



Survival of European adolescents and young adults diagnosed with cancer in 2010–2014

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ABSTRACT

Background: We used the comprehensive definition of AYA (age 15 to 39 years) to update 5-year relative survival (RS) estimates for AYAs in Europe and across countries and to evaluate improvements in survival over time.

Methods: We used data from EUROCARE-6. We analysed 700,000 AYAs with cancer diagnosed in 2000–2013 (follow-up to 2014). We focused the analyses on the 12 most common cancers in AYA. We used period analysis to estimate 5-year RS in Europe and 5-year RS differences in 29 countries (2010–2014 period estimate) and over time (2004–06 vs. 2010–14 period estimates).

Findings: 5-year RS for all AYA tumours was 84%, ranging from 70% to 90% for most of the 12 tumours analysed. The exceptions were acute lymphoblastic leukaemia, acute myeloid leukaemia, and central nervous system tumours, presenting survival of 59%, 61%, and 62%, respectively. Differences in survival were observed among European countries for all cancers, except thyroid cancers and ovarian germ-cell tumours. Survival improved over time for most cancers in the 15- to 39-year-old age group, but for fewer cancers in adolescents and 20- to 29-year-olds.

Interpretation: This is the most comprehensive study to report the survival of 12 cancers in AYAs in 29 European countries. We showed variability in survival among countries most likely due to differences in stage at diagnosis, access to treatment, and lack of referral to expert centres. Survival has improved especially for haematological cancers. Further efforts are needed to improve survival for other cancers as well, especially in adolescents.

1. Introduction

1.1. Background and rationale

In Europe, 112,000 people develop cancer between ages 15 and 39, corresponding to 5% of all new cancer diagnoses [1]. Although rare, cancer is the fourth leading cause of death in adolescents and young adults (AYAs) globally [2].

EUROCARE data on AYAs showed a 5-year relative survival (RS) of 79% in 1999–2002 for all cancers combined, improving significantly to 82% in 2005–07 [3]. However, the cancer types occurring in this age group have a unique distribution and survival varies by cancer type.

To ensure the best results, young people who develop malignant tumours should be referred to specialised centres. European cooperative studies have helped highlight the lack of equitable access to oncology services that provide expert cancer care [4]. However, initiatives to develop national policies for AYAs with cancer have been implemented in different forms and to different extents across Europe [4]. The last comparison of cancer survival among AYAs (aged 15–24 years) across European countries dates back to 1995 [5].

1.2. Objectives

To provide updated population-based analyses of 5-year RS for AYAs with cancer in Europe, across 29 European countries and present 5-year RS over time.

We have used the all-inclusive definition of the AYA age range,

namely 15 to 39 years. To avoid masking the heterogeneity typical of AYA cancers, we also present results by sex and AYA age group for 12 major cancers typically occurring in AYAs.

2. Methods

We used the EUROCARE-6 adult database which includes data from 108 population-based cancer registries (CRs) from 29 countries. Registries provided information on the site and morphology of each diagnosed cancer, which were coded according to the International Classification of Disease for Oncology, Third Edition, first update (ICD-O-3.1). We included only malignant cancers. If two or more cancers were diagnosed in a patient within the study period, we included all of them. We excluded from the analyses cases ascertained solely through a death certificate or autopsy report, those alive at diagnosis with unknown survival time, and those with invalid data items.

The most common cancers in AYAs were grouped into 12 diagnostic categories adapted from Barr (Supplementary Material, Table S1) [6].

2.1. Overall survival

We calculated 5-year RS in the follow-up period 2010–2014 using the period approach based on cases diagnosed in 2006–2013, who were followed up for vital status to December 31, 2014 [7]. We estimated RS, the ratio of observed to expected survival in the general population of the same age, sex, and calendar year and calculate 95% confidence intervals (CIs). We estimated expected survival using the Ederer II method

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[8]. When comparing RS estimates, we considered differences to be significant if CIs did not overlap.

To provide valid estimates of European survival we applied population weightings to region-specific RS estimates to correct for differing numbers of AYAs in the five different regions of Europe (northern [Denmark, Finland, Iceland, and Norway], central [Austria, Belgium, France, Germany, Netherlands, and Switzerland], southern [Croatia, Cyprus, Italy, Malta, Portugal, Slovenia, and Spain], eastern [Bulgaria, Czechia, Estonia, Latvia, Lithuania, Poland, and Slovakia], and the UK and Ireland [England, Ireland, Northern Ireland, Scotland, and Wales]). The weightings applied to RS estimates for each European region consisted of the ratio of the population in the region to that of the European population as a whole.

5-year RS by sex was age standardised. Weightings for 15–19-, 20–29-, and 30–39-year-olds were based on the distribution of incident cases in the three age groups in the EUROCARE-6 database, corresponding to 6%, 27%, and 67%, respectively.

We used a funnel plot to identify relevant survival differences across European countries and the EUROCARE-6 pool as a proxy for Europe. We considered a difference to be relevant if it fell outside the ± 2 standard error band.

To identify differences in survival among countries, possibly due to differences in stage distribution at diagnosis, we calculated 5-year RS conditional to surviving one year as the ratio of 5-year to 1-year RS, for each AYA cancer across countries.

2.2. Survival time trends

We analysed survival trends from 2004 to 2014 using the period approach [9]. We defined two follow-up periods, namely 2010–2014 (cohort diagnosed in 2006–2013) and 2004–2006 (cohort diagnosed in 2000–2006). We presented changes over time in RS for AYA cancers using funnel plots for AYAs as a whole and by age groups (15–19, 20–29, 30–39 years-of-age). In both periods, 5-year RS was age standardised, using cancer-specific weights.

3. Results

Only 1% of cancers in AYAs were excluded. Most cancers (97%) were verified microscopically (Table 1). Morphology was unspecified in 4% of cancers eligible for analysis. Only 3% of cancers diagnosed in 2005–2008 were lost to follow-up (Table 1).

Table 2 shows 5-year RS for all cancers combined and for the 12 most frequently diagnosed tumours in AYAs. Five-year RS for all cancers combined was 84%. Haemopoietic malignancies were the most common cancers in the 15–19 and 20–29-year age groups. At all AYA ages, survival was 95% for Hodgkin lymphomas (HLs), 84% for Non-Hodgkin lymphomas (NHLs), 93% for Chronic myeloid leukaemia (CML), and 59% for Acute myeloid leukaemia (AML). Acute lymphoblastic leukaemia (ALL) survival was 61% overall but was higher in adolescents (73%) than in older adults (about 50%). Germ cell tumor (GCT) and skin melanoma were the second and third most common cancers in 15–19 and 19–29-year-olds; both had 5-year RS greater than 90% in all age groups. For all AYA ages, 5-year RS was 64% for osteosarcoma, 52% for Ewing family tumours, and 86% for chondrosarcoma. Among soft tissue sarcomas (STSs) for AYAs of all ages, good 5-year RS was observed for liposarcomas, leiomyosarcoma, synovial sarcoma, and fibromatous tumours, proving lowest for rhabdomyosarcomas.

Among the Central nervous system (CNS) tumours, survival from astrocytoma not otherwise specified (NOS) differed between adolescents (83% and 30–39-year-olds (68%). Anaplastic astrocytoma was very low in adolescents, increasing in young adults but with no major differences in survival between age groups. For all AYA ages, survival was highest from ependymoma and lowest from glioblastoma. Carcinomas were rarely diagnosed in adolescents, but occurrence increased with advancing age. In adolescents, thyroid carcinoma was the most

common carcinoma (5-year RS, 99%). In young adults, female genital tract and breast carcinomas were the most common malignancies, with 5-year RS of around 85% in all age groups. Other relatively common carcinomas in young adults were thyroid and colorectal carcinomas, showing excellent and intermediate 5-year RS (99% and 66%, respectively).

Table 3 shows 5-year RS by sex in AYAs and by AYA age groups. Survival was better for females than males for leukaemias, AML, lymphomas, NHLs, CNS tumours, STS, bone sarcomas, and skin melanoma. Differences were not observed in adolescents, with the exception of lymphomas, but increased from age 20–29 years onwards.

Table 4 shows 5-year RS by countries. Differences in survival were observed among European countries for all AYA cancers, except thyroid cancers and ovarian GCT. Testicular GCT, breast cancer, and HL were the cancers with the lowest intercountry differences in survival (ie, the difference between the countries with the best and worst survival): 12%, 13%, 15%, respectively. AML and bone sarcomas were the cancers with the highest intercountry difference in survival: 58% and 42%, respectively. For all the other cancers, the survival gap ranged from 20% to 40%.

Belgium, Germany, Norway, Denmark, and the Netherlands most often displayed survival above the European average (Table 4; Supplementary Material, Fig. S1). Poland and Bulgaria had lower survival than the EU average for most AYA cancers. We observed no differences from the European average for the remaining countries for most AYA cancers.

We observed lower conditional survival differences compared to differences in 5-year RS among countries for AML, NHL, CNS, and colorectal cancers but not for ALL, STS, bone sarcomas, and cervical cancers (Supplementary Material, Table S2).

Survival rose from 2004–2006 to 2010–2014 for all AYA cancers except STS and thyroid tumours (Fig. 1a). In adolescents (Fig. 1b), there was no evidence of improvement in survival for AML, NHL, CNS tumours, bone sarcoma, ovarian GCT, skin melanoma, and cancers of the thyroid, colon, rectum, breast, and cervix. STS survival increased only in adolescents. In 20–29-year-olds (Fig. 1c), survival did not increase for bone sarcomas, STS, GCT of the ovary, and colorectal and thyroid cancers. In the older age group (Fig. 1d), STS and thyroid cancers were the only ones in which survival failed to improve. Detailed time trend survival data are shown in Supplementary Material, Table S3.

4. Discussion

Our two key findings were that AYAs have good 5-year RS (from 70% to 90%) for most cancers, with a slightly lower survival for AML, ALL, and CNS tumours, and that survival has improved over time for most cancers in the 15- to 39-year-old age group, but for fewer cancers in adolescents and 20- to 29-year-olds. Another important finding of our study was that differences in survival remained among European countries.

The observed survival for AML is in line with other studies [10]. Neither paediatric nor adult protocols are ideal for AYAs and the development of AYA-specific approaches is recommended [11]. We observed an increase in 5-year RS for AML, which reached the survival of ALL (nearly 60%). ALL survival is approximately 60%.

The application of paediatric protocols has improved ALL outcomes, but most AYA patients were still treated with an adult regimen [12]. We observed higher survival for ALL in adolescents compared to the older age groups, which likely reflects the increasing use of paediatric treatment protocols in adolescents.

