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## Cancer among Adolescents and Young Adults between 2000 and 2016 in France:

## InCIDENCE AND IMPROVED SURVIVAL

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#### Abstract

Purpose: This study was undertaken to determine cancer survival and describe the spectrum of cancers diagnosed among French adolescent and young adult (AYA) population.


Methods: All cases of cancer diagnosed in 15-24 years, recorded by all French populationbased registries (18\% of the French population), over the 2000-2016 period, were included. Age-standardized incidences rates (ASR), conventional annual percentage change (cAPC) of incidence over time, and 5-year overall survival (5yOS) were calculated.

Results: We analyzed 2,734 cancer diagnoses in adolescents and 4,199 in young adults. Overall incidence rates were $231.9 / 10^{6}$ in 15-19 year olds and $354.0 / 10^{6}$ in 20-24 year olds. The most frequently diagnosed cancers in male AYA were malignant gonadal germ-cell tumors (GCT), Hodgkin lymphoma (HL), and malignant melanoma, and were HL, thyroid carcinoma, and malignant melanoma in females. Cancer incidence was stable over time with a cAPC of $0.8 \%(p=0.72)$. For all cancers combined, $5 y O S$ was $86.6 \%$ ( $95 \% \mathrm{CI}: 85.8-87.4$ ), greater than $85 \%$ for HL, non-Hodgkin lymphomas (NHL), GCT, thyroid carcinomas, and malignant melanomas, and around $60 \%$ and lower for osteosarcomas, Ewing tumors, hepatic carcinomas, and rhabdomyosarcomas. The 5yOS has significantly improved from 2000-2007 to 2008-2015 for all cancers pooled, with a substantial gain of 4\% for 15-19 year-olds, and $3 \%$ for 20-24 year-olds.

Conclusion: Notwithstanding the encouraging results for some cancers, and overall, persistent poorer survivals in AYA were shown compared to children for acute lymphoblastic leukemia, osteosarcoma, Ewing tumor, rhabdomyosarcoma and malignant hepatic tumors. These disparities require further investigation to identify and address the causes of these inferior outcomes.

## Introduction

Incidence and survival within the adolescents and young adults (AYA) population can be misleading when assessed across all tumor streams. The latest French report (2000-2008) ${ }^{1}$ described an overall incidence rate (IR) 219.4 per million adolescents (age 15-19 years) and 293.1 per million young adults (age $20-24$ years). For all cancers combined, substantial survival gains were achieved, with an increase of 5-year overall survival (OS) from $62.0 \%$ ( $95 \% \mathrm{CI}$ : $57.5-66.5$ ) in the $1978-1982$ period to $81.8 \%$ ( $95 \% \mathrm{CI}$ : 79.5-83.9) in the 2000-2004 period. An improvement in survival was found for leukemia, lymphoma, and central nervous system (CNS) tumors in subgroup analysis. Conversely, no increase in survival over time was observed for malignant bone tumors. ${ }^{1,2}$ AYA had significantly worse 5 -year OS, during the 2000s, than children (0-14 years) for acute lymphoblastic leukemia (ALL, $62.8 \%$ vs. $89.8 \%$ ), non-Hodgkin lymphomas (NHL, $78.9 \%$ vs. $88.3 \%$ ), CNS tumors ( $67.3 \%$ vs. $71.9 \%$ ), and bone sarcomas ( $50.0 \%$ vs. $74.4 \%$ ). ${ }^{1,3}$ To improve cancer outcomes for AYA, various initiatives have been implemented in France since 2011, ${ }^{4}$ including promoting collaboration between pediatric and adult oncologists, developing French national policies for managing AYA with cancer, and setting up specific treatment units. Nevertheless it is unclear whether the adoption of pediatric-based protocols in adult centers has abolished disparities in AYA outcomes between pediatric and adult centers and improved outcomes at a population-level. Using a population-based cohort of AYA in France, the objectives were to provide updated statistics covering incidence and survival and to describe incidence and survival trends of these patients from 2000 to 2016.

## Methods

## Source of data

The registration of cancers in AYA is ensured by eighteen general and specialized population-based registries of the Francim network, covering 18\% of the French population. Medico-administrative sources (health institution claims databases of public or private health institutions used to obtain hospital patient information coded on discharge, and health insurance schemes databases) and medical sources (multidisciplinary team meetings databases in oncology, histology reports databases) were used to identify cases. Vital status was obtained by active search in medical records and by matching the French Cancer Registries files and the national population register "Repertoire National d'Identification des Personnes Physiques" sorted by date and place of birth to obtain the mention of death and the date of death. The cut-off date was defined as June 30, 2018.

## Population

Data were taken from the common database of all Francim network registries, and included gender, age at diagnosis, and diagnostic information. In line with the recommendations of the European Network of Cancer Registries ${ }^{5}$ and the third version of the International Classification of Childhood Cancer (ICCC-3), ${ }^{6}$ eligibility criteria were: diagnosis of cancer, for CNS localization according to the first revision of the third edition of the International Classification of Disease for Oncology (ICDO-3), ${ }^{7}$ benign and borderline tumors were also considered; from 15 to 24 years of age at diagnosis; and period of diagnosis between January 1, 2000 and December 31, 2016. Cutaneous carcinomas were excluded.

## Statistical Analyses

All data were retrieved, tabulated by tumor type and categorized using the ICCC-3 levels: 12 main diagnostic groups, 47 diagnostic subgroups, and 2-11 divisions of selected subgroups. ${ }^{6}$ The males/females (M/F) ratio was the ratio of number of cases in males to that in females.

The IR were calculated for the 17-year period, 2000-2016, and based on person-years derived from the annual estimates of population by age and sex provided by the Institute of Statistics and Economic Studies. Crude and age-specific IR were calculated and age-standardized rates (ASR) were estimated by the direct method using the world population for the age 15-24 years. ${ }^{8}$ Methods based on Poisson distribution were used to specify the $95 \%$ confidence interval $(95 \% \mathrm{CI})$ for the IR. ${ }^{9}$ Time trend in the incidence was estimated by the conventional annual percent change (cAPC) calculated as the slope of the linear regression used to model the natural logarithm of the IR as a function of the calendar year. ${ }^{10}$ Survival analysis was performed on a dataset containing all cases diagnosed between January 1, 2000 and December 31,2015 and followed-up until June 30, 2018. The probability of OS was estimated using the Kaplan-Meier method. ${ }^{11}$ The endpoint of interest was death from any cause for OS, with the date of diagnosis acting as the time origin. Survival curves between groups were compared using the log-rank test and the trend in survival over time periods was estimated using the logrank test for trend. ${ }^{12,13}$ Cox models were used to calculate the hazard ratios of death (HRs) and their $95 \%$ CI. ${ }^{14}$ Statistical tests were two-sided with a significant level of 0.05 . All statistical analyses were performed using the SAS version 9.4 (SAS Institute Inc., Cary, North Carolina, USA, 2013).

## Results

## Patient characteristics

Table 1 shows the number of cancers in AYA, diagnosed from 2000 to 2016, with main data quality indicators by French administrative areas where a French Cancer Registry is established. Most cancers were microscopically verified (98.6\%) and only $2 \%$ had unspecified morphology. A total of 2,734 15-19-year-old adolescents (39.4\%) and 4,199 2024 -year-old young adults (60.6\%) were included. Table 2 shows the distribution of tumors by
age group and diagnostic group and the $\mathrm{M} / \mathrm{F}$ ratios for each tumor type. The most common diagnoses in 15-19 year olds were lymphomas (27.7\%): Hodgkin lymphoma (HL) 20.4\%, NHL $6.0 \%$. In young adults (20-24 years), the most frequent tumors were malignant epithelial tumors (33.8\%): thyroid carcinomas (13.5\%), malignant melanomas (10.2\%). In 15-24-yearolds, approximately $30.7 \%$ of cancers were tumors of adulthood, especially thyroid carcinomas $11.6 \%$ and malignant melanomas $8.5 \%$. Embryonal malignancies, including Wilms tumor, hepatoblastoma, neuroblastoma, and medulloblastoma, were rare accounting for less than $1 \%$ of cases. For all cancers combined, the $\mathrm{M} / \mathrm{F}$ ratios were 1.0 for adolescents, for young adults, and for both. In male AYA, the most common cancers were malignant germ-cell tumors (GCT), malignant bone tumors, soft-tissue sarcomas, and leukemia, with $\mathrm{M} / \mathrm{F}$ ratio of $5.0,1.5,1.4$, and 1.4 respectively. Conversely, malignant melanomas and thyroid carcinomas were more frequent in female AYA (M/F ratio 0.6 and 0.2 , respectively).

## Incidence

Table 2 shows the specific IR and ASR from 2000 to 2016 for the main tumor types by age group, computed with both genders. The ASR for the 15-24-year-old population was 289.4 per million ( $95 \% \mathrm{CI} \%$ : $279.8-299.2$ ). The incidence (rate per million) was lowest in 15-19 year olds: 232.2 (males) and 231.7 (females). This incidence increased to 351.4 (males) and 372.2 (females) in 20-24 year olds. The highest ASR in males aged from 15 to 24 years was seen for malignant gonadal GCT $(\mathrm{ASR}=89.2,95 \% \mathrm{CI}: 82.8-96.1)$. HL was the second most frequent tumor type in males $(\mathrm{ASR}=51.7,95 \% \mathrm{CI}: 46.8-56.9)$, followed by malignant melanoma ( $\mathrm{ASR}=21.7,95 \% \mathrm{CI}$ : 18.5-25.2). In AYA females, HL represented the most frequent cancer type with an ASR of $58.6(95 \% \mathrm{CI}: 52.6-65.2)$, thyroid carcinoma the second $(\mathrm{ASR}=54.1,95 \% \mathrm{CI}: 48.4-60.2)$, and malignant melanoma the third $(\mathrm{ASR}=30.795 \% \mathrm{CI}: 26.6-$ 35.4). Cancer incidence in AYA for both genders was stable over time with a cAPC of $0.8 \%$
( $95 \% \mathrm{CI}:-3.5 \% ;+5.3 \%, \mathrm{p}=0.72$, Fig.1). No variation in incidence was observed by age group, gender, or each ICCC-3 diagnostic group.

## Overall Survival

Table 3 describes the 1-, 2-, and 5-year OS among AYA with cancer from 2000 to 2015 by ICCC-3 diagnostic groups and subgroups ( $\mathrm{n}=6,480$ ). With $2.9 \%$ lost to follow-up (Table 1 ), the median follow-up time in the cohort was 103 months (min-max: 0-222 months). At the end time, 983 AYA had died with a median time after diagnosis of 21 months (min-max: 0194 months). For all cancers combined, OS was $95.3 \%$ ( $95 \%$ CI: $94.8-95.8$ ) at 1 year, $91.3 \%$ ( $95 \% \mathrm{CI}$ : $90.6-92.0$ ) at 2 years, and $86.6 \%$ ( $95 \% \mathrm{CI}$ : $85.8-87.4$ ) at 5 years. The 5 -year OS greater than $85 \%$ were observed for HL, NHL, GCT, thyroid carcinomas, cervix uteri carcinomas, and malignant melanomas whereas 5 -year OS was around $60 \%$ and lower for osteosarcomas, Ewing tumors, hepatic carcinomas, and rhabdomyosarcomas. The 5-year OS were close to $65-80 \%$ for ALL, acute myeloid leukemia (AML), CNS tumors, and malignant renal tumors.

A comparison of 5-year OS in the studied periods (2000-2007 and 2008-2015) with those in earlier time periods (1972-1982, 1983-1987, 1988-1992, and 1993-1997 data from reference ${ }^{2}$ ) indicated that substantial survival gains were achieved for all tumors pooled (Table 4), with an increase from $62.0 \%(95 \% \mathrm{CI}: 57.5-66.5)$ in the $1978-82$ period to $88.0 \%$ ( $95 \% \mathrm{CI}: 86.9-$ 89.0) in the 2008-15 period. Since 1997, survival improvement was especially seen in leukemia and CNS tumors. For malignant bone tumors, the increase in survival was only observed during the last analyzed period (2008-15). Since 1993, survival was stable for softtissue sarcomas.

The 5-year OS has significantly improved from 2000-2007 to 2008-2015 for all cancers pooled, with a substantial gain of about $4 \%$ for 15-19 year-olds, and $3 \%$ for 20-24 year-olds
(Table 5). Increases in 5-year OS concerned most of diagnostic groups and were especially apparent for osteosarcomas in both age groups ( $\mathrm{p}<0.01$ ), and carcinomas in 20-24 year-olds $(\mathrm{p}=0.04)$. Conversely, a significant decrease over time was observed for astrocytomas in 2024 year-olds ( $\mathrm{p}=0.01$ ), due to differences in percentage of pilocytic astrocytoma and glioblastoma, respectively $51 \%$ vs. $12 \%$ during the $2000-2007$ period, and $24 \%$ vs. $45 \%$ during the 2008-2015 period.

