancer, with a 14-fold higher rate in northern America (325 per 100,000 in both sexes combined) compared to sub-Saharan Africa (24 per 100,000). A nine-fold difference was observed combined for colorectal cancer between Oceania (286 per 100,000) and sub-Saharan Africa (32 per 100,000). The magnitude of the differences was smallest for liver cancer, where rates varied three-fold (from 29 per 100,000 Northern America to 89 per 100,000 in Asia in both sexes).

Future burden of cancer among older adults

Overall, the number of new cancer cases (all cancer sites combined) is expected to double by 2035 (14.0 million) among older adults; from 3.9 to 8.5 million (a 118% increase) among older males, and from 2.8 to 5.7 million among older females (a 104% increase). This rise is observed in all world regions (Fig. 4), with the greatest relative increase expected in Middle East and North Africa (157%) and the smallest relative increase in Europe (47%). The increase is expected to be much larger in less developed regions with an estimated increase of 144% by 2035, as compared to 54% in the more developed regions.

In absolute terms, the greatest number of additional cases are projected to be in China (2.3 million additional cases) followed by Asia (1.1 million), Europe (0.9 million) and North America (0.8 million). By 2035, older adults are predicted to represent 58% of the total cancer incidence burden globally. In northern America, Europe, Oceania and China, over two thirds of all cases will be diagnosed among older adults (Fig. 5).

As a comparison, the number of cancer cases among adults aged 0–64 years will decrease in Europe over the same period (−3% all sexes combined; Supporting Information Appendix p. 14) and will increase in other world regions but at a lower rate than among the older age group (ranging from +4% in