The histological heterogeneity and low incidence of CNS tumours makes their management challenging in AYAs. We observed that adolescents have a higher proportion of embryonal tumours and a lower proportion of high-grade gliomas compared to young adults, which helps explain why survival from CNS tumours is higher in adolescents than in 30–39-year-olds. However, despite recent significant advances in neuro-oncology, CNS tumours among AYAs continued to contribute

Table 1
Cancer cases in adolescents and young adults (aged 15–39 years) diagnosed in 2000–13, in 29 European countries, with data quality indicators.

| Country | Percentage population covered by cancer registration (%) | Eligible cases diagnosed in 2000–13 | Invalid cases excluded from survival analysis | | | | Quality indicators | | | |
|--------------------------------|----------------------------------------------------------|-------------------------------------|-----------------------------------------------|------------------------|----------------------------------|------------------------------------------------------------------|-----------------------------------|--------------------------|-------------------------------------------------|------------------------------|
| | | | Major errors | Death certificate only | Incidentally detected at autopsy | Alive cases at diagnosis with unknown survival time [#] | Valid cases for survival analysis | Microscopic confirmation | Morphology not otherwise specified [§] | 2005–2008 Lost to follow-up* |
| AT_Austria National | 100% | 21 497 | 0 (0%) | 200 (0.9%) | 0 (0%) | 0 (0%) | 21 297 | 20 784 (97.6%) | 621 (2.9%) | 0/5382 (0%) |
| BE_Belgium National | 100% | 25 154 | 0 (0%) | 0 (0%) | 4 (0%) | 330 (1.3%) | 24 820 | 24 698 (99.5%) | 228 (0.9%) | 136/7789 (0%) |
| BG_Bulgaria National | 100% | 19 375 | 43 (0.2%) | 627 (3.2%) | 0 (0%) | 0 (0%) | 18 705 | 18 039 (96.4%) | 864 (4.6%) | 0/3435 (0%) |
| CR_Croatia National | 100% | 11 859 | 0 (0%) | 72 (0.6%) | 0 (0%) | 69 (0.6%) | 11 718 | 10 012 (85.4%) | 2029 (17.3%) | 0/2157 (0%) |
| CY_Cyprus National | 100% | 2099 | 0 (0%) | 12 (0.6%) | 0 (0%) | 0 (0%) | 2087 | 2071 (99.2%) | 20 (1%) | 0/637 (0%) |
| CZ_Czech Republic National | 100% | 29 773 | 4 (0%) | 79 (0.3%) | 191 (0.6%) | 141 (0.5%) | 29 361 | 28 616 (97.5%) | 1065 (3.6%) | 0/6666 (0%) |
| DK_Denmark National | 100% | 17 540 | 7 (0%) | 0 (0%) | 7 (0%) | 2 (0%) | 17 529 | 17 171 (98%) | 616 (3.5%) | 50/4091 (1.2%) |
| EE_Estonia National | 100% | 2973 | 0 (0%) | 8 (0.3%) | 23 (0.8%) | 1 (0%) | 2941 | 2871 (97.6%) | 90 (3.1%) | 11/636 (0%) |
| FI_Finland National | 100% | 12 467 | 86 (0.7%) | 2 (0%) | 44 (0.4%) | 0 (0%) | 12 378 | 12 296 (99.3%) | 222 (1.8%) | 0/2672 (0%) |
| FR_France (CRs Pool) | 29% | 34 079 | 0 (0%) | 0 (0%) | 0 (0%) | 196 (0.6%) | 33 883 | 33 663 (99.4%) | 260 (0.8%) | 85/7295 (0%) |
| GE_Germany (CRs Pool) | 35% | 57 383 | 39 (0.1%) | 632 (1.1%) | 19 (0%) | 232 (0.4%) | 56 493 | 53 963 (95.5%) | 747 (1.3%) | 217/13 575 (0%) |
| IC_Iceland National | 100% | 1015 | 0 (0%) | 0 (0%) | 4 (0.4%) | 0 (0%) | 1011 | 1006 (99.5%) | 7 (0.7%) | 0/220 (0%) |
| IR_Ireland National | 100% | 12 317 | 0 (0%) | 8 (0.1%) | 8 (0.1%) | 0 (0%) | 12 301 | 12 105 (98.4%) | 304 (2.5%) | 0/3097 (0%) |
| IT_Italy (CRs Pool) | 49% | 71 571 | 1 (0%) | 68 (0.1%) | 13 (0%) | 221 (0.3%) | 71 269 | 67 775 (95.1%) | 4365 (6.1%) | 702/20 720 (0%) |
| LT_Lithuania National | 100% | 7981 | 0 (0%) | 108 (1.4%) | 6 (0.1%) | 19 (0.2%) | 7848 | 7488 (95.4%) | 572 (7.3%) | 59/1696 (0%) |
| LV_Latvia National | 100% | 5026 | 6 (0.1%) | 142 (2.8%) | 36 (0.7%) | 0 (0%) | 4877 | 4582 (94%) | 565 (11.6%) | 0/826 (0%) |
| ML_Malta National | 100% | 1047 | 4 (0.4%) | 2 (0.2%) | 2 (0.2%) | 0 (0%) | 1042 | 1015 (97.4%) | 23 (2.2%) | 0/226 (0%) |
| NL_The Netherlands National | 100% | 50 942 | 3 (0%) | 0 (0%) | 31 (0.1%) | 0 (0%) | 50 910 | 49 043 (99.3%) | 367 (0.7%) | 0/11 249 (0%) |
| NO_Norway National | 100% | 15 101 | 237 (1.6%) | 7 (0%) | 13 (0.1%) | 0 (0%) | 14 847 | 14 713 (99.1%) | 153 (1%) | 0/3324 (0%) |
| PL_Poland National | 100% | 75 863 | 22 (0%) | 332 (0.4%) | 27 (0%) | 486 (0.6%) | 75 018 | 69 438 (92.6%) | 9012 (12%) | 0/16 650 (0%) |
| PT_Portugal (CRs Pool) | 98% | 23 188 | 91 (0.4%) | 6 (0%) | 0 (0%) | 69 (0.3%) | 23 023 | 22 575 (98.1%) | 841 (3.7%) | 56/5904 (0%) |
| SK_Slovakia National | 100% | 11 671 | 2 (0%) | 194 (1.7%) | 38 (0.3%) | 0 (0%) | 11 477 | 11 280 (98.3%) | 281 (2.4%) | 0/3153 (0%) |
| SL_Slovenia National | 100% | 5741 | 0 (0%) | 0 (0%) | 11 (0.2%) | 0 (0%) | 5730 | 5707 (99.6%) | 45 (0.8%) | 0/1436 (0%) |
| SP_Spain (CRs Pool) | 21% | 24 449 | 127 (0.5%) | 71 (0.3%) | 11 (0%) | 11 (0%) | 24 230 | 23 915 (98.7%) | 439 (1.8%) | 45/6482 (0%) |
| SW_Switzerland (CRs Pool) | 24% | 5419 | 33 (0.6%) | 0 (0%) | 1 (0%) | 18 (0.3%) | 5367 | 5342 (99.5%) | 38 (0.7%) | 131/1342 (0.1%) |
| UK_England National | 100% | 129 944 | 187 (0.1%) | 409 (0.3%) | 0 (0%) | 0 (0%) | 129 383 | 12 5100 (96.7%) | 3078 (2.4%) | 0/28 624 (0%) |
| UK_Northern Ireland National | 100% | 5190 | 0 (0%) | 9 (0.2%) | 2 (0%) | 0 (0%) | 5179 | 4873 (94.1%) | 249 (4.8%) | 0/1240 (0%) |
| UK_Scotland National | 100% | 14 850 | 1 (0%) | 11 (0.1%) | 12 (0.1%) | 1 (0%) | 14 826 | 14 621 (98.6%) | 185 (1.2%) | 15/3252 (0%) |
| UK_Wales National | 100% | 7201 | 1 (0%) | 24 (0.3%) | 0 (0%) | 0 (0%) | 7177 | 6301 (87.8%) | 366 (5.1%) | 0/1701 (0%) |
| European Pool (108 CRs) | 58% | 702 715 | 2417 (0%) | 3023 (0.4%) | 503 (0.1%) | 1796 (0.3%) | 696 727 | 67 1063 (96.3%) | 27 652 (3.9%) | 4949/170 799 (0%) |

For "Invalid case excluded from survival analysis", the denominator for the percentages is the number of eligible cases diagnosed in 2000–2013. For data quality indicators, the denominator for the percentages is the number of valid cases for survival analysis, unless specified otherwise. [#]Patient alive at diagnosis but with no information on follow-up time. [§]Morphology not otherwise specified (NOS) are: Unspecified leukaemias and related disorders (Morphologies=9800-9801,9805,9820,9860,9930, all sites), Unspecified lymphomas (Morphologies=9590,9596, all sites), Unspecified soft tissue sarcomas (Morphologies=8800-8802,8805, in all sites except C40.0-C41.9), Unspecified bone sarcomas (Morphologies=8000-8005,8800-8801,8805, in C40.0-C41.9), NOS morphologies of the Central Nervous system (Morphologies=8000-8005 in C700-C729,C751-C753) and NOS morphologies of all the all sites, except CNS (Morphologies=8000-8005, in C00-C399,C420-C699,C730-C750,C754-C809). *Proportion of patients diagnosed during 2005–2008, censored before Dec 31, 2013, with less than 5 years of follow-up; the proportion is calculated for cases diagnosed in 2005–07 in Croatia and Germany, where the follow-up closing date was Dec 31, 2012. In France, Germany, Italy, Portugal, Spain, and Switzerland registries are local rather than national and were pooled together; in Portugal the three registries participating in EURO-CARE-6 cover the whole country (excluding the Azores), which is not the case in Spain and Italy.