During the 2000-2007 period, there were no statistically significant differences in 5-year OS between adolescents (15-19 years) and young adults (20-24 years) whatever the main diagnostic group (Table 5). However, during the latest studied period, young adults (20-24 years) diagnosed with ALL, astrocytoma, or Ewing's sarcoma had significantly a higher risk of dying from the disease compared to adolescents (15-19 years): HR=2.0 (IC95\%: 1.1-3.5), $\mathrm{HR}=2.2$ (IC95\%: 1.2-3.9), and $\mathrm{HR}=2.3$ (IC95\%: 1.1-4.8), respectively. The histologic distribution of pilocytic astrocytoma and glioblastoma were significantly different between adolescents and young adults: $61 \%$ and $12 \%$ in 15 - to 19 -year-olds, vs. $24 \%$ and $45 \%$ in 20 to 24 -year-olds ( $\mathrm{p}<0.01$ ).

## Discussion

Considering the emergence of interest in oncology in the AYA group, we examined incidence and survival of 15-24 year olds in order to better define the burden of the cancer for this age group. The two major findings in the present study were that cancer incidence in AYA remained stable during the 2000-2016 period, and the 5-year OS combined has significantly improved over time, especially for osteosarcoma. Another major finding of our study was that, during the latest studied period, adolescents had significantly better 5 -year OS than young adults for ALL, Ewing's sarcomas, and astrocytomas.

The major strength of this study is its homogenization of compulsory registration based to various sources of notification of 18 population-based cancer registries providing a nonbiased and valid view of the situation in France during the studied period, compared to clinical series which report better survival than population-based studies. The coverage is $18 \%$ of the whole country. However, these registries have provided the estimates of national rates for decades and they are the gold standard referred to by all descriptive studies. Roughly 2,300 new cases of cancers in AYA are currently diagnosed each year in France (900 in adolescents and 1,400 in young adults).

Several studies have described cancer incidence and survival in AYA, but few of them were based on the same period and the same age ranges. ${ }^{10,15-21}$ Our incidence rates in 15-19 year olds were comparable to those reported in other countries. ${ }^{10,15-18}$ In 20-24 year olds, highest incidence was observed in the United States (US): 386 per million. ${ }^{10}$ Marked differences between France and the US occurred for thyroid carcinoma (IR per million: 78 versus 122 for young females, no difference for males) and for melanoma (IR per million: 47 versus 57 for young white females, no difference for males). In the US, the incidence of thyroid carcinoma in AYA population increased by $4.0 \%$ per year from 1988 to 2006, $8.6 \%$ per year from 2006 to 2009 , and $1.4 \%$ from 2009 to 2016 , likely a consequence of ultrasound screening. ${ }^{22}$ For melanoma, this suggests that American white female young adults may share high exposures that are associated with malignant melanoma. Jones et al ${ }^{23}$ have reported that, during 19992009, the percentage of white American students who never or rarely wore sunscreen when outside on a sunny day for $>1$ hour increased from $57.5 \%$ to $69.4 \%$ (with an increase most pronounced among white female students). We reported a non-significant increase of +0.8 in incidence for all malignancies over time in 15- to 24 -year olds. Vast differences between countries were observed in the incidence trend for all cancers combined. Gupta et al ${ }^{24}$ have reported that the incidence of AYA (15-39 years) cancer rose over the 1998-2012 period in 23
countries, decreased in two countries, and remained stable in the other 16. Striking increases were noted for thyroid and testicular in 33 and 22 countries respectively, including France. The 5-year observed survivals in this study were similar to those reported for AYA in the US $(2009-2015)^{10}$, in Australia (2000-2014) ${ }^{18}$, in the United-Kingdom (UK: 2005-2010) ${ }^{19}$, and in 27 European countries participating in EUROCARE-5 (2000-2007) ${ }^{21}$. However marked differences between France and the UK occurred for NHL ( $88 \%$ vs. $79 \%$ ), bone sarcomas ( $65 \%$ vs. $56 \%$ ), soft-tissue sarcomas ( $67 \%$ vs. $61 \%$ ), and GCT ( $93 \%$ vs. $82 \%$ ). Compared to EUROCARE-5 study ${ }^{21}$, we reported higher survival for ALL, CNS tumors, Ewing's sarcoma, and soft-tissue sarcomas especially in 15-19 years. These survival disparities may be due to differences in tumor classification used (ICDO-2 vs. ICDO-3), in tumor selection (inclusion or not of benign/borderline CNS tumors), in distribution of cases by stages at diagnosis, by histological or biological subtypes, or by grades of neoplasm, and in treatment strategies by age over time.

Compared to results of the latest French reports among AYA, ${ }^{1,2}$ we found an improvement in survival from 1978 to 2015 , to achieve a 5 -year OS of $88.0 \%$ ( $95 \% \mathrm{CI}: 86.9-89.0$ ) for all cancers combined during the 2008-2015 period. Increases in survival over time have been observed for all diagnostic groups, except for soft-tissue sarcomas with a 5 -year OS around $70 \%$ since the mid- 90 s. Compared to children and older adults, AYA with soft-tissue sarcomas have not experienced an improvement in survival. ${ }^{25,26}$ The reasons for this disparity remain unclear, but following issues have been mentioned: delays in diagnosis, trial availability and participation, aspects of the organization of care, national centralization of sarcoma care, international consortia, and factors related to tumor biology. ${ }^{27}$ In our series, comparison of 5-year OS of osteosarcoma AYA treated during 2000 to 2007 and 2008 to 2015 revealed a significant improvement of $14 \%$ in adolescents and $40 \%$ in young adults. One of the most crucial factors contributing to the increase in survival is the setting up of the

French OS2006/sarcome-09 study using methotrexate-etoposide-ifosfamide based regimen, randomized to receive or not high doses of zoledronic acid adapted from those given for pediatric osteosarcoma patients. ${ }^{28,29}$

During the latest studied period, 5 -year OS was worse in young adults than in adolescents and in children ${ }^{3}$ for $\operatorname{ALL}(63.2 \%, 79.3 \%$, and $89.8 \%$, respectively), for astrocytoma $(49.6 \%$, $74.8 \%$, and $87.0 \%$, respectively), and Ewing tumor ( $38.1 \%, 70.4 \%$, and $73.8 \%$, respectively). Interest has recently been paid to AYA with ALL, particularly because all reports so far published indicate that these patients have a better outcome when treated with pediatric rather than adult therapeutic protocols. ${ }^{30}$ In France since 2003, adolescents with ALL have been treated in or according to pediatric trials (either the FRALLE-2000 or EORTC-58951 trials) ${ }^{31}$ and young adults markedly benefited from a pediatric approach by the Group for Research on Adult Acute Lymphoblastic Leukemia (GRAALL). ${ }^{32,33}$ This may explain the difference in survival between adolescents and young adults. Although the inclusion of asparaginase in pediatric-inspired chemotherapy regimens has a positive impact on survival in AYA patients, factors accounting for differences in outcome compared to children include incidence of adverse events ${ }^{34}$ and heterogeneity in ALL biology. ${ }^{35}$ Differences in survival between children, adolescents and young adults with astrocytoma result of different distribution of gliomas with varying prognosis depending on tumor grade. Low-grade astrocytomas (WHO grades I and II including especially pilocytic astrocytomas) are the most frequently encountered brain tumors in early childhood and adolescence, while high-grade astrocytomas (WHO grades III and IV, such as anaplastic astrocytomas and glioblastomas) tend to occur at increasing rates with increasing age. ${ }^{36}$ Several studies have analyzed potential correlations between Ewing sarcoma patients' ages and prognosis, but results have been inconsistent, and it remains unproven whether age in the AYA range by itself truly confers inferior survival. ${ }^{37}$ For this reason, European cooperative group trials have included patients up to the age of 50
years. ${ }^{38}$ Moreover, in the EURO-EWING99 clinical trial, it has been observed that some toxicities (neutropenia, thrombocytopenia and stomatitis) may even decrease with age. ${ }^{38}$ It remains to be determined whether less toxicity represents less treatment administered to older patients, or whether age distribution of biologic factors and Ewing-like tumor entities, treated as Ewing sarcoma and having different clinical behavior, can be held responsible. ${ }^{39}$ Even though the survival between adolescents and young adults seemed to be similar for the other cancers, these AYA patients had persistent worse 5 -year overall survival than children for osteosarcoma, rhabdomyosarcoma, and malignant hepatic tumors. ${ }^{1,3}$ Several factors are believed to have influenced the lack of survival improvement noted for AYA: access to clinical trials, biologic characteristics of these cancers, access to health-care professionals and services, and specific treatment strategies.,40,41

## Conclusion

We have presented updated data representing a comprehensive analysis of cancer incidence and survival in AYA in France during the 2000-2016 period. Notwithstanding the encouraging results for some cancers, and overall, persistent poorer survivals in AYA were shown compared to children for ALL, osteosarcoma, Ewing tumor, rhabdomyosarcoma and malignant hepatic tumors. These survival disparities observed require further investigation to identify and address the causes of these inferior outcomes.

## Author Disclosure Statements

No competing financial interests exist.

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TABLE 1.CANCER CASES IN ADOLESCENTS AND YOUNG ADULTS DIAGNOSED IN 2000-2016, in 19 French Administrative Areas, with data quality indicators

Abbreviations: ICCC-3, third version of the International Classification of Childhood Cancer.

Table 2. Number of Tumors, sex Ratio, and cancer irs per million in AYA in France FROM 2000 TO 2016 DETAILED BY DIAGNOSTIC GROUPS AND SUBGROUPS

Abbreviations: AYA, adolescents and young adults; ICCC-3, third version of the International Classification of Childhood Cancer; GCT, Germ-Cell tumors; cPNET, central primitive neuroectodermal tumors; pPNET, peripheral primitive neuroectodermal tumors; M/F ratio, Male/Female ratio; IR, Incidence rates per million; ASR, age-standardized incidence rates per million; $95 \%$ CI, $95 \%$ confidence interval.

FIG. 1. Time trend in age-standardized incidence rates estimated by the conventional annual percent change, in AYA (15-24 years) in France between 2000 and 2016

Abbreviations: cAPC, conventional annual percent change; ASR, age-standardized incidence rates per million; AYA, adolescents and young adults.
table 3. One-, Two-, and Five-year Overall Survival among AYa with Cancer FROM 2000 to 2015 By ICCC-3 DiAgnostic Groups

Abbreviations: AYA, adolescents and young adults; ICCC-3, third version of the International Classification of Childhood Cancer; GCT, Germ-Cell tumors; cPNET, central primitive neuroectodermal tumors; pPNET, peripheral primitive neuroectodermal tumors; OS, Overall Survival; $95 \% \mathrm{CI}, 95 \%$ confidence interval.