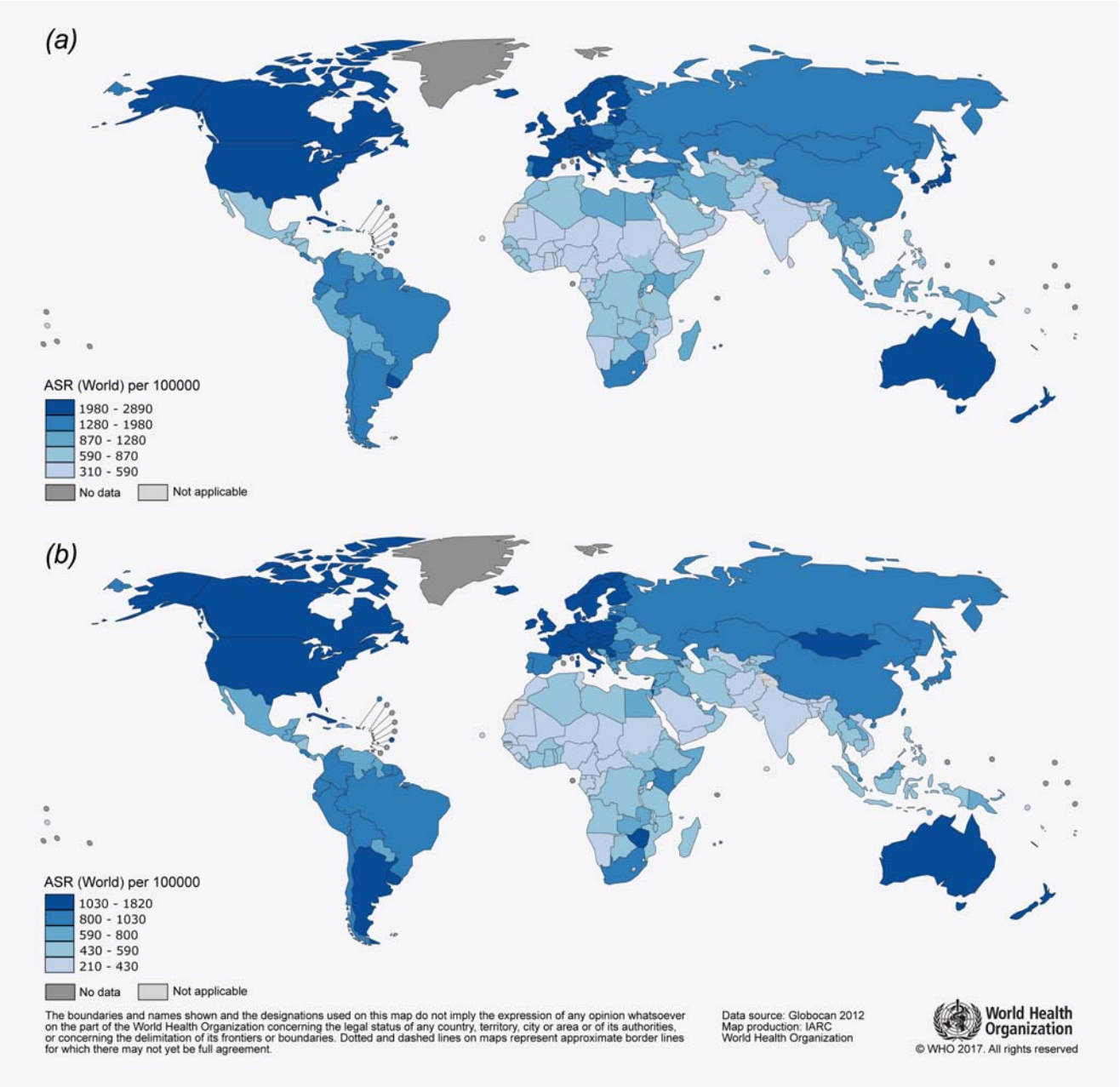

Figure 1. Age-standardised incidence rates for all cancer sites combined in adults aged 65 years and older (per 100,000 inhabitants) in 184 countries in 2012 among (*a*) males and (*b*) females. [Color figure can be viewed at wileyonlinelibrary.com]

northern America to +78% in Middle-East and North Africa). Among adults aged 75 years and older, similar increase as the 65+ years was observed, that is, +126% in older males and +106% in older females (Supporting Information Appendix p. 15).

Discussion

Almost seven million new cancer cases were diagnosed among adults aged 65 and older in 2012 worldwide and about half of all cancer cases occurred in less developed regions. At global and regional levels, a disproportionate part of this burden is borne by men as incidence rates were 15–90% higher among older males than females. Prostate, breast, lung and colorectal cancers were the main contributors of the burden in most regions but infection-related cancers represented a greater share of the burden in less developed regions. By 2035, the number of new cancer cases among older persons is expected to double, with rises observed uniformly in all regions: 58% of all new cases in 2035 will be among older adults aged 65 years and over, as compared to 48% in 2012. While the relative increase is greater in less developed countries, the higher proportion of older people in more developed countries indicates