Table 2

Five-year relative survival (RS) estimates for the most common cancers affecting European adolescents and young adults (aged 15–39 years) in 2010–2014, reported with number of cases (N) and 95% confidence intervals (95%CI).

| | 15-39 years | | | 15-19 years | | | 20-29 years | | | 30-39 years | | |
|--------------------------------------------------------------------------------|-------------|-----------------------|------|-------------|--------------------------|------|-------------|--------------------------|-------|-------------|--------------------------|-------|
| | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE |
| Leukaemias and related disorders | 9971 | 73.5% (72.5% - 74.4%) | 0.5% | 1678 | 71.8% (69.2–74.2%) | 1.2% | 3158 | 71.0% (69.2–72.8%) | 0.9% | 5136 | 75.4% (74.1–76.6%) | 0.6% |
| -Acute lymphoblastic leukaemia | 2311 | 60.9% (58.6–63.2%) | 1.1% | 872 | 73.2% (69.7–76.4%) | 1.7% | 817 | 55.1% (51.0–58.9%) | 2.0% | 641 | 52.0% (47.6–56.2%) | 2.1% |
| -Acute myeloid leukaemia | 3323 | 59.3% (57.4–61.2%) | 0.9% | 470 | 61.1% (55.6–66.2%) | 2.7% | 1154 | 61.6% (58.2–64.7%) | 1.6% | 1700 | 57.4% (54.7–60.0%) | 1.3% |
| -Chronic myeloid leukaemia | 1451 | 93.1% (91.4–94.5%) | 0.8% | 108 | 89.0% (79.6–94.2%) | 3.5% | 454 | 93.9% (90.6–96.1%) | 1.3% | 893 | 92.9% (90.7–94.6%) | 1.0% |
| Lymphomas | 25 071 | 89.8% (89.4–90.2%) | 0.2% | 3357 | 92.1% (91.0–93.1%) | 0.5% | 9 654 | 91.1% (90.4–91.7%) | 0.3% | 12 061 | 88.1% (87.4–88.8%) | 0.3% |
| -Non-Hodgkin lymphomas | 9907 | 84.0% (83.2–84.8%) | 0.4% | 875 | 83.6% (80.6–86.2%) | 1.4% | 3 037 | 83.2% (81.6–84.6%) | 0.7% | 6018 | 84.4% (83.4–85.4%) | 0.5% |
| - Lymphoblastic | 343 | 60.8% (55.0–66.1%) | 2.8% | 92 | 68.3% (56.6–77.4%) | 5.2% | 143 | 56.7% (47.7–64.7%) | 4.3% | 112 | 59.7% (48.5–69.2%) | 5.2% |
| - Burkitt | 622 | 75.0% (70.8–78.6%) | 2.0% | 127 | 75.0% (64.0–83.0%) | 4.7% | 214 | 79.5% (72.4–84.9%) | 3.1% | 286 | 70.8% (64.2–76.4%) | 3.0% |
| - Diffuse large B-cell (DLBCL) | 3418 | 82.1% (80.6–83.5%) | 0.7% | 257 | 88.1% (83–91.7%) | 2.1% | 1123 | 83.2% (80.5–85.5%) | 1.3% | 2 049 | 81.1% (79.1–83.0%) | 1.0% |
| - Primary mediastinal large B-cell excluded from DLBCL | 421 | 90.4% (85.7–93.6%) | 1.9% | 49 | 91.7%* (79.3%* –96.8%*) | 4% | 174 | 87.5% (77.9–93.1%) | 3.6% | 196 | 91.8% (87.0–94.9%) | 1.9% |
| - Anaplastic T- and null-cell, excluding NK/T-cell | 375 | 81.9% (76.6–86.0%) | 2.3% | 70 | 81.0% (66.8–89.6%) | 5.6% | 149 | 84.0% (75.5–89.8%) | 3.5% | 159 | 78.8% (70.5–85.0%) | 3.6% |
| - Follicular | 1543 | 94.6% (93.2–95.8%) | 0.6% | 46 | 95.4% (85.2–98.6%) | 2.7% | 296 | 93.1% (88.5–95.9%) | 1.8% | 1212 | 94.9% (93.2–96.2%) | 0.7% |
| - NK/T-cell (excluded from anaplastic T-cell) | 515 | 58.1% (52.8–63.0%) | 2.6% | 46 | 67.4%* (50.8%* - 79.5%*) | 7.3% | 166 | 61.8% (52.1–70.2%) | 4.5% | 304 | 55.0% (48.2–61.4%) | 3.3% |
| - MALT (mucosa-associated lymphoid tissue) | 659 | 95.1% (93.0–96.6%) | 0.9% | 30 | 100% (100–100%) | 0.0% | 176 | 96.8% (93.1–98.5%) | 1.2% | 450 | 93.8% (91.0–95.8%) | 1.2% |
| - Other non-Hodgkin lymphoma NOS | 1548 | 85.3% (83.0–87.3%) | 1.1% | 127 | 84.6%* (76.6%* - 90.0%*) | 3.4% | 484 | 87.6% (83.6–90.7%) | 1.8% | 943 | 84.1% (81.0–86.8%) | 1.5% |
| -Hodgkin lymphoma | 13 604 | 95.0% (94.6–95.3%) | 0.2% | 2379 | 95.5% (94.5–96.3%) | 0.4% | 6256 | 95.3% (94.7–95.8%) | 0.3% | 4970 | 94.2% (93.5–94.9%) | 0.4% |
| Central nervous system and other intracranial and intraspinal neoplasms | 9722 | 61.6% (60.5–62.8%) | 0.6% | 1004 | 64.3% (60.6–67.8%) | 1.8% | 3271 | 66.0% (64.0–67.9%) | 1.0% | 5448 | 58.5% (57.0–60.0%) | 0.8% |
| -Oligodendroglioma | 1180 | 77.5% (74.7–80.0%) | 1.3% | 63 | 65.1% (51.1–76.0%) | 6.3% | 377 | 77.9% (72.8–82.3%) | 2.4% | 744 | 78.6% (75.1–81.7%) | 1.6% |
| - Oligodendroglioma, low grade/ NOS | 837 | 84.8% (82.0–87.3%) | 1.3% | 42 | 82.5% (67.2–91.1%) | 5.7% | 272 | 84.7% (79.2–88.8%) | 2.4% | 525 | 85.0% (81.3–88.0%) | 1.7% |
| - Oligodendroglioma, anaplastic | 348 | 59.2% (53.0–64.8%) | 3.0% | 22 | 29.4%* (12.3%* - 49.0%) | 9.9% | 106 | 57.2% (44.4–68.1%) | 6.0% | 222 | 62.9% (55.3–69.6%) | 3.6% |
| -Ependymoma | 657 | 88.1% (85.0–90.5%) | 1.4% | 96 | 86.7% (77.3–92.4%) | 3.6% | 227 | 87.7% (81.5–91.9%) | 2.5% | 333 | 88.6% (84.3–91.9%) | 1.9% |
| -Medulloblastoma | 372 | 72.6% (67.5–77.1%) | 2.4% | 107 | 70.8% (59.8–79.3%) | 4.9% | 162 | 72.1% (64.0–78.7%) | 3.7% | 106 | 74.2% (64.7–81.4%) | 4.2% |
| -Astrocytoma, low grade/NOS | 1415 | 74.0% (71.2–76.6%) | 1.3% | 137 | 82.8% (73.1–89.3%) | 4.0% | 508 | 81.8% (77.3–85.5%) | 2.0% | 775 | 68.1% (64.2–71.7%) | 1.9% |
| -Astrocytoma, anaplastic | 885 | 49.1% (45.0–53.1%) | 2.0% | 57 | 37.0%* (24.5%* –49.6%*) | 6.5% | 329 | 52.1% (45.2–58.5%) | 3.3% | 507 | 49.6% (44.1–54.8%) | 2.7% |
| -Glioblastoma | 1748 | 22.2% (19.9–24.5%) | 1.2% | 128 | 23.5% (14.7–33.5%) | 4.8% | 465 | 27.9% (22.6–33.4%) | 2.7% | 1167 | 20.4% (17.7–23.1%) | 1.4% |
| Bone sarcomas | 2860 | 69.6% (67.6–71.5%) | 1.0% | 910 | 65.2% (61.6–68.6%) | 1.7% | 1028 | 68.5% (65.1–71.7%) | 1.6% | 935 | 74.9% (71.6–78.0%) | 1.6% |
| -Osteosarcoma | 995 | 64.7% (61.2–67.9%) | 1.7% | 452 | 67.0% (61.8–71.6%) | 2.4% | 319 | 62.0% (55.6–67.7%) | 3.0% | 228 | 64.9% (57.6–71.3%) | 3.4% |
| -Chondrosarcoma | 694 | 85.8% (82.3–88.7%) | 1.6% | 69 | 84.0% (72.4–91.0%) | 4.5% | 233 | 91.1% (86.2–94.3%) | 2.0% | 396 | 84.1% (79.3–87.9%) | 2.1% |
| -Ewing family of tumours of bone | 718 | 51.9% (47.6–56.0%) | 2.1% | 310 | 54.0% (47.7–60.0%) | 3.1% | 293 | 49.1% (42.2–55.6%) | 3.3% | 122 | 51.8% (40.9–61.6%) | 5.2% |
| Soft tissue sarcomas (excluding skin sarcomas) | 4710 | 69.0% (67.5–70.5%) | 0.7% | 653 | 67.0% (62.8–70.9%) | 2.0% | 1471 | 65.2% (62.3–68.0%) | 1.4% | 2599 | 71.5% (69.4–73.4%) | 1.0% |
| -Liposarcoma | 743 | 86.5% (83.6–89.0%) | 1.4% | 37 | 100%* (100%* - 100%*) | 0.0% | 163 | 89.0% (81.5–93.5%) | 2.9% | 542 | 84.8% (81.2–87.8%) | 1.6% |
| -Leiomyosarcoma | 585 | 74.7% (70.1–78.6%) | 2.1% | 27 | 91.7%* (70.0%* - 97.9%*) | 5.7% | 124 | 80.3% (69.4–87.6%) | 4.5% | 435 | 70.9% (65.3–75.8%) | 2.6% |
| -Synovial sarcoma | 586 | 64.9% (60.4–69.0%) | 2.1% | 104 | 72.1% (61–80.6%) | 4.9% | 223 | 67.2% (59.8–73.6%) | 3.4% | 260 | 59.9% (53.1–66.1%) | 3.3% |
| -Fibromatous neoplasms | 577 | 85.4% (81.7–88.5%) | 1.7% | 50 | 87.2% (77–93.1%) | 3.9% | 199 | 87.6% (81.6–91.7%) | 2.5% | 332 | 83.4% (77.7–87.7%) | 2.5% |
| -Rhabdomyosarcoma | 408 | 41.7% (36.2–47.1%) | 2.7% | 183 | 46.6% (38.3–54.5%) | 4.1% | 138 | 35.5% (26.7–44.5%) | 4.5% | 97 | 37.1%* (27.0%* –47.2%*) | 5.2% |
| - Paediatric rhabdomyosarcoma | 239 | 37.5% (30.9–44.2%) | 3.3% | 127 | 42.1% (32.6–51.2%) | 4.7% | 80 | 33.2% (22.5–44.2%) | 5.5% | 39 | 29.7%* (15.8%* - 45.0%*) | 7.7% |
| - Embryonal rhabdomyosarcoma, NOS | 101 | 54.8% (43.7–64.6%) | 5.3% | 52 | 60.6% (43.9–73.7%) | 7.5% | 35 | 55.5%* (36.9%* - 70.7%*) | 5.1% | 17 | 36.9%* (15.1%* –59.1%*) | 12.0% |
| - Alveolar rhabdomyosarcoma | 138 | 20.3% (13.2–28.6%) | 3.9% | 75 | 23.4%* (14.1%* - 34.1%*) | 5.2% | 45 | 14.7% (6.0–27.0%) | 5.4% | 22 | 22.0%* (7.0%* - 42.1%*) | 9.5% |
| - Rhabdomyosarcoma, NOS | 132 | 45.5% (33.2–57.0%) | 6.0% | 46 | 47.7% (29.9–63.5%) | 8.6% | 45 | 47.1% (24.9–66.5%) | 10.9% | 41 | 37.6%* (20.3%* - 54.9%*) | 9.2% |
| Germ cell and trophoblastic of testis | 24 184 | 96.9% (96.6–97.2%) | 0.1% | 1157 | 97.0% (95.7–98.0%) | 0.5% | 10 197 | 96.6% (96.1–97.0%) | 0.2% | 12 844 | 97.1% (96.7–97.5%) | 0.2% |

