Progress towards the WHO Global Initiative for Childhood Cancer target of 60% 5-year survival for all childhood cancers combined, 1990–2019 (CONCORD-4): a Cancer Survival Index derived for 68 countries by analysis of individual records for 613 021 children from 307 population-based cancer registries

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Summary

Background CONCORD is a global public health programme for long-term surveillance of population-based cancer survival. The first three cycles of this programme focused primarily on adults. In CONCORD-4, for the first time, we also included all cancers in children. The WHO Global Initiative for Childhood Cancer (GICC), published in 2018, set a target for 5-year survival for all childhood cancers combined, worldwide, to reach 60% by 2030. We designed the protocol for CONCORD-4 to assess progress towards this target in as many countries as possible.

Methods We identified population-based cancer registries from the members of the International Association of Cancer Registries and other sources. We invited 513 registries in 101 countries to submit anonymised individual records for all children (aged 0–14 years) living in their territory who were diagnosed with any form of cancer during the 30-year period 1990–2019, or later years. The data included demographic variables, the morphological type and anatomical location of the tumour, and the follow-up for the vital status of each child. We used the data for 2010–19 to construct a set of weights that reflect the global frequency distribution of childhood cancers, by age, sex, and subtype, both for the 12 major groups in the third edition of the International Classification of Childhood Cancer (ICCC-3) and for the six WHO tracer cancers prioritised in the GICC. We estimated 5-year net survival for children diagnosed during 1990–2019 by age, sex, and type of cancer, using the Pohar Perme estimator. We then used the weights to construct a Cancer Survival Index (CSI) as a weighted average of these survival estimates, for each country and each 5-year period during 1990–2019 for the 12 ICCC-3 groups and separately for the six WHO tracer cancers.

Findings We received 679 776 individual records for children diagnosed with cancer during 1990–2022 from 307 population-based cancer registries in 68 countries and territories, 52 with 100% national coverage. We produced two sets of weights, by age, sex, and type of cancer, reflecting the global distribution of cancer in children, both for all childhood cancers and for the six WHO tracer cancers. We restricted survival analyses to 613 021 children diagnosed during 1990–2019. The 5-year CSI for all childhood cancers combined increased in most countries between 1990 and 2019. For children diagnosed during 2015–19, the CSI was more than 80% in most high-income countries, in the range 60–80% in most upper-middle-income countries, and in the range 50–60% in the five participating lower-middle-income countries.

Interpretation The new CSI enables quantitative international comparison of trends in survival for all childhood cancers combined and for the six WHO tracer cancers, through a simple three-way standardisation by age, sex and subtype. The CSI should be a useful tool to monitor future trends. In most high-income, upper-middle-income, and lower-middle-income countries participating in CONCORD-4, the all-cancers CSI was either close to or had already passed the GICC target to reach 60% 5-year survival for all childhood cancers combined, worldwide, by 2030. The GICC target therefore may not be ambitious enough.

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See **Comment** page 1304

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Research in context

Evidence before this study

Survival differs widely between the various types of cancer in children, and between countries defined by their World Bank national income group. In 2018, WHO published the Global Initiative for Childhood Cancer (GICC), with the central target of reaching 60% survival (presumed to be 5 years) for all childhood cancers combined, worldwide, by 2030. No single metric exists to enable monitoring of progress towards this target. We searched PubMed for articles published in English, without date limits, using the following search string: "Population-based cancer regist*"[tiab] OR population-based registr* OR "population-based study"[tiab:~0] OR "EUROCARE"[tiab] AND "case-mix-standardised survival"[tiab:~0] OR "all cancers combined survival"[tiab:~0] OR "case-mix by cancer "[tiab:~0] OR "cancer survival index"[tiab:~0] OR "one-number index"[tiab:~0] OR "all cancers survival"[tiab:~0] OR "patient survival for all cancers combined"[ti:~0]". At present, the only attempt to evaluate progress towards the GICC target is derived from simulation-based model estimates of net survival for 197 countries. In most of these countries, real-world data from population-based cancer registries are not available. The estimates include all types of cancer combined in the age range 0–14 years in a single pool, despite the well known differences in survival by age, sex, and type of cancer. Some large comparisons of survival for all cancers combined were produced by the EUROCARE project, in Europe, or by NORDCAN, in northern Europe only, or in single countries (Canada, China, Denmark, and the USA). In these studies, an estimate of survival for all cancers combined, in adults or in children, was based on a double standardisation, starting from the usual standardisation by age, followed by a further standardisation by case-mix or cancer type, and sex. This approach implies the use of two sets of weights, one for age-standardisation and another to reflect the cancer type and sex distribution of the patients included in each study. These distributions are not representative of the global population of cancer patients—in this context, children. The cancer survival indices derived for all these studies are not directly comparable either between countries or over time.

Added value of this study

The current cycle of the CONCORD programme for global surveillance of trends in population-based cancer survival (CONCORD-4) has extended coverage to include data for adults diagnosed with one of 22 malignancies, and for the first time, also includes data on all children diagnosed with a cancer during 1990–2022. CONCORD-4 provides the largest global real-world database on childhood cancer, including data from 307 population-based cancer registries in 68 countries, 52 with 100% national coverage. We created two sets of weights that reflect the global frequency distribution of childhood cancers by age, sex, and subtype: one set for the 12 major groups defined in the 3rd edition of the International Classification of Childhood Cancer, and another for the six tracer cancers prioritised by WHO in 2021. For each country and 5-year calendar period during the three decades 1990–2019, we then constructed a Cancer Survival Index (CSI), which enables quantitative comparisons of net survival for all childhood cancers combined, between countries and over time. Both sets of weights, which allow for a simple three-way standardisation by age, sex, and subtype, are now available for national and international research on childhood cancer survival. 30-year trends in the CSI offer a robust, long-term baseline against which to evaluate progress towards the GICC 2030 target.

Implications of all the available evidence

The CSI will facilitate monitoring of real-world progress towards the GICC target for childhood cancer survival. The CSI that includes all childhood cancers is a better indicator than the CSI based on the six WHO tracer cancers, especially for lower-middle-income countries, where diagnostic facilities are often inadequate, and the need to improve survival is even more urgent. WHO should devote even greater efforts to increase the coverage of population-based cancer registries worldwide and to facilitate data sharing for international research. In most high-income and upper-middle-income countries, impressive trends in survival for all childhood cancers combined since 1990 have already exceeded the GICC target for 2030, suggesting that a more ambitious target could be set. In low-income countries and lower-middle-income countries, where 60% of the world's children live, late presentation, abandonment of treatment, and suboptimal health-care systems are major contributors to poor survival.

Introduction

The target of the WHO Global Initiative for Childhood Cancer (GICC), published in 2018, is to reach 60% survival for all childhood cancers combined, worldwide, by 2030.[1] The duration of survival was not explicitly stated, but was presumed to be 5 years.

In 2021, WHO prioritised six "tracer" cancers, to help monitor overall progress: acute lymphoblastic leukaemia, Burkitt lymphoma, Hodgkin lymphoma, retinoblastoma, Wilms tumour, and low-grade glioma.[2] The tracer cancers were not chosen to imply greater importance than other cancers, but "to help inform a broader response relevant to all childhood cancers".[2] The six tracer cancers were described as representing 50–60% of all childhood cancers, as being highly curable with proven therapies, and with potential 5-year survival of 85% or higher.

5-year survival for children with cancer has increased steadily in high-income countries (HICs) over the past 50 years, but to a lesser extent in countries in lower-income groups.[3] In launching the GICC, WHO suggested that survival for all childhood cancers combined might reach 80% in HICs, but only 20% in some low-income and middle-income countries, as defined by the World Bank.[2] The frequency of each type of childhood cancer varies between countries in the World Bank income groups.[4] Only about 10% of the world's children live in HICs.[5] Survival also differs between each type of cancer in children, as well as by age at diagnosis and sex.[6,7]

Assessment of progress towards the GICC target of 60% 5-year survival for all childhood cancers combined, worldwide, requires a simple, one-number metric that can be robustly compared over time and between countries, regardless of their level of income, and which takes into account international differences in the frequency of childhood cancers by age, sex, and type of cancer. No such metric currently exists.

For adults, international comparisons of survival from each type of cancer have been produced since 2004 by applying a set of standard weights to the survival estimates for each of five age groups within the age range 15–99 years.[8] Three sets of weights are needed, depending on the pattern of incidence by age. This approach produces an age-weighted average of survival for all ages combined, or age-standardised survival.[8] For children, it has been conventional to use a simple average of the survival estimates for each type of cancer in three age groups (0–4, 5–9, and 10–14 years).[9]

Age-standardised survival estimates for each type of cancer, taken separately, can be compared between countries, or over time, but this approach cannot be used for all cancers combined, because survival varies so widely between cancers, as well as by sex.

A national cancer survival index for adults, obtained with weights derived from the marginal distribution of all cancers by age, sex, and site, has been produced for England and Wales.[10,11] This index enables examination of trends from all cancers combined within a country, but for international comparisons the same weights must be used for every country.

The largest international comparisons of survival for all cancers combined were produced by the EUROCARE project in Europe. Three studies focused on cancers in adults,[12–14] and two focused on cancers in children.[3,7] Survival for all cancers combined was obtained through age-standardisation of survival for each cancer, followed by a further standardisation (or adjustment) by case-mix and sex[3,14] or by case-mix only.[7] Two studies included international trends in survival for all cancers combined over up to 10 years: 1999–2007 for adults,[14] and 2004–14 for children.[7] A similar approach, with a double standardisation, has been used to examine survival for all cancers combined, in adults, in Canada, China, Denmark, and the USA.[15–18] Trends in observed survival for all children (aged 0–14 years) diagnosed during 1992–2017, weighted by sex and cancer type, have been published for Canada.[19]

The only international study of long-term trends in survival for all cancers combined, in adults, is a comparison between the five Nordic countries over the 40-year period 1964–2003, based on the NORDCAN database. The weights were taken from the combined distribution in all five countries, by sex, of the 15 most common cancers and all other cancers combined during 1999–2003.[15]

We aimed to obtain a one-number index of net survival for all childhood cancers combined, which is directly comparable between countries and over time, to monitor progress towards the GICC target for 2030—namely, that 5-year survival for all childhood cancers combined should reach 60% worldwide.

Methods

Study design

On Dec 13, 2022, we invited 513 population-based cancer registries from the members of the International Association of Cancer Registries and other sources in 101 countries to submit anonymised individual records in a single file for all children (aged 0–14 years) living in their territory who were diagnosed with any form of cancer during the 20-year period 2000–19 or later years. Older registries were also invited to submit data for children diagnosed during the 1990s. We also invited submission of data for adults (aged 15–99 years) diagnosed with one of 22 cancers or groups of cancers: we will report on those data separately. A further invitation was issued jointly with the Organisation for Economic Co-operation and Development (OECD) in May, 2023.

Of the 513 registries, 18 were in Africa (11 countries), 58 were in central and South America, including the Caribbean (19 countries), 71 were in North America (two countries), 143 were in Asia (25 countries), 212 were in Europe (40 countries), and 11 were in Oceania (four countries).

Countries and territories were defined by their UN name and continent as of 2025.[20] The names of jurisdictions used in the text, tables, graphics, maps, and appendix are based on those used for statistical purposes by the Statistics Division of the UN Secretariat; similarly, we use the term “national coverage” to contrast with “regional coverage” for statistical purposes. These designations and the presentation of data do not imply any assumption regarding the political affiliation of countries or territories, or the expression of any opinion whatsoever on the part of the CONCORD programme concerning the legal status of any country, territory, city, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. Cyprus is a member state of the European Union but it is part of Asia. Barbados, Costa Rica, Cuba, El Salvador, French Guiana, Guadeloupe, Guatemala, Martinique, Mexico, Puerto Rico, and Trinidad and Tobago (Caribbean and central America) were grouped with South America as central and South America.