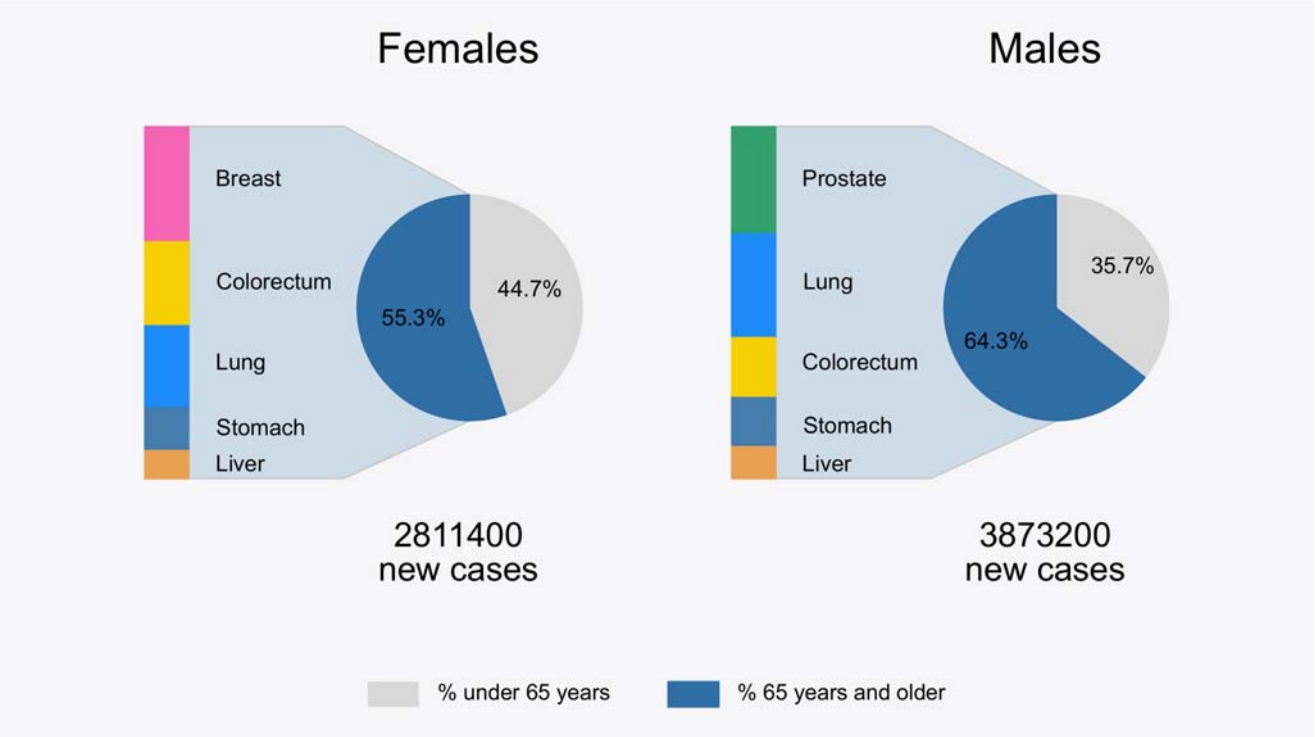

Figure 2. Proportion of the five leading cancer types among females and males aged 65 years and older in 2012 worldwide. [Color figure can be viewed at wileyonlinelibrary.com]

that the absolute increase in these regions will be substantial. This is likely to lead to substantial pressure on health services, and bring major economic and societal costs.

Given the rapid projected increase in cancers among older people, there is an urgent need to focus on comprehensive cancer control strategies for this age group, which are tailored to local needs and priorities. Preventive strategies focused on the most frequent incident cancers within each region are likely to be critical,[13] particularly in less developed regions with limited financial and human resources, including oncology capacity to provide the necessary cancer care to an ageing population.[14,15]

Contrary to other world regions, in China breast cancer did not contribute to the five most frequent cancers diagnosed among females aged 65 years and older. Recent studies have indeed reported younger age at diagnosis among breast cancer patients in China compared to Europe or the United States of America.[16,17] Further studies to assess possible biological reasons to this pattern are warranted. Additionally, in China, lung cancer is the leading cancer in older females and males. Though the high smoking rates in older Chinese males can explain our finding, smoking is not probably the main risk factor among older Chinese females since smoking rates are quite low among females.[18,19] Chinese women are however particularly exposed to second-hand smoking and high levels of high household air pollution originating mainly from cooking with poor ventilation or heating stoves using biomass, coal and other solid fuels.[20] Moreover, outdoor air pollution particulate matters mainly derived from natural phenomena, anthropogenic and industrial activities and traffic-related sources through the combustion of coal and petroleum products may also explain part of this finding.

From a life course perspective, the preceding age group 45–64 years is seen as a crucial window of opportunity for cancer prevention that can impact on reducing the burden at older ages.[21] This mid-life influence of behavioural, social and environmental risk determinants of health accumulates and may presage health and well-being in later life.[21] Given the cancer profiles at older ages observed in this study and the high prevalence of modifiable lifestyle factors among the middle-aged within the more developed regions, interventions aiming at reducing factors such as smoking, obesity, physical inactivity and diet should be pursued. Yet evidence suggests that cancer prevention is also effective at older ages. Smoking cessation at later ages still can reduce the risk of lung cancer,[22] obesity at older age remains a risk factor for cancer,[23] physical activity reduces the risk of colon cancer in this age group,[24] while adherence to dietary recommendations may also lower the risk of cancer among older adults.[25]

