Educational and occupational outcomes of childhood cancer survivors 30 years after diagnosis: a French cohort study

Agnes Dumas*,1,2, Claire Berger3,4,5, Pascal Auquier6, Gérard Michel6,7, Brice Fresneau8, Rodrigue Séchêou Allodji1,9,10, Nadia Haddy1,9,10, Carole Rubino1,9,10, Gilles Vassal9, Dominique Valteau-Couanet8, Sandrine Thouvenin-Doulet3, Léonie Casagrand4,5, Hélène Pacquement11, Chiraz El-Fayech1,8, Odile Oberlin8, Catherine Guibout1,9,10 and Florent de Vathaire1,9,10

1CESP (Centre for Research in Epidemiology and Population Health) U1018, Inserm, 94807 Villejuif, France; 2Social and Human Sciences Research Unit, Gustave Roussy, 94805 Villejuif, France; 3Department of Paediatric Haematology-Oncology, CHU Saint-Etienne, 42270 Saint-Priest-en-Jarez, France; 4Rhone-Alpes Childhood Cancer Registry, 42000 Saint-Etienne, France; 5Laboratory SNA-EPIS EA4607, Jean Monnet University, 42000 Saint-Etienne, France; 6Quality of Life Research Unit (EA3279), APHM, Aix Marseille University, 13385 Marseille, France; 7Department of Paediatric Haematology-Oncology, La Timone, 13005 Marseille, France; 8Department of Paediatric and Adolescent Oncology, Gustave Roussy, 94805 Villejuif, France; 9Department of Clinical Research, Gustave Roussy, 94805 Villejuif, France; 10Paris XI University and 11Department of Paediatric Oncology, Institut Curie, 75005 Paris, France

Background: Although survival from childhood cancer has increased, little is known on the long-term impact of treatment late effects on occupational attainment or work ability.

Methods: A total of 3512 five-year survivors treated before the age of 19 years in 10 French cancer centres between 1948 and 2000 were identified. Educational level, employment status and occupational class of survivors were assessed by a self-reported questionnaire. These outcome measures were compared with sex–age rates recorded in the French population, using indirect standardisation. Paternal occupational class was also considered to control for the role of survivors’ socioeconomic background on their achievement. Multivariable analyses were conducted to explore clinical characteristics associated with the outcomes.

Results: A total of 2406 survivors responded to the questionnaire and survivors aged below 25 years were included in the current analysis. Compared with national statistics adjusted on age and sex, male survivors were more likely to be college graduates (39.2% vs 30.9% expected; P < 0.001). This higher achievement was not observed either for leukaemia or central nervous system (CNS) tumour survivors. Health-related unemployment was higher for survivors of CNS tumour (28.1% vs 4.3%; P < 0.001) but not for survivors of other diagnoses. Survivors of non-CNS childhood cancer had a similar or a higher occupational class than expected.

Conclusions: Survivors treated for CNS tumour or leukaemia, especially when treatment included cranial irradiation, might need support throughout their lifespan.

Medical progress over the past four decades has improved survival from childhood cancer. Nowadays, in developed countries, ~80% of children and adolescents with cancer survive (Kaatsch, 2010). However, 40% of survivors report a chronic health condition 5 years after diagnosis, which increases to 73% of survivors by 30 years after diagnosis (Oeffinger et al., 2006). Given the possible...
Social outcomes 30 years after childhood cancer

MATERIALS AND METHODS

Study population and data collection. The study received approval from the French Data Protection Authority (CNIL) and from the ethics committee of the National Institute of Medical Research and Health (INSERM). Eligible patients were diagnosed under the age of 19 years for solid malignant tumours, benign cerebral tumours and haematological malignancies. These patients were 5-year survivors treated between 1948 and 2000 in 10 centres located in various areas of France. Tumour type, treatment, date of birth and date of diagnosis were extracted from the medical files. Other data were collected using a self-administered questionnaire sent by mail. In 2005, according to the National Death Registration System, 3512 five-year survivors aged 18 years and over were alive and therefore eligible for the present study. From 2005 to 2010, 2406 survivors returned the questionnaire (Figure 1). For the current analysis, survivors aged below 25 years were excluded, considering that education is not necessarily achieved before age 25 years ($n = 337$), as well as survivors aged 65 years or over ($n = 3$).

Comparison data from national statistics. General population norms were extracted from surveys conducted by the French Bureau of statistics (INSEE). Educational level and employment status were extracted from the 2007 Employment Survey, a quarterly household survey on employment outcomes in which 75 000 people are surveyed each year (for further information, please go to http://www.insee.fr/en/methodes/default.asp?page=source/ope-rp.htm). The collection is carried out via a self-administered questionnaire in the census and via face-to-face interviews in the two other surveys. Correction of non-response is made by the Bureau of statistics so that the surveys are representative of the French population. Data were provided by the ADISP-CMH (Data archives of the Public Statistics–Centre Maurice Halbwachs).

Outcome measures. Educational level was defined by the highest diploma obtained, considering the four French cycles of education as follows: (1) no diploma or below middle school; (2) middle school (usually achieved at 14 years of age); (3) vocational school (15/16 years of age) and high school (18 years of age); and (4) college (bachelor, master or thesis usually achieved at 21, 25 and 28 years of age respectively). The French educational system is quite similar to the US system, with the exception of an additional ‘vocational’ track: after middle school, around 14 years of age, students either go to high school or follow this vocational track, which leads to a blue-collar job. School education in France is free of charge and compulsory until the age of 16 years. College fees are not expensive (<500€ per year) and the state can provide fellowships.