Table 4. Trends in Five-Year Overall Survival among adolescents and young
adults with Cancer from 1978 to 2015 By ICCC-3 Diagnostic Groups
Abbreviations: ICCC-3: third version of the International Classification of Childhood Cancer; OS: Overall Survival; 95\%CI: 95\% confidence interval

* Data from reference ${ }^{2}$
\# Only malignant CNS tumors were included (exclusion of benign or borderline tumors)
${ }^{\mathrm{a}} \mathrm{p}<0.05$ Comparison between diagnostic periods (2000-2007 vs 2008-2015)

Table 5. Trends in Five-year Overall Survival among adolescents and young ADULTS WITH CANCER FROM 2000-2007 TO 2008-2015 BY ICCC-3 DIAGNOSTIC GROUPS Abbreviations: ICCC-3, third version of the International Classification of Childhood Cancer; 5yOS, Five-year Overall Survival; 95\%CI, 95\% confidence interval. ${ }^{\mathrm{a}} \mathrm{p}<0.05$ Comparison between diagnostic periods (2000-2007 vs 2008-2015) ${ }^{\mathrm{b}} \mathrm{p}<0.05$ Comparison between age groups (15-19 years vs 20-24 years)

Table 1.Cancer cases in adolescents and young adults diagnosed in 2000-2016, in 19 French Administrative Areas, with data
QUALITY INDICATORS

| French Administrative Areas | Registered period | Incidence analysis (2000-2016) |  |  | Survival analysis (2000-2015) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Patient included N | Microscopically Verified N (\%) | Unspecified cases according to ICCC-3 $\mathrm{N} \text { (\%) }$ | Patient included <br> N | Lost to follow-up N (\%) |
| 14-Calvados | 2000-2015 | 396 | 391 (98.7) | 6 (1.5) | 392 | 5 (1.3) |
| 16-Charente | 2008-2016 | 123 | 120 (97.6) | 1 (0.8) | 110 | 5 (4.5) |
| 17-Charente/Maritime | 2008-2016 | 189 | 187 (98.9) | 2 (1.1) | 164 | 19 (11.6) |
| 25-Doubs | 2000-2016 | 336 | 326 (97.0) | 10 (3.0) | 320 | 0 (0.0) |
| 33-Gironde | 2005,2008-2016 | 594 | 579 (97.5) | 7 (1.2) | 532 | 18 (3.4) |
| 34-Hérault | 2000-2016 | 632 | 624 (98.7) | 12 (1.9) | 573 | 25 (4.4) |
| 38-Isère | 2000-2016 | 816 | 810 (99.3) | 7 (0.9) | 775 | 17 (2.2) |
| 44-Loire Atlantique | 2000-2016 | 836 | 830 (99.3) | 10 (1.2) | 780 | 22 (2.8) |
| 50-Manche | 2000-2016 | 245 | 242 (98.8) | 4 (1.6) | 234 | 14 (6.0) |
| 59-Lille Area | 2008-2016 | 315 | 313 (99.4) | 4 (1.3) | 284 | 4 (1.4) |
| 67- Bas Rhin | 2000-2014 | 644 | 631 (98.0) | 10 (1.6) | 642 | 13 (2.0) |
| 68- Haut Rhin | 2000-2016 | 457 | 454 (99.3) | 1 (0.2) | 429 | 19 (4.4) |
| 79-Deux-Sèvres | 2008-2016 | 124 | 122 (98.4) | 3 (2.4) | 108 | 2 (1.9) |
| 80-Somme | 2000-2016 | 325 | 320 (98.5) | 7 (2.2) | 309 | 9 (2.9) |
| 81-Tarn | 2000-2016 | 173 | 171 (98.8) | 1 (0.6) | 157 | 3 (1.9) |
| 85-Vendée | 2000-2016 | 429 | 427 (99.5) | 3 (0.7) | 404 | 7 (1.7) |
| 86-Vienne | 2008-2016 | 151 | 146 (96.7) | 2 (1.3) | 133 | 3 (2.3) |
| 87-Haute Vienne | 2009-2016 | 99 | 97 (98.0) | 2 (2.0) | 89 | 2 (2.2) |
| 90- Territoire de Belfort | 2007-2016 | 49 | 48 (98.0) | 1 (2.0) | 45 | 1 (2.2) |
| Total | 2000-2016 | 6933 | 6838 (98.6) | 93 (1.3) | 6480 | 188 (2.9) |

Abbreviations: ICCC-3, third version of the International Classification of Childhood Cancer.
GROUPS AND SUBGROUPS

| Diagnostic groups and subgroups (ICCC-3) | Adolescents (15-19 years) |  |  | Young adults (20-24 years) |  |  | AYA (15-24 years) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | n (\%) | $\begin{gathered} \mathrm{M} / \mathrm{F} \\ \text { ratio } \end{gathered}$ | IR [95\%CI] | n (\%) | $\begin{gathered} \mathrm{M} / \mathrm{F} \\ \text { ratio } \end{gathered}$ | IR [95\%CI] | n (\%) | $\begin{aligned} & \hline \mathbf{M} / \mathbf{F} \\ & \text { ratio } \end{aligned}$ | ASR [95\%CI] |
| I. Leukemias, myeloproliferative/dysplastic diseases | 365 (13.4) | 1.5 | 31.0 [27.9-34.3] | 318 (7.6) | 1.2 | 26.8 [23.9-29.9] | 683 (9.9) | 1.4 | 29.0 [26.0-32.2] |
| Ia. Lymphoblastic leukemias | 196 (7.2) | 2.1 | 16.6 [14.4-19.1] | 111 (2.6) | 2.2 | 9.4 [7.7-11.3] | 307 (4.4) | 2.1 | 13.2 [11.2-15.4] |
| Ia1. Precursor cell leukemias | 195 (7.1) | 2.1 | 16.5 [14.3-19] | 100 (2.4) | 2.2 | 8.4 [6.9-10.3] | 295 (4.3) | 2.1 | 12.7 [10.8-14.9] |
| Ia2. Mature B-cell leukemias | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 8 (0.2) | 3.0 | 0.7 [0.3-1.3] | 9 (0.1) | 2.0 | 0.4 [0.1-0.9] |
| Ia3. Mature T-cell and NK cell leukemias | 0 (0.0) | - | 0.0 [0.1-0.3] | 3 (0.1) | 0.5 | 0.3 [0.0-0.7] | 3 (0.0) | 0.5 | 0.1 [0.1-0.5] |
| Ib . Acute myeloid leukemias | 102 (3.7) | 1.1 | 8.7 [7.1-10.5] | 87 (2.1) | 0.9 | 7.3 [5.9-9.0] | 189 (2.7) | 1.0 | 8.0 [6.5-9.8] |
| Ic. Chronic myeloproliferative diseases | 42 (1.5) | 1.0 | 3.6 [2.6-4.8] | 96 (2.3) | 1.0 | 8.1 [6.6-9.9] | 138 (2.0) | 1.0 | 5.7 [4.4-7.2] |
| Id. Myelodysplastic diseases | 16 (0.6) | 0.8 | 1.4 [0.8-2.2] | 19 (0.5) | 0.7 | 1.6 [1.0-2.5] | 35 (0.5) | 0.8 | 1.5 [0.9-2.3] |
| Ie. Unspecified and other specified leukemias | 9 (0.3) | 3.5 | 0.8 [0.3-1.5] | 5 (0.1) | 0.3 | 0.4 [0.1-1.0] | 14 (0.2) | 1.3 | 0.6 [0.2-1.2] |
| II. Lymphomas and lymphoreticular neoplasms | 758 (27.7) | 0.9 | 64.3 [59.8-69.1] | 956 (22.8) | 1.0 | 80.6 [75.6-85.9] | 1714 (24.7) | 0.9 | 72.0 [67.2-77.0] |
| IIa. Hodgkin disease | 557 (20.4) | 0.8 | 47.3 [43.4-51.3] | 703 (16.7) | 0.9 | 59.3 [55-63.8] | 1260 (18.2) | 0.8 | 52.9 [48.8-57.2] |
| IIb. Non-Hodgkin lymphomas | 164 (6.0) | 1.0 | 13.9 [11.9-16.2] | 227 (5.4) | 1.2 | 19.1 [16.7-21.8] | 391 (5.6) | 1.1 | 16.4 [14.2-18.8] |
| IIb 1. Precursor-cell lymphomas | 12 (0.4) | 5.0 | 1.0 [0.5-1.8] | 14 (0.3) | 2.5 | 1.2 [0.6-2.0] | 26 (0.4) | 3.3 | 1.1 [0.6-1.9] |
| IIb2. Mature B-cell lymphomas | 101 (3.7) | 0.9 | 8.6 [7.0-10.4] | 160 (3.8) | 1.3 | 13.5 [11.5-15.8] | 261 (3.8) | 1.1 | 10.9 [9.1-12.9] |
| Ilb3. Mature T-cell and NK-cell lymphomas | 47 (1.7) | 1.0 | 4.0 [2.9-5.3] | 46 (1.1) | 0.8 | 3.9 [2.8-5.2] | 93 (1.3) | 0.9 | 3.9 [2.9-5.2] |
| IIb4. Unspecified Non-Hodgkin lymphomas | 4 (0.1) | 0.0 | 0.3 [0.1-0.9] | 7 (0.2) | 0.8 | 0.6 [0.2-1.2] | 11 (0.2) | 0.4 | 0.5 [0.2-1.0] |
| IIc. Burkitt lymphoma | 23 (0.8) | 3.6 | 2.0 [1.2-2.9] | 15 (0.4) | 4.0 | 1.3 [0.7-2.1] | 38 (0.5) | 3.8 | 1.6 [1.0-2.5] |
| IId. Miscellaneous lymphoreticular neoplasms | 13 (0.5) | 3.3 | 1.1 [0.6-1.9] | 8 (0.2) | 1.0 | 0.7 [0.3-1.3] | 21 (0.3) | 2.0 | 0.9 [0.4-1.6] |
| IIe. Unspecified lymphoma | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 3 (0.1) | 0.0 | 0.3 [0.0-0.7] | 4 (0.1) | 0.0 | 0.2 [0.0-0.6] |

Table 2. (Continued)

| Diagnostic groups and subgroups (ICCC-3) | Adolescents (15-19 years) |  |  | Young adults (20-24 years) |  |  | AYA (15-24 years) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | n (\%) | $\begin{aligned} & \mathbf{M} / \mathbf{F} \\ & \text { ratio } \\ & \hline \end{aligned}$ | IR [95\%CI] | n (\%) | $\begin{gathered} \mathrm{M} / \mathrm{F} \\ \text { ratio } \end{gathered}$ | IR [95\%CI] | n (\%) | $\begin{aligned} & \mathbf{M} / \mathbf{F} \\ & \text { ratio } \end{aligned}$ | ASR [95\%CI] |
| III. Central nervous system tumors | 332 (12.1) | 1.1 | 28.2 [25.2-31.4] | 411 (9.8) | 1.3 | 34.6 [31.4-38.2] | 743 (10.7) | 1.2 | 31.2 [28.1-34.6] |
| IIIa. Ependymomas and choroid plexus tumor | 31 (1.1) | 1.6 | 2.6 [1.8-3.7] | 25 (0.6) | 1.5 | 2.1 [1.4-3.1] | 56 (0.8) | 1.5 | 2.4 [1.6-3.4] |
| IIIa1. Ependymomas | 26 (1.0) | 1.9 | 2.2 [1.4-3.2] | 23 (0.5) | 1.3 | 1.9 [1.2-2.9] | 49 (0.7) | 1.6 | 2.1 [1.3-3.1] |
| IIIa2. Choroid plexus tumor | 5 (0.2) | 0.7 | 0.4 [0.1-1.0] | 2 (0.0) | - | 0.2 [0.0-0.6] | 7 (0.1) | 1.3 | 0.3 [0.1-0.8] |
| IIIb. Astrocytomas | 106 (3.9) | 1.3 | 9.0 [7.4-10.9] | 122 (2.9) | 1.7 | 10.3 [8.5-12.3] | 228 (3.3) | 1.5 | 9.6 [7.9-11.5] |
| IIIc. Intracranial and intraspinal embryonal tumors | 26 (1.0) | 2.3 | 2.2 [1.4-3.2] | 25 (0.6) | 5.3 | 2.1 [1.4-3.1] | 51 (0.7) | 3.3 | 2.2 [1.4-3.2] |
| IIIc 1.Medulloblastomas | 18 (0.7) | 3.5 | 1.5 [0.9-2.4] | 19 (0.5) | 8.5 | 1.6 [1.0-2.5] | 37 (0.5) | 5.2 | 1.6 [0.9-2.5] |
| IIIc2. cPNET | 5 (0.2) | 0.7 | 0.4 [0.1-1.0] | 5 (0.1) | 4.0 | 0.4 [0.1-1.0] | 10 (0.1) | 1.5 | 0.4 [0.1-1.0] |
| IIIc3. Medulloepithelioma | 1 (0.0) | 0.0 | 0.1 [0.0-0.0.5] | $1(0.0)$ | 0.0 | 0.1 [0.0-0.5] | 2 (0.0) | 0.0 | 0.1 [0.0-0.5] |
| IIIc4. Atypical teratoid/rhabdoid tumor | 2 (0.1) | - | 0.2 [0.0-0.6] | 0 (0.0) | - | 0.0 [0.1-0.3] | 2 (0.0) | - | 0.1 [0.0-0.5] |
| IIId. Other gliomas | 43 (1.6) | 0.7 | 3.6 [2.6-4.9] | 101 (2.4) | 1.2 | 8.5 [6.9-10.3] | 144 (2.1) | 1.1 | 5.9 [4.7-7.5] |
| IIId1. Oligodendrogliomas | 20 (0.7) | 0.8 | 1.7 [1.0-2.6] | 58 (1.4) | 1.2 | 4.9 [3.7-6.3] | 78 (1.1) | 1.1 | 3.2 [2.3-4.4] |
| IIId2. Mixed and unspecified gliomas | 22 (0.8) | 0.7 | 1.9 [1.2-2.8] | 42 (1) | 1.2 | 3.5 [2.6-4.8] | 64 (0.9) | 1.0 | 2.7 [1.8-3.8] |
| IIId3. Neuroepithelial glial tumors | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 1 (0.0) | - | 0.1 [0.0-0.5] | 2 (0.0) | 1.0 | 0.1 [0.0-0.5] |
| IIIe. Other specified intracranial and intraspinal tumors | 115 (4.2) | 0.9 | 9.8 [8.1-11.7] | 121 (2.9) | 0.8 | 10.2 [8.5-12.2] | 236 (3.4) | 0.9 | 10.0 [8.2-11.9] |
| IIIe 1. Pituitary adenomas and carcinomas | 6 (0.2) | 2.0 | 0.5 [0.2-1.1] | 4 (0.1) | 0.3 | 0.3 [0.1-0.9] | 10 (0.1) | 1.0 | 0.4 [0.1-1.0] |
| IIIe2. Tumors of sellar region | 10 (0.4) | 0.7 | 0.8 [0.4-1.6] | 20 (0.5) | 1.2 | 1.7 [1.0-2.6] | 30 (0.4) | 1.0 | 1.2 [0.7-2.1] |
| IIIe3. Pineal parenchymal tumors | 2 (0.1) | 1.0 | 0.2 [0.0-0.6] | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 3 (0.0) | 0.5 | 0.1 [0.0-0.6] |
| IIIe4. Neuronal and mixed neuronal-glial tumors | 68 (2.5) | 0.9 | 5.8 [4.5-7.3] | 51 (1.2) | 1.0 | 4.3 [3.2-5.7] | 119 (1.7) | 0.9 | 5.1 [3.9-6.5] |
| IIIe5. Meningiomas | 29 (1.1) | 0.9 | 2.5 [1.6-3.5] | 45 (1.1) | 0.7 | 3.8 [2.8-5.1] | 74 (1.1) | 0.8 | 3.1 [2.2-4.3] |
| IIIf. Unspecified intracranial and intraspinal neoplasms | 11 (0.4) | 0.8 | 0.9 [0.5-1.7] | 17 (0.4) | 1.4 | 1.4 [0.8-2.3] | 28 (0.4) | 1.2 | 1.2 [0.6-2.0] |
| IV. Neuroblastoma | 13 (0.5) | 1.6 | 1.1 [0.6-1.9] | 12 (0.3) | 0.3 | 1.0 [0.5-1.8] | 25 (0.4) | 0.8 | 1.1 [0.6-1.8] |
| IVa. Neuroblastoma and ganglioneuroblastoma | 6 (0.2) | 2.0 | 0.5 [0.2-1.1] | 3 (0.1) | 0.5 | 0.3 [0.0-0.7] | 9 (0.1) | 1.3 | 0.4 [0.1-0.9] |
| IVb. Other peripheral nervous cell tumors | 7 (0.3) | 1.3 | 0.6 [0.2-1.2] | 9 (0.2) | 0.3 | 0.8 [0.3-1.4] | 16 (0.2) | 0.6 | 0.7 [0.3-1.3] |
| VI. Renal tumors | 20 (0.7) | 0.7 | 1.7 [1.0-2.6] | 42 (1) | 1.2 | 3.5 [2.6-4.8] | 62 (0.9) | 1.0 | 2.6 [1.7-3.6] |
| VIa. Nephroblastoma. other nonepithelial renal tumors | 6 (0.2) | 0.0 | 0.5 [0.2-1.1] | 7 (0.2) | 1.3 | 0.6 [0.2-1.2] | 13 (0.2) | 0.4 | 0.5 [0.2-1.2] |
| VIa 1. Nephroblastoma | 4 (0.1) | 0.0 | 0.3 [0.1-0.9] | 6 (0.1) | 2.0 | 0.5 [0.2-1.1] | 10 (0.1) | 0.7 | 0.4 [0.1-1.0] |
| VIa2. Rhabdoid renal tumors | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | $1(0.0)$ | 0.0 | 0.1 [0.0-0.5] | 2 (0.0) | 0.0 | 0.1 [0.0-0.5] |
| VIa4. pPNET of kidney | $1(0.0)$ | 0.0 | 0.1 [0.0-0.5] | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | 0.0 | 0.0 [0.0-0.4] |
| VIb. Renal carcinoma | 14 (0.5) | 1.3 | 1.2 [0.6-2.0] | 34 (0.8) | 1.3 | 2.9 [2.0-4.0] | 48 (0.7) | 1.3 | 2.0 [1.3-2.9] |
| VIc. Unspecified malignant renal tumors | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 1 (0.0) | 0.0 | 0.0 [0.0-0.4] |