(continued on next page)

Table 2 (continued)

| | 15-39 years | | | 15-19 years | | | 20-29 years | | | 30-39 years | | |
|----------------------------------------------------|----------------|---------------------------|-------------|---------------|---------------------------|-------------|---------------|---------------------------|-------------|----------------|---------------------------|-------------|
| | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE |
| Germ cell and trophoblastic of ovary | 861 | 95.5% (93.4–96.9%) | 0.9% | 213 | 96.3% (91.8–98.4%) | 1.5% | 420 | 96.2% (93.6–97.8%) | 1.0% | 236 | 92.8% (86.8–96.1%) | 2.2% |
| Melanoma - malignant | 25 402 | 92.9% (92.5–93.2%) | 0.2% | 801 | 94.6% (92.5–96.1%) | 0.9% | 7448 | 94.0% (93.3–94.7%) | 0.3% | 17 160 | 92.3% (91.8–92.7%) | 0.2% |
| Thyroid carcinoma | 19 290 | 99.5% (99.4–99.6%) | 0.1% | 1 024 | 99.5% (98.6–99.8%) | 0.3% | 5927 | 99.7% (99.4–99.8%) | 0.1% | 12 326 | 99.4% (99.2–99.6%) | 0.1% |
| Carcinoma of colon and rectum (excluding appendix) | 7872 | 65.9% (64.7–67.1%) | 0.6% | 85 | 54.1% (41.9–64.8%) | 5.8% | 1409 | 64.4% (61.3–67.3%) | 1.5% | 6385 | 66.4% (65.1–67.7%) | 0.6% |
| Carcinoma of breast | 34 002 | 86.4% (86.0–86.8%) | 0.2% | 29 | 88.4% (71.3–95.6%) | 5.5% | 3402 | 84.1% (82.7–85.4%) | 0.7% | 30 637 | 86.7% (86.3–87.1%) | 0.2% |
| Carcinoma of uterine cervix | 14 091 | 85.9% (85.1–86.6%) | 0.4% | 18 | 86.3%* (54.6%* - 96.5%) | 9.2% | 3254 | 88.3% (86.4–89.9%) | 0.9% | 10 912 | 85.2% (84.4–86.0%) | 0.4% |
| All cancers | 212 135 | 84.1% (83.9–84.3%) | 0.1% | 12 441 | 84.2% (83.5–84.9%) | 0.4% | 57 994 | 87.1% (86.8–87.4%) | 0.2% | 141 727 | 82.9% (82.7–83.1%) | 0.1% |

* = Not area-weighted

NOS= Not otherwise specified

significantly to mortality [13].

HL, NHL, CML, testicular GCT, skin melanoma, STS, bone sarcomas, thyroid, breast, cervical, and colorectal cancers displayed 5-year RS between 70% and 90%. Survival was highest among 30–39-year-olds for bone sarcomas, STS, and colorectal cancers. The tumour case mix helps explain the differences for bone sarcomas and STS. Chondrosarcoma had a high RS (> 80%), representing 40% of bone sarcomas in the 30–39 age group compared to only 8% in adolescents. Liposarcoma and leiomyosarcomas also had a high RS and were more common in 30–39-year-olds than among adolescents, who had a high rate of rhabdomyosarcomas with an RS of approximately 50%. Finally, lower survival for colorectal cancer in adolescents has been attributed to the higher proportion of advanced stage lesions and a worse histological subtype compared to older AYAs [14].

Survival rose over the study period for almost all tumours (Fig. 1). The tumours with the greatest increase in survival were ALL and CML (11%) followed by AML and NHL (8% and 6%, respectively). Paediatric protocols have been reported to contribute to improved ALL survival; allogeneic haematopoietic stem-cell transplantation and tyrosine kinase inhibitors (TKI) have helped increase survival in CML [15]; whereas advances in diagnostics, and better use of classic chemotherapy have contributed to better AML survival [16]. Risk-adapted therapy and better assessment and prognostication in AYA with NHL can contribute to explain improvements in survival [17]. For the other cancers we observed an increase in survival between 2% and 4% but they were all tumours which already had a survival between 80% and 90%, in 2004–2006.

In adolescents, we found no evidence of survival improvement for AML, CNS tumours, and bone sarcomas whereas survival for STS rose. These results are consistent with data from earlier periods and have been attributed both to failure to treat adolescents with cancer at optimal settings and to their lower enrolment in clinical trials [3,18]. Rhabdomyosarcoma (RMS) is the most common sarcoma in adolescents. The number of adolescents with RMS enrolled in European paediatric Soft Tissue Sarcoma Study Group protocols (period 2008–2015) compared to the expected number of adolescent cases was 0.64. This was similar to the ratio in children, which stood at 0.77 [19].

Our study confirmed that differences in survival remained among European countries. STS, bone sarcomas, and CNS cancers are rare and complex to treat, and treatment should be centralised in expert centres [20], meaning that different levels of centralisation can help explain differences in survival among countries. In Poland, for example, at the time of the study, most CNS cancers and STS were centralised at the cancer centres in Warsaw and survival was in line with the other countries for these tumours only. For cervical cancers, various availability of and access to screening or human papilloma virus vaccination may explain some of the differences in survival among countries. Cervical cancer survival was lower than the European average in most countries where screening was opportunistic or unavailable, or roll out was incomplete [21]. However, differences in survival may also be due to the quality of and access to care. Countries with low survival for cervical cancer (eg, Bulgaria and Poland) also had low survival for many other cancers that lack screening programmes. In the case of ALL, TKI availability remains a significant issue owing to its financial burden on patients [22]. Furthermore, treatment adherence and the expertise of the multidisciplinary team are underestimated prognostic factor for ALL [23].

For AML, NHL, CNS, and colorectal cancers, we observed lower differences among countries in conditional survival than in 5-year RS, supporting the importance of healthcare organisation in providing earlier detection. Finally, cancers in AYA have distinctive clinical features which make treatment more complex than similar cancers in adults or children. For example, breast cancer in AYA is biologically more aggressive than in older women [24]; young-onset skin melanoma has a distinct biology [25]. Thus, differing access to clinical expertise may be particularly relevant for AYAs with cancers.

Table 3
Age-standardised and age-stratified 5-year relative survival (RS) in European adolescents and young adults (aged 15–39 years) in 2010–2014 for the most common cancers, by sex, reported by number of cases (N) and 95% confidence intervals (95%CI).