Protocol for data collection

We requested data covering as many years as possible during 1990–2022, provided the incidence data were

	1990–94	1995–99	2000–04	2005–09	2010–14	2015–19	2020–22	All records	All classified records, 1990–2022
ICCC-3 group									
I: Leukaemias	6216 (30·4%)	7494 (29·8%)	39 664 (31·4%)	44 058 (30·3%)	50 551 (30·0%)	50 207 (29·7%)	7749 (31·5%)	205 939 (30·3%)	205 939 (30·4%)
II: Lymphomas	2500 (12·2%)	3040 (12·1%)	15 025 (11·9%)	16 597 (11·4%)	20 320 (12·0%)	20 877 (12·4%)	3108 (12·6%)	81 467 (12·0%)	81 467 (12·0%)
III: CNS	4086 (20·0%)	5036 (20·0%)	26 074 (20·6%)	31 993 (22·0%)	37 312 (22·1%)	37 260 (22·1%)	5116 (20·8%)	146 877 (21·6%)	146 877 (21·7%)
IV: Neuroblastoma	1286 (6·3%)	1489 (5·9%)	8064 (6·4%)	9007 (6·2%)	9953 (5·9%)	9558 (5·7%)	1317 (5·4%)	40 674 (6·0%)	40 674 (6·0%)
V: Retinoblastoma	536 (2·6%)	598 (2·4%)	3195 (2·5%)	3696 (2·5%)	4096 (2·4%)	4000 (2·4%)	599 (2·4%)	16 720 (2·5%)	16 720 (2·5%)
VI: Renal tumours	1004 (4·9%)	1344 (5·3%)	6434 (5·1%)	6926 (4·8%)	7665 (4·5%)	7347 (4·4%)	1078 (4·4%)	31 798 (4·7%)	31 798 (4·7%)
VII: Hepatic tumours	225 (1·1%)	285 (1·1%)	1878 (1·5%)	2191 (1·5%)	2785 (1·7%)	2833 (1·7%)	484 (2·0%)	10 681 (1·6%)	10 681 (1·6%)
VIII: Bone tumours	866 (4·2%)	1122 (4·5%)	5721 (4·5%)	6097 (4·2%)	7050 (4·2%)	7026 (4·2%)	1026 (4·2%)	28 908 (4·3%)	28 908 (4·3%)
IX: Soft tissue sarcomas	1375 (6·7%)	1741 (6·9%)	7943 (6·3%)	10 153 (7·0%)	11 655 (6·9%)	11 548 (6·8%)	1570 (6·4%)	45 985 (6·8%)	45 985 (6·8%)
X: Germ-cell tumours	732 (3·6%)	988 (3·9%)	4880 (3·9%)	5873 (4·0%)	6596 (3·9%)	6692 (4·0%)	932 (3·8%)	26 693 (3·9%)	26 693 (3·9%)
XI: Other epithelial neoplasms	1239 (6·1%)	1644 (6·5%)	5864 (4·6%)	6609 (4·5%)	8177 (4·8%)	8862 (5·2%)	1207 (4·9%)	33 602 (4·9%)	33 602 (5·0%)
XII: Other and unspecified neoplasms	244 (1·2%)	312 (1·2%)	1250 (1·0%)	1623 (1·1%)	1831 (1·1%)	2058 (1·2%)	301 (1·2%)	7619 (1·1%)	7619 (1·1%)
Unclear	32 (0·2%)	39 (0·2%)	155 (0·1%)	189 (0·1%)	209 (0·1%)	204 (0·1%)	32 (0·1%)	860 (0·1%)	..
Unknown	111 (0·5%)	54 (0·2%)	253 (0·2%)	271 (0·2%)	440 (0·3%)	383 (0·2%)	76 (0·3%)	1588 (0·2%)	..
Other	..	..	..	..	..	..	..	365 (0·1%)	..
All childhood malignancies	20 452 (100·0%)	25 186 (100·0%)	126 400 (100·0%)	145 283 (100·0%)	168 640 (100·0%)	168 855 (100·0%)	24 595 (100·0%)	679 776 (100·0%)	676 963 (100·0%)
WHO tracer cancer									
1: Acute lymphoblastic leukaemia	4664 (22·8%)	5582 (22·2%)	29 185 (23·1%)	32 446 (22·3%)	37 953 (22·5%)	37 354 (22·1%)	6007 (24·4%)	153 191 (22·5%)	153 191 (22·6%)
2: Hodgkin lymphoma	1021 (5·0%)	1209 (4·8%)	5668 (4·5%)	5954 (4·1%)	6326 (3·8%)	6341 (3·8%)	924 (3·8%)	27 443 (4·0%)	27 443 (4·1%)
3: Burkitt lymphoma	293 (1·4%)	425 (1·7%)	2521 (2·0%)	2829 (1·9%)	3103 (1·8%)	2899 (1·7%)	541 (2·2%)	12 611 (1·9%)	12 611 (1·9%)
4: Retinoblastoma	536 (2·6%)	598 (2·4%)	3195 (2·5%)	3696 (2·5%)	4096 (2·4%)	4000 (2·4%)	599 (2·4%)	16 720 (2·5%)	16 720 (2·5%)
5: Wilms tumour	919 (4·5%)	1213 (4·8%)	5764 (4·6%)	6161 (4·2%)	6863 (4·1%)	6419 (3·8%)	948 (3·9%)	28 287 (4·2%)	28 287 (4·2%)
6: Low-grade glioma	1105 (5·4%)	1793 (7·1%)	10 692 (8·5%)	12 855 (8·8%)	15 249 (9·0%)	15 029 (8·9%)	2059 (8·4%)	58 782 (8·6%)	58 782 (8·7%)
All WHO tracer cancers	8538 (41·7%)	10 820 (43·0%)	57 025 (45·1%)	63 941 (44·0%)	73 590 (43·6%)	72 042 (42·7%)	11 078 (45·0%)	297 034 (43·7%)	297 034 (43·9%)
All other cancers	11 771 (57·6%)	14 273 (56·7%)	68 967 (54·6%)	80 882 (55·7%)	94 401 (56·0%)	96 226 (57·0%)	13 409 (54·5%)	379 929 (55·9%)	379 929 (56·1%)
Unclear	32 (0·2%)	39 (0·2%)	155 (0·1%)	189 (0·1%)	209 (0·1%)	204 (0·1%)	32 (0·1%)	860 (0·1%)	..
Unknown	111 (0·5%)	54 (0·2%)	253 (0·2%)	271 (0·2%)	440 (0·3%)	383 (0·2%)	76 (0·3%)	1588 (0·2%)	..
Other	..	..	...	..	..	..	..	365 (0·1%)	..
All childhood malignancies	20 452 (100·0%)	25 186 (100·0%)	126 400 (100·0%)	145 283 (100·0%)	168 640 (100·0%)	168 855 (100·0%)	24 595 (100·0%)	679 776 (100·0%)	676 963 (100·0%)

Data are n (%). ICCC-3=International Classification of Childhood Cancer (3rd edition).[21] Unclear=site–morphology combination does not match any ICCC-3 group or WHO tracer cancer.[2] Unknown=no morphology code. Other=year of diagnosis later than 2022 or unknown.

***Table 1:* Number of records received for children diagnosed with cancer during 1990–2022 (CONCORD-4) for 12 major ICCC-3 groups and six WHO tracer cancers, by calendar period of diagnosis**

See **Online** for appendix

considered to be complete, with data on the vital status of those children at the end of the period for which data were submitted, or a later year. The protocol and data specification were translated from English into Japanese, Portuguese, and Russian.

Definition of cancer groups

We grouped cancers in children into one of the 12 major groups in the third edition of the International Classification of Childhood Cancer (ICCC-3),[21,22] using the morphology and topography codes in the International Classification of Diseases for Oncology, third edition (ICD-O-3)[23] as well as its first and second revisions (appendix pp 5–6).[24,25]

With the exception of retinoblastoma, the six WHO tracer cancers are all subsets of one of the 12 major ICCC-3 groups, and we defined them from the same sources (appendix p 7). A standard, widely accepted definition for low-grade glioma is not available. We adopted an extended version of the ICCC-3 classification,[26] incorporating additional morphology codes that were introduced in the WHO Blue Books on the classification of CNS tumours (4th and

5th editions),[27,28] and the definitions from the Central Brain Tumor Registry of the United States.[29] This approach enabled quality control to be performed consistently for all data sets, and allowed the records to be grouped for analysis in the same way for all registries (table 1).

Quality control

We developed a new suite of programs to perform quality control for childhood cancer data in a survival analysis. This enabled us to check data quality for each of the 12 ICCC-3 groups, which are based on morphology, instead of topography, used for most adult cancers. As in previous CONCORD cycles, data quality checks were done in three phases: protocol adherence, exclusions, and editorial checks.[30] After each phase, a detailed report was sent to each cancer registry for discussion, to ensure that data cleaning was sufficiently thorough and robust before proceeding with survival analyses. Rectifying errors or inconsistencies often led to resubmission of data, and re-iteration of all three phases of quality control. Quality control was performed on all data for 1990–2022.

Tumour registrations with unlikely or rare combinations of age and morphology were excluded from survival analyses, unless confirmed as correct by the registry. The exclusion criteria are based on discussions with oncologists and pathologists, the WHO Classification of Tumours volumes,[28,31] and the check and conversion programs published by the International Agency for Research on Cancer.[32]

Survival estimates were considered less reliable if 15% or more of children were lost to follow-up or censored within 5 years of diagnosis. For children diagnosed in 2015 or later, this criterion was applied for those censored alive before Dec 31, 2019—the closure date for these analyses. Survival estimates were also considered less reliable if 15% or more of children were registered only from a death certificate or at autopsy, because their survival would be unknown. Finally, estimates were also considered less reliable if one or more of the following dates was incomplete for 15% or more of children: unknown year of birth, unknown month or year of diagnosis, or unknown year of last known vital status. Less reliable estimates are flagged in figures and tables when they are the only available information from a given country or territory.

Statistical analysis

We focused survival analyses on children diagnosed during the 30-year period 1990–2019. We used the classical cohort approach to estimate 5-year survival for children diagnosed during the five quinquennia from 1990 to 2014, because in most datasets all children had been followed up for at least 5 years by Dec 31, 2019. We used the period approach[33] for children diagnosed during 2015–19, because 5 years of follow-up data were not available for all children.

We categorised age into four groups (<1, 1–4, 5–9, and 10–14 years), calendar period into six quinquennia (1990–94, 1995–99, 2000–04, 2005–09, 2010–14, and 2015–19), sex as male and female, and country by World Bank group of national income as of 2015, the midpoint of the most recent decade, 2010–19: low-income country (LIC), lower-middle-income country (LMIC), upper-middle-income country (UMIC), and HIC.

We estimated net survival at 5 years since diagnosis by age, sex, and calendar period, using the Pohar Perme estimator,[34] both for each of the 12 major ICCC-3 groups, and for each of the six WHO tracer cancers, using the algorithm *stns*[35] in Stata (version 18). Net survival is the cumulative probability of surviving up to a given time since diagnosis, such as 5 years, after correcting for other causes of death (background mortality), and taking account of the fact that competing risks of death vary with age and sex. To control for background mortality, we created a library of 28 000 complete life tables of all-cause mortality rates by single year of age (0–99 years), sex, single calendar year (1990–2022) and, where available, by race or ethnicity, for each participating country or registry.[36] For some registries, subregional life tables were also constructed. A detailed report will be made available for the life tables for each registry in due course. The library is freely available online.

For the **library** see https://csg.lshtm.ac.uk/life-tables/

Where survival estimates for a given combination of age and type of cancer were not available for both boys and girls, the same estimate was used for both sexes. Where data were available for more than one registry in a given country, the survival estimates were derived by pooling the data for that country, without weighting, but excluding data from registries for which the survival estimates were considered less reliable.

Weights

We produced two sets of weights by age, sex, and type of cancer, reflecting the different patterns of cancer incidence in children in each World Bank national income group.

First, we examined the distribution of records submitted to CONCORD-4 for children diagnosed during the most recent decade, 2010–19, by age and sex, for each of the 12 ICCC-3 groups of childhood cancer, in each World Bank income group (appendix p 9), and separately for the six WHO tracer cancers (appendix p 10).

Second, since population-based cancer registries are mainly located in HICs, we generated factors by which to scale up the distribution of cases from LMICs and UMICs, to prevent the weights being skewed by data from HICs. To achieve this, we needed to estimate the number of children diagnosed during 2010–19 for whom we would have expected to receive data, if the populations covered by registries participating in CONCORD-4 had been similar in all three World Bank income groups. For this purpose, we used the populations of children in 2015 in each participating registry, by age and World Bank national income group.[5,37] In 2015, the total population of children covered by participating registries was more than 233 million. The childhood population in participating HICs (176 031 667) was 4·61 times more than in UMICs and 8·96 times more than in LMICs (appendix p 11).

Third, we used these factors, 4·61 and 8·96, to scale up the numbers of children in the CONCORD-4 database from UMICs and LMICs, respectively. The underlying assumption was that the distributions by age, sex, and type of cancer in the CONCORD-4 database from UMICs and LMICs were broadly similar to other countries in the same World Bank income group. This scale-up was done for the 12 ICCC-3 groups (appendix p 12) and separately for the six WHO tracer cancers (appendix p 13).

Fourth, we then scaled up further for differences between World Bank groups in the global population of children in 2015. This was done to achieve a broad comparison with the likely global distribution of children with cancer, by age, sex, and type of cancer (ICCC-3 group or WHO tracer cancer). The UN Population Division estimate of the global population of children in 2015 was almost two billion (1 978 844 011),[5] with 10·3% in HICs, 29·2% in UMICs, and 60·5% in LMICs and LICs. We therefore used factors of 3 and 6 to scale up the numbers of children diagnosed in UMICs and LMICs, respectively (appendix p 14).