Table 2. (Continued)

| Diagnostic groups and subgroups (ICCC-3) | Adolescents (15-19 years) |  |  | Young adults (20-24 years) |  |  | AYA (15-24 years) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | n (\%) | $\begin{aligned} & \mathrm{M} / \mathrm{F} \\ & \text { ratio } \end{aligned}$ | IR [95\%CI] | n (\%) | $\begin{gathered} \mathrm{M} / \mathrm{F} \\ \text { ratio } \\ \hline \end{gathered}$ | IR [95\%CI] | n (\%) | $\begin{aligned} & \mathbf{M} / \mathbf{F} \\ & \text { ratio } \end{aligned}$ | ASR [95\%CI] |
| VII. Hepatic tumors | 11 (0.4) | 0.8 | 0.9 [0.5-1.7] | 20 (0.5) | 1.9 | 1.7 [1.0-2.6] | 31 (0.4) | 1.4 | 1.3 [0.7-2.1] |
| VIIa. Hepatoblastoma | 1 (0.0) | - | 0.1 [0.0-0.5] | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | - | 0.0 [0.0-0.4] |
| VIIb. Hepatic carcinoma | 9 (0.3) | 0.5 | 0.8 [0.3-1.5] | 20 (0.5) | 1.9 | 1.7 [1.0-2.6] | 29 (0.4) | 1.2 | 1.2 [0.7-2.0] |
| VIIc. Unspecified malignant hepatic tumors | 1 (0.0) | - | 0.1 [0.0-0.5] | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | - | 0.0 [0.0-0.4] |
| VIII. Malignant bone tumors | 217 (7.9) | 1.5 | 18.4 [16.0-21.0] | 122 (2.9) | 1.6 | 10.3 [8.5-12.3] | 339 (4.9) | 1.5 | 14.6 [12.5-16.9] |
| VIIIa. Osteosarcomas | 107 (3.9) | 1.7 | 9.1 [7.4-11.0] | 48 (1.1) | 1.4 | 4.0 [3.0-5.4] | 155 (2.2) | 1.6 | 6.7 [5.3-8.3] |
| VIIIb. Chondrosarcomas | 17 (0.6) | 0.9 | 1.4 [0.8-2.3] | 32 (0.8) | 0.9 | 2.7 [1.8-3.8] | 49 (0.7) | 0.9 | 2.0 [1.3-3.0] |
| VIIIc. Ewing tumor and related sarcomas of bone | 83 (3.0) | 1.5 | 7.0 [5.6-8.7] | 36 (0.9) | 3.5 | 3.0 [2.1-4.2] | 119 (1.7) | 1.9 | 5.2 [4.0-6.6] |
| VIIId. Other specified malignant bone tumors | 8 (0.3) | 0.3 | 0.7 [0.3-1.3] | 6 (0.1) | 2.0 | 0.5 [0.2-1.1] | 14 (0.2) | 0.8 | 0.6 [0.2-1.2] |
| VIIId2. Malignant chordomas | 6 (0.2) | 0.0 | 0.5 [0.2-1.1] | 2 (0.0) | - | 0.2 [0.0-0.6] | 8 (0.1) | 0.3 | 0.3 [0.1-0.9] |
| VIIId3. Odotongenic malignant tumors | 1 (0.0) | - | 0.1 [0.0-0.5] | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | - | 0.0 [0.0-0.4] |
| VIIId4. Miscellaneous malignant bone tumors | 1 (0.0) | - | 0.1 [0.0-0.5] | 4 (0.1) | 1.0 | 0.3 [0.1-0.9] | 5 (0.1) | 1.5 | 0.2 [0.0-0.7] |
| VIIIe. Unspecified malignant bone tumors | 2 (0.1) | - | 0.2 [0.0-0.6] | 0 (0.0) | - | 0.0 [0.1-0.3] | 2 (0.0) | - | 0.1 [0.0-0.5] |
| IX. Soft tissue and other extraosseous sarcomas | 134 (4.9) | 1.4 | 11.4 [9.5-13.5] | 165 (3.9) | 1.4 | 13.9 [11.9-16.2] | 299 (4.3) | 1.4 | 12.6 [10.6-14.8] |
| IXa.Rhabdomyosarcomas | 33 (1.2) | 1.5 | 2.8 [1.9-3.9] | 23 (0.5) | 2.8 | 1.9 [1.2-2.9] | 56 (0.8) | 1.9 | 2.4 [1.6-3.5] |
| IXb.Fibrosarcomas. and other fibrous neoplasms | 26 (1.0) | 0.9 | 2.2 [1.4-3.2] | 26 (0.6) | 0.9 | 2.2 [1.4-3.2] | 52 (0.8) | 0.9 | 2.2 [1.4-3.2] |
| IXb1.Fibroblastic and myofibroblastic tumors | 17 (0.6) | 1.4 | 1.4 [0.8-2.3] | 13 (0.3) | 0.6 | 1.1 [0.6-1.9] | 30 (0.4) | 1.0 | 1.3 [0.7-2.1] |
| IXb2.Nerve sheath tumors | $9(0.3)$ | 0.3 | 0.8 [0.3-1.5] | 13 (0.3) | 1.2 | 1.1 [0.6-1.9] | 22 (0.3) | 0.7 | 0.9 [0.5-1.7] |
| IXc. Kaposi sarcoma | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 1 (0.0) | 0.0 | 0.0 [0.0-0.4] |
| IXd.Other specified soft tissue sarcomas | 62 (2.3) | 1.6 | 5.3 [4.0-6.6.7] | 87 (2.1) | 1.4 | 7.3 [5.9-9.0] | 149 (2.1) | 1.4 | 6.2 [4.9-7.8] |
| IXd1-2.Ewing tumors and pPNET of soft tissue | 16 (0.6) | 1.7 | 1.4 [0.8-2.2] | 11 (0.3) | 1.8 | 0.9 [0.5-1.7] | 27 (0.4) | 1.7 | 1.2 [0.6-2.0] |
| IXd3.Extrarenal rhabdoid tumor | 0 (0.0) | - | 0.0 [0.1-0.3] | 3 (0.1) | 0.5 | 0.3 [0.0-0.7] | 3 (0.0) | 0.5 | 0.1 [0.1-0.5] |
| IXd4.Liposarcomas | 8 (0.3) | 0.6 | 0.7 [0.3-1.3] | 14 (0.3) | 1.3 | 1.2 [0.6-2.0] | 22 (0.3) | 1.0 | 0.9 [0.5-1.6] |
| IXd5.Fibrohistiocytic tumors | 2 (0.1) | 1.0 | 0.2 [0.0-0.6] | 5 (0.1) | 0.7 | 0.4 [0.1-1.0] | 7 (0.1) | 0.8 | 0.3 [0.1-0.8] |
| IXd6.Meiomyosarcomas | 6 (0.2) | - | 0.5 [0.2-1.1] | 10 (0.2) | 1.0 | 0.8 [0.4-1.6] | 16 (0.2) | 2.2 | 0.7 [0.3-1.3] |
| IXd7.Synovial sarcomas | 19 (0.7) | 1.4 | 1.6 [1.0-2.5] | 23 (0.5) | 1.9 | 1.9 [1.2-2.9] | 42 (0.6) | 1.6 | 1.8 [1.1-2.7] |
| IXd8. Blood vessel tumors | 4 (0.1) | 0.3 | 0.3 [0.1-0.9] | 5 (0.1) | 0.3 | 0.4 [0.1-1.0] | $9(0.1)$ | 0.3 | 0.4 [0.1-0.9] |
| IXd9. Osseous and chondromatous neoplasms | 1 (0.0) | - | 0.1 [0.0-0.5] | 5 (0.1) | 0.7 | 0.4 [0.1-1.0] | 6 (0.1) | 1.0 | 0.2 [0.1-0.7] |
| IXd10. Alveolar soft parts sarcoma | $1(0.0)$ | 0.0 | 0.1 [0.0-0.5] | 4 (0.1) | - | 0.3 [0.1-0.9] | 5 (0.1) | 4.0 | 0.2 [0.0-0.7] |
| IXd11. Miscellaneous soft tissue sarcomas | 5 (0.2) | - | 0.4 [0.1-1.0] | 7 (0.2) | 2.5 | 0.6 [0.2-1.2] | 12 (0.2) | 5.0 | 0.5 [0.2-1.1] |
| IXe Unspecified soft tissue sarcomas | 13 (0.5) | 2.3 | 1.1 [0.6-1.9] | 28 (0.7) | 1.5 | 2.4 [1.6-3.4] | 41 (0.6) | 1.7 | 1.7 [1.0-2.6] |