| | All AYA patients (age-standardised) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------------------------------------------------------|-------------------------------------|-------------|---------------|-------------|--------|-------------|---------------|-------------|------|-------------|---------------|-------------|--------|-------------|---------------|-------------|------|-------|---------------|-------|------|-------|---------------|------|--------|-------|---------------|------|--------|-------|---------------|------|------|-------|---------------|------|------|-------|-------------|------|
| | Male | | | | Female | | | | Male | | | | Female | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | N | RS (95% CI) | SE | RS (95% CI) | N | RS (95% CI) | SE | RS (95% CI) | N | RS (95% CI) | SE | RS (95% CI) | N | RS (95% CI) | SE | RS (95% CI) | | | | | | | | | | | | | | | | | | | | | | | | |
| Leukaemias and related disorders | 5575 | 71.6% | (70.2%–73.0%) | 0.7% | 4412 | 75.6% | (74.2%–77.0%) | 0.7% | 1003 | 72.3% | (69.3%–75.0%) | 1.5% | 675 | 70.7% | (67.0%–74.1%) | 1.8% | 1770 | 67.8% | (65.4%–70.0%) | 1.2% | 1389 | 74.2% | (71.7%–76.4%) | 1.2% | 2349 | 76.6% | (74.7%–78.3%) | 0.9% | 256 | 55.5% | (48.8%–61.7%) | 3.3% | | | | | | | | |
| -Acute lymphoblastic leukaemia | 1491 | 51.9% | (48.0%–55.6%) | 1.9% | 842 | 57.0% | (52.1%–61.5%) | 2.4% | 579 | 75.5% | (71.6%–78.9%) | 1.9% | 296 | 69.1% | (63.4%–74.1%) | 2.7% | 527 | 55.6% | (51.1%–59.8%) | 2.2% | 291 | 57.9% | (51.7%–63.7%) | 3.1% | 385 | 48.3% | (43.0%–53.4%) | 2.7% | 852 | 58.8% | (50.3%–57.2%) | 1.8% | 832 | 58.8% | (55.2%–62.2%) | 1.4% | | | | |
| -Acute myeloid leukaemia | 1704 | 54.9% | (52.1%–57.5%) | 1.3% | 1635 | 60.6% | (57.9%–63.3%) | 1.3% | 239 | 57.3% | (50.3%–63.6%) | 3.4% | 231 | 62.4% | (55.3%–68.5%) | 3.3% | 605 | 57.0% | (52.7%–61.0%) | 2.1% | 553 | 64.8% | (60.5%–68.7%) | 2.1% | 542 | 91.9% | (89.1%–94.0%) | 1.2% | 353 | 93.5% | (90.1%–95.7%) | 1.4% | 5140 | 89.4% | (88.5%–90.3%) | 0.4% | 2437 | 86.5% | (85%–87.8%) | 0.7% |
| -Chronic myeloid leukaemia | 884 | 92.3% | (90.2%–93.9%) | 0.9% | 573 | 93.8% | (91.2%–95.6%) | 1.1% | 66 | 89.4% | (78.6%–94.9%) | 3.9% | 43 | 93.3% | (80.6%–97.8%) | 3.7% | 276 | 93.8% | (90.1%–96.2%) | 1.5% | 178 | 94.7% | (89.9%–97.3%) | 1.8% | 3581 | 82.8% | (81.4%–84.0%) | 0.7% | 2264 | 94.5% | (93.4%–95.4%) | 0.5% | 2303 | 61.0% | (59%–63.1%) | 1.0% | | | | |
| Lymphomas | 13 710 | 87.5% | (86.9%–88.1%) | 0.3% | 11 389 | 90.3% | (89.7%–90.9%) | 0.3% | 1784 | 90.8% | (89.3%–92.1%) | 0.7% | 1600 | 93.4% | (92%–94.6%) | 0.6% | 5004 | 89.6% | (88.7%–90.5%) | 0.4% | 4650 | 91.9% | (91.1%–92.7%) | 0.4% | 3581 | 82.8% | (81.4%–84.0%) | 0.7% | 2264 | 94.5% | (93.4%–95.4%) | 0.5% | 2303 | 61.0% | (59%–63.1%) | 1.0% | | | | |
| -Non-Hodgkin lymphomas | 5858 | 82.5% | (81.4%–83.6%) | 0.6% | 4076 | 86.0% | (84.9%–87.1%) | 0.6% | 559 | 82.0% | (78.4%–85.1%) | 1.7% | 321 | 87.3% | (82.8%–90.6%) | 2.0% | 1719 | 81.9% | (79.9%–83.7%) | 1.0% | 1319 | 84.6% | (82.5%–86.5%) | 1.0% | 3581 | 82.8% | (81.4%–84.0%) | 0.7% | 2264 | 94.5% | (93.4%–95.4%) | 0.5% | 2303 | 61.0% | (59%–63.1%) | 1.0% | | | | |
| -Hodgkin lymphoma | 6940 | 93.5% | (92.7%–94.2%) | 0.4% | 6687 | 94.8% | (94.0%–95.4%) | 0.4% | 1152 | 95.4% | (94.0%–96.3%) | 0.6% | 1243 | 95.3% | (93.9%–96.4%) | 0.6% | 3082 | 94.3% | (93.4%–95.1%) | 0.4% | 3180 | 95.3% | (94.5%–96.0%) | 0.4% | 2706 | 93% | (91.9%–93.9%) | 0.5% | 2264 | 94.5% | (93.4%–95.4%) | 0.5% | 2303 | 61.0% | (59%–63.1%) | 1.0% | | | | |
| Central Nervous System and other intracranial and intraspinal neoplasms | 5582 | 58.2% | (56.8%–59.5%) | 0.7% | 4151 | 62.9% | (61.4%–64.4%) | 0.8% | 580 | 65.0% | (60.8%–68.8%) | 2.0% | 431 | 64.3% | (59.3%–68.8%) | 2.4% | 1857 | 64.2% | (61.9%–66.4%) | 1.1% | 1417 | 67.4% | (64.8%–69.8%) | 1.3% | 3146 | 55.1% | (53.3%–56.9%) | 0.9% | 2264 | 94.5% | (93.4%–95.4%) | 0.5% | 2303 | 61.0% | (59%–63.1%) | 1.0% | | | | |
| Bone sarcomas | 1696 | 68.6% | (65.5%–71.5%) | 1.5% | 1182 | 77.7% | (74.6%–80.5%) | 1.5% | 582 | 61.6% | (57.4%–65.5%) | 2.1% | 328 | 70.5% | (65.1%–75.2%) | 2.6% | 609 | 61.8% | (57.8%–65.6%) | 2.0% | 425 | 75.5% | (71.0%–79.5%) | 2.2% | 505 | 72.0% | (67.8%–75.8%) | 2.1% | 430 | 79.2% | (74.9%–82.9%) | 2.0% | | | | | | | | |
| Soft tissue sarcomas (excluding skin sarcomas) | 2460 | 65.0% | (62.9%–66.9%) | 1.0% | 2269 | 72.7% | (70.6%–74.6%) | 1.0% | 388 | 62.6% | (57.4%–67.3%) | 2.5% | 272 | 71.4% | (65.4%–76.6%) | 2.9% | 764 | 58.4% | (54.7%–62.0%) | 1.8% | 708 | 71.5% | (67.9%–74.7%) | 1.7% | 1309 | 67.8% | (65.1%–70.3%) | 1.3% | 1290 | 73.3% | (70.8%–75.7%) | 1.3% | | | | | | | | |
| Melanoma - malignant | 9165 | 89.8% | (89.1%–90.4%) | 0.3% | 16 255 | 95.2% | (94.8%–95.5%) | 0.2% | 313 | 93.9% | (90.4%–96.1%) | 1.4% | 492 | 94.8% | (92.3%–96.5%) | 1.0% | 2342 | 90.3% | (89.0%–91.5%) | 0.6% | 5015 | 96.5% | (95.9%–97.0%) | 0.3% | 6411 | 89.2% | (88.4%–90.0%) | 0.4% | 10749 | 94.7% | (94.3%–95.1%) | 0.2% | | | | | | | | |
| Thyroid carcinoma | 3881 | 98.8% | (98.2%–99.1%) | 0.2% | 15 387 | 99.7% | (99.5%–99.8%) | 0.1% | 224 | 98.3% | (95.1%–99.4%) | 0.9% | 801 | 99.3% | (98.6%–99.9%) | 0.2% | 1132 | 99.3% | (98.4%–99.7%) | 0.3% | 4787 | 99.8% | (99.6%–99.9%) | 0.1% | 2526 | 98.6% | (97.9%–99.0%) | 0.3% | 9800 | 99.6% | (99.4%–99.7%) | 0.1% | | | | | | | | |
| Carcinoma of colon and rectum (excluding appendix) | 4063 | 64.2% | (62.4%–66.0%) | 0.9% | 3833 | 62.8% | (60.9%–64.7%) | 1.0% | 56 | 58.1% | (43.2%–70.3%) | 7.0% | 33 | 47.4% | (29.6%–63.3%) | 8.8% | 741 | 62.7% | (58.9%–66.1%) | 1.8% | 683 | 61.6% | (57.7%–65.1%) | 1.9% | 3267 | 65.4% | (63.7%–67.1%) | 0.9% | 3118 | 64.7% | (63.0%–66.4%) | 0.9% | | | | | | | | |
| Carcinoma of breast | 113 | 82.2% | (70.4%–89.6%) | 4.7% | 33 957 | 85.3% | (84.4%–86.2%) | 0.5% | NE | NE | NE | NE | 28 | 86.1% | (67.0%–94.6%) | 6.5% | 15 | 74.6% | (39.7%–91.1%) | 12.8% | 3389 | 83.2% | (81.9%–84.5%) | 0.7% | 30 540 | 86.1% | (85.7%–86.5%) | 0.2% | 30 540 | 86.1% | (85.7%–86.5%) | 0.2% | | | | | | | | |

NE=Not Estimable.

We confirmed the female sex to be an indicator of better survival compared to the male sex. Our results are coherent with previous reports of a minimal female advantage at birth, which then grows from puberty until menopause [26]. Our data supports also a similar level of tumour aggressiveness in both sexes, although the underlying reasons are not well understood. Some hypotheses include behavioural factors and health care access [27], biological differences [28], and psychological factors [29].

Our study has several strengths. We evaluated the results in a large, unbiased population-based database. We used the updated classification of tumours occurring in AYA [6]. This is the most comprehensive study to include most AYA cancers and countries. Although follow-up did not extend beyond 2014, we estimated 5-year RS using the period approach to provide reliable predictions of 5-year RS for patients diagnosed up to the end of the study period.

Limitations include the relatively old diagnostic period and the end of follow-up used for the analyses. Our data also lack grade, stage, and treatment data, limiting interpretations of the results.

Tumours of AYAs can be treated effectively resulting in excellent survival in most cases, but they are mostly rare. Accordingly, AYAs developing malignancies should be referred to expert centres [4]. Collaboration among the European reference networks (PaedCAN, EURACAN, EuroBloodNet) is recommended to ensure the definition of a trans-age treatment protocol. International cooperative groups also play an important role in organising clinical research for these young people. Cancer registries remain an important source of information for monitoring cancer survival in AYAs.

CRedit authorship contribution statement

Guevara Marcela: Writing – review & editing. **Bernasconi Alice:** Data curation, Formal analysis, Methodology, Writing – original draft. **Demuru Elena:** Writing – review & editing. **Mousavi Seyed Mohsen:** Writing – review & editing. **Blum Marcel:** Writing – review & editing. **Eberle Andrea:** Writing – review & editing. **Ferrari Andrea:** Writing – review & editing. **Stiller Charles:** Writing – review & editing. **Visser Otto:** Writing – review & editing. **Canete-Nieto Adela:** Writing – review & editing. **Spycher Ben:** Writing – review & editing. **Bielska-Lasota Magdalena:** Writing – review & editing. **Katalinic Alexander:** Writing – review & editing. **Working Group EUROCARE-6:** Writing – review & editing, Data curation. **Lasalvia Paolo:** Data curation, Formal analysis, Methodology, Writing – original draft. **Marcos-Gragera Rafael:** Writing – review & editing. **Vener Claudia:** Writing – review & editing. **Paapsi Keiu:** Writing – review & editing. **Innos Kaire:** Writing – review & editing. **Trama Annalisa:** Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing. **Botta Laura:** Methodology, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

We analysed pseudonymised data collected from 108 population-based cancer registries, after approval by the Ethics Committee of the National Cancer Institute of Milan (INT73/16; April 21, 2016). We hold these data in trust from each participating registry for the statistical analyses agreed in the EUROCARE-6 protocol, available at <http://www.eurocare.it>. We are not allowed to share individual data. Aggregated level data, in the form of counts, rates, or survival proportions, can be only shared after express permission from the participating registries. These data should be requested by contacting the corresponding author or the Eurocare Secretariat (eurocare.secretariat@istitutotumori.mi.it).