Finally, the numbers of children with cancer shown for the 12 ICCC-3 groups (appendix p 15) and the six WHO tracer cancers (appendix p 16) are the frequency distributions of children diagnosed during 2010–19 received in CONCORD-4, by age, sex, and type of cancer, scaled up for the smaller populations covered by participating registries in LMICs and UMICs, and for the proportion of the global population of children in each World Bank income group in 2015. The two sets of weights in table 2 are the proportions of the total number of records in the appendix (pp 15–16), in each cell defined by age, sex, and cancer type.

We used these weights to construct a Cancer Survival Index (CSI) of 5-year net survival for all cancers combined, as a weighted average of the survival estimates by age, sex, and type of cancer, for each country and calendar period, both for all 12 major ICCC-3 groups combined, and for the six WHO tracer cancers combined. The formulas for the CSI and its 95% CI are described in the appendix (p 3). CSI values for a given country are flagged as less reliable if one or more of the underlying 5-year net survival components was considered less reliable. We only mention reliable CSI values in the text.

Trends in the CSI over the 30-year period 1990–2019 and international variations in the CSI for children diagnosed during 2015–19 are presented by UN world region, World Bank national income group in 2015, and the average national gross domestic product (GDP) per capita during 2010–14. Trendline plots were created with R (version 4.3.1) in RStudio, with *ggplot2* and other packages. Bar charts and scatterplots were generated in Microsoft Excel. For all 12 ICCC-3 groups combined, and for the six WHO tracer cancers combined, we examined the correlation between the CSI for 2015–19 in each country and the mean annual GDP per capita, and the mean health expenditure during 2010–14, to allow at least 3 years for implementation. Spearman's rank correlation[38] analyses were done with data from 58 countries with complete information on all three variables.

Ethical and statutory approvals

The Cancer Survival Group (CSG), which leads the CONCORD programme, maintains annual approvals for processing sensitive personal data for this research from the UK's statutory Health Research Authority (HRA; reference ECC 3-04(i)/2011, last updated May 8, 2025), the NHS Research Ethics Service (11/LO/0331, June 5, 2024, until end of study), the Ethics Committee of the London School of Hygiene and Tropical Medicine (LSHTM, #28686, Feb 25, 2026) and the Swedish Ethical Review Authority (2025-01614-01-760477). The HRA also approves the CSG's System-Level Security Policy, governing data security. The CSG is also certified for its managerial, physical, and electronic security procedures by the UK's National Cyber Security Centre (Feb 17, 2026).

The European Commission adopted an adequacy decision in respect of the UK data protection regime under Article 45(3) of the General Data Protection Regulation (GDPR),[39] on June 28, 2021; on Dec 19, 2025, the decision was extended to Dec 27, 2031. Under this decision, the legal basis for transfers of personal data from the European Economic Area (the 27 EU member states plus Iceland, Liechtenstein, and Norway) to the UK remains that which operated under the EU-GDPR before the UK left the EU.

Role of the funding source

The funders of the study played no part in study design, data collection, quality control, data analysis, interpretation of the findings, writing of the manuscript, or the decision to submit the manuscript for publication.

Results

Of the 322 registries (71 countries) that participated in CONCORD-3,[30] nine registries did not respond to repeated enquiries. Regional registries in France (n=21), Switzerland (n=7), and Romania (n=1) did not send childhood data, because data were provided by national childhood registries (figure 1). A further 25 registries had merged into larger regional registries. Two national registries (Greece and Gibraltar) and five regional registries, in Argentina, Brazil, and Italy, were no longer operational. Of the 239 operational registries with childhood data, 29 (12·1%) were prevented from participating due to legal or administrative issues. Overall, data were submitted by 207 (86·6%) of the

	Boys				Girls			
	<1 year	1–4 years	5–9 years	10–14 years	<1 year	1–4 years	5–9 years	10–14 years
ICCC-3 group								
I: Leukaemias	0·010255	0·083534	0·060463	0·049568	0·008039	0·066805	0·047372	0·035999
II: Lymphomas	0·002604	0·019281	0·030680	0·030350	0·002291	0·009559	0·012599	0·017613
III: CNS	0·005559	0·028776	0·032381	0·027685	0·004635	0·024453	0·027790	0·023620
IV: Neuroblastoma	0·007529	0·012922	0·003282	0·000396	0·006908	0·011060	0·003084	0·000563
V: Retinoblastoma	0·004588	0·013330	0·000539	0·000001	0·004627	0·012116	0·000426	0·000013
VI: Renal tumours	0·003219	0·013092	0·004446	0·001173	0·002648	0·015070	0·005456	0·001577
VII: Hepatic tumours	0·003092	0·005492	0·000822	0·001323	0·002076	0·003168	0·000770	0·000630
VIII: Bone tumours	0·000169	0·001200	0·006436	0·015110	0·000131	0·001017	0·005989	0·013460
IX: Soft tissue sarcomas	0·003044	0·009055	0·008509	0·009033	0·002361	0·006973	0·006411	0·009275
X: Germ-cell tumours	0·002963	0·007154	0·001836	0·005765	0·002493	0·002748	0·004239	0·009074
XI: Other epithelial neoplasms	0·000255	0·000881	0·003589	0·009951	0·000391	0·001059	0·003802	0·014567
XII: Other and unspecified neoplasms	0·001722	0·004228	0·002906	0·003716	0·001448	0·003821	0·002165	0·003704
WHO tracer cancer								
1: Acute lymphoblastic leukaemia	0·009380	0·142430	0·101124	0·072144	0·007941	0·113308	0·078514	0·050842
2: Hodgkin lymphoma	0·000024	0·008548	0·024779	0·028036	0·000024	0·001667	0·007803	0·019528
3: Burkitt lymphoma	0·000016	0·009155	0·012782	0·009222	0·000053	0·002979	0·004525	0·003799
4: Retinoblastoma	0·009919	0·028817	0·001165	0·000002	0·010002	0·026192	0·000920	0·000029
5: Wilms tumour	0·006236	0·025887	0·008646	0·001600	0·004950	0·030042	0·011039	0·002284
6: Low-grade glioma	0·002807	0·020406	0·021785	0·019778	0·002012	0·020577	0·020399	0·015883

The sum of the weights is unity (1·000000), both for the 12 ICCC-3 groups and for the six WHO tracer cancers. ICCC-3=International Classification of Childhood Cancer (3rd edition).

Table 2: **Weights by age (years), sex, and type of cancer, used to create the Cancer Survival Index for all childhood cancers combined (12 ICCC-3 groups), and for the six WHO tracer cancers combined**

239 operational registries with childhood data, in 56 of the countries that participated in CONCORD-3.

Of the 191 registries (30 countries) that had not previously participated in the CONCORD programme, 23 (nine countries) did not respond. Childhood data were not available from 33 registries. Of the 132 operational registries with childhood data, 17 (12·9%) could not send data because of legal or administrative issues, five because of staffing issues, and ten because adequate follow-up data were not available, leaving 100 (75·8%) of the 132 operational registries with childhood data, in 12 countries that participated in the CONCORD programme for the first time (figure 1).

Overall, we received 679 776 individual tumour registrations of children with cancer (table 1) from 307 population-based cancer registries, 82·7% of the 371 operational registries with childhood data (figure 1; appendix p 19). These registries covered a combined population of more than 1 billion people (all ages), including 233 million children, in 2015. Data with 100% coverage of the national population of children were provided by 52 of the 68 participating countries and territories. National population coverage was achieved for the first time in Chile (from 14% in CONCORD-3), Japan (from 41% in CONCORD-3), Switzerland (from 55% in CONCORD-3), and the USA (from 86% in CONCORD-3). World and regional maps are shown in the appendix (pp 20–50). After discussion with each cancer registry, and correction of the data, where possible, we excluded 860 (0·1%) records for which the ICD-O-3 codes for morphology and topography did not match any of the 12 major groups in ICCC-3; 1588 (0·2%) for which no morphology code could be provided; and 365 (0·1%) for which the year of diagnosis was missing or greater than 2022, leaving the data for 676 963 records (99·6% of those received) that could be classified in one of the 12 major ICCC-3 groups (table 1).

Leukaemias, lymphomas, and CNS tumours comprised 64·1% of all cancers in children (table 1). The 205 939 leukaemias (ICCC-3 group I) comprised 30·4% of childhood cancers, followed by 146 877 tumours of the CNS (group III, 21·7%) and 81 467 lymphomas (group II, 12·0%). These proportions have remained stable for more than 30 years (1990–2022). Soft tissue sarcomas (group IX, 45 985, 6·8%) and neuroblastoma (group IV, 40 674, 6·0%) were the next most common malignancies. This pattern was also fairly consistent throughout 1990–2022.

The six WHO tracer cancers represented 43·9% of all cancer records received. This proportion remained stable throughout the period 1990–2022, with the proportion of acute lymphoblastic leukaemia (24·4%) slightly higher during 2020–22, and low-grade glioma (about 9%) also slightly higher since 2000–04 (table 1).

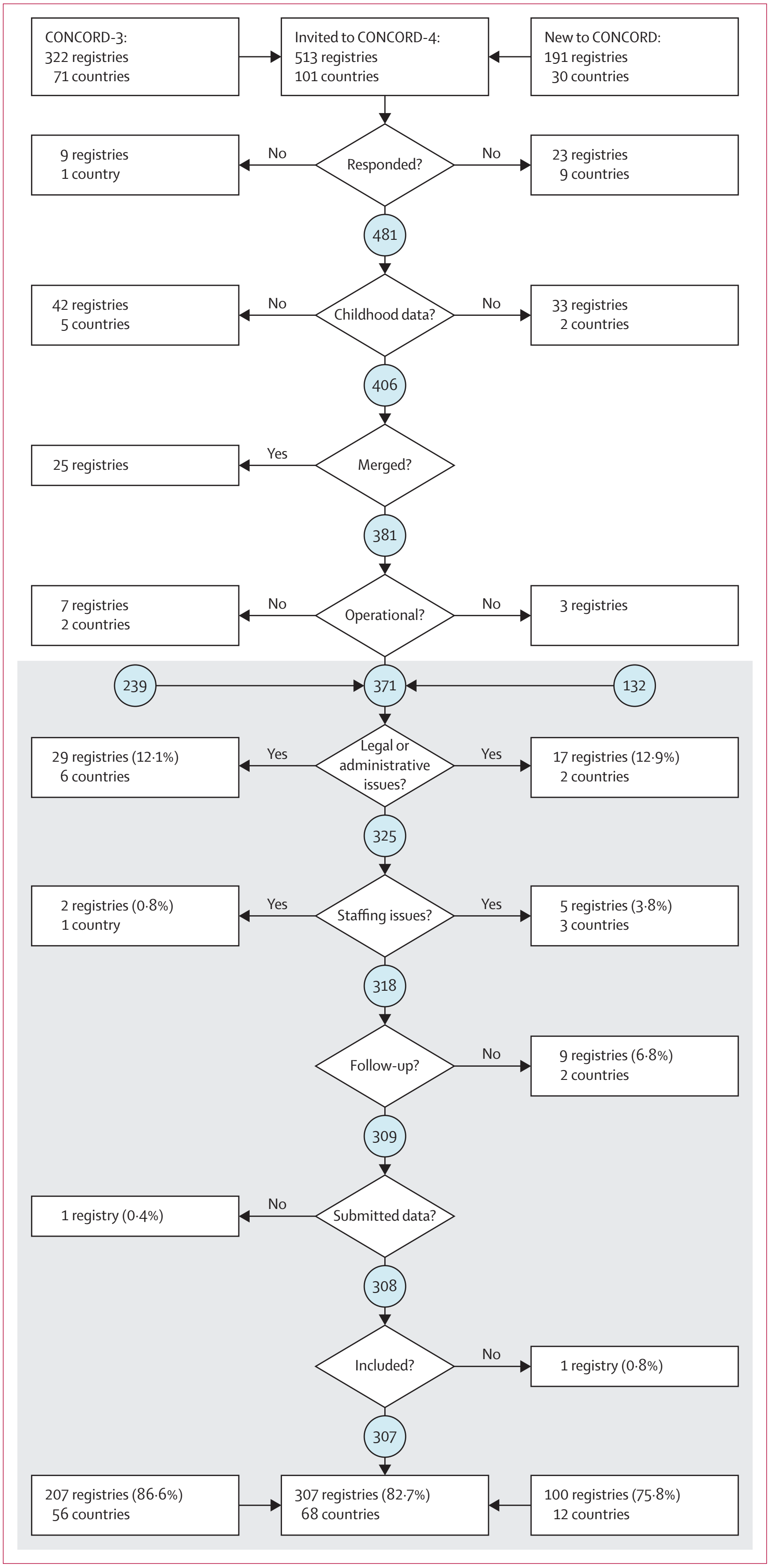


Figure 1: **Recruitment of cancer registries**

The numbers of countries excluded refer to countries for which the only cancer registry or all registries had to be excluded. The percentages refer to the number of operational registries (shaded area).