TABLE 2. (Continued)

| Diagnostic groups and subgroups (ICCC-3) | Adolescents (15-19 years) |  |  | Young adults (20-24 years) |  |  | AYA (15-24 years) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | n (\%) | $\mathbf{M} / \mathbf{F}$ ratio | IR [95\%CI] | n (\%) | $\begin{gathered} \mathrm{M} / \mathrm{F} \\ \text { ratio } \\ \hline \end{gathered}$ | IR [95\%CI] | n (\%) | M/F ratio | ASR [95\%CI] |
| X. Germ-cell tumors. and other neoplasms of gonads | 292 (10.7) | 2.7 | 24.8 [22.0-27.8] | 721 (17.2) | 7.0 | 60.8 [56.4-65.4] | 1013 (14.6) | 5.0 | 41.7 [38.2-45.5] |
| Xa. Intracranial and intraspinal germ cell tumors | 31 (1.1) | 6.8 | 2.6 [1.8-3.7] | 16 (0.4) | 7.0 | 1.3 [0.8-2.2] | 47 (0.7) | 6.8 | 2.0 [1.3-3.0] |
| Xa1. germinomas | 20 (0.7) | 19.0 | 1.7 [1-2.6.0] | 9 (0.2) | - | 0.8 [0.3-1.4] | 29 (0.4) | 28.0 | 1.3 [0.7-2.1] |
| Xa2. teratomas | 3 (0.1) | 0.5 | 0.3 [0.0-0.8] | 5 (0.1) | 1.5 | 0.4 [0.1-1.0] | 8 (0.1) | 1.0 | 0.3 [0.1-0.9] |
| Xa3. embryonal carcinomas | 0 (0.0) | - | 0.0 [0.1-0.3] | $1(0.0)$ | - | 0.1 [0.0-0.5] | 1 (0.0) | - | 0.0 [0.0-0.4] |
| Xa4. yolk sac tumor | 1 (0.0) | - | 0.1 [0.0-0.0.5] | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | - | 0.0 [0.0-0.4] |
| Xa5. choriocarcinomas | 3 (0.1) | 2.0 | 0.3 [0.0-0.8] | 1 (0.0) | - | 0.1 [0.0-0.5] | 4 (0.1) | 3.0 | 0.2 [0.0-0.6] |
| Xa6. tumors of mixed forms | 4 (0.1) | - | 0.3 [0.1-0.9] | 0 (0.0) | - | 0.0 [0.1-0.3] | 4 (0.1) | - | 0.2 [0.1-0.6] |
| Xb. Malignant extracranial and extragonadal GCT | 14 (0.5) | 2.5 | 1.2 [0.6-2.0] | 35 (0.8) | 2.5 | 3.0 [2.1-4.1] | 49 (0.7) | 2.5 | 2.0 [1.3-3.0] |
| $\mathrm{Xb1}$. germinomas | 8 (0.3) | 1.7 | 0.7 [0.3-1.3] | 10 (0.2) | 9.0 | 0.8 [0.4-1.6] | 18 (0.3) | 3.5 | 0.8 [0.3-1.4] |
| Xb 2 . teratomas | 3 (0.1) | - | 0.3 [0.0-0.8] | 3 (0.1) | 2.0 | 0.3 [0.0-0.7] | 6 (0.1) | 5.0 | 0.3 [0.0-0.8] |
| Xb3. Embryonal carcinomas | 0 (0.0) | - | 0.0 [0.1-0.3] | 1 (0.0) | - | 0.1 [0.0-0.5] | 1 (0.0) | - | 0.0 [0.0-0.4] |
| Xb4. Yolk sac tumor | 0 (0.0) | - | 0.0 [0.1-0.3] | 7 (0.2) | - | 0.6 [0.2-1.2] | 7 (0.1) | - | 0.3 [0.2-0.8] |
| Xb5. Choriocarcinomas | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 10 (0.2) | 0.4 | 0.8 [0.4-1.6] | 11 (0.2) | 0.4 | 0.4 [0.2-1.0] |
| $\mathrm{Xb6}$. Other and unspecified malignant mixed GCT | 2 (0.1) | - | 0.2 [0.0-0.6] | 4 (0.1) | 3.0 | 0.3 [0.1-0.9] | 6 (0.1) | 5.0 | 0.2 [0.0-0.7] |
| Xc. Malignant gonadal germ cell tumors | 224 (8.2) | 3.5 | 19.0 [16.6-21.7] | 626 (14.9) | 15.1 | 52.8 [48.7-57.1] | 850 (12.3) | 8.6 | 34.9 [31.7-38.3] |
| Xc1. germinomas | 48 (1.8) | 1.2 | 4.1 [3.0-5.4] | 189 (4.5) | 9.5 | 15.9 [13.7-18.4] | 237 (3.4) | 4.9 | 9.7 [8.1-11.5] |
| Xc2. teratomas | 49 (1.8) | 2.3 | 4.2 [3.1-5.5] | 106 (2.5) | 8.6 | 8.9 [7.3-10.8] | 155 (2.2) | 5.0 | 6.4 [5.1-8.0] |
| Xc3. embryonal carcinomas | 37 (1.4) | 36.0 | 3.1 [2.2-4.3] | 133 (3.2) | 132.0 | 11.2 [9.4-13.3] | 170 (2.5) | 84.0 | 6.9 [5.6-8.5] |
| Xc4. yolk sac tumor | 12 (0.4) | 1.4 | 1.0 [0.5-1.8] | 20 (0.5) | 2.3 | 1.7 [1.0-2.6] | 32 (0.5) | 1.9 | 1.3 [0.8-2.2] |
| Xc5. choriocarcinomas | 7 (0.3) | 2.5 | 0.6 [0.2-1.2] | 9 (0.2) | - | 0.8 [0.3-1.4] | 16 (0.2) | 7.0 | 0.7 [0.3-1.3] |
| Xc6. tumors of mixed forms | 71 (2.6) | 13.2 | 6.0 [4.7-7.6] | 169 (4.0) | 55.3 | 14.2 [12.2-16.6] | 240 (3.5) | 29.0 | 9.9 [8.2-11.8] |
| Xd . Gonadal carcinoma | 17 (0.6) | 0.0 | 1.4 [0.8-2.3] | 38 (0.9) | 0.0 | 3.2 [2.3-4.4] | 55 (0.8) | 0.0 | 2.3 [1.5-3.3] |
| Xe . Other and unspecified malignant gonadal tumors | 6 (0.2) | 0.5 | 0.5 [0.2-1.1] | 6 (0.1) | 2.0 | 0.5 [0.2-1.1] | 12 (0.2) | 1.0 | 0.5 [0.2-1.1] |

Table 2. (Continued)

| Diagnostic groups and subgroups (ICCC-3) | Adolescents (15-19 years) |  |  | Young adults (20-24 years) |  |  | AYA (15-24 years) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | n (\%) | $\begin{gathered} \text { M/F } \\ \text { ratio } \end{gathered}$ | IR [95\%CI] | n (\%) | $\begin{gathered} \hline \mathbf{M} / \mathrm{F} \\ \text { ratio } \\ \hline \end{gathered}$ | IR [95\%CI] | n (\%) | $\begin{aligned} & \mathrm{M} / \mathrm{F} \\ & \text { ratio } \\ & \hline \end{aligned}$ | ASR [95\%CI] |
| XI. Epithelial neoplasms and malignant melanomas | 580 (21.2) | 0.5 | 49.2 [45.3-53.4] | 1419 (33.8) | 0.4 | 119.6 [113.5-126] | 1999 (28.8) | 0.4 | 82.3 [77.4-87.6] |
| XIa. Adrenocartical carcinomas | 4 (0.1) | 1.0 | 0.3 [0.1-0.9] | 10 (0.2) | 0.4 | 0.8 [0.4-1.6] | 14 (0.2) | 0.6 | 0.6 [0.2-1.2] |
| XIb. Thyroid carcinomas | 241 (8.8) | 0.3 | 20.4 [17.9-23.2] | 566 (13.5) | 0.2 | 47.7 [43.9-51.8] | 807 (11.6) | 0.2 | 33.3 [30.1-36.7] |
| XIc. Nasopharyngeal carcinomas | 21 (0.8) | 3.2 | 1.8 [1.1-2.7] | 14 (0.3) | 1.0 | 1.2 [0.6-2.0] | 35 (0.5) | 1.9 | 1.5 [0.9-2.4] |
| XId.Malignant melanomas | 156 (5.7) | 0.7 | 13.2 [11.2-15.5] | 430 (10.2) | 0.5 | 36.3 [32.9-39.8] | 586 (8.5) | 0.6 | 24.1 [21.4-26.9] |
| XIf. Other and unspecified carcinomas | 158 (5.8) | 0.6 | 13.4 [11.4-15.7] | 399 (9.5) | 0.4 | 33.6 [30.4-37.1] | 557 (8) | 0.4 | 22.9 [20.3-25.8] |
| XIf1. Carcinomas of salivary glands | 21 (0.8) | 0.4 | 1.8 [1.1-2.7] | 22 (0.5) | 0.7 | 1.9 [1.2-2.8] | 43 (0.6) | 0.5 | 1.8 [1.1-2.8] |
| XIf2. Carcinomas of colon and rectum | 16 (0.6) | 0.3 | 1.4 [0.8-2.2] | 49 (1.2) | 0.5 | 4.1 [3.1-5.5] | 65 (0.9) | 0.5 | 2.7 [1.8-3.7] |
| XIf3. Carcinomas of appendix | 67 (2.5) | 0.7 | 5.7 [4.4-7.2] | 55 (1.3) | 0.4 | 4.6 [3.5-6.0] | 122 (1.8) | 0.6 | 5.2 [4.0-6.7] |
| XIf4. Carcinomas of lung | 13 (0.5) | 1.2 | 1.1 [0.6-1.9] | 41 (1.0) | 1.0 | 3.5 [2.5-4.7] | 54 (0.8) | 1.0 | 2.2 [1.5-3.2] |
| XIf5. Carcinomas of thymus | 5 (0.2) | 0.7 | 0.4 [0.1-1.0] | 6 (0.1) | 1.0 | 0.5 [0.2-1.1] | 11 (0.2) | 0.8 | 0.5 [0.2-1.0] |
| XIf6. Carcinomas of breast | 4 (0.1) | 0.0 | 0.3 [0.1-0.9] | 90 (2.1) | 0.0 | 7.6 [6.1-9.3] | 94 (1.4) | 0.0 | 3.8 [2.9-4.9] |
| XIf7. Carcinomas of cervix uteri | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 40 (1) | 0.0 | 3.4 [2.4-4.6] | 41 (0.6) | 0.0 | 1.6 [1.1-2.4] |
| XIf8. Carcinomas of bladder | 1 (0.0) | - | 0.1 [0.0-0.5] | 1 (0.0) | - | 0.1 [0.0-0.5] | 2 (0.0) | - | 0.1 [0.0-0.5] |
| XIf9. Carcinomas of eye | 0 (0.0) | - | 0.0 [0.1-0.3] | 2 (0.0) | 1.0 | 0.2 [0.0-0.6] | 2 (0.0) | 1.0 | 0.1 [0.1-0.5] |
| XIf10. Carcinomas of other specified sites | 29 (1.1) | 0.7 | 2.5 [1.6-3.5] | 82 (2.0) | 0.6 | 6.9 [5.5-8.6] | 111 (1.6) | 0.6 | 4.6 [3.5-5.9] |
| XIf11. Carcinomas of unspecified sites | 1 (0) | - | 0.1 [0.0-0.5] | 11 (0.3) | 2.7 | 0.9 [0.5-1.7] | 12 (0.2) | 3.0 | 0.5 [0.2-1.0] |
| XII. Other and unspecified malignant neoplasms | 12 (0.4) | 3.0 | 1.0 [0.5-1.8] | 13 (0.3) | 1.2 | 1.1 [0.6-1.9] | 25 (0.4) | 1.8 | 1.1 [0.6-1.8] |
| XIIa. Other specified malignant tumors | $9(0.3)$ | 3.5 | 0.8 [0.3-1.5] | 6 (0.1) | 1.0 | 0.5 [0.2-1.1] | 15 (0.2) | 2.0 | 0.6 [0.3-1.3] |
| XIIa1. Gastrointestinal stromal tumor | $5(0.2)$ | 4.0 | 0.4 [0.1-1.0] | 2 (0.0) | 1.0 | 0.2 [0.0-0.6] | 7 (0.1) | 2.5 | 0.3 [0.1-0.8] |
| XIIa4. Other complex mixed and stromal neoplams | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 1 (0.0) | 0.0 | 0.1 [0.0-0.5] | 2 (0.0) | 0.0 | 0.1 [0.0-0.5] |
| XIIa5. Mesothelioma | 3 (0.1) | - | 0.3 [0.0-0.8] | 3 (0.1) | 2.0 | 0.3 [0.0-0.7] | 6 (0.1) | 5.0 | 0.3 [0.0-0.8] |
| XIIb. Other unspecified malignant tumors | 3 (0.1) | 2.0 | 0.3 [0.0-0.8] | 7 (0.2) | 1.3 | 0.6 [0.2-1.2] | 10 (0.1) | 1.5 | 0.4 [0.1-1.0] |
| Total | 2734 (100.0) | 1.0 | 231.9 [223.3-240.8] | 4199 (100.0) | 1.0 | 354.0 [343.4-364.9] | 6933 (100.0) | 1.0 | 289.4 [279.8-299.2] |

[^0] peripheral primitive neuroectodermal tumors; M/F ratio, Male/Female ratio; IR, Incidence rates per million; ASR, age-standardized incidence rates per million; $95 \%$ CI, $95 \%$ confidence interval.