Table 4

Five-year relative survival (RS) estimates for the most common cancers affecting European adolescents and young adults (aged 15–39 years) in 2010–2014, by country, reported by number of cases (N) and 95% confidence intervals (95%CI).

| | Acute lymphoblastic leukaemia | | | Acute myeloid leukaemia | | | Non-Hodgkin lymphomas | | | Hodgkin lymphoma | | | CNS and other intracranial and intraspinal neoplasms | | | Bone sarcomas | | |
|----------------------------------------|-------------------------------|------------------------------------|-------------|-------------------------|------------------------------------|-------------|-----------------------|------------------------------------|-------------|------------------|------------------------------------|-------------|------------------------------------------------------|------------------------------------|-------------|---------------|------------------------------------|-------------|
| | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE |
| AT_Austria National | 69 | 67.3% (54.6% - 77.2%) | 5.8% | 100 | 56.8% (46.0% - 66.2%) | 5.2% | 243 | 83.5% (78.2% - 87.6%) | 2.4% | 293 | 95.0% (91.8% - 97.0%) | 1.3% | 283 | 70.0% (64.4% - 74.9%) [†] | 2.7% | 86 | 69.6% (58.5% - 78.3%) | 5.1% |
| BE_Belgium National | 117 | 63.7% (54.1% - 71.9%) | 4.6% | 162 | 63.3% (55.0% - 70.6%) | 4.0% | 487 | 85.4% (81.8% - 88.3%) | 1.7% | 576 | 97.0% (95.1% - 98.2%) [†] | 0.7% | 404 | 63.3% (58.3% - 67.8%) | 2.4% | 137 | 74.1% (65.5% - 80.9%) | 3.9% |
| BG_Bulgaria National | 57 | 50.5% (35.6% - 63.7%) | 7.3% | 74 | 21.2% (12.9% - 30.8%) [‡] | 4.6% | 195 | 71.1% (64.1% - 77.0%) [§] | 3.3% | 280 | 83.1% (78.1% - 87.1%) [§] | 2.3% | 256 | 48.8% (42.5% - 54.8%) [§] | 3.2% | 77 | 48.6% (37.2% - 59.0%) [§] | 5.6% |
| CR_Croatia National | 31 | 54.3% (31.5% - 72.3%) | 10.7% | 40 | 37.5% (19.9% - 55.0%) [‡] | 9.3% | 151 | 76.9% (66.7% - 84.3%) | 4.4% | 186 | 88.7% (81.7% - 93.2%) [§] | 2.9% | 187 | 67.1% (58.4% - 74.4%) | 4.1% | 60 | 79.3% (63.2% - 89.0%) | 6.4% |
| CY_Cyprus National | 13 | 57.7% (31.4% - 77.0%) | 12.1% | 17 | 79.1% (53.2% - 91.7%) [†] | 9.4% | 50 | 87.6% (74.3% - 94.3%) | 4.8% | 85 | 96.7% (89.6% - 99.0%) | 2.0% | 18 | 64.5% (37.2% - 82.3%) | 11.8% | 12 | 79.2% (47.9% - 92.9%) | 10.8% |
| CZ_Czech Republic National | 62 | 58.0% (43.1% - 70.3%) | 7.0% | 93 | 51.1% (39.6% - 61.6%) | 5.7% | 336 | 86.5% (82.0% - 90.0%) | 2.0% | 505 | 94.9% (92.3% - 96.6%) | 1.1% | 369 | 57.7% (52.2% - 62.9%) | 2.7% | 90 | 58.6% (46.9% - 68.5%) | 5.5% |
| DK_Denmark National | 60 | 80.4% (67.9% - 88.4%) [†] | 5.1% | 57 | 59.3% (43.8% - 71.8%) | 7.2% | 183 | 88.3% (82.8% - 92.1%) | 2.3% | 230 | 95.3% (91.4% - 97.4%) | 1.5% | 166 | 58.8% (50.9% - 66.0%) | 3.9% | 62 | 69.4% (56.2% - 79.3%) | 5.9% |
| EE_Estonia National | 19 | 50.6% (26.1% - 70.8%) | 11.9% | 16 | 56.8% (30.2% - 76.6%) | 12.3% | 57 | 71.4% (59.2% - 80.6%) [§] | 5.5% | 75 | 90.8% (80.8% - 95.8%) | 3.6% | 45 | 72.1% (56.6% - 82.9%) | 6.7% | 10 | 90.3% (46.1% - 98.7%) [†] | 9.5% |
| FI_Finland National | 47 | 69.7% (54.1% - 80.9%) | 6.8% | 53 | 68.5% (53.7% - 79.4%) | 6.6% | 213 | 82.0% (76.2% - 86.5%) [†] | 2.6% | 302 | 98.3% (95.8% - 99.3%) [†] | 0.8% | 210 | 61.8% (54.8% - 68.1%) | 3.4% | 43 | 78.3% (63.3% - 87.8%) | 6.1% |
| FR_France (CRs Pool) | 123 | 67.7% (58.8% - 75.0%) | 4.1% | 185 | 67.3% (58.2% - 73.7%) [†] | 3.5% | 551 | 87.6% (84.5% - 90.1%) [†] | 1.4% | 790 | 94.9% (92.2% - 96.0%) | 0.8% | 443 | 60.1% (54.7% - 64.4%) | 2.3% | 162 | 71.3% (63.3% - 77.9%) | 3.4% |
| GE_Germany (CRs Pool) | 220 | 62.9% (55.3% - 69.5%) | 3.6% | 319 | 60.2% (54.1% - 65.8%) | 3.0% | 837 | 85.9% (83.0% - 88.3%) | 1.3% | 1,095 | 97.1% (95.7% - 98.0%) [†] | 0.6% | 775 | 64.3% (60.5% - 67.8%) | 1.9% | 234 | 66.5% (59.1% - 72.8%) | 3.5% |
| IC_Iceland National | 3 | 50.0% (5.8% - 84.5%) | 25.0% | + | + | + | 10 | 91.0% (50.4% - 98.7%) | 8.7% | 21 | 100% (100% - 100%) | 0.0% | 11 | 56.6% (24.4% - 79.4%) | 14.9% | 3 | 100% (100% - 100%) | 0.0% |
| IR_Ireland National | 41 | 64.1% (47.5% - 76.7%) | 7.5% | 59 | 64.4% (50.4% - 75.4%) | 6.4% | 177 | 90.0% (84.0% - 93.9%) [†] | 2.4% | 249 | 96.6% (93.1% - 98.3%) | 1.2% | 190 | 71.1% (63.5% - 77.4%) [†] | 3.5% | 44 | 59.5% (42.3% - 73.1%) | 8.0% |
| IT_Italy (CRs Pool) | 220 | 53.6% (46.7% - 60.0%) [‡] | 3.4% | 325 | 65.5% (59.6% - 70.8%) [†] | 2.9% | 1,177 | 85.3% (83.0% - 87.4%) | 1.1% | 1,519 | 95.9% (94.8% - 96.8%) | 0.5% | 691 | 61.6% (57.8% - 65.2%) | 1.9% | 236 | 74.9% (68.7% - 80.1%) | 2.9% |
| LV_Latvia National | 13 | 58.6% (32.1% - 77.7%) | 12.1% | 17 | 54.2% (30.1% - 73.2%) | 11.4% | 56 | 67.3% (54.0% - 77.6%) [§] | 6.0% | 114 | 92.1% (84.9% - 96.0%) | 2.7% | 108 | 65.2% (55.0% - 73.7%) | 4.8% | 28 | 57.7% (37.5% - 73.5%) | 9.4% |
| LT_Lithuania National | 34 | 58.1% (38.7% - 73.2%) | 9.0% | 35 | 45.9% (28.9% - 61.4%) | 8.5% | 109 | 80.4% (71.0% - 87.0%) | 4.0% | 144 | 97.2% (91.9% - 99.1%) | 1.5% | 123 | 59.1% (50.0% - 67.1%) | 4.4% | 32 | 59.2% (40.0% - 74.1%) | 8.8% |
| ML_Malta National | 4 | 28.6% (1.4% - 69.1%) | 22.3% | 2 | 66.7% (5.4% - 94.5%) | 27.2% | 32 | 71.0% (51.7% - 83.8%) | 8.2% | 24 | 92.4% (72.3% - 98.1%) | 5.3% | 12 | 84.0% (49.3% - 95.8%) [†] | 10.5% | 3 | 50.0% (0.6% - 91.1%) | 35.4% |
| NO_Norway National | 58 | 59.1% (45.1% - 70.6%) | 6.6% | 63 | 72.7% (59.4% - 82.2%) [†] | 5.8% | 181 | 91.7% (86.5% - 94.9%) [†] | 2.1% | 253 | 97.8% (94.9% - 99.1%) [†] | 1.0% | 213 | 64.2% (57.4% - 70.2%) | 3.3% | 59 | 74.5% (61.7% - 83.6%) | 5.5% |
| PL_Poland National | 299 | 53.2% (47.1% - 59.0%) [‡] | 3.0% | 378 | 46.3% (40.9% - 51.6%) [‡] | 2.7% | 787 | 74.7% (71.3% - 77.8%) [‡] | 1.7% | 1,720 | 91.3% (89.8% - 92.7%) [‡] | 0.7% | 1,746 | 63.8% (61.3% - 66.2%) | 1.2% | 412 | 63.7% (58.5% - 68.4%) [‡] | 2.5% |
| PT_Portugal (CRs Pool) | 48 | 55.1% (39.3% - 68.3%) | 7.5% | 87 | 52.6% (40.9% - 63.0%) | 5.7% | 384 | 80.8% (75.9% - 84.8%) | 2.2% | 495 | 94.4% (91.9% - 96.2%) | 1.1% | 266 | 59.3% (52.9% - 65.2%) | 3.1% | 79 | 56.9% (44.4% - 67.6%) [‡] | 6.0% |
| SK_Slovakia National | 44 | 45.7% (26.8% - 62.8%) | 9.5% | 50 | 59.7% (39.5% - 75.0%) | 9.2% | 125 | 84.7% (73.9% - 91.3%) | 4.3% | 199 | 89.5% (84.2% - 93.2%) [‡] | 2.3% | 164 | 58.3% (49.4% - 66.2%) | 4.3% | 47 | 58.0% (38.9% - 73.0%) | 8.9% |
| SL_Slovenia National | 15 | 75.1% (40.8% - 91.2%) | 12.5% | 21 | 49.5% (26.6% - 68.8%) | 11.2% | 71 | 90.4% (80.7% - 95.4%) | 3.5% | 86 | 97.2% (90.6% - 99.2%) | 1.8% | 57 | 68.6% (54.7% - 79.1%) | 6.2% | 21 | 63.3% (39.9% - 79.6%) | 10.3% |
| SP_Spain (CRs Pool) | 82 | 49.8% (37.6% - 60.9%) | 6.0% | 130 | 60.4% (50.8% - 68.7%) | 4.6% | 418 | 81.9% (77.5% - 85.6%) | 2.0% | 476 | 92.1% (89.2% - 94.2%) [‡] | 1.3% | 266 | 58.8% (52.6% - 64.5%) | 3.0% | 84 | 61.0% (49.5% - 70.6%) | 5.4% |
| SW_Switzerland (CRs Pool) | 13 | 52.0% (22.5% - 75.1%) | 14.3% | 28 | 61.6% (40.4% - 77.1%) | 9.5% | 79 | 87.7% (77.5% - 93.4%) | 3.9% | 133 | 98.3% (93.0% - 99.6%) [†] | 1.2% | 64 | 63.3% (49.7% - 74.1%) | 6.3% | 18 | 74.3% (44.6% - 89.6%) | 11.2% |
| NL_The Netherlands National | 148 | 70.3% (62% - 77.0%) [†] | 3.8% | 209 | 63.3% (56.0% - 69.6%) | 3.5% | 660 | 86.1% (83.2% - 88.5%) | 1.4% | 789 | 97.1% (95.5% - 98.1%) [†] | 0.6% | 601 | 59.2% (55.0% - 63.1%) | 2.1% | 197 | 75.8% (68.9% - 81.3%) | 3.2% |
| UK_England National | 417 | 67.5% (62.5% - 72.0%) [†] | 2.4% | 704 | 58.0% (54.1% - 61.6%) | 1.9% | 1,970 | 85.2% (83.5% - 86.7%) | 0.8% | 2,532 | 94.3% (93.3% - 95.1%) | 0.5% | 1,774 | 57.7% (55.3% - 59.9%) [‡] | 1.2% | 554 | 73.5% (69.5% - 77.0%) | 1.9% |
| UK_Northern Ireland National | 11 | 72.8% (37.1% - 90.3%) | 13.4% | 22 | 55.2% (34.6% - 71.7%) | 9.7% | 44 | 74.7% (58.9% - 85.2%) | 6.6% | 82 | 94.2% (85.9% - 97.7%) | 2.7% | 74 | 60.0% (47.2% - 70.6%) | 6.0% | 20 | 59.9% (33.5% - 78.6%) | 11.8% |
| UK_Scotland National | 51 | 65.9% (50.9% - 77.2%) | 6.7% | 62 | 64.7% (50.6% - 75.7%) | 6.5% | 194 | 82.6% (76.3% - 87.4%) | 2.8% | 266 | 94.8% (91.2% - 97.0%) | 1.4% | 155 | 48.0% (39.9% - 55.6%) [‡] | 4.0% | 58 | 71.0% (57.3% - 81.0%) | 6.0% |
| UK_Wales National | 23 | 49.3% (27.2% - 68.1%) | 10.9% | 35 | 69.1% (48.9% - 82.6%) | 8.6% | 77 | 84.9% (73.4% - 91.6%) | 4.5% | 107 | 86.3% (78.0% - 91.7%) [‡] | 3.4% | 102 | 66.2% (55.3% - 75.1%) | 5.1% | 34 | 71.9% (52.6% - 84.5%) | 8.1% |
| Eurocare-6 Pool (Area weighted) | 2,311 | 60.9% (58.6% - 63.2%) | 1.1% | 3,323 | 59.3% (57.4% - 61.2%) | 0.9% | 9,907 | 84.0% (83.2% - 84.8%) | 0.4% | 13,604 | 95.0% (94.6% - 95.3%) | 0.2% | 9,722 | 61.6% (60.5% - 62.8%) | 0.6% | 2,860 | 69.6% (67.6% - 71.5%) | 1.0% |