In less developed regions, namely in sub-Saharan Africa, some Asian countries such as India and, to some extent, Latin America and the Caribbean, infection-related cancers, mainly liver, gastric and cervical cancers, were important contributors to the burden of cancer among older adults. Strategies to deal with these cancers earlier in life, for example, reduction of the

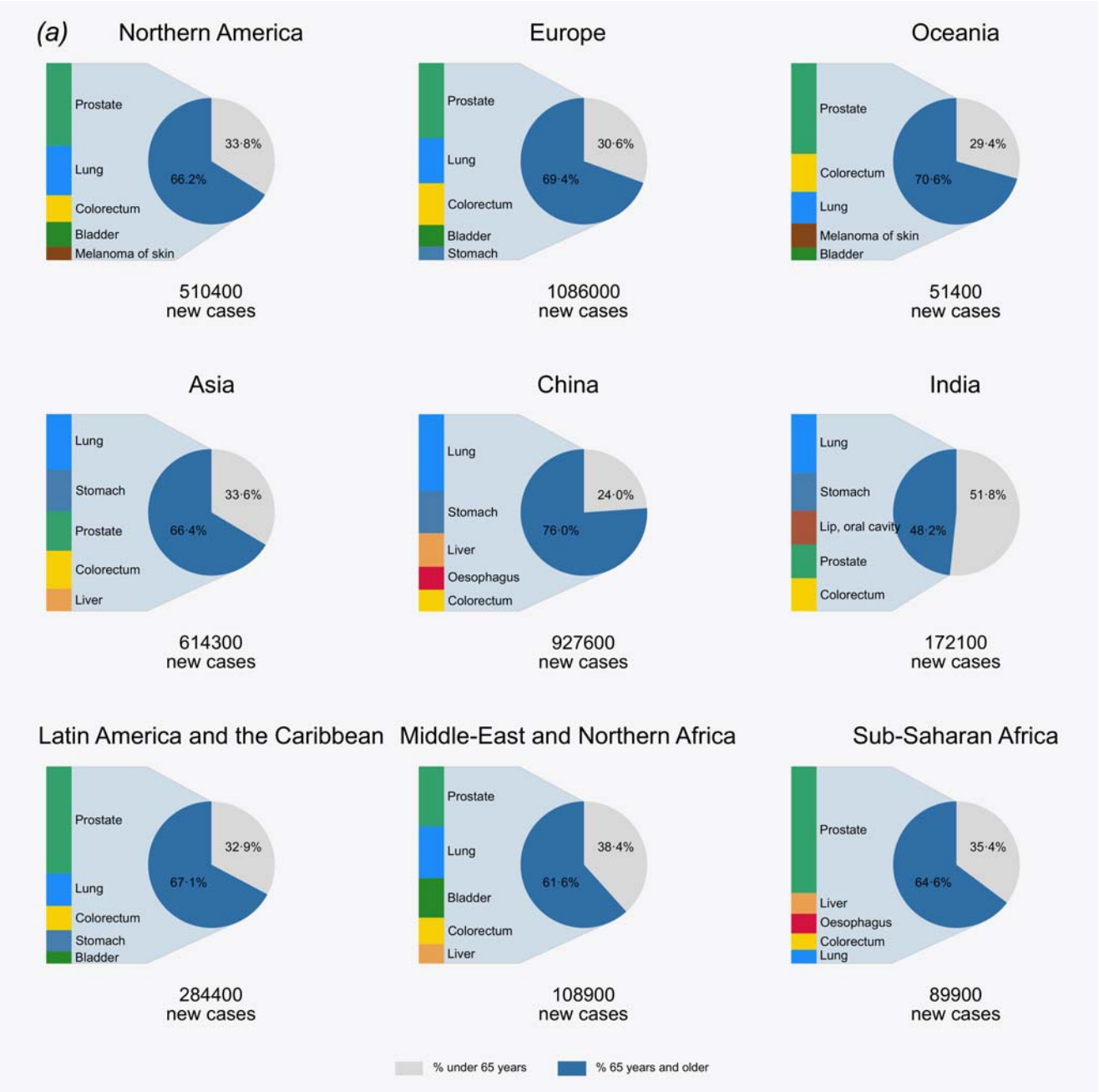

Figure 3. Figure continued on next page. [Color figure can be viewed at wileyonlinelibrary.com]