Table 3. One-, Two-, and Five-year Overall Survival among AYA with Cancer

FROM 2000 TO 2015 BY ICCC-3 DIAGNOSTIC GROUPS

| ICCC-3 diagnostic groups and subgroups | n | $\begin{aligned} & \text { 1-year OS } \\ & \%[95 \% \mathrm{CI}] \end{aligned}$ | $\begin{aligned} & \text { 2-year OS } \\ & \%[95 \% \mathrm{CI}] \end{aligned}$ | $\begin{aligned} & \text { 5-year OS } \\ & \%[95 \% \mathrm{CI}] \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |
| I. Leukemias, myeloproliferative/dysplastic diseases | 645 | 88.4 [85.6-90.6] | 80.4 [77.1-83.3] | 73.4 [69.7-76.6] |
| Ia. Lymphoblastic leukemias | 292 | 87.3 [82.9-90.6] | 78.7 [73.5-83.0] | 69.6 [63.9-74.6] |
| Ia1. Precursor cell leukemias | 280 | 87.8 [83.4-91.2] | 79.2 [74.0-83.5] | 69.8 [63.9-74.9] |
| Ia2. Mature B-cell leukemias | 9 | 77.8 [36.5-93.9] | 66.7 [28.2-87.8] | 66.7 [28.2-87.8] |
| Ia3. Mature T-cell and NK cell leukemias | 3 | 66.7 [5.4-94.5] | 66.7 [5.4-94.5] | 66.7 [5.4-94.5] |
| Ib . Acute myeloid leukemias | 176 | 83 [76.5-87.8] | 72.2 [64.9-78.2] | 64.4 [56.8-71.0] |
| Ic. Chronic myeloproliferative diseases | 130 | 100.0 [-] | 99.2 [94.7-99.9] | 96.8 [91.7-98.8] |
| Id. Myelodysplastic diseases | 34 | 91.2 [75.1-97.1] | 82.1 [64.3-91.5] | 75.6 [57.0-87.0] |
| Ie. Unspecified and other specified leukemias | 14 | 64.3 [34.3-83.3] | 42.9 [17.7-66.0] | 42.9 [17.7-66.0] |
| II. Lymphomas and reticuloendothelial neoplasms | 1594 | 98.1 [97.3-98.7] | 96.0 [94.9-96.8] | 94.1 [ $92.8-95.1]$ |
| IIa. Hodgkin disease | 1170 | 99.7 [99.1-99.9] | 98.0 [97.0-98.7] | 96.5 [95.3-97.4] |
| IIb. Non-Hodgkin lymphomas | 365 | 94.5 [91.5-96.4] | 91.1 [87.7-93.6] | 87.6 [83.7-90.6] |
| IIb1. Precursor-cell lymphomas | 25 | 84 [62.8-93.7] | 76.0 [54.2-88.4] | 68.0 [46.1-82.5] |
| IIb2. Mature B-cell lymphomas | 239 | 95.3 [91.7-97.4] | 92.4 [88.1-95.1] | 88.7 [83.8-92.2] |
| IIb3. Mature T-cell and NK-cell lymphomas | 91 | 95.5 [88.5-98.3] | 93.3 [85.7-96.9] | 91.0 [82.8-95.4] |
| IIb4. Unspecified Non-Hodgkin lymphomas | 10 | 90.0 [47.3-98.5] | 80.0 [40.9-94.6] | 80.0 [40.9-94.6] |
| IIc. Burkitt lymphoma | 38 | 94.7 [80.6-98.7] | 89.5 [74.3-95.9] | 89.5 [74.3-95.9] |
| IId. Miscellaneous lymphoreticular neoplasms | 17 | 88.2 [60.6-96.9] | 82.4 [54.7-93.9] | 82.4 [54.7-93.9] |
| IIe. Unspecified lymphoma | 4 | 50.0 [5.8-84.5] | 50.0 [5.8-84.5] | 50.0 [5.8-84.5] |
| III. Central nervous system tumors | 695 | 92.7 [90.5-94.4] | 86.4 [83.6-88.7] | 78.1 [74.7-81] |
| IIIa. Ependymomas and choroid plexus tumor | 52 | 98 [86.9-99.7] | 96.1 [85.2-99.0] | 89.2 [76.0-95.4] |
| IIIa1. Ependymomas | 45 | 100.0 [-] | 97.7 [84.9-99.7] | 90.0 [75.4-96.1] |
| IIIa2. Choroid plexus tumor | 7 | 85.7 [33.4-97.9] | 85.7 [33.4-97.9] | 85.7 [33.4-97.9] |
| IIIb. Astrocytomas | 213 | 90.9 [86.2-94.1] | 78.0 [71.7-83.0] | 66.7 [59.8-72.8] |
| IIIc. Intracranial and intraspinal embryonal tumors | 47 | 89.4 [76.3-95.4] | 85.1 [71.3-92.6] | 71.1 [55.3-82.1] |
| IIIc1.Medulloblastomas | 34 | 97.1 [80.9-99.6] | 91.2 [75.1-97.1] | 81.7 [63.6-91.4] |
| IIIc2. cPNET | 9 | 66.7 [28.2-87.8] | 66.7 [28.2-87.8] | 20.0 [1.2-55.7] |
| IIIc3. Medulloepithelioma | 2 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IIIc4. Atypical teratoid/rhabdoid tumor | 2 | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] |
| IIId. Other gliomas | 141 | 85.6 [78.6-90.5] | 77.7 [69.8-83.8] | 63.7 [55.0-71.1] |
| IIId1. Oligodendrogliomas | 78 | 85.5 [75.4-91.7] | 78.9 [68.0-86.5] | 68.4 [56.7-77.6] |
| IIId2. Mixed and unspecified gliomas | 61 | 85.2 [73.6-92.0] | 77.0 [64.3-85.7] | 59.7 [46.1-71.0] |
| IIId3. Neuroepithelial glial tumors | 2 | 100.0 [-] | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] |
| IIIe. Other intracranial and intraspinal tumors | 217 | 98.1 [95.1-99.3] | 97.2 [93.9-98.7] | 96.1 [92.4-98] |
| IIIe1. Pituitary adenomas and carcinomas | 10 | 100.0 [-] | 100.0 [-] | 100 [100-100] |
| IIIe2. Tumors of sellar region | 29 | 100.0 [-] | 100.0 [-] | 95.5 [71.9-99.3] |
| IIIe3. Pineal parenchymal tumors | 3 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IIIe4. Neuronal and mixed neuronal-glial tumors | 112 | 98.2 [93.0-99.5] | 97.3 [91.8-99.1] | 96.3 [90.4-98.6] |
| IIIe5. Meningiomas | 63 | 96.8 [87.8-99.2] | 95.2 [85.8-98.4] | 95.2 [85.8-98.4] |
| IIIf. Unspecified neoplasms | 27 | 92.3 [72.6-98.0] | 92.3 [72.6-98.0] | 88.5 [68.4-96.1] |
| IV. Neuroblastoma | 24 | 87.5 [66.1-95.8] | 83.3 [61.5-93.4] | 79.2 [57.0-90.8] |
| IVa. Neuroblastoma and ganglioneuroblastoma | 9 | 66.7 [28.2-87.8] | 66.7 [28.2-87.8] | 55.6 [20.4-80.5] |
| IVb . Other peripheral nervous cell tumors | 15 | 100 - | 93.3 [61.3-99.0] | 93.3 [61.3-99.0] |

Table 3. (CONTINUED)

| ICCC-3 diagnostic groups and subgroups | n | $\begin{aligned} & \text { 1-year OS } \\ & \%[95 \% \mathrm{CI}] \end{aligned}$ | $\begin{gathered} \text { 2-year OS } \\ \%[95 \% \mathrm{CI}] \\ \hline \end{gathered}$ | $\begin{gathered} \text { 5-year OS } \\ \% \text { [95\%CI] } \\ \hline \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: |
| VI. Renal tumors | 55 | 90.7 [79.2-96.0] | 88.9 [76.9-94.8] | 79.1 [65.4-87.9] |
| VIa. Nephroblastoma and other nonepithelial tumors | 11 | 81.8 [44.7-95.1] | 81.8 [44.7-95.1] | 71.6 [35.0-89.9] |
| VIa1. Nephroblastoma | 8 | 100.0 [-] | 100.0 [-] | 85.7 [33.4-97.9] |
| VIa2. Rhabdoid renal tumors | 2 | 0.0 [-] | 0.0 [-] | 0.0 [-] |
| VIa4. pPNET of kidney | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| VIb. Renal carcinoma | 43 | 92.9 [79.5-97.6] | 90.5 [76.6-96.3] | 80.5 [64.6-89.7] |
| VIc. Unspecified malignant renal tumors | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| VII. Hepatic tumors | 31 | 71.0 [51.6-83.7] | 58.1 [39.0-73.1] | 33.4 [17.3-50.4] |
| VIIa. Hepatoblastoma | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| VIIb. Hepatic carcinoma | 29 | 69.0 [48.8-82.5] | 55.2 [35.6-71.0] | 28.4 [13.0-46.0] |
| VIIc. Unspecified malignant hepatic tumors | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| VIII. Malignant bone tumors | 313 | 94.2 [90.9-96.3] | 82.2 [77.5-86.1] | 65.1 [59.4-70.3] |
| VIIIa. Osteosarcomas | 145 | 93.8 [88.3-96.7] | 82.6 [75.3-87.9] | 60.3 [51.5-67.9] |
| VIIIb. Chondrosarcomas | 42 | 100.0 [-] | 92.7 [79.0-97.6] | 90.0 [75.6-96.1] |
| VIIIc. Ewing tumor and related sarcomas of bone | 113 | 92.9 [86.3-96.4] | 77.0 [68.1-83.7] | 61.1 [51.3-69.5] |
| VIIId. Other specified malignant bone tumors | 12 | 90.9 [50.8-98.7] | 90.9 [50.8-98.7] | 72.7 [37.1-90.3] |
| VIIId2. Malignant chordomas | 6 | 80.0 [20.4-96.9] | 80.0 [20.4-96.9] | 40.0 [5.2-75.3] |
| VIIId3. Odotongenic malignant tumors | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| VIIId4. Miscellaneous malignant bone tumors | 5 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| VIIIe. Unspecified malignant bone tumors | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IX. Soft tissue and other extraosseous sarcomas | 288 | 90.5 [86.5-93.4] | 79.9 [74.8-84.2] | 66.8 [60.9-72.1] |
| IXa.Rhabdomyosarcomas | 52 | 84.6 [71.6-92.0] | 61.5 [47.0-73.2] | 48.1 [34.1-60.8] |
| IXb.Fibrosarcomas, and other fibrous neoplasms | 50 | 89.8 [77.2-95.6] | 85.7 [72.4-92.9] | 79.1 [64.6-88.2] |
| IXb1.Fibroblastic and myofibroblastic tumors | 29 | 100.0 [-] | 96.4 [77.2-99.5] | 89.0 [69.7-96.3] |
| $\mathrm{IXb} 2 . \mathrm{Nerve}$ sheath tumors | 21 | 76.2 [51.9-89.3] | 71.4 [47.2-86.0] | 66.7 [42.5-82.5] |
| IXc. Kaposi sarcoma | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IXd.Other specified soft tissue sarcomas | 144 | 93.6 [88.1-96.6] | 84.4 [77.3-89.5] | 70.6 [62.1-77.6] |
| IXd1-2.Ewing tumors and pPNET of soft tissue | 27 | 92.6 [73.5-98.1] | 74.1 [53.2-86.7] | 58.3 [37.4-74.4] |
| IXd3.Extrarenal rhabdoid tumor | 3 | 33.3 [0.9-77.4] | 0.0 [-] | 0.0 [-] |
| IXd4.Liposarcomas | 22 | 100.0 [-] | 100.0 [-] | 95.2 [70.7-99.3] |
| IXd5.Fibrohistiocytic tumors | 7 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IXd6.Meiomyosarcomas | 16 | 100.0 [-] | 100.0 [-] | 87.5 [58.6-96.7] |
| IXd7.Synovial sarcomas | 39 | 97.4 [82.8-99.6] | 89.3 [73.8-95.8] | 65.7 [47.3-78.9] |
| IXd8. Blood vessel tumors | 8 | 75 [31.5-93.1] | 62.5 [22.9-86.1] | 50.0 [15.2-77.5] |
| IXd9. Osseous and chondromatous neoplasms | 6 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IXd10. Alveolar soft parts sarcoma | 4 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| IXd11. Miscellaneous soft tissue sarcomas | 12 | 81.8 [44.7-95.1] | 54.5 [22.9-78.0] | 36.4 [11.2-62.7] |
| IXe Unspecified soft tissue sarcomas | 41 | 87.8 [73.2-94.7] | 80.5 [64.8-89.7] | 62.6 [45.7-75.6] |