(continued on next page)

Table 4 (continued)

| | Soft tissue sarcomas (excluding skin) | | | Germ cell and trophoblastic of testis | | | Melanoma - malignant | | | Carcinoma of colon and rectum (excluding appendix) | | | Carcinoma of breast | | | Carcinoma of uterine cervix | | |
|----------------------------------------|---------------------------------------|------------------------------------|-------------|---------------------------------------|------------------------------------|-------------|----------------------|------------------------------------|-------------|----------------------------------------------------|------------------------------------|-------------|---------------------|------------------------------------|-------------|-----------------------------|------------------------------------|-------------|
| | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE | N | RS (95% CI) | SE |
| AT_Austria National | 150 | 71.4% (63.4% - 77.9%) | 3.7% | 684 | 96.6% (94.8% - 97.7%) | 0.7% | 784 | 95.7% (94.0% - 97.0%) [†] | 0.7% | 188 | 70.8% (63.8% - 76.8%) | 3.3% | 837 | 86.6% (84.2% - 88.6%) | 1.1% | 262 | 86.6% (81.8% - 90.2%) | 2.1% |
| BE_Belgium National | 219 | 79.2% (72.9% - 84.3%) [†] | 2.9% | 890 | 96.8% (95.3% - 97.9%) | 0.6% | 1,435 | 95.5% (94.2% - 96.5%) [†] | 0.6% | 340 | 73.6% (68.4% - 78.1%) [†] | 2.5% | 1,928 | 88.9% (87.3% - 90.2%) [†] | 0.7% | 481 | 89.2% (86.0% - 91.7%) [†] | 1.5% |
| BG_Bulgaria National | 170 | 65.2% (57.2% - 72.1%) | 3.8% | 519 | 87.4% (84.1% - 90.1%) [§] | 1.5% | 217 | 67.9% (61.2% - 73.7%) [§] | 3.2% | 217 | 49.8% (43.0% - 56.2%) [§] | 3.4% | 906 | 80.4% (77.6% - 82.9%) [§] | 1.3% | 776 | 69.2% (65.7% - 72.5%) [§] | 1.7% |
| CR_Croatia National | 51 | 61.9% (44.2% - 75.4%) | 8.1% | 312 | 93.8% (89.5% - 96.4%) | 1.7% | 211 | 87.9% (81.7% - 92.1%) | 2.6% | 132 | 57.5% (47.3% - 66.5%) | 4.9% | 354 | 83.9% (78.5% - 88.0%) | 2.4% | 197 | 83.0% (75.5% - 88.3%) | 3.2% |
| CY_Cyprus National | 24 | 80.0% (57.7% - 91.3%) | 8.2% | 86 | 99.0% (91.9% - 99.9%) | 1.1% | 35 | 73.1% (54.5% - 85.1%) [§] | 7.7% | 28 | 66.9% (46.5% - 81.0%) | 8.9% | 135 | 92.7% (86.7% - 96.0%) [†] | 2.3% | 30 | 87.5% (69.6% - 95.2%) | 6.0% |
| CZ_Czech Republic National | 190 | 63.4% (55.8% - 70.1%) | 3.7% | 1,218 | 94.8% (93.2% - 96.0%) [§] | 0.7% | 946 | 93.6% (91.6% - 95.1%) | 0.9% | 350 | 61.8% (56.2% - 66.9%) | 2.7% | 1,161 | 85.2% (82.8% - 87.3%) | 1.1% | 955 | 87.3% (84.8% - 89.3%) | 1.1% |
| DK_Denmark National | 111 | 66.9% (56.9% - 75.1%) | 4.7% | 697 | 99.4% (98.1% - 99.8%) [†] | 0.4% | 1,347 | 97.4% (96.3% - 98.1%) [†] | 0.5% | 145 | 63.5% (55.1% - 70.8%) | 4.0% | 685 | 87.4% (84.6% - 89.7%) | 1.3% | 480 | 91.8% (89.0% - 94.0%) [†] | 1.3% |
| EE_Estonia National | 23 | 60.7% (37.6% - 77.5%) | 10.4% | 56 | 96.9% (84.1% - 99.4%) | 2.7% | 105 | 94.2% (86.5% - 97.6%) | 2.5% | 25 | 60.6% (37.6% - 77.3%) | 10.3% | 110 | 90.1% (82.4% - 94.5%) | 3.0% | 99 | 90.4% (82.6% - 94.8%) | 3.0% |
| FI_Finland National | 90 | 68.2% (57.4% - 76.8%) | 5.0% | 403 | 96.2% (93.7% - 97.8%) | 1.0% | 430 | 95.9% (93.4% - 97.5%) [†] | 1.0% | 119 | 74.0% (64.8% - 81.1%) | 4.1% | 482 | 84.7% (81.1% - 87.7%) | 1.7% | 177 | 88.8% (83.1% - 92.6%) | 2.4% |
| FR_France (CRs Pool) | 235 | 72.3% (66.0% - 77.7%) | 3.0% | 1,103 | 96.8% (95.2% - 97.7%) | 0.6% | 1,241 | 93.4% (92.1% - 95.0%) | 0.7% | 390 | 69.5% (64.7% - 73.8%) | 2.3% | 2,103 | 88.6% (86.8% - 89.8%) [†] | 0.7% | 405 | 87.0% (82.7% - 89.9%) | 1.7% |
| GE_Germany (CRs Pool) | 377 | 67.4% (61.8% - 72.4%) | 2.7% | 2,888 | 97.8% (97.1% - 98.4%) [†] | 0.3% | 2,786 | 95.8% (94.9% - 96.6%) [†] | 0.4% | 710 | 71.0% (67.1% - 74.6%) [†] | 1.9% | 3,183 | 88.2% (86.9% - 89.4%) [†] | 0.6% | 1,239 | 87.1% (84.9% - 89.1%) | 1.1% |
| IC_Iceland National | 8 | 83.4% (27.1% - 97.5%) | 15.2% | 27 | 100% (100% - 100%) | 0.0% | 45 | 100% (100% - 100%) | 0.0% | 10 | 85.8% (33.1% - 97.9%) | 13.2% | 37 | 87.6% (72.4% - 94.7%) | 5.3% | 33 | 92.1% (77.3% - 97.4%) | 4.4% |
| IR_Ireland National | 76 | 67.9% (55.7% - 77.4%) | 5.6% | 457 | 98.0% (95.9% - 99.1%) | 0.7% | 463 | 90.3% (87.0% - 92.7%) | 1.4% | 141 | 70.3% (61.5% - 77.4%) | 4.1% | 598 | 83.7% (80.4% - 86.5%) | 1.5% | 392 | 85.9% (81.9% - 89.1%) | 1.8% |
| IT_Italy (CRs Pool) | 447 | 71.8% (67.2% - 75.9%) | 2.2% | 1,937 | 97.2% (96.3% - 97.9%) | 0.4% | 2,465 | 93.9% (92.8% - 94.8%) | 0.5% | 622 | 66.6% (62.6% - 70.3%) | 2.0% | 3,293 | 88.3% (87.2% - 89.3%) [†] | 0.5% | 566 | 84.8% (81.5% - 87.6%) | 1.6% |
| LV_Latvia National | 36 | 64.1% (45.0% - 78.0%) | 8.5% | 81 | 90.3% (81.0% - 95.2%) | 3.4% | 66 | 84.0% (72.1% - 91.2%) | 4.7% | 47 | 66.6% (50.1% - 78.7%) | 7.3% | 165 | 80.8% (73.5% - 86.3%) | 3.2% | 182 | 71.4% (64.2% - 77.4%) [§] | 3.3% |