Employment status was assessed considering four mutually exclusive outcomes, whether survivors were (1) employed, (2) unemployed and seeking work, (3) unemployed because of health, that is, people unable to work because of illness or disability, who receive disability benefits and who do not seek work (referred to as ‘health-related unemployment’) and (4) in an ‘other situation’ (student, homemaker and retired).
Occupational attainment was considered using the French classification of occupation (PCS 2003), which is divided into six occupational classes. The lower classes (‘Manual workers’ and ‘Farmers/Craftsmen, shopkeepers’) are the most physical occupations, accessible with no or little education. Because of an insufficient number of farmers, we merged this class with the one of craftsmen and shopkeepers, as they are close on the socio-occupational level, so that occupational attainment was classified into five mutually exclusive categories. The upper class (‘Managers and professionals’) encloses the highest-skilled jobs, that is, non-physical occupations requiring a high educational level. The two other classes are intermediate groups including clerks, service and sales workers, technicians and associate professionals. Occupational class referred to current occupation at the time of study or to previous occupation if the person was currently seeking work.

Information on level of education, occupation and employment status was missing for 107, 171 and 106 survivors, respectively. In addition, 218 economically inactive survivors who were not in labour force (students, homemakers, retired or unemployed because of health) were excluded from the analysis on occupation.

The survivor’s questionnaire included the exact same questions used by the French Bureau of Statistics to define educational level, employment status and occupational attainment, with the same mutually exclusive categories.

**Statistical analysis**

**External analyses.** Over the last decades, in most western countries, patterns of educational and occupational attainment have considerably changed between men and women (Breen and Jonsson, 2005). Therefore, the educational level and the occupational class observed in the survivors’ cohort were compared with the distribution expected in a cohort of the same age and gender distribution. Expected proportions were calculated using indirect standardisation: stratum-specific rates from the French population were averaged, using as weights the stratum sizes of the study population. Chi-square tests were performed to compare the differences between observed and expected distributions. In order to pinpoint the category that was different (e.g., high school or college), \( \chi^2 \)-tests were also performed for each level of the variable. We dealt with the problem of multiple testing using the Bonferroni correction. Standardised incidence ratios (ratios of observed to expected proportions) were computed, as well as their confidence intervals (CIs), assuming a Poisson distribution.

**Definition of strata.** Strata were defined using gender and 5-year age groups. Given that the frequency of unemployment varied in France between 2005 and 2010, the analysis on employment status was adjusted on interview year, using the National statistics for each year between 2005 and 2010. The distributions of educational level and occupational class did not vary between 2005 and 2010 in the National statistics nor in the survivors’ cohort. Thus, we used the 2007 employment survey and census data, because it was the year with the largest number of questionnaires completed.

In order to adjust the educational level of survivors on their socioeconomic background, a stratum including paternal occupation was added to the gender and age strata. We used paternal

Figure 1. Flow diagram.
occupation, a conventional measure of the socioeconomic background (Liberatos et al., 1988), because of the important part of economically inactive mothers in the study population. Paternal occupation was defined using the French classification of occupations, also used for the survivors.

We searched for interactions between variables of interest: in the survivor’s cohort, paternal occupation did not vary significantly with respect to survivors’ gender, type of diagnosis or period of diagnosis.

Internal analyses. Multivariable analyses were conducted to examine, within survivors, the clinical characteristics associated with educational or occupational achievement. Using binary logistic regression, we examined the following binary outcomes: (1) being a college graduate vs lower educational level, (2) being a manager vs other occupations and (3) health-related unemployment vs ability to work. The following clinical factors were considered: age at diagnosis, childhood cancer group, whether treated with chemotherapy or cranial irradiation. Models were also adjusted for sex and age, two well-known factors related to educational and occupational attainment (Breen and Jonsson, 2005), or health-related unemployment (Schuring et al., 2007). The socioeconomic background of survivors was also included in the models examining educational and occupational achievement. Odds ratio (OR) and their 95% CIs were calculated. Analyses were conducted using SAS 9.3 software (SAS Institute, Cary, NC, USA). All P-values reported are two-sided; values < 0.05 were considered significant.

RESULTS

As compared with responders, non-responders were significantly more likely to be male, to be young and to be leukaemia survivors (Table 1). Among responders, mean age at diagnosis was 6 years (range 0–18) and mean age at the time of study was 36 years (range 25–64). Mean time elapsed from diagnosis to questionnaire completion was 30 years. Cranial irradiation was received by 89.2% of patients treated for CNS tumour, by 50.6% of patients treated for leukaemia, by 27.0% of patients treated for lymphoma and by 7.5% of patients treated for other types of tumours.

Education. Survivors had a higher level of education than the French population of the same age and gender. Significant differences were restricted to the lowest and the highest educational categories investigated: survivors were significantly less likely to have no or little education (11.4% vs 16.8% expected; P < 0.001), while they were more likely to be college graduates (38.9% vs 33.5%; P < 0.001) (Table 2).

When stratifying the analysis by gender, male survivors were significantly more likely to be college graduates than the French population (39.2% vs 30.9%; P < 0.001). However, this was not true for female survivors, who were, on the other hand, more likely to have attended vocational schools (24.5% vs 20.5% expected; P < 0.05) (Table 2).

This higher educational achievement was not observed for CNS tumour and leukaemia survivors, or for patients who had received