likelihood of infection as well as vaccination for hepatitis B and Human Papilloma Virus, will have a long-term benefit among those aged 65 years and older.

Cancer screening at older ages – that is, 75 years old and over – has been discouraged due to lack of randomised clinical trials including this age group and to concerns of the negative impact of screening, for example, anxiety, over-diagnosis, false reassurance from an erroneously negative test, complications related to the screening test and over-treatment.[26] The decision to screen or not to screen older adults depends not only on age but also on other factors including healthy life expectancy,[27] cognitive status, risk of disease and notably, individual choice.[28] For the latter, this implies that older adults understand the risks and benefits of the screening intervention being offered.

There are complexities inherent in treating cancer among older populations. The paucity of evidence on the benefits and risks of treatment among older patients partly stems from their common exclusion from clinical trials.[6,29,30] There is emerging evidence of possible under-treatment of older

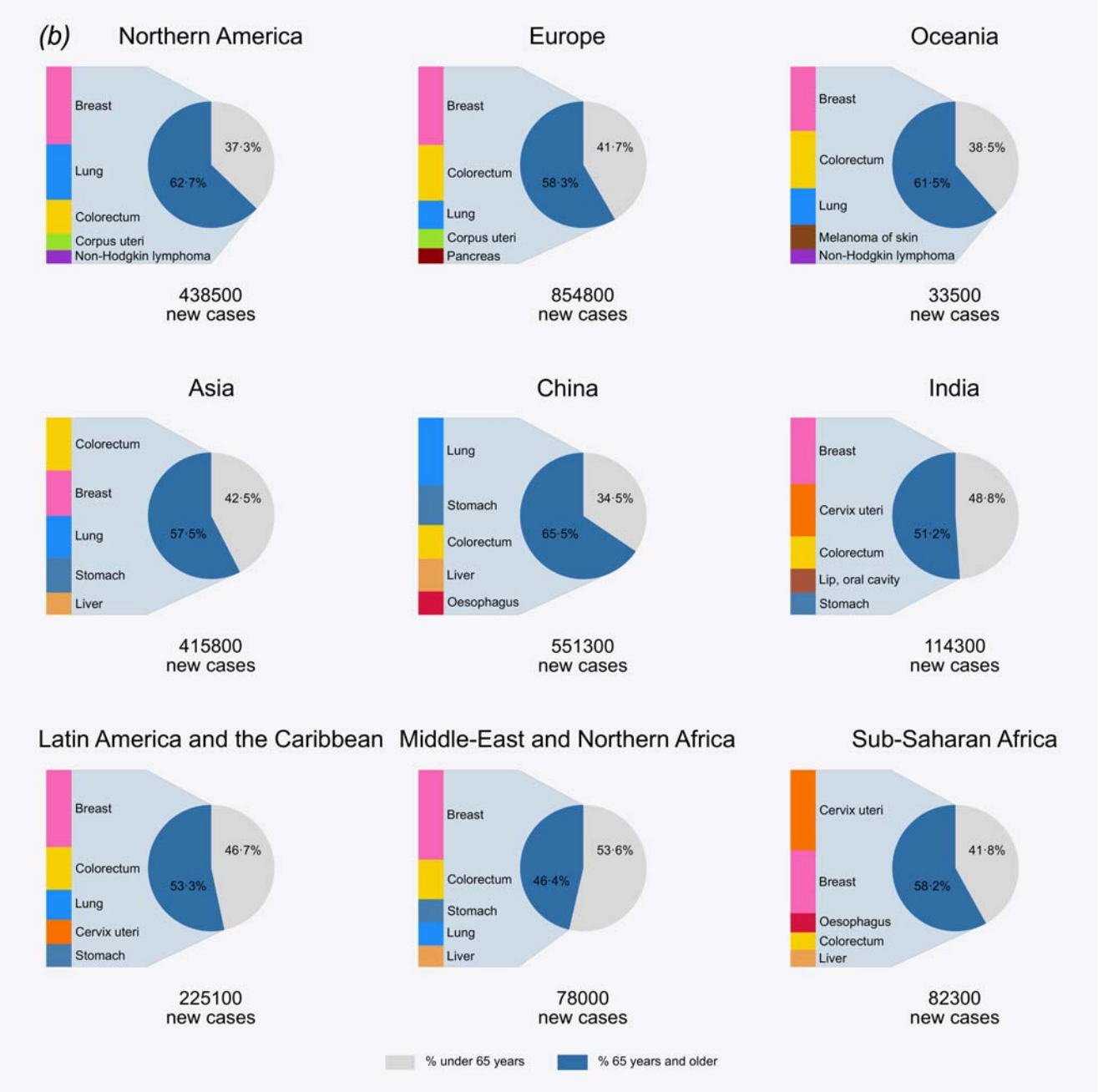

Figure 3. Proportion of the five leading cancer types among (*a*) males aged 65 years and older in 2012 by world region and (*b*) females aged 65 years and older in 2012 by world region. [Color figure can be viewed at wileyonlinelibrary.com]

people,[31] for instance, a large European study has reported that the odds of being treated with breast-conserving surgery plus radiotherapy decreases with increasing age,[32] despite a recent SEER analysis showing a significant survival benefit of adjuvant radiation after breast conserving surgery among older patients.[33]

While there is substantial heterogeneity among older people in terms of their general health status, cancer diagnosis and management are commonly influenced by the co-existence of other diseases or conditions (comorbidity). The prevalence of comorbid conditions among older cancer patients is high, for example, in the United States one-third to one-half of older cancer patients were found to have comorbid conditions.[34] Comorbidities are associated with poorer survival, lower treatment receipt, poorer quality of life, higher health care costs and longer (and, therefore, more expensive) hospital stay, especially for cancers that generally have better prognosis.[3,34,35]

Due to a heterogeneity in the health status and prognosis of older cancer patients, chronological age is not a meaningful