| LT_Lithuania National | 53 | 67.3% (52.0% - 78.8%) | 6.8% | 94 | 93.5% (84.7% - 97.3%) | 2.9% | 110 | 86.6% (78.5% - 91.8%) | 3.3% | 58 | 67.4% (53.2% - 78.1%) | 6.4% | 254 | 79.2% (73.7% - 83.7%) [§] | 2.5% | 276 | 82.7% (77.5% - 86.8%) | 2.4% |
| ML_Malta National | 9 | 29.0% (5.6% - 58.8%) | 15.5% | 33 | 97.0% (76.7% - 99.6%) | 3.3% | 36 | 97.4% (80.7% - 99.7%) | 2.7% | 15 | 84.0% (56.7% - 94.8%) [†] | 8.8% | 48 | 81.3% (66.9% - 89.9%) | 5.7% | 13 | 89.0% (43.1% - 98.4%) | 10.5% |
| NO_Norway National | 76 | 73.1% (61.3% - 81.8%) | 5.2% | 770 | 99.0% (97.7% - 99.6%) [†] | 0.4% | 601 | 93.3% (90.9% - 95.1%) | 1.1% | 193 | 69.3% (62.1% - 75.4%) | 3.4% | 552 | 86.0% (82.6% - 88.7%) | 1.6% | 393 | 92.2% (89.1% - 94.5%) [†] | 1.4% |
| PL_Poland National | 535 | 66.7% (62.2% - 70.8%) | 2.2% | 2,995 | 92.9% (91.8% - 93.8%) [§] | 0.5% | 1,485 | 82.7% (80.5% - 84.7%) [§] | 1.1% | 896 | 57.1% (53.5% - 60.6%) [§] | 1.8% | 3,198 | 81.3% (79.8% - 82.8%) [§] | 0.8% | 1,242 | 75.1% (72.4% - 77.6%) [§] | 1.3% |
| PT_Portugal (CRs Pool) | 167 | 68.1% (60.2% - 74.8%) | 3.7% | 399 | 97.0% (94.5% - 98.4%) | 0.9% | 370 | 94.1% (91.1% - 96.2%) | 1.3% | 313 | 63.5% (57.8% - 68.6%) [§] | 2.7% | 1,291 | 88.4% (86.6% - 90.0%) | 0.9% | 420 | 85.9% (81.8% - 89.1%) | 1.9% |
| SK_Slovakia National | 85 | 62.5% (49.8% - 72.8%) | 5.9% | 456 | 95.2% (91.7% - 97.3%) | 1.4% | 201 | 84.7% (77.3% - 89.8%) [§] | 3.1% | 119 | 55.4% (45.8% - 63.9%) [§] | 4.7% | 287 | 81.6% (76.9% - 85.4%) | 2.2% | 289 | 83.6% (77.3% - 88.3%) | 2.8% |
| SL_Slovenia National | 27 | 45.5% (25.3% - 63.7%) [§] | 10.2% | 252 | 98.0% (94.8% - 99.3%) | 1.0% | 242 | 90.2% (85.8% - 93.3%) | 1.9% | 64 | 57.1% (44.4% - 67.9%) | 6.0% | 216 | 90.0% (85.4% - 93.3%) | 2.0% | 106 | 96.3% (89.9% - 98.6%) [†] | 1.9% |
| SP_Spain (CRs Pool) | 175 | 64.2% (56.2% - 71.2%) | 3.8% | 652 | 97.5% (95.7% - 98.5%) | 0.7% | 543 | 92.4% (89.7% - 94.5%) | 1.2% | 254 | 71.5% (65.5% - 76.7%) | 2.9% | 1,180 | 87.2% (85.2% - 88.9%) | 1.0% | 264 | 80.8% (75.3% - 85.2%) [§] | 2.5% |
| SW_Switzerland (CRs Pool) | 33 | 64.0% (41.5% - 79.7%) | 9.9% | 210 | 97.4% (93.8% - 99.0%) | 1.2% | 276 | 96.6% (93.3% - 98.3%) [†] | 1.2% | 45 | 72.2% (55.3% - 83.6%) | 7.2% | 245 | 88.1% (83.0% - 91.7%) | 2.2% | 50 | 98.0% (86.2% - 99.7%) [†] | 2.0% |
| NL_The Netherlands National | 275 | 70.6% (64.6% - 75.7%) | 2.8% | 1,842 | 98.4% (97.6% - 98.9%) [†] | 0.3% | 2,572 | 94.0% (93.0% - 94.9%) [†] | 0.5% | 535 | 67.9% (63.8% - 71.7%) | 2.0% | 2,716 | 87.2% (85.9% - 88.4%) | 0.6% | 766 | 89.5% (87.1% - 91.5%) [†] | 1.1% |
| UK_England National | 944 | 67.5% (64.4% - 70.4%) | 1.5% | 4,207 | 98.1% (97.6% - 98.5%) [†] | 0.2% | 5,160 | 93.7% (93.0% - 94.4%) [†] | 0.3% | 1,642 | 61.3% (58.9% - 63.6%) [§] | 1.2% | 6,768 | 84.1% (83.2% - 85.0%) [§] | 0.4% | 3,247 | 86.8% (85.6% - 87.9%) | 0.6% |
| UK_Northern Ireland National | 35 | 47.3% (30.6% - 62.2%) [§] | 8.3% | 159 | 99.0% (94.8% - 99.8%) [†] | 0.8% | 212 | 95.0% (90.9% - 97.3%) | 1.6% | 57 | 71.9% (58.0% - 81.9%) | 6.1% | 220 | 83.8% (78.2% - 88.1%) | 2.5% | 207 | 92.1% (87.5% - 95.1%) [†] | 1.9% |
| UK_Scotland National | 90 | 58.6% (47.2% - 68.4%) | 5.4% | 455 | 98.2% (96.2% - 99.2%) | 0.7% | 614 | 95.4% (93.3% - 96.9%) [†] | 0.9% | 146 | 59.2% (50.8% - 66.6%) | 4.1% | 660 | 79.9% (76.6% - 82.8%) [§] | 1.6% | 451 | 88.8% (85.5% - 91.4%) | 1.5% |
| UK_Wales National | 54 | 59.9% (44.9% - 72.0%) | 7.0% | 240 | 96.7% (92.9% - 98.5%) | 1.3% | 263 | 87.7% (82.8% - 91.2%) [§] | 2.1% | 77 | 60.1% (47.4% - 70.6%) | 6.0% | 295 | 86.0% (81.4% - 89.5%) | 2.1% | 196 | 82.6% (76.4% - 87.4%) | 2.8% |
| Eurocare-6 Pool (Area weighted) | 4,710 | 69% (67.5% - 70.5%) | 0.7% | 24,184 | 96.9% (96.6% - 97.2%) | 0.1% | 25,402 | 92.9% (92.5% - 93.2%) | 0.2% | 7,872 | 65.9% (64.7% - 67.1%) | 0.6% | 34,002 | 86.4% (86.0% - 86.8%) | 0.2% | 14,091 | 85.9% (85.1% - 86.6%) | 0.4% |

NE=Not Estimable; [†]=Survival above the European average; [§]=Survival below the European average.

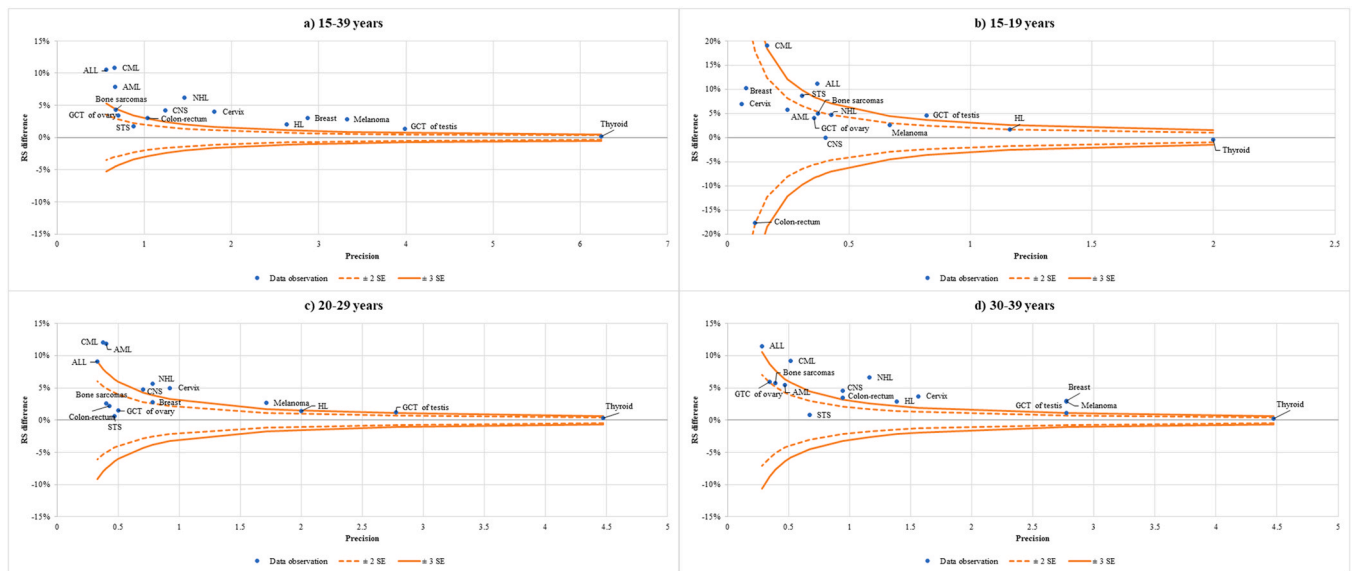


Fig. 1. Funnel plot of the difference in 5-year relative survival (RS) between the periods 2004–2006 and 2010–2014, by cancer type and age groups: (a) 15–39 years; (b) 15–19 years; (c) 20–29 years; (d) 30–39 years.

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Data access

Annalisa Trama had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.ejca.2024.113558](https://doi.org/10.1016/j.ejca.2024.113558).

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