| Table 1. Characteristics of respondents and non-respondents |
|---------------------------------|----------------|----------------|----------------|
| Characteristics                 | Respondents (N = 2066) | Non-respondents (N = 1008) | P-value*          |
|---------------------------------|----------------|----------------|----------------|
| Sex                             |                 |                 | <0.001          |
| Women                           | 1008 (48.8)    | 376 (37.3)     |                |
| Men                             | 1058 (51.2)    | 632 (62.7)     |                |
| Year of diagnosis               |                 |                 | <0.001          |
| < 1970                          | 361 (17.5)     | 101 (10.0)     |                |
| 1970–1979                       | 800 (38.7)     | 311 (30.9)     |                |
| 1980–1989                       | 836 (40.5)     | 444 (44.0)     |                |
| > 1990                          | 69 (3.3)       | 152 (15.1)     |                |
| Age at first cancer (years)     |                 | 0.231           |
| 0–4                             | 993 (48.1)     | 470 (46.6)     |                |
| 5–9                             | 527 (25.5)     | 286 (28.4)     |                |
| 10+                             | 546 (26.4)     | 252 (25.0)     |                |
| Childhood cancer group          |                 | <0.001          |
| Leukaemia                       | 158 (7.6)      | 199 (19.7)     |                |
| Nephroblastoma                  | 441 (21.3)     | 117 (11.6)     |                |
| Neuroblastoma                   | 258 (12.5)     | 110 (10.9)     |                |
| Hodgkin’s lymphoma              | 126 (6.1)      | 48 (4.8)       |                |
| Non-Hodgkin’s lymphoma          | 229 (11.1)     | 124 (12.3)     |                |
| Bone or soft tissue sarcoma     | 377 (18.2)     | 144 (14.3)     |                |
| CNS tumour                      | 203 (9.8)      | 131 (13.0)     |                |
| Other solid cancerb             | 274 (13.3)     | 135 (13.4)     |                |
| Treatment                       |                 | <0.001          |
| Chemotherapy and radiotherapy   | 1085 (52.5)    | 442 (43.8)     |                |
| Chemotherapy only               | 524 (25.4)     | 311 (30.9)     |                |
| Radiotherapy only               | 314 (15.2)     | 139 (13.8)     |                |
| No radiotherapy, nor chemotherapy| 143 (6.9)     | 116 (11.5)     |                |
| Year of birth                   |                 | <0.001          |
| 1939–1969                       | 808 (39.1)     | 287 (28.5)     |                |
| 1970–1974                       | 510 (24.7)     | 157 (15.6)     |                |
| 1975–1979                       | 490 (23.7)     | 209 (20.7)     |                |
| 1980–1988                       | 258 (12.5)     | 355 (35.2)     |                |

Abbreviation: CNS = central nervous system.
*P-values of χ²-tests comparing the distribution of characteristics between respondents and non-respondents.
bRetinoblastoma, gonadal tumour, thyroid tumour and other types of carcinoma.
Men

Women

Both male and female survivors were more likely to be high school graduates (6.5% vs 4.2% expected) (Table 3). In multivariable logistic regression (Table 5), when the sex, the age and the socioeconomic background were controlled for, odds of holding a managerial occupation were negatively influenced by diagnosis of CNS tumour (OR = 0.31; 95% CI = 0.12–0.79) and by cranial irradiation (OR = 0.47; 95% CI = 0.30–0.75).

**Table 2. Educational level, employment status and occupational class of survivors, by gender, compared with the French population of the same age and gender**

| Outcome                                      | All                | Men                     | Women                    |
|----------------------------------------------|--------------------|-------------------------|--------------------------|
| (O)                           | (E)                | (O/E)                   | (O)                      | (E)                  | (O/E)                   | (O)                      | (E)                  | (O/E)                   |
| Educational level               | N (%)              | (95% CI)                | P-value*                 | N (%)              | (95% CI)                | P-value*                 | N (%)              | (95% CI)                | P-value*                 |
| < Middle school                 | 223 (11.4)         | 329 (16.8)              | 0.7 (0.6–0.8)            | <0.001              | 107 (10.7)              | 169 (17.0)              | 0.6 (0.5–0.8)          | <0.001              | 116 (12.0)              | 160 (16.4)              | 0.7 (0.6–0.9)            | <0.001              |
| Middle school                  | 123 (6.3)          | 133 (6.8)               | 0.9 (0.8–1.1)           | <0.001              | 58 (5.8)               | 65 (6.5)               | 0.9 (0.7–1.2)          | <0.001              | 65 (6.7)               | 69 (7.2)               | 0.9 (0.7–1.2)            | <0.001              |
| Vocational school              | 510 (26.9)         | 472 (24.1)              | 1.1 (1.0–1.2)           | <0.001              | 274 (27.5)              | 275 (27.6)              | 1.0 (0.9–1.1)          | <0.001              | 236 (24.5)              | 197 (20.5)              | 1.2 (1.1–1.4)            | <0.001              |
| High school                    | 340 (17.4)         | 367 (18.7)              | 0.9 (0.8–1.0)           | <0.001              | 167 (16.6)              | 179 (18.0)              | 0.9 (0.8–1.1)          | <0.001              | 173 (18.0)              | 187 (19.4)              | 0.9 (0.8–1.1)            | <0.001              |
| College                        | 763 (38.9)         | 657 (33.5)              | 1.2 (1.1–1.3)           | <0.001              | 390 (39.2)              | 308 (30.9)              | 1.3 (1.1–1.4)          | <0.001              | 373 (38.7)              | 349 (36.2)              | 1.1 (1.0–1.2)            | <0.001              |

| Employment status              |                    |                        |                         |                    |                        |                         |                    |                        |                         |
|--------------------------------|--------------------|-------------------------|-------------------------|--------------------|------------------------|-------------------------|--------------------|------------------------|-------------------------|
| Employed                       | 1551 (79.1)        | 1558 (79.5)             | 1.0 (1.0–1.1)           | <0.001              | 844 (83.6)             | 860 (85.1)             | 1.0 (0.9–1.1)         | <0.001              | 707 (74.4)             | 698 (73.5)             | 1.0 (0.9–1.1)            | <0.001              |
| Unemployed seeking work        | 139 (7.1)          | 186 (9.5)               | 0.7 (0.6–0.9)           | <0.001              | 70 (6.9)               | 86 (8.5)               | 0.8 (0.6–1.0)         | <0.001              | 69 (7.3)               | 100 (10.5)             | 0.7 (0.5–0.9)            | <0.001              |
| Unemployed because of health   | 128 (6.5)          | 82 (4.2)                | 1.6 (1.3–1.9)           | <0.001              | 57 (5.6)               | 40 (4.4)               | 1.4 (1.1–1.9)         | <0.001              | 71 (7.5)               | 42 (4.4)               | 1.7 (1.3–2.1)            | <0.001              |
| Other situation                | 142 (7.2)          | 135 (6.9)               | 1.1 (0.9–1.2)           | <0.001              | 39 (3.9)               | 25 (2.5)               | 1.6 (1.1–2.1)         | <0.001              | 103 (10.8)             | 110 (11.6)             | 0.9 (0.8–1.1)            | <0.001              |