We then excluded duplicate registrations and multiple primary malignancies, leaving unique records for 673 302 children who were diagnosed with an invasive malignant neoplasm during the 33-year period 1990–2022 (appendix p 17). Tumours of the CNS with ICD-O-3 codes for benign (0) or uncertain (1) behaviour were also included.

Data quality was high in most countries, including LMICs (appendix p 17). Only 27 842 (4·1%) of 673 302 records were considered ineligible for survival analysis, because of incomplete dates, or behaviour other than primary, invasive malignancy (ICD-O-3 behaviour code 3), or age 15 years or older. Of the remaining 645 460 records, a further 9406 (1·5%) were excluded because they were death-certificate-only (DCO) registrations, or the vital status or sex was unknown, or they included invalid dates, or various inconsistencies between age, sex, site, and morphology, leaving data for 636 054 children (98·5% of those eligible).

Almost all cancers were microscopically verified (98·0%). Non-specific morphology codes were seen for more than 20% of records in South Africa and Thailand, and more than 30% in Mongolia and Indonesia, although several ICCC-3 groups include non-specific morphologies (appendix p 17). The proportion of children lost to follow-up was more than 10% in Cyprus and South Africa. Censoring within 5 years of diagnosis exceeded 20% in registries in Martinique (22·2%), Guadeloupe (25·7%), and Algerian registries (33·3%).

The 613 021 children diagnosed during 1990–2019 and included in survival analyses are presented by country and calendar period in the appendix (p 8).

For children diagnosed during 2015–19, the 5-year CSI for all childhood cancers combined exceeded 80% in most HICs. The CSI was in the range 60–80% in most UMICs, and 50–60% in the five participating LMICs (table 3, figure 2). In HICs, the CSI ranged from 61·4% in French Guiana and 69·9% in Trinidad and Tobago to 89·0% in Norway. In UMICs, reliable values of the 5-year CSI ranged from 61·0% in Peru to 80% or higher in Russia (81·5%) and Belarus (84·2%). In LMICs, the differences were less marked, from 54·1% in Indonesia to 59·3% in Guatemala.

The 5-year CSI increased steadily from 2000–04 to 2015–19 in all world regions, and, for those countries with longer time series, over the 30-year period 1990–2019 (table 3, figure 3). The trends were less consistent in Africa and central America.

Among the seven participating countries in eastern Europe, the increase in the 5-year CSI was more marked in UMICs than HICs. As a result, the overall range in the CSI was reduced from almost 30% in 2000–04 (53·6% in Bulgaria to 81·9% in Czech Republic) to 14% in 2015–19 (73·2% in Romania to 86·9% in Czech Republic). The CSI values for 2015–19 in Russia (81·5%), Hungary (80·7%), Bulgaria (73·7%), and Romania (73·2%) were still lower than in HICs. In northern Europe, steady increases in the 5-year CSI substantially reduced the range in CSI values, from 31% in 1990–94 (46·9% in Lithuania to 78·2% in Norway) to less than 10% in 2015–19 (80·8% in Latvia to 89·0% in Norway, including 85·6% in Lithuania).

The 5-year CSI for all childhood cancers diagnosed during 2015–19 shows a curvilinear relationship with the average national GDP during 2010–14 (figure 4A; rho 0·70, p<0·0001). The CSI was lower in LMICs than in HICs and slightly higher in UMICs, but there was no consistent pattern in HICs when the mean annual GDP exceeds $30 000 per capita. The mean annual health

	1990–94	1995–99	2000–04	2005–09	2010–14	2015–19
Africa						
Algeria*†	52·4% (48·0–57·1)	39·6% (38·2–41·0)	35·7% (31·1–41·1)	62·3% (57·6–67·5)	43·5% (39·4–48·1)	47·7% (43·3–52·6)
La Réunion‡	··	··	··	··	55·1% (51·7–58·9)	··
Nigeria†§	··	··	40·1% (35·7–45·1)	64·5% (57·5–72·3)	70·8% (67·1–74·8)	58·8% (52·7–65·5)
South Africa*†	··	··	73·9% (71·7–76·2)	74·5% (73·6–75·4)	66·6% (59·8–74·3)	77·7% (75·3–80·2)
Central and South America						
Argentina*‡	··	··	60·5% (59·4–61·7)	66·2% (65·0–67·3)	71·1% (70·0–72·1)	72·0% (71·0–73·0)
Brazil*	··	55·8% (50·1–62·2)	62·8% (60·1–65·6)	66·0% (63·5–68·6)	67·2% (64·9–69·5)	67·7% (65·2–70·2)
Chile‡	··	··	61·5% (55·9–67·7)	71·7% (69·6–73·8)	71·3% (69·7–73·0)	77·1% (75·6–78·7)
Colombia*	··	··	57·7% (54·0–61·6)	60·5% (57·4–63·7)	67·0% (63·8–70·4)	72·7% (69·9–75·7)
Costa Rica*‡	··	··	91·4% (89·1–93·8)	83·5% (81·2–85·9)	79·3% (76·7–82·1)	78·1% (74·8–81·5)
Cuba*‡	··	··	58·3% (55·8–60·9)	65·5% (63·0–68·0)	67·9% (65·4–70·5)	65·4% (62·7–68·2)
Ecuador*	57·9% (52·9–63·3)	53·6% (49·4–58·1)	53·9% (50·5–57·5)	59·8% (57·3–62·5)	58·0% (55·6–60·4)	64·0% (61·7–66·3)
El Salvador‡§	··	··	··	··	48·0% (43·7–52·6)	55·3% (52·3–58·5)
French Guiana‡	··	··	··	··	66·0% (62·2–69·9)	61·4% (58·3–64·8)
Guadeloupe†‡	··	··	··	··	66·4% (59·0–74·8)	60·2% (59·7–60·8)
Guatemala‡§	··	··	··	··	61·3% (58·1–64·6)	59·3% (56·9–61·8)
Martinique†‡	··	··	··	··	49·5% (44·5–55·0)	57·3% (55·7–58·9)
Mexico*	··	··	··	··	58·8% (51·7–66·8)	68·2% (64·2–72·4)
Peru*	··	··	··	··	56·5% (54·6–58·5)	61·0% (58·3–63·9)
Puerto Rico‡	··	··	76·4% (73·1–79·8)	78·1% (74·6–81·8)	81·0% (78·1–84·1)	88·2% (85·8–90·8)
Trinidad and Tobago‡	··	··	60·8% (55·2–66·8)	46·0% (40·1–52·9)	51·2% (45·4–57·8)	69·9% (66·5–73·4)
Uruguay‡	··	··	··	··	69·3% (64·9–74·1)	77·9% (74·4–81·6)
North America						
Canada	74·9% (72·8–77·1)	76·4% (74·4–78·5)	81·9% (80·6–83·2)	83·2% (82·0–84·5)	83·5% (82·2–84·8)	84·2% (83·0–85·4)
USA‡	··	··	81·0% (80·7–81·4)	84·2% (83·9–84·6)	86·3% (85·9–86·6)	87·1% (86·6–87·5)
Asia						
Cyprus‡	··	··	··	73·5% (68·4–78·9)	71·4% (64·3–79·1)	73·8% (70·0–77·7)
Georgia*‡	··	··	··	··	··	75·8% (72·4–79·4)
Indonesia§	··	··	··	··	53·7% (49·6–58·1)	54·1% (50·0–58·6)
Israel‡	··	··	81·2% (79·2–83·3)	80·8% (79·0–82·6)	83·2% (81·6–84·9)	87·0% (85·4–88·5)
Japan‡	66·2% (63·6–68·8)	74·2% (71·6–76·8)	74·2% (72·6–75·8)	76·7% (75·3–78·2)	83·3% (82·2–84·3)	85·9% (85·1–86·6)
Kuwait‡	··	··	65·2% (61·1–69·6)	57·9% (54·3–61·8)	68·6% (64·3–73·2)	75·5% (71·8–79·4)
Mongolia‡§	··	··	··	··	32·3% (29·3–35·6)	58·7% (54·0–63·7)
Qatar‡	··	··	57·3% (49·7–66·2)	61·1% (50·0–74·7)	57·0% (50·9–63·7)	75·8% (70·1–82·0)
Saudi Arabia‡	··	··	··	··	75·8% (74·1–77·6)	80·5% (78·9–82·2)
Singapore‡	··	··	72·5% (69·1–76·0)	74·8% (71·6–78·2)	83·1% (80·3–85·9)	83·2% (80·5–86·0)
South Korea‡	··	··	67·6% (66·1–69·1)	71·8% (70·4–73·1)	72·9% (71·6–74·2)	75·2% (74·0–76·5)
Taiwan‡	··	··	69·8% (68·2–71·5)	72·6% (70·9–74·3)	73·1% (71·4–74·9)	77·4% (75·7–79·2)
Thailand*	··	··	··	55·7% (52·2–59·4)	64·5% (61·1–68·1)	66·0% (62·8–69·4)
Türkiye*	··	49·7% (44·2–55·9)	65·6% (63·0–68·4)	72·1% (70·3–73·9)	75·9% (74·6–77·3)	80·2% (78·9–81·5)

(Table 3 continues on next page)

	1990–94	1995–99	2000–04	2005–09	2010–14	2015–19
(Continued from previous page)						
Europe						
Austria‡	77·0% (74·6–79·5)	81·3% (79·0–83·6)	81·1% (78·8–83·5)	84·3% (82·2–86·3)	85·0% (82·9–87·1)	85·1% (83·1–87·1)
Belarus*‡	··	··	73·2% (70·9–75·6)	75·9% (73·6–78·4)	82·3% (80·3–84·2)	84·2% (82·5–86·0)
Belgium‡	··	··	80·6% (77·3–84·0)	84·4% (82·8–86·1)	85·4% (83·8–87·0)	84·9% (83·4–86·5)
Bulgaria*‡	48·1% (44·1–52·4)	53·7% (50·4–57·2)	53·6% (50·4–57·0)	66·9% (63·9–70·0)	72·1% (69·3–75·1)	73·7% (70·6–77·0)
Croatia‡	··	··	74·0% (71·2–77·0)	79·1% (75·7–82·5)	79·0% (76·2–82·0)	81·1% (78·5–83·8)
Czech Republic‡	··	··	81·9% (79·8–84·1)	83·3% (81·5–85·3)	87·2% (85·2–89·3)	86·9% (85·3–88·6)
Denmark‡	··	··	77·6% (74·9–80·4)	81·6% (78·8–84·4)	82·1% (79·3–85·0)	83·1% (80·8–85·4)
Estonia‡	··	··	66·5% (61·6–71·8)	70·9% (66·7–75·3)	74·3% (69·8–79·0)	85·7% (82·8–88·7)
France‡	··	··	81·4% (80·6–82·3)	84·1% (83·4–84·9)	85·5% (84·8–86·2)	86·3% (85·4–87·1)
Germany	65·3% (61·2–69·6)	63·2% (58·6–68·3)	71·2% (66·9–75·7)	83·9% (82·2–85·6)	86·8% (85·6–88·0)	85·2% (84·0–86·5)
Hungary‡	··	··	70·2% (67·9–72·6)	78·1% (75·9–80·5)	77·9% (75·8–80·1)	80·7% (78·6–82·9)
Ireland‡	73·6% (68·1–79·6)	78·7% (75·6–82·0)	80·4% (77·9–83·0)	81·1% (78·5–83·8)	84·9% (82·9–87·0)	87·7% (85·7–89·7)
Italy	71·5% (68·7–74·3)	79·1% (77·1–81·3)	81·6% (80·0–83·1)	84·2% (83·1–85·3)	86·4% (85·5–87·3)	86·9% (86·0–87·8)
Latvia‡	··	··	69·7% (65·1–74·6)	72·2% (66·8–78·1)	74·0% (67·0–81·7)	80·8% (77·1–84·8)
Lithuania‡	46·9% (43·3–50·8)	52·8% (48·8–57·0)	60·1% (56·5–64·0)	69·0% (64·7–73·4)	81·2% (77·5–85·0)	85·6% (82·8–88·4)
Malta‡	··	··	66·7% (60·6–73·6)	71·8% (67·4–76·5)	66·7% (64·0–69·6)	82·7% (79·7–85·8)
Netherlands‡	··	··	79·0% (77·5–80·5)	81·5% (80·0–83·0)	85·7% (84·4–87·0)	··
Norway‡	78·2% (75·4–81·2)	77·2% (74·4–80·1)	84·5% (82·2–86·8)	81·7% (79·2–84·1)	84·7% (82·0–87·6)	89·0% (87·1–90·9)
Poland‡	··	··	74·3% (72·9–75·7)	78·6% (77·3–79·8)	82·5% (81·3–83·8)	84·0% (82·8–85·2)
Portugal‡	··	69·7% (65·4–74·4)	76·8% (74·8–78·9)	81·0% (79·1–82·9)	83·2% (81·3–85·2)	85·5% (83·7–87·4)
Romania*‡	··	··	··	··	68·7% (66·4–71·1)	73·2% (71·1–75·3)
Russia*	··	70·2% (65·1–75·8)	63·8% (59·9–68·0)	70·0% (66·7–73·5)	76·4% (73·5–79·3)	81·5% (78·9–84·3)
Slovenia‡	62·8% (58·4–67·6)	71·2% (66·8–75·8)	78·2 (74·2–82·5)	79·0% (74·9–83·5)	81·6% (77·9–85·6)	87·8% (84·7–91·0)
Spain	62·9% (50·0–79·1)	71·6% (65·3–78·6)	76·4% (74·9–77·9)	78·6% (77·3–79·9)	82·4% (81·2–83·6)	85·4% (84·3–86·5)
Switzerland‡	74·2% (71·7–76·7)	77·7% (75·2–80·2)	80·6% (78·3–82·9)	83·0% (80·9–85·1)	85·8% (83·9–87·7)	88·5% (86·8–90·2)
UK‡	72·1% (70·9–73·2)	74·8% (73·8–75·8)	79·1% (78·1–80·0)	83·3% (82·5–84·1)	84·6% (83·8–85·3)	85·8% (85·1–86·5)
Oceania						
Australia‡	··	75·7% (73·9–77·5)	80·9% (79·5–82·2)	82·7% (81·4–83·9)	85·8% (84·6–87·1)	86·1% (85·1–87·2)
New Zealand‡	··	··	76·7% (73·9–79·7)	78·6% (75·8–81·6)	79·9% (77·4–82·4)	82·8% (80·4–85·4)