Table 3. (CONTINUED)

| ICCC-3 diagnostic groups and subgroups | n | $\begin{gathered} \text { 1-year OS } \\ \%[95 \% \mathrm{CI}] \\ \hline \end{gathered}$ | $\begin{aligned} & \text { 2-year OS } \\ & \%[95 \% \mathrm{CI}] \end{aligned}$ | $\begin{gathered} \text { 5-year OS } \\ \%[95 \% \mathrm{CI}] \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: |
| X. Germ-cell tumors, and other neoplasms of gonads | 948 | 97.0 [95.7-97.9] | 94.5 [92.9-95.8] | 92.9 [91-94.4] |
| Xa . Intracranial and intraspinal germ cell tumors | 42 | 97.6 [84.3-99.7] | 88.1 [73.7-94.9] | 83.3 [68.2-91.7] |
| Xa1. germinomas | 26 | 100.0 [-] | 92.3 [72.6-98.0] | 88.5 [68.4-96.1] |
| Xa2. teratomas | 7 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| Xa4. yolk sac tumor | 1 | 100.0 [-] | 0.0 [-] | 0.0 [-] |
| Xa5. choriocarcinomas | 4 | 75.0 [12.8-96.1] | 75.0 [12.8-96.1] | 75.0 [12.8-96.1] |
| Xa6. tumors of mixed forms | 4 | 100.0 [-] | 75.0 [12.8-96.1] | 50.0 [5.8-84.5] |
| Xb . Malignant extracranial and extragonadal GCT | 47 | 85.1 [71.3-92.6] | 72.3 [57.2-82.9] | 69.4 [53.8-80.7] |
| Xb 1. germinomas | 17 | 88.2 [60.6-96.9] | 88.2 [60.6-96.9] | 88.2 [60.6-96.9] |
| Xb 2 . teratomas | 6 | 66.7 [19.5-90.4] | 33.3 [4.6-67.6] | 33.3 [4.6-67.6] |
| Xb3. Embryonal carcinomas | 1 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| Xb4. Yolk sac tumor | 6 | 100.0 [-] | 50.0 [11.1-80.4] | 50.0 [11.1-80.4] |
| Xb5. Choriocarcinomas | 11 | 81.8 [44.7-95.1] | 72.7 [37.1-90.3] | 72.7 [37.1-90.3] |
| $\mathrm{Xb6}$. Other and unspecified malignant mixed GCT | 6 | 83.3 [27.3-97.5] | 83.3 [27.3-97.5] | 62.5 [14.2-89.3] |
| Xc. Malignant gonadal germ cell tumors | 798 | 98.2 [97.0-98.9] | 96.9 [95.5-97.9] | 95.7 [94.0-96.9] |
| Xc1. germinomas | 220 | 99.5 [96.7-99.9] | 99.1 [96.3-99.8] | 99.1 [96.3-99.8] |
| Xc 2 . teratomas | 148 | 99.3 [95.2-99.9] | 96.6 [91.9-98.6] | 93.5 [87.9-96.6] |
| Xc3. embryonal carcinomas | 159 | 100.0 [-] | 99.4 [95.5-99.9] | 98.0 [94.1-99.4] |
| Xc4. yolk sac tumor | 29 | 96.4 [77.2-99.5] | 96.4 [77.2-99.5] | 96.4 [77.2-99.5] |
| Xc5. choriocarcinomas | 16 | 87.1 [57.3-96.6] | 73.7 [44.1-89.2] | 73.7 [44.1-89.2] |
| Xc6. tumors of mixed forms | 226 | 96.0 [92.4-97.9] | 95.1 [91.3-97.2] | 93.7 [89.6-96.2] |
| Xd. Gonadal carcinoma | 50 | 88.0 [75.2-94.4] | 82.0 [68.3-90.2] | 77.9 [63.6-87.1] |
| Xe. Other and unspecified malignant gonadal tumors | 11 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| XI. Epithelial neoplasms and malignant melanomas | 1883 | 97.1 [96.2-97.8] | 95.3 [94.2-96.1] | 92.5 [91.2-93.7] |
| XIa. Adrenocartical carcinomas | 14 | 78.6 [47.2-92.5] | 57.1 [28.4-78.0] | 57.1 [28.4-78.0] |
| XIb. Thyroid carcinomas | 746 | 99.7 [98.9-99.9] | 99.7 [98.9-99.9] | 99.4 [98.5-99.8] |
| XIc. Nasopharyngeal carcinomas | 33 | 90.9 [74.4-97.0] | 84.8 [67.4-93.4] | 77.8 [58.7-88.8] |
| XId.Malignant melanomas | 560 | 98.9 [97.6-99.5] | 97.8 [96.2-98.7] | 95.3 [93.1-96.8] |
| XIf. Other and unspecified carcinomas | 531 | 92.3 [89.7-94.3] | 87.9 [84.8-90.4] | 81.7 [78.1-84.8] |
| XIf1. Carcinomas of salivary glands | 40 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| XIf2. Carcinomas of colon and rectum | 64 | 92.2 [82.2-96.7] | 85.9 [74.7-92.4] | 67.9 [54.7-78.0] |
| XIf3. Carcinomas of appendix | 109 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| XIf4. Carcinomas of lung | 54 | 90.6 [78.8-96.0] | 88.6 [76.4-94.7] | 82.7 [69.4-90.6] |
| XIf5. Carcinomas of thymus | 11 | 100.0 [-] | 90.9 [50.8-98.7] | 81.8 [44.7-95.1] |
| XIf6. Carcinomas of breast | 91 | 94.5 [87.3-97.7] | 91.2 [83.2-95.5] | 82.7 [73.0-89.2] |
| XIf7. Carcinomas of cervix uteri | 40 | 97.5 [83.5-99.6] | 87.5 [72.5-94.6] | 87.5 [72.5-94.6] |
| XIf8. Carcinomas of bladder | 2 | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] |
| XIf9. Carcinomas of eye | 2 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| XIf10. Carcinomas of other specified sites | 107 | 84.1 [75.7-89.8] | 75.7 [66.4-82.8] | 70.7 [61.0-78.4] |
| XIf11. Carcinomas of unspecified sites | 11 | 40.9 [12.7-67.9] | 30.7 [7.3-58.6] | 0.0 [-] |
| XII. Other and unspecified malignant neoplasms | 24 | 74.6 [51.9-87.7] | 70.2 [47.4-84.5] | 65.5 [42.6-81.1] |
| XIIa. Other specified malignant tumors | 14 | 92.9 [59.1-99.0] | 92.9 [59.1-99.0] | 85.1 [52.3-96.1] |
| XIIa1. Gastrointestinal stromal tumor | 6 | 100.0 [-] | 100.0 [-] | 100.0 [-] |
| XIIa4. Other complex mixed and stromal neoplams | 2 | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] | 50.0 [0.6-91.0] |
| XIIa5. Mesothelioma | 6 | 100.0 [-] | 100.0 [-] | 83.3 [27.3-97.5] |
| XIIb. Other unspecified malignant tumors | 10 | 46.7 [15.0-73.7] | 35.0 [8.5-64.0] | 35.0 [8.5-64.0] |
| Total | 6480 | 95.3 [94.8-95.8] | 91.3 [90.6-92.0] | 86.6 [85.8-87.4] |

Abbreviations: AYA, adolescents and young adults; ICCC-3, third version of the International Classification of Childhood Cancer; GCT, Germ-Cell tumors; cPNET, central primitive neuroectodermal tumors; pPNET, peripheral primitive neuroectodermal tumors; OS, Overall Survival; 95\%CI, 95\% confidence interval.
Table 4. Trends in Five-year Overall Survival among adolescents and young adults with Cancer from 1978 to 2015 by

## ICCC-3 Diagnostic Groups

| ICCC-3 diagnostic groups | 5-year OS |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \% (95\%CI) |  |  |  |  |  |
|  | 1978-82* | 1983-87* | 1988-92* | 1993-97* | 2000-07 | 2008-15 |
| I. Leukemia | 28.6 (16.1-41.1) | 25.3 (13.9-36.7) | 30.3 (20.3-40.3) | 49.5 (38.9-60.1) | 69.5 (63.5-74.7) | 76.2 (71.5-80.2) |
| II. Lymphomas | 72.0 (63.8-80.2) | 77.9 (71.4-84.4) | 86 (80.3-91.7) | 87.6 (82.9-92.3) | 93.4 (91.6-95.5) | 94.2 (92.5-95.5) |
| III. Central Nervous System tumors | 47.4 (32.5-62.3)\# | 61.7 (46.4-77.0)\# | 63.3 (51.3-75.3)\# | 60.1 (47.9-72.3)\# | 77.6 (72.1-82.2) | 78.3 (73.9-82.1) |
| VIII. Malignant bone tumors | 59.3 (40.7-77.9) | 48.4 (30.8-66.0) | 58.6 (43.5-73.7) | 60.3 (47.2-73.4) | 58.2 (48.9-66.4) | 70.0 (62.7-76.2) ${ }^{\text {a }}$ |
| IX. Soft tissue and other extraosseous sarcomas | 56.1 (36.3-75.9) | 50.7 (33.8-67.6) | 49.2 (35.7-62.7) | 73.1 (60.0-86.2) | 65.6 (56.6-73.2) | 67.5 (59.3-74.5) |
| X. Germ-cell tumors | 73.2 (63.4-83.0) | 78 (69.4-86.6) | 88.5 (83.2-93.8) | 91.1 (86.6-95.6) | 91.2 (87.9-93.6) | 94.3 (91.9-96.0) ${ }^{\text {a }}$ |
| XI. epithelial neoplasms and melanomas | 75.9 (66.7-85.1) | 74.6 (66.6-82.6) | 85.7 (80.4-91.0) | 89.9 (86.2-93.6) | 90.9 (88.5-92.9) | $93.5(91.8-94.7)^{\text {a }}$ |
| All tumors | 62.0 (57.5-66.5) | 66.0 (61.9-70.1) | 73.2 (70.1-76.3) | 80.2 (77.7-82.8) | 81.8 (79.5-83.9) | 88.0 (86.9-89.0) ${ }^{\text {a }}$ |

Abbreviations: ICCC-3: third version of the International Classification of Childhood Cancer; OS: Overall Survival; $95 \%$ CI: $95 \%$ confidence interval