| Occupational class             |                    |                        |                         |                    |                        |                         |                    |                        |                         |
|--------------------------------|--------------------|-------------------------|-------------------------|--------------------|------------------------|-------------------------|--------------------|------------------------|-------------------------|
| Manual workers                 | 287 (17.1)         | 399 (23.8)              | 0.7 (0.6–0.8)           | <0.001              | 210 (23.6)             | 322 (36.2)             | 0.7 (0.6–0.8)         | <0.001              | 77 (9.8)               | 75 (9.5)               | 1.0 (0.8–1.3)            | <0.001              |
| Farmers, craftsmen, shopkeepers| 96 (5.8)           | 111 (6.6)               | 0.9 (0.7–1.1)           | <0.001              | 68 (7.7)               | 82 (9.2)               | 0.8 (0.6–1.1)         | <0.001              | 28 (3.5)               | 30 (3.7)               | 0.9 (0.6–1.4)            | <0.001              |
| Clerks, service and sales      | 491 (29.3)         | 476 (28.4)              | 1.0 (0.9–1.1)           | <0.001              | 195 (21.9)             | 120 (13.5)             | 1.6 (1.4–1.9)         | <0.001              | 296 (37.6)             | 359 (45.6)             | 0.8 (0.7–0.9)            | <0.001              |
| Technicians and associate      | 415 (24.7)         | 433 (25.8)              | 1.0 (0.9–1.1)           | <0.001              | 179 (20.1)             | 209 (23.5)             | 0.9 (0.8–1.0)         | <0.001              | 236 (30.0)             | 223 (28.4)             | 1.1 (0.9–1.2)            | <0.001              |
| Professionals and managers     | 388 (23.1)         | 258 (15.4)              | 1.5 (1.4–1.7)           | <0.001              | 238 (26.7)             | 157 (17.7)             | 1.5 (1.3–1.7)         | <0.001              | 150 (19.1)             | 101 (12.8)             | 1.5 (1.3–1.7)            | <0.001              |

**Abbreviation:** CI = confidence interval.

* aP-values of \( \chi^2 \)-tests comparing observed and expected distributions.

* bP < 0.05 for observed and expected proportions for each level of the variable.

**DISCUSSION**

Compared with national statistics adjusted on age and sex, we found that most survivors of childhood cancer had a significantly higher educational level and occupational class than expected, even when controlling for their socioeconomic background. Unemployment and health-related unemployment were higher than expected for CNS tumour survivors, but not for survivors of other diagnoses.