Data are CSI (95% CI). CSI=Cancer Survival Index. *Upper-middle-income country. †Less reliable estimates (see text). ‡Data with 100% coverage of the national population; for Chile from 2007 and for Japan from 2016. §Lower-middle-income country (World Bank national income group; 2015).

Table 3: **5-year Cancer Survival Index for all childhood cancers combined, by continent, country, and calendar period of diagnosis**

expenditure during 2010–14, as a proportion of GDP, shows a more linear relationship with the 5-year CSI for 2015–19 (figure 4B, rho 0·55, $p<0·0001$), but mainly for HICs. Similar patterns were seen with the CSI for the six WHO tracer cancers (appendix p 51).

A sensitivity analysis showed that, in countries with subnational coverage during 2000–19, increases in population coverage did not materially affect the international range of CSI values (appendix p 18).

The 5-year CSI for the six WHO tracer cancers combined indicated that, for children diagnosed during 2015–19, most countries had already met or exceeded the WHO target, including most UMICs and LMICs (table 4, figure 5).

The 5-year CSI for the six WHO tracer cancers combined varied widely between the countries in all three World Bank groups. In HICs, the CSI ranged from 77·9% in Kuwait to 90% or more in Canada, the USA, Puerto Rico, three Asian countries (Israel, Japan, and Singapore), 17 European countries (Austria, Belgium, Croatia, Czech Republic, Estonia, France, Germany, Italy, Ireland, Lithuania, Malta, Norway, Portugal, Slovenia, Spain, Switzerland, and the UK), and Australia.

In UMICs, the CSI was lower than 60% in Peru and Thailand, and higher than 80% in Colombia, Costa Rica, Georgia, Türkiye, and four European countries (Belarus, Bulgaria, Romania, and Russia). In particular, in Belarus the CSI (93·8%) reached a level seen in many HICs.

In LMICs, the CSI was slightly lower than 60% in Mongolia (57·9%) and Indonesia (59·7%), and higher than 60% in Guatemala (65·8%) and El Salvador (68·5%).

Trends in the 5-year CSI for the six WHO tracer cancers combined from 1990–94 to 2015–19 were similar to those for all childhood cancers combined, but typically 5–10% higher (figure 6).

Discussion

Childhood cancer survival is a major global health challenge, yet the disease burden is not fully known, in part because of the scarcity of population-based cancer registries, particularly in low-income and middle-income countries.[40] To the best of our knowledge, this is the largest

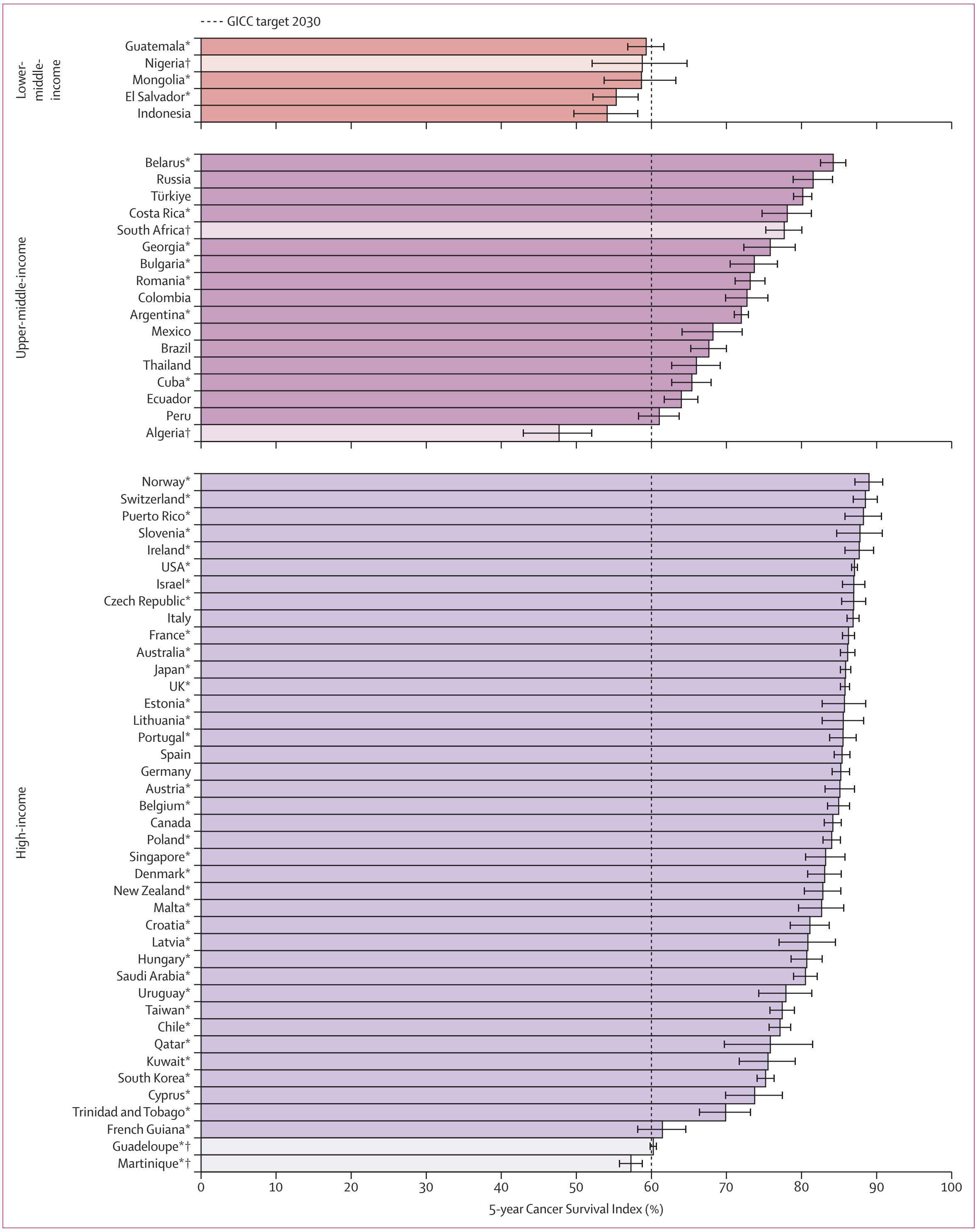
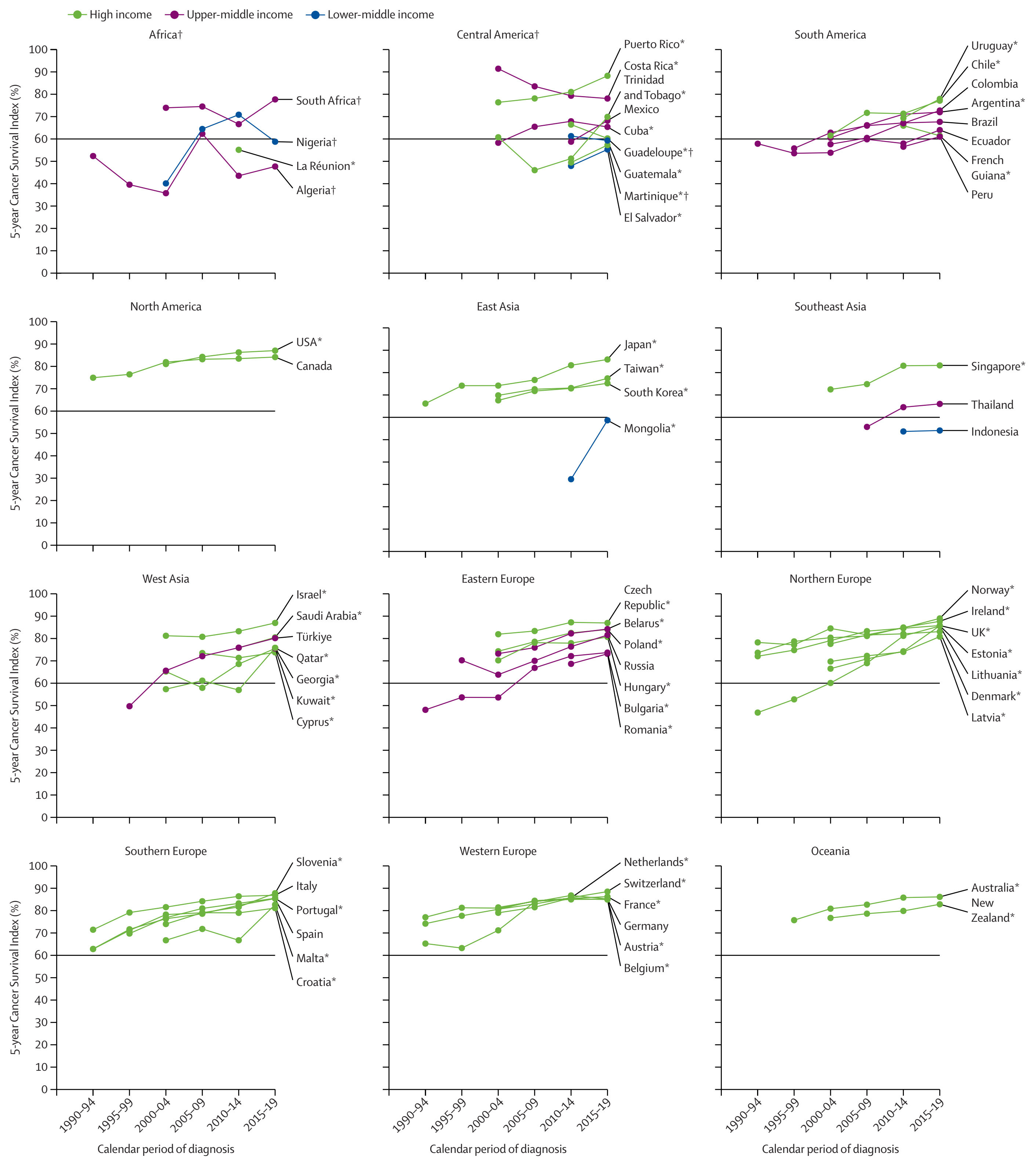


Figure 2: **5-year Cancer Survival Index for all childhood cancers combined, 2015–19, by country, and World Bank national income group in 2015**
La Réunion and the Netherlands did not submit data for children diagnosed during 2015–19 (see table 3). GICC=Global Initiative for Childhood Cancer. Error bars represent 95% CIs. *Data with 100% coverage of national population; Japan from 2016. †Less reliable estimates (see text) are shown in paler colours.