* Data from reference ${ }^{2}$
\# Only malignant CNS tumors were included (exclusion of benign or borderline tumors)
a p $<0.05$ Comparison between diagnostic periods (2000-2007 vs 2008-2015)
ICCC-3 DIAGNOSTIC GROUPS

| ICCC-3 diagnostic groups and subgroups | Adolescents (15-19 years) |  |  |  | Young adults (20-24 years) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 2000-2007 |  | 2008-2015 |  | 2000-2007 |  | 2008-2015 |  |
|  | n | 5yOS [95\%CI] | n | 5yOS [95\%CI] | n | 5yOS [95\%CI] | n | 5yOS [95\%CI] |
| I. Leukemias, myeloproliferative/myelodysplastic diseases | 141 | 67.9 [59.5-74.9] | 201 | 76.4 [69.7-81.8] | 122 | 71.3 [62.4-78.5] | 181 | 76.1 [69.0-81.8] |
| Ia. Lymphoblastic leukemias | 83 | 69.6 [58.4-78.3] | 100 | 79.3 [69.8-86.2] ${ }^{\text {b }}$ | 39 | 59.0 [42.0-72.5] | 70 | 63.2 [ $50.4-73.5]^{\text {b }}$ |
| Ib. Acute myeloid leukemias | 39 | 59.0 [42.0-72.5] | 55 | 62.4 [47.7-74.0] | 36 | 63.9 [46.1-77.2] | 46 | 71.4 [55.9-82.3] |
| Ic. Chronic myeloproliferative diseases | 15 | 93.3 [61.3-99.0] | 26 | 100.0 [-] | 35 | 94.3 [79.0-98.5] | 54 | 98.1 [87.6-99.7] |
| Id. Myelodysplastic / myeloproliferative diseases | 2 | 50.0 [0.6-91.0] | 14 | 77.9 [45.9-92.3] | 9 | 77.8 [36.5-93.9] | 9 | 76.2 [33.2-93.5] |
| Ie. Unspecified and other specified leukemias | 3 | 33.3 [0.9-77.4] | 6 | 50.0 [11.1-80.4] | 3 | 33.3 [0.9-77.4] | 2 | 50.0 [0.6-91.0] |
| II. Lymphomas and reticuloendothelial neoplasms | 286 | 94.4 [91.0-96.5] | 409 | 95.0 [92.4-96.8] | 335 | 93.4 [90.2-95.6] | 564 | 93.6 [91.2-95.4] |
| IIa. Hodgkin disease | 210 | 97.6 [94.3-99.0] | 300 | 98.0 [95.5-99.1] | 241 | 95.8 [92.4-97.7] | 419 | 95.5 [93.0-97.2] |
| IIb. Non-Hodgkin lymphomas | 66 | 86.2 [75.1-92.5] | 85 | 86.8 [77.5-92.5] | 82 | 87.8 [78.5-93.2] | 132 | 88.2 [80.8-92.9] |
| IIc. Burkitt lymphoma | 7 | 100.0 [-] | 16 | 81.3 [52.5-93.5] | 8 | 100.0 [-] | 7 | 85.7 [33.4-97.9] |
| IId. Miscellaneous lymphoreticular neoplasms | 3 | 33.3 [0.9-77.4] | 7 | 100.0 [-] | 3 | 66.7 [5.4-94.5] | 4 | 100.0 [-] |
| IIe. Unspecified lymphoma | - | - | - | - | 1 | 0.0 [-] | 2 | 50.0 [0.6-91.0] |
| III. Central nervous system tumors | 119 | 80.3 [71.9-86.5] | 187 | 81.3 [74.7-86.4] | 151 | 75.4 [67.6-81.6] | 238 | 76.0 [69.8-81.1] |
| IIIa. Ependymomas and choroid plexus tumor | 6 | 83.3 [27.3-97.5] | 22 | 85.7 [53.9-96.2] | 6 | 83.3 [27.3-97.5] | 18 | 94.4 [66.6-99.2] |
| IIII. Astrocytomas | 37 | 77.8 [60.4-88.2] | 61 | 74.8 [61.6-84.0] ${ }^{\text {b }}$ | 43 | 73.7 [57.5-84.5] ${ }^{\text {a }}$ | 72 | 49.6 [37.0-61.0] ${ }^{\text {a,b }}$ |
| IIIc. Intracranial and intraspinal embryonal tumors | 9 | 66.7 [28.2-87.8] | 14 | 85.7 [53.9-96.2] | 10 | 50.0 [18.4-75.3] | 14 | 76.6 [43.3-91.9] |
| IIId. Other gliomas | 16 | 43.8 [19.8-65.6] | 24 | 47.8 [26.8-66.1] | 50 | 67.3 [52.3-78.6] | 51 | 73.6 [58.7-83.9] |
| IIIe. Other specified intracranial and intraspinal neoplasms | 45 | 97.7 [84.9-99.7] | 61 | 96.7 [87.3-99.2] | 38 | 94.4 [79.5-98.6] | 73 | 95.3 [85.9-98.5] |
| IIIf. Unspecified intracranial and intraspinal neoplasms | 6 | 83.3 [27.3-97.5] | 5 | 100.0 [-] | 5 | 80.0 [20.4-96.9] | 11 | 90.0 [47.3-98.5] |
| IV. Neuroblastoma, other peripheral nervous cell tumors | 5 | 60.0 [12.6-88.2] | 7 | 100.0 [-] | 6 | 66.7 [19.5-90.4] | 6 | 83.3 [27.3-97.5] |
| IVa. Neuroblastoma and ganglioneuroblastoma | 2 | 0.0 [-] | 4 | 100.0 [-] | 1 | 100.0 [-] | 2 | 50.0 [0.6-91.0] |
| IVb . Other peripheral nervous cell tumors | 3 | 100.0 [-] | 3 | 100.0 [-] | 5 | 80.0 [20.4-96.9] | 4 | 100.0 [-] |
| VI. Renal tumors | 12 | 81.8 [44.7-95.1] | 5 | 80.0 [20.4-96.9] | 13 | 84.6 [51.2-95.9] | 25 | 74.4 [51.3-87.7] |
| VIa. Nephroblastoma and other nonepithelial renal tumors | - | - | - | - | 1 | 100.0 [-] | 4 | 37.5 [1.1-80.8] |
| VIb. Renal carcinoma | 6 | 80.0 [20.4-96.9] | 5 | 80.0 [20.4-96.9] | 11 | 81.8 [44.7-95.1] | 21 | 80.0 [54.9-92.0] |
| VII. Hepatic tumors | 6 | 33.3 [4.6-67.6] | 5 | 60.0 [12.6-88.2] | 6 | 16.7 [0.8-51.7] | 14 | 35.7 [13.0-59.4] |
| VIIb. Hepatic carcinoma | 5 | 20.0 [0.8-58.2] | 4 | 50.0 [5.8-84.5] | 6 | 16.7 [0.8-51.7] | 14 | 35.7 [13.0-59.4] |

Table 5.(Continued)

| ICCC-3 diagnostic groups and subgroups | 15-19 years |  |  |  | 20-24 years |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 2000-2007 |  | 2008-2015 |  | 2000-2007 |  | 2008-2015 |  |
|  | n | 5yOS [95\%CI] | n | 5yOS [95\%CI] | n | 5yOS [95\%CI] | n | 5yOS [95\%CI] |
| VIII. Malignant bone tumors | 82 | 60.5 [49.0-70.2] ${ }^{\text {a }}$ | 120 | 72.1 [62.8-79.4] ${ }^{\text {a }}$ | 41 | 53.7 [37.4-67.4] | 70 | 66.5 [53.7-76.6] |
| VIIIa. Osteosarcomas | 46 | 55.6 [40-68.6] ${ }^{\text {a }}$ | 56 | 69.8 [55.3-80.4] ${ }^{\text {a }}$ | 14 | 28.6 [8.8-52.4] ${ }^{\text {a }}$ | 29 | 68.4 [47.9-82.2] ${ }^{\text {a }}$ |
| VIIIb. Chondrosarcomas | 8 | 75.0 [31.5-93.1] | 7 | 100.0 [-] | 8 | 100.0 [-] | 19 | 87.7 [58.8-96.8] |
| VIIIc. Ewing tumor and related sarcomas of bone | 25 | 64.0 [42.2-79.4] | 53 | 70.4 [55.6-81.1] ${ }^{\text {b }}$ | 17 | 52.9 [27.6-73.0] | 18 | 38.1 [16.6-59.5] ${ }^{\text {b }}$ |
| VIIId. Other specified malignant bone tumors | 3 | 66.7 [5.4-94.5] | 3 | 66.7 [5.4-94.5] | 2 | 50.0 [0.6-91.0] | 4 | 100.0 [-] |
| IX. Soft tissue and other extraosseous sarcomas | 52 | 70.6 [56.0-81.1] | 76 | 67.7 [55.3-77.4] | 74 | 62.2 [50.1-72.1] | 86 | 67.4 [55.7-76.6] |
| IXa.Rhabdomyosarcomas | 12 | 41.7 [15.2-66.5] | 17 | 58.8 [32.5-77.8] | 13 | 38.5 [14.1-62.8] | 10 | 50.0 [18.4-75.3] |
| IXb.Fibrosarcomas, and other fibrous neoplasms | 10 | 77.8 [36.5-93.9] | 16 | 80.8 [51.4-93.4] | 13 | 76.9 [44.2-91.9] | 11 | 81.8 [44.7-95.1] |
| IXd.Other specified soft tissue sarcomas | 24 | 79.2 [57.0-90.8] | 36 | 66.8 [47.6-80.3] | 37 | 70.3 [52.8-82.3] | 47 | 67.9 [50.8-80.2] |
| IXe Unspecified soft tissue sarcomas | 6 | 83.3 [27.3-97.5] | 7 | 68.6 [21.3-91.2] | 10 | 40.0 [12.3-67.0] | 18 | 65.8 [39.1-83.0] |
| X. Germ-cell tumors, and other neoplasms of gonads | 112 | 88.0 [80.2-92.8] | 156 | 93.4 [88.1-96.4] | 293 | 92.4 [88.7-94.9] | 387 | 94.6 [91.8-96.5] |
| Xa. Intracranial and intraspinal germ cell tumors | 12 | 75.0 [40.8-91.2] | 17 | 82.4 [54.7-93.9] | 5 | 80.0 [20.4-96.9] | 8 | 100.0 [-] |
| Xb . Malignant extracranial and extragonadal germ cell tumors | 7 | 71.4 [25.8-92.0] | 6 | 66.7 [19.5-90.4] | 12 | 66.7 [33.7-86.0] | 22 | 72.7 [49.1-86.7] |
| Xc. Malignant gonadal germ cell tumors | 88 | 92.9 [84.9-96.8] | 118 | 96.4 [90.7-98.6] | 255 | 94.4 [90.7-96.6] | 337 | 97.2 [94.7-98.5] |
| Xd. Gonadal carcinoma | 5 | 60.0 [12.6-88.2] | 10 | 90.0 [47.3-98.5] | 16 | 81.3 [52.5-93.5] | 19 | 73.3 [47.2-87.9] |
| Xe. Other and unspecified malignant gonadal tumors | - | - | - | - | 5 | 100.0 [-] | 1 | 100.0 [-] |
| XI. Other malignant epithelial neoplasms and melanomas | 207 | 92.1 [87.5-95.1] | 342 | 93.7 [90.3-95.9] | 463 | $90.4[87.3-92.8]^{\text {a }}$ | 871 | 93.4 [91.4-94.9] ${ }^{\text {a }}$ |
| XIa. Adrenocartical carcinomas | 2 | 0.0 [-] | 2 | 0.0 [-] | 2 | 50.0 [0.6-91.0] | 8 | 87.5 [38.7-98.1] |
| XIb. Thyroid carcinomas | 94 | 100.0 [-] | 136 | 100.0 [-] | 166 | 99.4 [95.8-99.9] | 350 | 99.1 [97.3-99.7] |
| XIc. Nasopharyngeal carcinomas | 5 | 60.0 [12.6-88.2] | 15 | 78.0 [45.5-92.5] | 4 | 75.0 [12.8-96.1] | 9 | 87.5 [38.7-98.1] |
| XId.Malignant melanomas | 61 | 94.9 [85.1-98.3] | 86 | 95.9 [87.8-98.7] | 168 | 93.4 [88.4-96.3] | 245 | 96.4 [93.0-98.2] |
| XIf. Other and unspecified carcinomas | 45 | 79.8 [64.8-89.0] | 103 | 87.3 [78.6-92.6] | 123 | 75.4 [66.7-82.1] | 260 | 83.2 [78.0-87.3] |
| XII. Other and unspecified malignant neoplasms | 7 | 71.4 [25.8-92.0] | 5 | 80.0 [20.4-96.9] | 7 | 51.4 [11.8-81.3] | 5 | 60.0 [12.6-88.2] |
| XIIa. Other specified malignant tumors | 5 | 100.0 [-] | 4 | 100.0 [-] | 1 | 0.0 [-] | 4 | 75.0 [12.8-96.1] |
| XIIb. Other unspecified malignant tumors | 2 | 0.0 [-] | 1 | 0.0 [-] | 6 | 62.5 [14.2-89.3] | 1 | 0.0 [-] |
| Total | 1028 | 83.3 [80.8-85.5] ${ }^{\text {a }}$ | 1511 | 87.0 [85.2-88.7] ${ }^{\text {a }}$ | 1509 | 85.5 [83.6-87.2] $^{\text {a }}$ | 2432 | 88.6 [87.2-89.8] ${ }^{\text {a }}$ |

[^1]$\mathrm{b} p<0.05$ Comparison between age groups (15-19 years vs 20-24 years)



[^0]:    Abbreviations: AYA, adolescents and young adults; ICCC-3, third version of the International Classification of Childhood Cancer; GCT, Germ-Cell tumors; cPNET, central primitive neuroectodermal tumors; pPNET,

[^1]:    Abbreviations: ICCC-3, third version of the International Classification of Childhood Cancer; 5yOS, Five-year Overall Survival; $95 \%$ CI, $95 \%$ confidence interval a $p<0.05$ Comparison between diagnostic periods ( $2000-2007$ vs 2008-2015)