Educational and occupational attainment. The higher educational attainment of French survivors, besides CNS tumour and leukaemia survivors, is congruent with the results of studies conducted in Germany, with survivors of adolescent cancer (Dieluweit et al, 2011), and in Denmark, where male survivors of non-CNS tumours were also found to attain a higher educational level than controls (Koch et al, 2004). However, this higher achievement is in contrast to most of European studies, which have found that non-CNS tumour survivors had a similar educational level than controls (Koch et al, 2004; Lorenzi et al, 2009; Boman...
| Educational level | Hodgkin's lymphoma | Bone or soft tissue sarcoma | Central nervous system tumour | Leukaemia | Other diagnosis |
|------------------|--------------------|----------------------------|----------------------------|----------|----------------|
|                   | (O) | (E) | O/E | P-value^a | (O) | (E) | O/E | P-value^a | (O) | (E) | O/E | P-value^a | (O) | (E) | O/E | P-value^a |
| N (%)             |     |     |     |          |     |     |     |          |     |     |     |          |     |     |     |          |
| Middle school     | 11 (9.1) | 23 (18.7) | 0.5 (0.2-0.9) | c | 27 (7.4) | 68 (18.6) | 0.4 (0.3-0.6) | d | 71 (40.6) | 31 (17.5) | 2.3 (1.8-2.9) | d | 18 (1.5) | 19 (12.2) | 0.9 (0.6-1.5) | d | 96 (8.4) | 190 (16.6) | 0.5 (0.4-0.6) |
| Middle school     | 11 (9.1) | 9 (7.4) | 1.2 (0.6-2.2) | d | 22 (6.0) | 26 (7.1) | 0.8 (0.5-1.3) | d | 12 (6.7) | 12 (7.0) | 1.0 (0.5-1.8) | d | 26 (16.4) | 9 (5.8) | 2.9 (1.9-4.2) | d | 52 (4.6) | 78 (6.8) | 0.7 (0.5-0.9) |
| Vocational school | 30 (24.8) | 31 (25.4) | 1.0 (0.7-1.4) | d | 93 (25.5) | 95 (26.0) | 1.0 (0.8-1.3) | d | 53 (30.3) | 42 (24.2) | 1.3 (1.0-1.7) | d | 21 (13.4) | 30 (19.4) | 0.7 (0.4-1.1) | d | 313 (27.4) | 274 (24.0) | 1.1 (1.0-1.3) |
| High school       | 25 (20.7) | 21 (17.7) | 1.2 (0.8-1.8) | d | 54 (14.8) | 63 (17.7) | 0.9 (0.6-1.1) | d | 12 (6.9) | 32 (18.4) | 0.4 (0.2-0.7) | d | 52 (3.1) | 35 (22.2) | 1.5 (1.1-2.0) | c | 197 (17.2) | 215 (18.8) | 0.9 (0.6-1.1) |
| College           | 44 (36.4) | 37 (30.7) | 1.2 (0.9-1.6) | d | 168 (46.2) | 112 (30.9) | 1.5 (1.3-1.7) | d | 27 (15.4) | 57 (22.8) | 0.5 (0.3-0.7) | d | 40 (2.5) | 63 (40.3) | 0.6 (0.5-0.9) | d | 484 (42.4) | 386 (33.8) | 1.3 (1.1-1.4) |
| Employment status | 0.518 | 0.450 | <0.001 | 0.008 | 0.518 | 0.26 | <0.001 |
| Employed          | 97 (81.5) | 94 (78.8) | 1.0 (0.8-1.3) | d | 288 (81.8) | 279 (79.4) | 1.0 (0.9-1.2) | d | 96 (53.9) | 141 (90.0) | 0.7 (0.6-0.8) | d | 127 (80.9) | 125 (79.6) | 1.0 (0.9-1.2) |
| Unemployed and    | 9 (7.6) | 11 (9.1) | 0.8 (0.4-1.6) | d | 24 (6.8) | 32 (9.1) | 0.8 (0.5-1.1) | d | 21 (11.8) | 17 (9.3) | 1.2 (0.8-1.9) | d | 9 (5.7) | 17 (10.6) | 0.5 (0.2-1.0) | c | 76 (6.6) | 110 (9.5) | 0.7 (0.5-0.9) |
| seeking work      | 7 (5.9) | 5 (4.3) | 1.4 (0.6-2.9) | d | 17 (4.8) | 15 (4.4) | 1.1 (0.7-1.8) | d | 50 (28.1) | 8 (3.3) | 6.3 (4.6-8.2) | d | 4 (2.5) | 6 (3.8) | 0.7 (0.2-1.7) | d | 50 (4.3) | 48 (4.2) | 1.0 (0.8-1.4) |
| Unemployed        | 6 (5.0) | 9 (7.8) | 0.7 (0.2-1.5) | d | 23 (6.5) | 25 (7.2) | 0.9 (0.6-1.4) | d | 11 (6.2) | 13 (7.4) | 0.9 (0.4-1.5) | d | 17 (10.8) | 16 (10.1) | 1.7 (1.0-2.7) | c | 85 (7.4) | 77 (6.7) | 1.1 (0.9-1.4) |
| Other situation   | 85 (7.4) | 77 (6.7) | 1.1 (0.9-1.4) | | | | | 1 | | | | | | | | |
| Occupational class| 0.061 | 0.03 | <0.001 | 0.008 | 0.15 | 0.95 | <0.001 |
| Manual workers    | 16 (14.8) | 27 (24.1) | 0.6 (0.3-1.0) | d | 47 (14.5) | 79 (24.3) | 0.6 (0.4-0.8) | d | 37 (32.7) | 27 (23.9) | 1.4 (1.0-1.9) | d | 26 (20.2) | 30 (22.9) | 0.9 (0.6-1.3) | d | 161 (16.4) | 237 (23.7) | 0.7 (0.6-0.8) |
| Farmers, craftsmen, shopkeepers | 10 (9.0) | 8 (7.2) | 1.3 (0.6-2.3) | d | 20 (6.1) | 25 (7.7) | 0.8 (0.5-1.2) | d | 3 (2.7) | 8 (3.8) | 0.4 (0.1-1.1) | d | 4 (3.1) | 5 (3.9) | 0.8 (0.2-2.1) | d | 59 (5.9) | 65 (6.5) | 0.9 (0.7-1.2) |
| Clerks, service and sales workers | 36 (32.4) | 31 (28.0) | 1.2 (0.8-1.6) | d | 84 (25.8) | 86 (27.1) | 1.0 (0.8-1.2) | d | 47 (14.6) | 32 (28.0) | 1.5 (1.1-2.0) | c | 52 (4.0) | 40 (30.7) | 1.3 (1.0-1.7) | d | 272 (27.2) | 286 (28.6) | 1.0 (0.8-1.1) |
| Technicians and associates professionals | 25 (22.5) | 28 (25.1) | 0.9 (0.6-1.3) | d | 84 (25.8) | 81 (25.0) | 1.0 (0.8-1.3) | d | 19 (16.8) | 29 (25.6) | 0.7 (0.4-1.0) | d | 27 (20.9) | 36 (28.0) | 0.8 (0.5-1.1) | d | 260 (25.0) | 258 (25.8) | 1.0 (0.9-1.1) |
| Professionals and managers | 24 (21.6) | 17 (15.6) | 1.4 (0.9-2.1) | d | 90 (27.7) | 52 (15.9) | 1.7 (1.4-2.1) | d | 7 (6.2) | 18 (15.6) | 0.4 (0.2-0.8) | c | 20 (15.5) | 19 (14.4) | 1.1 (0.6-1.6) | d | 247 (24.7) | 153 (15.3) | 1.6 (1.4-1.8) |

Abbreviation: CI = confidence interval.

^aP-values of \( \chi^2 \)-tests comparing observed and expected distributions.

^bP-values of \( \chi^2 \)-tests comparing observed and expected proportions for each level of the variable.

^c0.05 > P-value > 0.001

^dP-value < 0.001

*Other diagnosis a includes nephroblastoma, neuroblastoma, non-Hodgkin's lymphoma, gonadal tumour, retinoblastoma, thyroid tumour and other types of carcinoma.
et al., 2010; Kuehni et al., 2012), or to findings of the US cohort, where deficits in education were found for survivors of various diagnoses (e.g., bone tumour, rhabdomyosarcoma or lymphoma) (Gurney et al., 2009). In the US cohort, survivors were also less likely to hold managerial occupations than their siblings, especially female survivors (Kirchhoff et al., 2011).