High income
Upper-middle income
Lower-middle income
Africa†
South Africa†
Nigeria†
La Réunion*
Algeria†
Central America†
Puerto Rico*
Costa Rica*
Trinidad and Tobago*
Mexico
Cuba*
Guadeloupe*†
Guatemala*
Martinique*†
El Salvador*
South America
Uruguay*
Chile*
Colombia
Argentina*
Brazil
Ecuador
French Guiana*
Peru
North America
USA*
Canada
East Asia
Japan*
Taiwan*
South Korea*
Mongolia*
Southeast Asia
Singapore*
Thailand
Indonesia
West Asia
Israel*
Saudi Arabia*
Türkiye
Qatar*
Georgia*
Kuwait*
Cyprus*
Eastern Europe
Czech Republic*
Belarus*
Poland*
Russia
Hungary*
Bulgaria*
Romania*
Northern Europe
Norway*
Ireland*
UK*
Estonia*
Lithuania*
Denmark*
Latvia*
Southern Europe
Slovenia*
Italy
Portugal*
Spain
Malta*
Croatia*
Western Europe
Netherlands*
Switzerland*
France*
Germany
Austria*
Belgium*
Oceania
Australia*
New Zealand*
5-year Cancer Survival Index (%)
0
10
20
30
40
50
60
70
80
90
100
1990–94
1995–99
2000–04
2005–09
2010–14
2015–19
Calendar period of diagnosis

study of childhood cancer survival for all cancers combined, including real-world data on more than 600 000 children from 307 population-based cancer registries, covering a combined population of more than 233 million children in 68 countries worldwide, for 52 of which national population coverage was 100%. To help monitor progress towards the GICC target of 60% 5-year survival for all childhood cancers combined by 2030, we developed a new index, the Cancer Survival Index (CSI). The CSI is a one-number index that allows quantitative examination of trends in survival for all childhood cancers combined within a country, as well as comparisons between countries and over time. Trends in the 5-year CSI for all childhood cancers combined showed consistent improvement in most countries worldwide. In Asia, an upward trajectory was maintained in most HICs. For example, the 5-year CSI in Japan rose markedly from 66·2% in 1990–94 to 85·9% in 2015–19, approaching the levels seen in North America and Europe. This improvement probably reflects the long-standing government commitment to subsidising cancer treatment for children and adolescents since the early 1970s.[41,42] Upward trends have occurred in other Asian countries. In Thailand, for example, the 5-year CSI increased from 55·7% in 2000–04 to 66·0% in 2015–19. This may reflect implementation of universal health-care coverage and nationwide guidelines to improve access to health care.[43,44]

Progress in the 5-year CSI for all childhood cancers combined has also occurred in North America, Oceania, and parts of Europe, where the CSI increased from approximately 60% in the 1990s to more than 80% in 2015–19. These steady gains over 30 years may be partly explained by more consistent availability of anticancer medicines on the WHO Essential Medicines List for children.[45,46]

Late presentation, abandonment of treatment, and sub-optimal health-care systems are major contributors to poor survival from childhood cancer in LICs and LMICs.[2,40,47] Major inequities exist in the oncology workforce, with as few as 0·09 oncologists per 100 000 population in LICs, compared with 1·6 per 100 000 in HICs.[48] Similar disparities exist in access to radiotherapy, from only 17% in LICs and 73% in LMICs to 93% in HICs.[49] The status of care for childhood cancers in ten LICs and LMICs in 2005–06 was assessed from in-person interviews with health professionals, as part of the My Child Matters programme.[50] Access to care and management was poor, deficient, or inconsistent in seven of the ten countries. 5-year survival, postulated solely on the basis of interviews, was as low as 5–10% in five countries, and 30–60% in the other five. The authors noted that even detailed surveys are not a substitute for national cancer registration.[50]

Recent improvements in the 5-year CSI for all cancers combined in eastern Europe may be partly explained by increased participation in international clinical trials for childhood leukaemia,[51] the most frequent malignancy in children. The persistent survival deficit in eastern Europe compared to other European regions may reflect less access to appropriate diagnostic facilities or chemotherapy.[46] Disparities in access to care persist, however, particularly in LMICs, where supply chain inefficiencies, high costs, and regulatory barriers still limit access to essential medicines.[45] Even within high-income regions, substantial regional disparities exist, such as in Europe, where there are variations in national formularies, and procurement policies can reduce the availability of medicines.[46] Countries that implement centralised procurement policies tend to achieve better access to a full range of essential medicines, supporting improved treatment adherence and outcomes. Nonetheless, equitable access remains a persistent challenge: the lowest levels of availabilty of essential medicines were observed in eastern European countries such as Romania and Bulgaria.[46]

Improvements in data quality and the completeness of follow-up for vital status in Latin America have allowed production of reliable estimates of the 5-year CSI, showing general upward trends. Despite this important success, achieving comprehensive cancer registration in Latin America remains difficult, especially the integration of data sources for childhood cancer. These problems arise from the inadequate organisation of health systems, poor availability and accessibility of childhood cancer hospital networks, and persistent fragmentation between public and private health-care sectors. Robust childhood cancer registries were established in Argentina in 2000,[52] and in Chile in 2006,[53] but Colombia and Ecuador still face considerable problems, with less than 50% of all cancers recorded in public systems. This reflects both limited coverage and structural inefficiency in health information systems.[54] Recent improvements in the childhood CSI in Argentina might be partially explained by implementation of the National Program for Pediatric Cancer in 2016. This programme included actions to strengthen the Registro Oncopediátrico Hospitalario Argentino, to promote timely and accurate diagnosis, to develop standardised treatment protocols in referral hospitals, and to improve training in clinical support and nursing care. These actions might have helped to improve outcomes for children with cancer, as well as the quality of cancer registration data.

In Peru, the first country in Latin America to implement the GICC, the 5-year CSI for the six WHO tracer cancers was 55·2% during 2010–19. This might be due to high treatment dropout (18%) and substantial out-of-pocket expenses, reported to be as high as 75% of a family's

***Figure 3:* Trends in the 5-year Cancer Survival Index for all childhood cancers combined, 1990–2019, by country, UN world region, and World Bank national income group in 2015**

The horizontal line in each graphic indicates the WHO Global Initiative for Childhood Cancer target of 60%. *Data with 100% coverage of the national population; for Chile from 2007 and Japan from 2016. †Less reliable estimates (see text).

Figure 4: **5-year Cancer Survival Index for all childhood cancers combined, 2015–19, by mean GDP per capita 2010–14 (A) and mean annual health expenditure 2010–14 (B)**
La Réunion and the Netherlands did not submit data for children diagnosed during 2015–19 (see table 3). For Taiwan, Guadeloupe, and Martinique, separate GDP data were not available from the World Bank. GDP=gross domestic product. *Data with 100% coverage of the national population; Japan from 2016. †Less reliable estimates (see text). Source: World Bank (https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD).

income following diagnosis of cancer in a child or adolescent.[55]

The six WHO tracer cancers represented 43·9% of the childhood cancer records submitted to CONCORD-4, less than the 50–60% mentioned by WHO.[2] In Morocco, a GICC pilot country, the proportion of WHO tracer cancers in a multicentre study during 2017–19 was only 30%.[56]

The incidence of and survival from childhood cancer vary widely by age, sex, and tumour type. Childhood cancer incidence varies worldwide, generally with higher incidence in boys than in girls.[57,58] Epithelial, renal, germ cell, and gonadal tumours are more common in girls.[57] Survival also differs between boys and girls, although patterns vary by age group and tumour type, as well as by geographical region: most studies report lower survival in boys for several cancers.[59–61] Cancer survival also differs by age, especially between infants and older children.[62] For these reasons, we consider that progress towards the GICC target can best be monitored with trends in a one-number CSI for each country, as a weighted average

	1990–94	1995–99	2000–04	2005–09	2010–14	2015–19
Africa						
Algeria*†	..	23·4% (23·4–23·4)	47·0% (40·9–54·1)	78·4% (73·9–83·2)	41·4% (36·1–47·6)	47·6% (39·9–56·6)
La Réunion‡	..	..	..	..	54·2% (50·1–58·5)	..
Nigeria†§	..	..	23·6% (22·5–24·8)	73·2% (71·5–74·9)	62·2% (56·8–68·2)	59·3% (56·7–62·0)
South Africa*¶	..	..	48·8% (40·0–90·9)	34·1% (32·4–35·9)	50·3% (48·5–52·1)	81·3%
Central and South America						
Argentina*‡	..	..	70·1% (68·5–71·7)	76·3% (74·8–77·8)	79·1% (77·8–80·4)	79·5% (78·3–80·8)
Brazil*	..	49·8% (41·5–59·7)	73·0% (68·9–77·3)	73·0% (69·6–76·6)	77·8% (74·3–81·5)	75·9% (72·5–79·4)
Chile‡	..	57·4% (53·8–61·2)	62·7% (53·6–73·4)	76·9% (74·3–79·6)	79·3% (77·3–81·3)	82·4% (80·6–84·3)
Colombia*	..	..	64·1% (59·0–69·5)	69·2% (65·0–73·7)	76·4% (72·3–80·7)	81·2% (77·5–85·0)
Costa Rica*‡	..	..	92·5% (87·9–97·3)	90·8% (88·1–93·6)	80·7% (76·9–84·6)	83·3% (79·0–87·8)
Cuba*‡	..	..	60·4% (56·4–64·8)	73·7% (69·9–77·7)	73·6% (69·7–77·8)	69·8% (65·6–74·3)
Ecuador*	60·0% (53·1–67·6)	60·8% (54·7–67·6)	60·0% (54·1–66·5)	60·8% (57·2–64·7)	62·6% (59·3–66·2)	65·9% (62·6–69·4)
El Salvador‡§	..	..	..	..	62·4% (55·3–70·4)	68·5% (64·3–73·0)
French Guiana‡¶	..	..	..	..	68·0% (63·0–73·5)	58·4%
Guadeloupe‡¶	..	..	..	..	64·4% (57·0–72·9)	57·0%
Guatemala‡§	..	..	..	..	64·1% (60·3–68·2)	65·8% (62·7–68·9)
Martinique‡¶	..	..	..	..	56·6% (49·8–64·3)	70·2%
Mexico*	..	..	..	..	67·0% (60·6–74·2)	77·8% (72·5–83·5)
Peru*	..	..	..	..	55·2% (52·7–57·8)	55·2% (52·0–58·7)
Puerto Rico‡	..	..	80·7% (75·4–86·4)	84·4% (79·5–89·7)	87·0% (83·2–91·0)	91·6% (88·9–94·5)
Trinidad and Tobago‡	..	..	64·0% (57·3–71·4)	42·4% (38·1–47·1)	52·7% (45·3–61·4)	85·4% (81·5–89·6)
Uruguay‡	..	..	..	..	83·1% (76·5–90·3)	83·4% (78·8–88·4)
North America						
Canada	84·9% (82·3–87·6)	86·7% (84·4–89·1)	91·0% (89·6–92·4)	92·2% (90·9–93·4)	91·6% (90·2–92·9)	92·2% (91·0–93·5)
USA‡	..	..	88·7% (88·2–89·2)	90·9% (90·4–91·4)	92·7% (92·2–93·1)	93·0% (92·5–93·5)
Asia						
Cyprus‡	..	..	..	67·8% (63·6–72·4)	80·8% (77·1–84·7)	86·6% (83·6–89·7)
Georgia‡*	..	..	..	..	..	81·9% (77·5–86·7)
Indonesia§	..	..	..	..	60·7% (54·9–67·2)	59·7% (53·5–66·5)
Israel‡	..	..	87·8% (84·8–90·9)	88·5% (86·2–90·9)	89·7% (87·0–92·6)	92·6% (90·5–94·8)
Japan‡	74·2% (70·4–78·2)	81·7% (78·3–85·2)	79·5% (76·8–82·4)	83·3% (81·3–85·5)	89·0% (87·7–90·4)	90·2% (89·2–91·2)
Kuwait‡	..	..	75·6% (68·9–82·9)	69·0% (62·6–76·1)	77·2% (75·7–78·6)	77·9% (74·3–81·7)
Mongolia‡§	..	..	..	..	29·7% (29·7–29·7)	57·9% (57·3–58·5)
Qatar‡	..	..	62·3% (55·3–70·3)	51·4% (34·4–76·8)	72·6% (72·6–72·6)	82·0% (78·2–85·9)
Saudi Arabia‡	..	..	..	..	84·5% (82·6–86·4)	86·3% (84·1–88·6)
Singapore‡	..	..	82·9% (78·4–87·7)	82·1% (78·5–85·9)	87·8% (85·0–90·7)	91·2% (88·3–94·3)
South Korea‡	..	..	71·1% (68·2–74·2)	73·4% (71·7–75·2)	78·0% (76·5–79·5)	79·6% (78·2–81·1)
Taiwan‡	..	..	76·6% (74·2–79·2)	79·4% (77·0–81·9)	79·3% (76·6–82·1)	84·7% (82·5–87·0)
Thailand*	..	..	..	61·5% (56·6–66·7)	66·2% (61·7–71·1)	58·6% (55·0–62·5)
Türkiye*	..	40·6% (34·0–48·5)	73·1% (69·1–77·3)	80·5% (78·2–83·0)	82·1% (80·1–84·1)	85·6% (83·8–87·3)