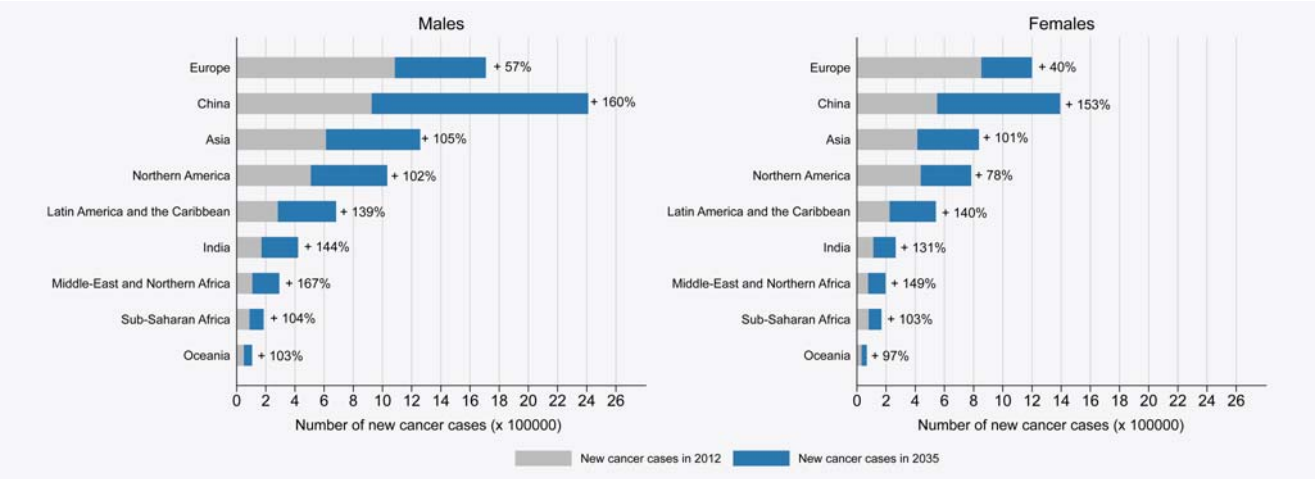

Figure 4. Estimated and projected (based on demographic changes) number of new cancer cases (all cancer sites combined) among males and females aged 65 years and older in 2012 and in 2035 by world region. [Color figure can be viewed at wileyonlinelibrary.com]

guide to treatment and long-term follow-up. For example, the International Society of Geriatric Oncology recommends comprehensive geriatric assessments, for example, functional status, comorbidities cognition, mental health status, fatigue, social status and support, nutrition and presence of geriatric symptoms[36], to allow tailored care for these patients.[37] Evidence suggests that these broad-based assessments are likely to have a positive effect both on completion of treatment, treatment toxicity and cancer survival within older age groups.[37,38] Further research is, however, required to assess the particular needs of older cancer patients, and optimal cancer control strategies for this population according to level of resource.

To our knowledge, this is the first assessment of the global incidence of cancer in older populations that incorporates regional comparisons and the projection of the burden by 2035. However, GLOBOCAN estimates should be interpreted with some caution as estimations are based on the availability and the quality of national incidence and mortality data.[39] In countries where national mortality data were available but national or subnational cancer registries were not, national incidence estimation relied on national mortality estimates and modelled survival. [39] However, mortality data may be less accurate for older age groups; where vital statistics system exists, mortality data rely on the accuracy of the information written on the death certificate. Identifying the underlying cause of death may be challenging in older adults who may present several comorbidities. In many low resource countries, verbal autopsy is the only method currently available to obtain estimates of the distribution of causes of death but the method may be less reliable in older age groups.[40] Furthermore, there is a higher probability of under-ascertainment of cancer cases at older age groups, notably in developing countries, where diagnostic facilities access to care may be limited. Robust cancer incidence data remains an overwhelming need in less developed regions, and the *Global Initiative for Cancer Registry* development (GICR) coordinated by IARC is ensuring all world regions have access to high-quality cancer data to inform cancer control planning (http://gicr.iarc.fr). Our projections did not take into account historical trends in cancer incidence. However, our projections for all cancer sites combined at global and regional levels are likely to be underestimated. Worldwide we have observed increases in the incidence of breast, colorectal and prostate cancer, especially in countries in transition. These cancer sites greatly affect our study population, and these countries contribute to a large proportion of the cancer burden in older adults. This rising rate is partially compensated by the decrease of infection-related cancers, notably stomach and cervical cancers, in very high, high and medium resource countries.[41] Unfortunately, 95% uncertainty intervals for the cancer estimates were not calculated for GLOBOCAN 2012 estimates and therefore are not presented in this study. Nonetheless, the quality of the data sources used to estimate the cancer burden have previously been assessed and reported,[39] and this provides a good indication as to the uncertainty surrounding the cancer estimate. As for the uncertainty surrounding the projection, the use of low or high variants for the population estimates did not impact our projection.

Conclusions

Given the expected two-fold rise in number of new cancer cases among older adults, and the major economic, societal and health system impacts that will ensue, there is a need for improvements in cancer surveillance to assist the development of geriatric oncological practice, and a global action plan to control cancer in older adults.