### Table 4. Level of education of survivors compared with the French population of the same age, same gender, adjusted on paternal occupation

| Outcome | All diagnoses | All but CNS tumour and leukaemia survivors | CNS tumour and leukaemia survivors |
|---------|---------------|------------------------------------------|-----------------------------------|
|         | (O) | (E) | O/E | P-value* | (O) | (E) | O/E | P-value* | (O) | (E) | O/E | P-value* |
| Educational level | | | | | | | | | | | | | |
| Middle School | 161 (9.8) | 271 (16.5) | 0.6 (0.5–0.7) | <0.001 | 99 (7.1) | 234 (16.8) | 0.4 (0.3–0.5) | <0.001 | 62 (24.9) | 37 (14.9) | 1.7 (1.3–2.2) | c |
| Vocational School | 103 (6.3) | 133 (8.1) | 0.8 (0.6–0.9) | d | 70 (5.0) | 114 (8.2) | 0.6 (0.5–0.8) | d | 33 (13.3) | 18 (7.4) | 1.8 (1.3–2.6) | c |
| High School | 416 (25.4) | 367 (22.4) | 1.1 (1.0–1.3) | d | 354 (25.4) | 315 (22.5) | 1.1 (1.0–1.3) | d | 62 (24.9) | 54 (21.5) | 1.2 (0.9–1.5) | d |
| College | 693 (42.2) | 579 (35.3) | 1.2 (1.1–1.3) | c | 631 (45.3) | 486 (34.9) | 1.3 (1.2–1.4) | c | 62 (24.9) | 94 (37.7) | 0.7 (0.5–0.9) | c |

Abbreviation: CI = confidence interval; CNS = central nervous system.

*P-values of χ²-tests comparing observed and expected distributions.

### Table 5. Characteristics associated with educational attainment, occupational attainment and health-related unemployment after childhood cancer: separate logistic regressions

| Characteristics | Odds of being a college graduate | Odds of being a manager | Odds of being unemployed because of health |
|----------------|----------------------------------|--------------------------|-------------------------------------------|
| N | (Odds Ratio (95% CI)) | (Odds Ratio (95% CI)) | (Odds Ratio (95% CI)) |
| Age at first cancer (years) | | | |
| 0–4 | 1 | 1 | 1 |
| 5–9 | 0.99 | (0.75–1.31) | 1.00 | (0.69–1.46) | 1.68 | (0.42–1.08) |
| 10+ | 1.18 | (0.87–1.61) | 1.00 | (0.69–1.46) | 0.62 | (0.37–1.03) |
| Cranial irradiation | | | |
| No | 1 | 1 | 1 |
| Yes | 0.48 | (0.35–0.66) | 0.47 | (0.30–0.75) | 3.23 | (1.95–5.37) |
| Chemotherapy | | | |
| No | 1 | 1 | 1 |
| Yes | 1.09 | (0.83–1.44) | 1.07 | (0.76–1.51) | 0.80 | (0.53–1.19) |
| Childhood cancer group | | | |
| Nephroblastoma | 0.70 | (0.41–1.20) | 1.03 | (0.50–2.12) | 0.51 | (0.15–1.78) |
| Leukaemia | 1.08 | (0.76–1.54) | 1.05 | (0.68–1.61) | 1.37 | (0.68–2.77) |
| Neuroblastoma | 0.99 | (0.61–1.60) | 1.03 | (0.58–1.84) | 1.76 | (0.71–4.33) |
| Hodgkin’s lymphoma | 0.93 | (0.62–1.38) | 0.99 | (0.62–1.61) | 0.90 | (0.38–2.13) |
| Non-Hodgkin’s lymphoma | 1.48 | (1.03–2.14) | 1.27 | (0.82–1.96) | 1.03 | (0.46–2.29) |
| Soft tissue sarcoma | 0.97 | (0.61–1.54) | 0.86 | (0.49–1.50) | 2.15 | (0.92–5.01) |
| Bone sarcoma | 0.97 | (0.26–0.84) | 0.31 | (0.12–0.79) | 4.63 | (2.07–10.34) |
| Other solid cancer* | 1.24 | (0.86–1.79) | 1.14 | (0.73–1.80) | 1.15 | (0.54–2.43) |
| Sex | | | |
| Female | 1 | 1 | 1 |
| Male | 1.04 | (0.85–1.27) | 1.85 | (1.43–2.39) | 0.67 | (0.47–0.95) |
| Year of birth | | | |
| 1939–1969 | 1 | 1 | 1 |
| 1970–1974 | 1.61 | (1.24–2.10) | 0.95 | (0.69–1.30) | 0.49 | (0.30–0.77) |
| 1975–1979 | 2.04 | (1.54–2.70) | 0.68 | (0.48–0.97) | 0.48 | (0.29–0.79) |
| 1980–1988 | 1.46 | (1.01–2.11) | 0.54 | (0.33–0.90) | 0.48 | (0.25–0.92) |
| Socioeconomic background | | | |
| Survivor’s father not a manager | 1 | 1 | 1 |
| Survivor’s father was a manager | 3.27 | (2.45–4.35) | 4.64 | (3.43–6.28) | – | – |

Abbreviations: CI = confidence interval; CNS = central nervous system; OR = odds ratio.

*Retinoblastoma, gonadal tumour, thyroid tumour and other types of carcinoma.
The poorer educational achievement of CNS tumour (Pastore et al, 2001; Mitby et al, 2003; Koch et al, 2004; Mody et al, 2008; Lorenzi et al, 2009; Boman et al, 2010; Lancashire et al, 2010; Dieluweit et al, 2011; Kuehni et al, 2012) and leukaemia survivors (Mitby et al, 2003; Mody et al, 2008; Lancashire et al, 2010), as well as the long-term adverse effect of cranial irradiation on cognitive functioning (Spiegler et al, 2004; Kadan-Lottick et al, 2010), have been shown previously. Another recurrent finding is the difference in educational attainment according to gender. Indeed, a significant proportion of studies, conducted in Europe or in the United States, have found that female gender was associated with a lower educational achievement (Mitby et al, 2003; Koch et al, 2004; Lorenzi et al, 2009; Lancashire et al, 2010; Dieluweit et al, 2011). Different mechanisms between men and women in the selection of a career could partly explain this finding, as suggested by a qualitative study based on 80 interviews with childhood cancer survivors randomly selected from the French cohort. In this study, 16% of male survivors said they had disregarded a typically blue-collar career choice during adolescence or young adulthood and had chosen an educational path leading to white-collar occupations, because of physical sequelae, or because of concerns about their future health, as compared with 5% of females (Dumas et al, 2015).