(Table 4 continues on next page)

	1990–94	1995–99	2000–04	2005–09	2010–14	2015–19
(Continued from previous page)						
Europe						
Austria‡	85·3% (81·2–89·5)	88·0% (84·4–91·8)	87·7% (84·8–90·7)	91·7% (89·0–94·4)	91·5% (88·4–94·6)	93·4% (91·1–95·7)
Belarus‡*	··	··	82·7% (79·5–86·0)	87·6% (84·8–90·6)	91·3% (89·0–93·7)	93·8% (91·9–95·8)
Belgium‡	··	··	86·8% (82·4–91·5)	92·6% (90·6–94·6)	91·8% (89·8–93·8)	93·4% (91·7–95·2)
Bulgaria‡*	57·4% (51·5–64·0)	65·9% (58·2–74·7)	65·2% (60·0–70·9)	77·5% (73·2–81·9)	81·0% (77·2–84·9)	84·5% (80·6–88·7)
Croatia‡	··	··	81·7% (77·5–86·1)	88·9% (85·2–92·7)	89·2% (85·7–93·0)	91·8% (88·7–95·1)
Czech Republic‡	··	··	90·8% (88·2–93·5)	91·0% (88·8–93·2)	92·1% (89·8–94·6)	91·0% (88·7–93·4)
Denmark‡	··	··	88·1% (84·0–92·4)	91·5% (88·9–94·0)	89·6% (87·2–92·1)	89·5% (86·3–92·9)
Estonia‡	··	··	63·5% (55·9–72·1)	84·6% (78·5–91·2)	89·6% (83·3–96·3)	94·7% (91·2–98·3)
France‡	··	··	89·7% (88·8–90·7)	91·7% (90·9–92·5)	91·1% (90·2–91·9)	91·9% (90·8–92·9)
Germany	82·6% (79·2–86·2)	69·3% (62·1–77·3)	72·2% (65·4–79·6)	91·1% (88·9–93·4)	92·8% (91·2–94·5)	91·8% (90·1–93·5)
Hungary‡	··	··	83·7% (80·6–87·0)	86·7% (83·8–89·7)	85·6% (82·9–88·4)	86·7% (84·0–89·6)
Ireland‡	70·6% (63·1–78·9)	84·9% (81·3–88·8)	85·9% (82·6–89·2)	88·3% (85·0–91·6)	93·4% (90·8–96·0)	93·9% (91·7–96·1)
Italy	67·2% (63·4–71·1)	86·3% (83·8–88·9)	86·9% (85·0–88·9)	90·3% (89·0–91·7)	90·1% (89·0–91·4)	91·2% (90·0–92·3)
Latvia‡¶	··	··	74·6% (69·2–80·4)	66·6% (59·3–74·8)	83·5% (76·5–91·1)	38·9%
Lithuania‡	52·8% (47·8–58·2)	56·4% (50·3–63·3)	77·6% (72·2–83·4)	76·9% (71·1–83·2)	84·0% (79·7–88·5)	93·9% (90·1–97·8)
Malta‡¶	··	··	77·8% (69·9–86·7)	81·1% (75·8–86·9)	80·4% (67·3–96·1)	92·6%
Netherlands‡	··	··	87·9% (86·2–89·7)	90·0% (88·3–91·8)	92·2% (90·8–93·7)	··
Norway‡	88·1% (85·0–91·3)	85·3% (81·7–89·1)	89·7% (86·6–92·9)	88·8% (85·4–92·3)	90·4% (87·5–93·3)	94·3% (92·1–96·5)
Poland‡	··	··	83·1% (81·1–85·1)	85·5% (83·7–87·3)	89·1% (87·3–90·9)	87·4% (85·6–89·3)
Portugal‡	··	79·1% (72·1–86·8)	82·9% (80·1–85·8)	88·7% (86·0–91·4)	89·5% (87·1–91·9)	90·9% (88·5–93·5)
Romania‡*	··	··	··	··	77·7% (74·6–80·9)	82·9% (80·3–85·6)
Russia*	··	18·1% (18·1–18·1)	32·9% (28·5–37·8)	76·0% (69·5–83·1)	83·0% (78·0–88·2)	88·0% (84·5–91·8)
Slovenia‡	70·2% (64·2–76·8)	81·7% (76·2–87·6)	83·5% (78·0–89·4)	85·6% (81·4–90·0)	85·5% (80·3–91·2)	96·2% (92·9–99·6)
Spain	67·1% (47·7–94·5)	84·7% (80·6–89·0)	85·4% (83·5–87·4)	86·2% (84·4–88·0)	88·2% (86·6–89·7)	90·9% (89·5–92·3)
Switzerland‡	81·3% (78·1–84·8)	88·5% (85·3–91·9)	89·0% (86·2–91·9)	89·8% (87·1–92·7)	91·1% (89·1–93·1)	94·1% (92·3–96·0)
UK‡	79·8% (78·2–81·4)	83·1% (81·8–84·4)	87·5% (86·5–88·6)	91·0% (90·1–91·9)	92·0% (91·2–92·8)	92·3% (91·5–93·1)
Oceania						
Australia‡	··	83·2% (80·9–85·6)	87·9% (86·2–89·5)	89·8% (88·3–91·2)	92·0% (90·7–93·4)	93·9% (92·8–95·0)
New Zealand‡	··	··	86·2% (83·1–89·5)	86·4% (82·8–90·1)	87·1% (84·5–89·8)	88·6% (86·2–91·0)

Data are CSI (95% CI). CSI=Cancer Survival Index. *Upper-middle-income country. †Less reliable estimates (see text). ‡Data with 100% coverage of the national population; for Chile from 2007 and for Japan from 2016. §Lower-middle-income country (World Bank national income group; 2015). ¶Less reliable estimate, based on small numbers of children; a confidence interval for the CSI cannot be produced for 2015–19. Latvia: no data on acute lymphoblastic leukaemia for 2015–19.

Table 4: **5-year Cancer Survival Index for the six WHO tracer cancers combined, by continent, country and calendar period of diagnosis**

of 5-year net survival by age, sex, and type of cancer, using a global set of weights.

For children with cancer, population-based survival is often presented as the observed or crude probability,[3,7,63,64] because in HICs, at least, the risk of death from other causes (background mortality) is typically very low. However, this study also included UMICs and LMICs, so we estimated net survival.[34] Net survival is corrected for background mortality, which varies widely by age, sex, and geography, and over time. For example, global variation in neonatal mortality (in the first month of life) ranged from around one death per 1000 livebirths to more than 40 deaths per 1000 livebirths in 2023,[65] and the mortality rate for children younger than 5 years varied more than 50-fold worldwide in 2019, from two deaths per 1000 livebirths in Slovenia to 117 per 1000 in Nigeria.[66] The global mortality rate for children younger than 5 years has also fallen by 61% during the 30-year period covered by this study, from 94 deaths per 1000 livebirths in 1990 to 37 deaths per 1000 in 2023.[65]

A CSI can only be constructed for countries and regions where population-based cancer registries exist and are able and willing to share the relevant data. In all, 46 (12·4%) of the 371 operational registries that collect childhood cancer data were prevented from participating in CONCORD-4 by legal or administrative problems. Of these, 32 registries are in seven countries that could not participate as a result. The global cancer burden in Africa and LMICs is projected to rise substantially by 2030,[67] but sub-Saharan Africa still lacks adequate coverage with population-based cancer registries. Even among the operational registries, including some that had participated in CONCORD-3, participation in CONCORD-4 was restricted by the African Cancer Registry Network, which would only allow sharing of data that had already been published, based on small

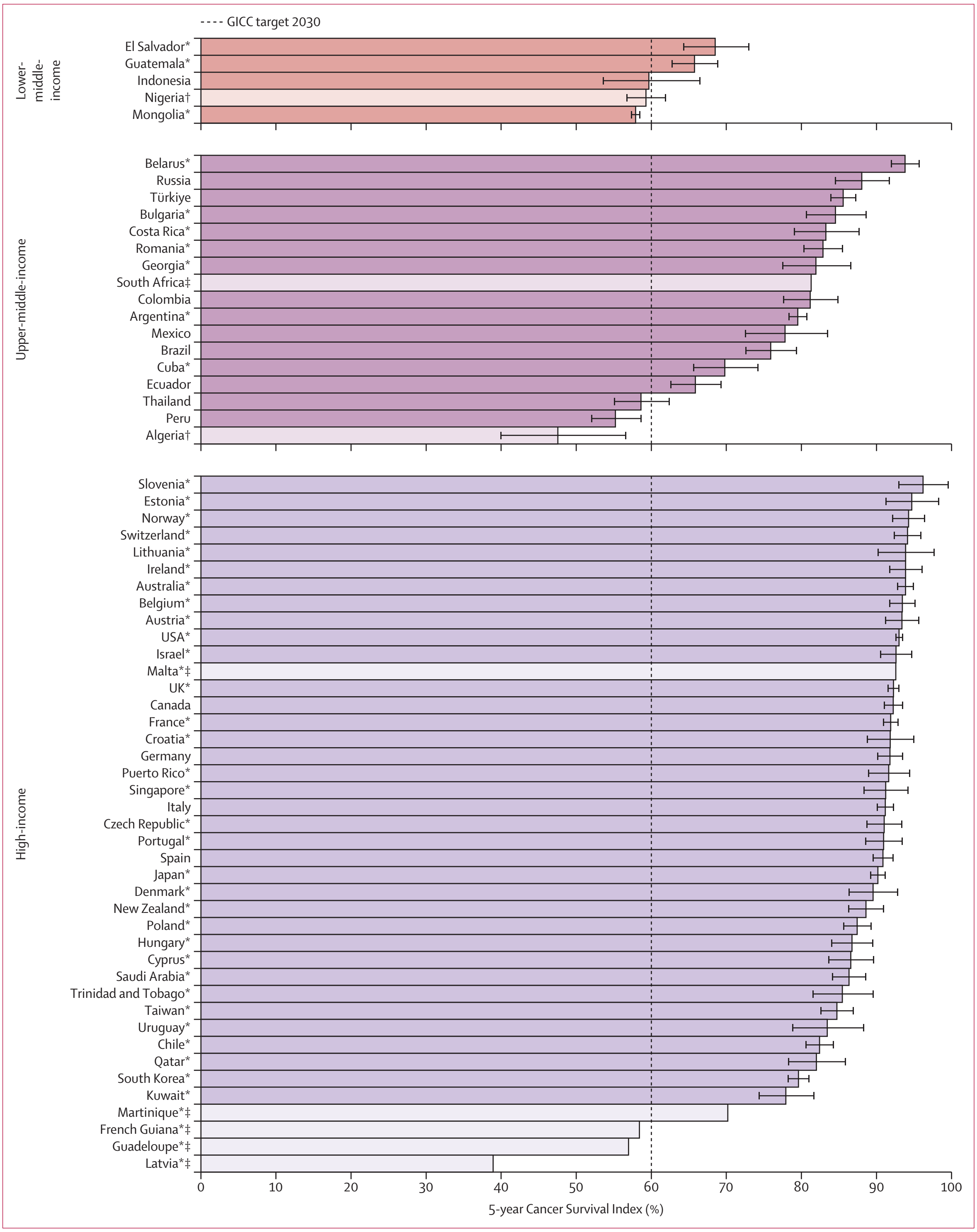
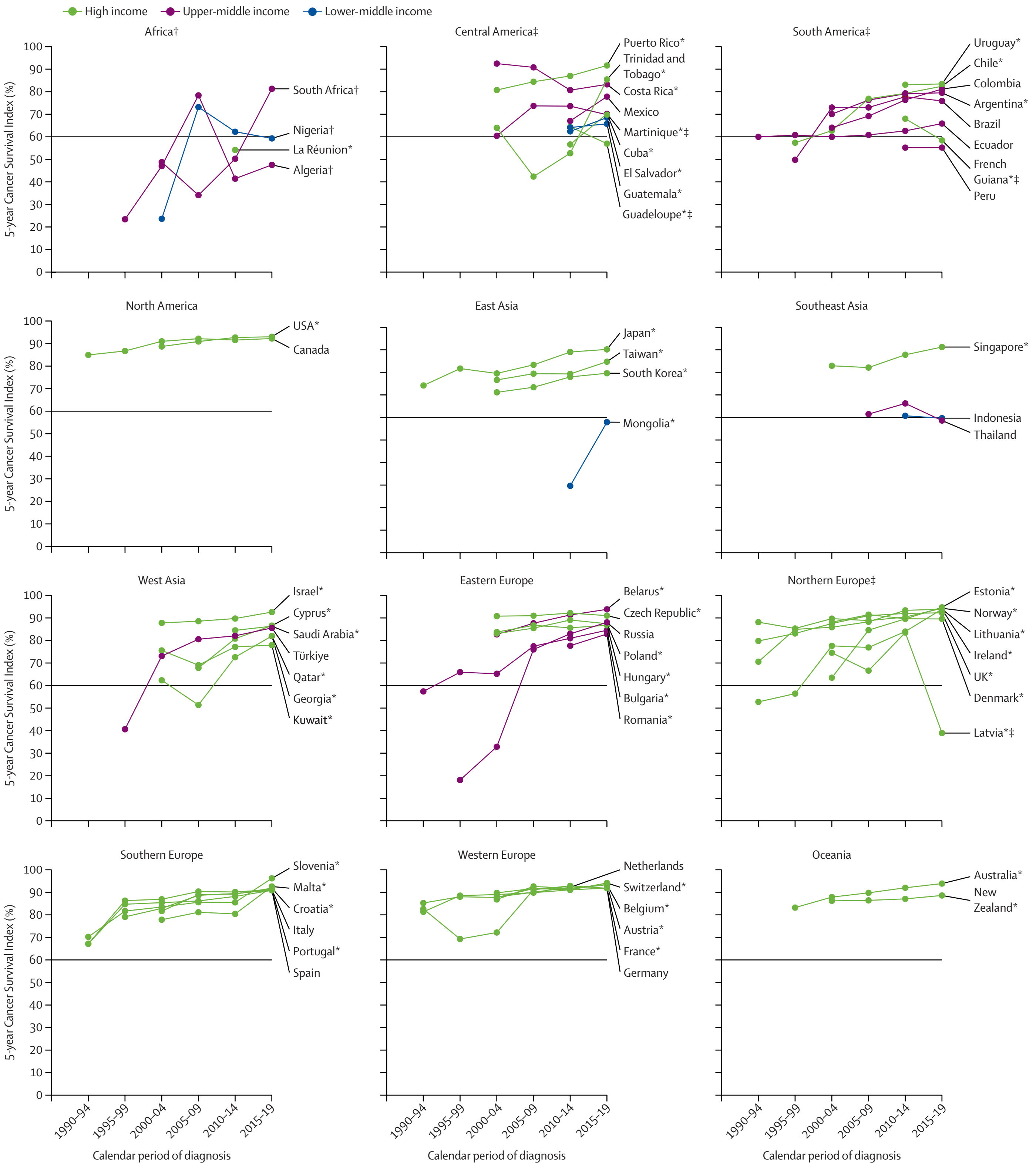