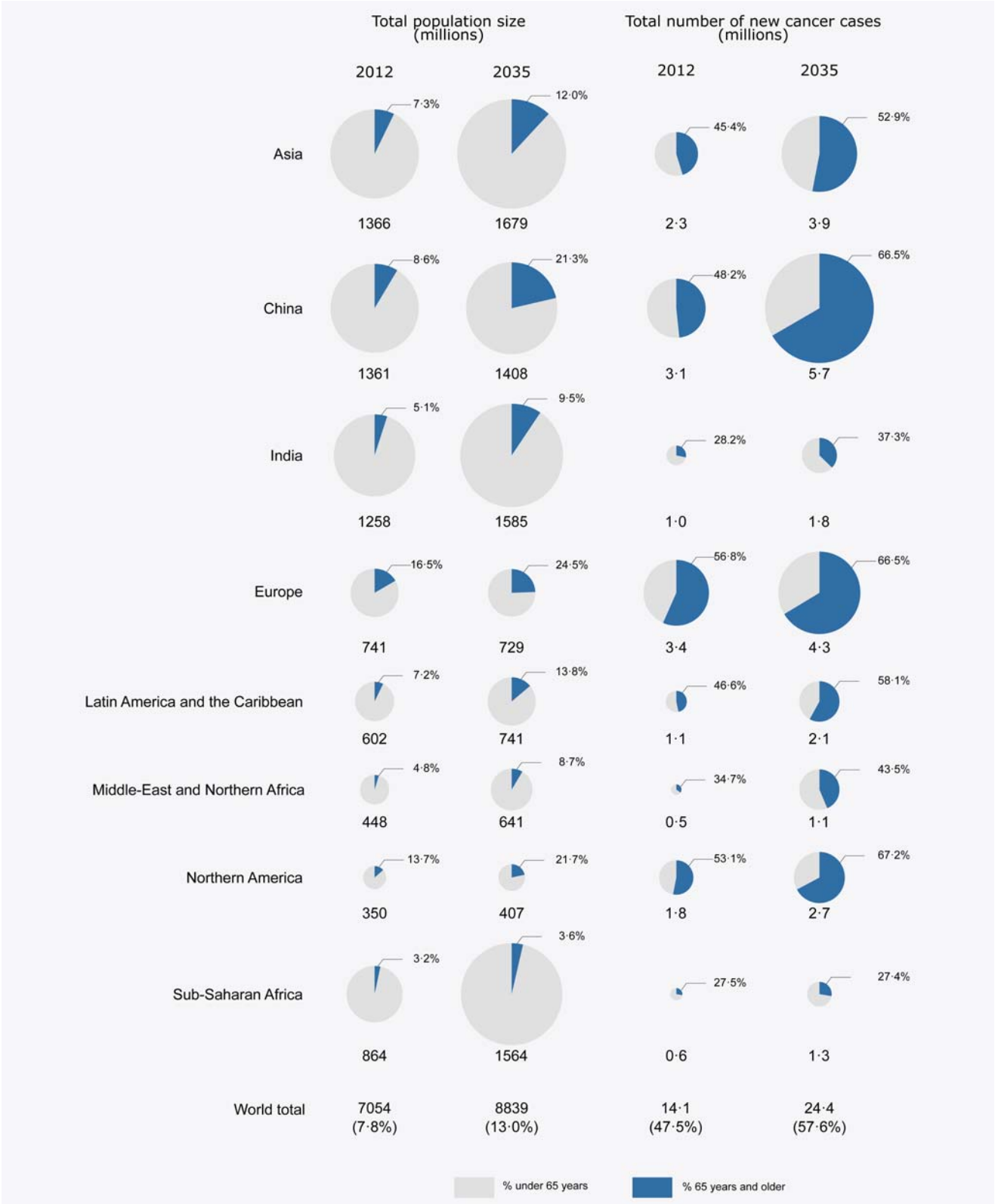

Figure 5. Estimated and projected share of population and new cancer cases aged 65 years or older by world region in 2012 and 2035. Notes. The relative size of Oceania region is too small to be presented in figure. Total population size is 37 million (11.2% of adults aged 65 years or older) in 2012 and 49 million (16.4%) in 2035; total number of new cancer cases is 0.2 million (54.9% of adults aged 65 years or older) in 2012 and 0.3 million (64.9%) in 2035. [Color figure can be viewed at wileyonlinelibrary.com]

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