**Employment status.** The higher unemployment rate of CNS tumour survivors found in our study is consistent with a meta-analysis showing that survivors of CNS tumours were nearly five times more likely to be unemployed than controls, whereas the risk for other diagnoses was not significant (de Boer et al, 2006). In our study, health-related unemployment of CNS tumour survivors was particularly high: 28% were unable to work because of health, as compared with 4% of the French population of the same age and gender. These results are similar to those of the US cohort, where, 25% of survivors of CNS tumour reported health-related unemployment, as compared with 2% of siblings (Kirschhoff et al, 2010).

Social outcomes such as unemployment or health-related unemployment can differ from one country to the other, depending on welfare policies and financial resources dedicated to welfare programmes, but they can also be influenced by other mechanisms. In a meta-analysis including 18 US studies and 14 European studies, American childhood cancer survivors had an overall three-fold risk of becoming unemployed, whereas no such risk was found for European survivors. According to the authors, this difference may result from a higher discrimination regarding cancer in the United States, given the fact that many employers there pay for health insurance of their employees, which is usually not the case in Europe (de Boer et al, 2006). In France, health insurance provides universal coverage, which is state-funded. Invalidity benefits are allocated to individuals who are unable to work. The amount of the disability pension depends on the level of incapacities and on past average annual earnings. The minimum allowance is 800€ per month in 2016.

**Strengths and limitations.** As compared with similar cohorts, the French cohort is characterised by its long-term follow-up: mean follow-up time was 30 years, as compared with 14 years in the German study (Dieluweit et al, 2011); in our study, 76% of survivors were ≥30 years of age, as compared with 59% in the British study (Lancashire et al, 2010), 33% in the Danish study (Koch et al, 2004), 29% in the Swiss study (Kuehni et al, 2012) or 22% in the US study (Mitby et al, 2003). Thus, a pessimistic explanation of our results, as compared with studies conducted with younger survivors, would be that patients from lower socioeconomic status die younger than those from higher ones do, resulting in a higher socioeconomic status of very long-term survivors. Unfortunately, we do not have data on the social status of patients who died before the study to support this hypothesis. Social inequalities in mortality, whether they result from inequality in access to information and health care or from differences in life styles and health behaviours, are well established in the general population. Despite a welfare policy according free medical care, the magnitude of inequalities in mortality between groups of higher and lower educational level is particularly high in France, especially for men (Mackenbach et al, 2008). Considering the important incidence of comorbidities in survivors in relation to prior cancer treatment (Oeffinger et al, 2006), the effect of social status on mortality could be stronger than for the general population, notably because of disparities in the management of treatment-related late effects. However, to our knowledge, no study has examined this latter issue. Indeed, all studies on social inequalities in survival from childhood cancer assess socioeconomic disparities through parental education or ecologic measures derived from the place of residence at the time of diagnosis (Gupta et al, 2014), because they focus on the effect of parental social status on survival, through access or adherence to treatment. Thus, even if these studies involve a long-term follow-up (Lightfoot et al, 2012), they do not include longitudinal data and they do not consider the possible cumulative effect of social disadvantage throughout the life course of survivors.

Several limitations should be considered when interpreting those results. Data were self-reported and may not be completely accurate. This study is a multicentre study that does not fully represent adult survivors in France. Leukaemia was not treated in some centres, resulting in a low percentage of leukaemia survivors in the study, despite the fact that it is the most common diagnosis in children (Kaatsch, 2010). Although treatments have changed considerably over the past decades, our study lacked statistical power to analyse potential differences between treatment eras for survivors of leukaemia or CNS tumour. Overall, 28.7% of eligible patients did not participate in the study. This may have induced a selection bias, as most vulnerable individuals are probably more difficult to reach. This bias may have accounted for the higher socioeconomic background of survivors. However, controlling for the role of socioeconomic status between responders and non-responders was impossible, as we did not have data on non-responders' socioeconomic status. Nevertheless, we addressed this possible selection bias by adjusting educational level on paternal occupation, that is, by looking at the chance to attain a given level of education depending on one's age, gender and socioeconomic background. The observed rate of survivors with a college degree remained significantly higher than the expected rate even after adjusting on paternal occupation, thereby strengthening our conclusions.

**CONCLUSION**

Most survivors of childhood cancer had higher educational level and occupational class than expected. This positive impact of childhood cancer could reflect social inequalities in long-term survival from childhood cancer. There is a clear need to further investigate this issue, bearing in mind that different mechanisms may be at work between male and female survivors. At the present time, in France, educational support for patients is restricted to the treatment duration, to prevent dropping out of school. Beyond the treatment period, educational and occupational supports for survivors of childhood or adolescent cancer are only available in a few cancer centres. Otherwise, support is provided on a national basis for all children or young adults with disabilities: it includes individualised support in standard schools, schools for children with special needs and services providing assistance and guidance for employment. The results of this study provide ground for concern for survivors treated for CNS tumour or leukaemia, especially when treatment included cranial irradiation, and point to the specific support these survivors might need throughout their lifespan.
We thank the patients and all the clinicians and research staff who participated in the study. We are grateful to Catherine Hill for her help in revising the manuscript. This work was supported by the French state (‘Institut National du Cancer’, ‘Agence Française de Sécurité Sanitaire et des Produits de Santé’, ‘Institut de Recherche en Santé Publique’ and ‘Programme Hospitalier de Recherche Clinique’), French charities and ‘Ligue Nationale Contre le Cancer’ and ‘Fondation ARC’ and one foundation (‘Fondation Pfizer pour la santé de l’enfant et de l’adolescent’). The researchers were independent from the funders. The funders were not involved in any part of the study design, data collection, analysis and interpretation of data, or in the decision to submit this article for publication.