Figure 5: **5-year Cancer Survival Index for the six WHO tracer cancers combined, 2015–19, by country and World Bank national income group in 2015**
La Réunion and the Netherlands did not submit data for children diagnosed during 2015–19 (see table 4). GICC=Global Initiative for Childhood Cancer. Error bars represent 95% CIs. *Data with 100% coverage of national population; Japan from 2016. †Less reliable estimates (see text) are shown. ‡Less reliable estimate, based on small numbers of children; a confidence interval for the CSI cannot be produced. Latvia: no data on acute lymphoblastic leukaemia for 2015–19 (see table 4 and Discussion). Less reliable estimates are shown in paler colours.


High income
Upper-middle income
Lower-middle income
5-year Cancer Survival Index (%)
0
10
20
30
40
50
60
70
80
90
100
Africa†
South Africa†
Nigeria†
La Réunion*
Algeria†
Central America‡
Puerto Rico*
Trinidad and Tobago*
Costa Rica*
Mexico
Martinique*‡
Cuba*
El Salvador*
Guatemala*
Guadeloupe*‡
South America‡
Uruguay*
Chile*
Colombia
Argentina*
Brazil
Ecuador
French Guiana*‡
Peru
North America
USA*
Canada
East Asia
Japan*
Taiwan*
South Korea*
Mongolia*
Southeast Asia
Singapore*
Indonesia
Thailand
West Asia
Israel*
Cyprus*
Saudi Arabia*
Türkiye
Qatar*
Georgia*
Kuwait*
Eastern Europe
Belarus*
Czech Republic*
Russia
Poland*
Hungary*
Bulgaria*
Romania*
Northern Europe‡
Estonia*
Norway*
Lithuania*
Ireland*
UK*
Denmark*
Latvia*‡
Southern Europe
Slovenia*
Malta*
Croatia*
Italy
Portugal*
Spain
Western Europe
Netherlands
Switzerland*
Belgium*
Austria*
France*
Germany
Oceania
Australia*
New Zealand*
1990–94
1995–99
2000–04
2005–09
2010–14
2015–19
Calendar period of diagnosis

samples. This leaves a major gap in internationally comparable monitoring of progress towards the GICC target for childhood cancer.

Cancer registries have been prioritised by WHO as a strategic component of surveillance for childhood cancer control,[2] but in the past decade, at least 13 registries have been formally closed, or have ceased operation, even in HICs. Access to data for cancer research has also become a wider problem.[68–70] Discussions with administrators, civil servants, and lawyers in many registries have often taken more than a year, reducing the timeliness of the results (appendix p 4). This situation contrasts sharply with the COVID-19 pandemic during 2020–23, when national and global counts of cases and deaths could be monitored in almost real time at the European Centre for Disease Prevention and Control.

The CSI enables quantitative comparison of trends over time in childhood cancer survival between countries in all World Bank national income groups, both for all childhood cancers combined and for the six WHO tracer cancers combined. Both sets of standard weights are now available for international research on childhood cancer survival.

At present, the only attempt to evaluate progress towards the GICC target of 60% 5-year survival for all childhood cancers combined by 2030 was derived from simulation-based model estimates of net survival for 197 countries; real-world data are not available for most of these countries.[71,72] Such models require many assumptions. The estimates include all types of cancer combined in the age range 0–14 years in a single pool, despite the well known differences in survival by age, sex, and type of cancer.

By contrast, the CSI that we have developed deploys real-world data from 307 population-based cancer registries in 68 countries over the 30-year period 1990–2019. The results should contribute to the recognition of the importance of population-based registries in providing real-world evidence of progress in cancer control for children, and the need to protect and expand cancer registration as the bedrock of cancer control.[73–76] The results offer a robust, long-term baseline against which to evaluate progress towards the GICC target, in countries from which population-based data are available. This should prompt WHO and national policy makers to establish cancer registries, or strengthen existing registries, if they expect to obtain a realistic assessment of progress towards the GICC target.[71] We consider it unsuitable to base a global strategy for cancer control on modelled survival estimates for countries where no population-based data are available, or to use modelled estimates when real-world estimates are available.

Figure 6: Trends in the 5-year Cancer Survival Index for the six WHO tracer cancers combined, 1990–2019, by country, UN world region and World Bank national income group in 2015

The horizontal line indicates the WHO Global Initiative for Childhood Cancer target of 60%. *Data with 100% coverage of the national population; for Chile from 2007 and Japan from 2016. †Less reliable estimates (see text). ‡Less reliable estimate, based on small numbers of children; no variability of the net survival estimates for some combinations of age, sex, and cancer type. Latvia: no data on acute lymphoblastic leukaemia for 2015–19 (see table 4 and Discussion).

An important limitation of this study is the absence of data from LICs. Since no data were submitted by registries in LICs, we combined the populations of children in LMICs and LICs to determine the scaling factors to construct the weights. For the same reason, we could not produce any real-world survival estimates to construct the CSI for any LIC. Childhood cancers are rare, and some participating registries cover small populations: 95% CIs around the CSI can be wide. South Korea did not submit data for bone tumours or retinoblastoma, so the CSI for this country is artificially low. The CSI of 38·9% for the six WHO tracer cancers in Latvia in 2015–19 is also artificially low, because data on acute lymphoblastic leukaemia were not submitted for that period, whereas the CSI values for 2000–14 were in the range 67–84%, and the CSI values for all cancers combined were in the range 70–80% throughout 2000–19. Data for some of the tracer cancers also showed inconsistent levels of detail in the coding of morphology for leukaemia, and there is no standard definition for low-grade glioma. Survival for CNS tumours will be lower in countries or regions where benign brain tumours are under-reported, or not registrable by law, as in New South Wales, and this may reduce the CSI for all cancers combined. Similarly, the CSI for WHO tracer cancers may be underestimated in countries where a high proportion of CNS tumours are of unspecified morphology, some of which may be low-grade gliomas.[77]

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These points suggest that the CSI for the six WHO tracer cancers is a less reliable guide to measure progress than the CSI that includes all childhood cancers, which is less susceptible to international variation in diagnostic precision.

The CONCORD-4 data specification included data on race or ethnicity. Cancer registries in Australia, Israel, Malaysia, New Zealand, Singapore, the UK, and the USA do collect data on race or ethnicity, and in Kuwait, Qatar, and Saudi Arabia, the registries collect data on nationality. Most European registries do not collect data on race or ethnicity, and in some countries, it is not legal to do so. Data on deaths and population counts by race, which are required to produce race-specific life tables of background mortality, are not yet available for most of the other countries, so we cannot estimate net survival by race for individual cancers in children in those countries. As a result, we cannot yet examine global trends or international variation in the CSI as a function of race. When such data are available, we will examine variation in the CSI by race for selected countries where the relative frequency of childhood cancers by ICCC-3 group is known to vary by race.

International comparisons of cancer survival by stage at diagnosis can also be informative. The Toronto staging system for childhood cancers was promulgated in 2016.[78] Submission of data on Toronto stage in CONCORD-4 was invited as an optional variable, because we knew that very few registries had collected it systematically, and that data would only be available for most registries since around 2016. These data cannot inform interpretation of trends or global variation in the CSI. We will address this issue when we publish survival estimates for each of the ICCC-3 groups of childhood cancer.

The CSI enables international comparisons of progress towards the GICC target for 2030 of 60% 5-year survival for all childhood cancers combined, regardless of the income level of the country in which the children live. The findings in this report offer a real-world baseline for monitoring childhood cancer survival globally, in the context of the GICC, which was launched in September, 2018. The analyses are focused on children diagnosed up to December, 2019. We will examine the impact of the COVID-19 pandemic (2020–23) on childhood cancer survival in a later publication. We will also evaluate any improvements that may be attributable to implementation of the CureAll framework[2] within the GICC.

The GICC target, set in 2018, was to reach 60% 5-year survival for all childhood cancers combined, worldwide, by 2030.[1] The 5-year CSI for all cancers combined among children diagnosed during 2015–19 was more than 80% in most HICs, in the range 60–80% in most UMICs, but only 50–60% in several LMICs, the World Bank group where most of the world's children live. In most HICs, UMICs, and LMICs participating in CONCORD-4, therefore, the 5-year CSI for all childhood cancers combined was either close to or had already passed the GICC target by 2019. This suggests that the GICC target might not be sufficiently ambitious. By contrast, we have been unable to assess progress towards the target in LICs, where efforts should focus on establishing or improving population-based cancer registries to allow monitoring of any progress.

The 5-year CSI for all childhood cancers combined is correlated with the mean annual GDP, but there is no consistent pattern in HICs when the GDP exceeds $30 000 per capita. Among HICs in which annual health expenditure exceeds 10% of GDP, the range of 5-year CSI values for 2015–19 is relatively small. This suggests that efficiency of resource allocation is a key component for improving cancer outcomes.

The CSI, as a simple, one-number summary of trends and international differences in survival from all childhood cancers combined, to monitor progress in survival towards the GICC target, is likely to generate interest among both policy makers and the general public.

The CSI that includes all childhood cancers (based on all 12 major ICCC-3 groups) will be more appropriate for monitoring progress towards the GICC target than the CSI based solely on the six WHO tracer cancers. This is especially relevant when the main interest is to improve survival in LMICs, where diagnostic procedures may not be sufficient to achieve a specific diagnosis for acute lymphoblastic leukaemia or low-grade glioma, which together comprise about 70% of all WHO tracer cancers.

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Contributors

CA and MPC drafted the CONCORD-4 protocol and data specification, and acquired the funding. MPC, CA, VDC, and FKB obtained and maintained statutory and ethical approvals. FKB, CEV, CA, MPC, and VDC prepared the life tables. CA, VDC, NS, FKB, CEV, KD, MKS, and MPC had access to all the raw data. VDC, CA, NS, FKB, MKS, CEV, KD, and MPC did the data preparation, quality control, and analyses. CA, VDC, NS, FKB, and MPC checked the results. CA and MPC drafted the report. All authors contributed to writing the final report and approved the version to be published. All members of the CONCORD Working Group had access to the results of all steps of data preparation, quality control, and analyses, and contributed to interpretation of the findings. The corresponding author had full access to all the raw data and took responsibility for the submission of the manuscript for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The anonymised data we received for this study from more than 300 population-based cancer registries in 68 countries are sensitive personal data relating to individuals, many of them still alive. We cannot share the raw data, which we hold in trust from each registry. Our contracts with participating registries do not allow sharing of the raw data with any external repository or data processor.

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