The authors declare no conflict of interest.

REFERENCES

Boman KK, Lindblad F, Hjern A (2010) Long-term outcomes of childhood cancer survivors in Sweden: a population-based study of education, employment, and income. Cancer 116(5): 1385–1391.

Breen R, Jonsson JO (2005) Inequality of opportunity in comparative perspective: recent research on educational attainment and social mobility. Ann Rev Sociol 31(1): 223–243.

de Boer A, Verbeek J, van Dijk F (2006) Adult survivors of childhood cancer and unemployment: A metaanalysis. Cancer 107(1): 1–11.

Dieluweit U, Debatin K-M, Grabow D, Kaatsch P, Peter R, Seitz DCM, Goldbeck I (2011) Educational and vocational achievement among long-term survivors of adolescent cancer in Germany. Pediatr Blood Cancer 56(3): 432–438.

Dumas A, Calibault I, Perrey C, Oberlin O, De Vathaire F, Amiel P (2015) Educational trajectories after childhood cancer: When illness experience matters. Soc Sci Med 135: 67–74.

Gupta S, Wilejto M, Pole JD, Guttmann A, Sung L (2014) Low socioeconomic status is associated with worse survival in children with cancer: a systematic review. PLoS ONE 9(2): e89482.

Gurney JG, Robison LL, Ness KK, de Boer A, Verbeek J, van Dijk F (2006) Adult survivors of childhood cancer and unemployment: A metaanalysis. Cancer 107(1): 1–11.

Kaatsch P (2010) Epidemiology of childhood cancer. Cancer Treat Rev 36(4): 277–285.

Kadan-Lottick NS, Zeltzer LK, Liu Q, Yasui Y, Ellenberg L, Gioia G, Robison LL, Krull KR (2010) Neurocognitive functioning in adult survivors of childhood non-central nervous system cancers. J Natl Cancer Inst 102(12): 881–893.

Kirchhoff AC, Krull KR, Hess KK, Park ER, Oeffinger KC, Hudson MM, Stovall M, Robison LL, Wickizer T, Leisenring W (2011) Occupational outcomes of adult childhood cancer survivors: a report from the childhood cancer survivor study. Cancer 117(13): 3033–3044.

Kirchhoff AC, Leisenring W, Krull KR, Hess KK, Friedman DL, Armstrong GT, Stovall M, Park ER, Oeffinger KC, Hudson MM, Robison LL, Wickizer T (2010) Unemployment among adult survivors of childhood cancer: a report from the childhood cancer survivor study. Med Care 48(11): 1015–1025.

Koch SV, Kejs AMT, Engholm G, Johansen C, Schmiegelow K (2004) Educational attainment among survivors of childhood cancer: a population-based cohort study in Denmark. Br J Cancer 91(5): 923–928.

Kuehni CE, Strippoli MP-F, Rueegg CS, Rehholz CE, Bergstrasser E, Grotzer M, von der Weid NX, Michel G. Swiss Pediatric Oncology G (2012) Educational achievement in Swiss childhood cancer survivors compared with the general population. Cancer 118(5): 1439–1449.

Lancashire ER, Frobisher C, Reulen RC, Winter DL, Glaser A, Hawkins MM (2010) Educational attainment among adult survivors of childhood cancer in Great Britain: a population-based cohort study. J Natl Cancer Inst 102(4): 254–270.

Liberatos P, Link BG, Kelsey JL (1988) The measurement of social class in epidemiology. Epidemiol Rev 10: 87–121.

Lightfoot TJ, Johnston WT, Simpson J, Smith AG, Ansell P, Crouch S, Roman E, Kinsey SE (2012) Survival from childhood acute lymphoblastic leukaemia: the impact of social inequality in the United Kingdom. Eur J Cancer 48(2): 263–269.

Lorenzi M, McMillan AJ, Siegel LS, Zumbo BD, Glickman V, Spinelli JJ, Goddard KJ, Pritchard SL, Rogers PC, McBride ML (2009) Educational outcomes among survivors of childhood cancer in British Columbia, Canada: report of the Childhood/Adolescent/Young Adult Cancer Survivors (CAYACS) Program. Cancer 115(10): 2234–2245.

Mackenbach JP, Stirbu I, Roskam AJ-R, Schaap MM, Menvielle G, Leinsalu M, Kunst AE. European Union Working Group on Socioeconomic Inequalities in H (2008) Socioeconomic inequalities in health in 22 European countries. N Engl J Med 358(23): 2468–2481.

Milby PA, Robison LL, Whitton JA, Zevon MA, Gibbs IC, Tersak JM, Meadows AT, Stovall M, Zeltzer LK, Mertens AC (2003) Utilization of special education services and educational attainment among long-term survivors of childhood cancer: a report from the Childhood Cancer Survivor Study. Cancer 97(4): 1115–1126.

Mody R, Li S, Dover DC, Sallan S, Leisenring W, Oeffinger KC, Yasui Y, Robison LL, Neglia JP (2008) Twenty-five-year follow-up among survivors of childhood acute lymphoblastic leukaemia: a report from the Childhood Cancer Survivor Study. Blood 111(12): 5515–5523.

Oeffinger KC, Mertens AC, Sklar CA, Kawashima T, Hudson MM, Meadows AT, Friedman DL, Marina N, Hobbie W, Kadan-Lottick NS, Schwartz CL, Leisenring W, Robison LL. Childhood Cancer Survivor S (2006) Chronic health conditions in adult survivors of childhood cancer. N Engl J Med 355(15): 1572–1582.

Pastore G, Mosso ML, Magnani C, Luzzatto L, Bianchi M, Terracini B (2001) Physical impairment and social life goals among adult long-term survivors of childhood cancer. Tumori 87(6): 372–378.

Schuring M, Burdorf L, Kunst A, Mackenbach J (2007) The effects of ill health on entering and maintaining paid employment: evidence in European countries. J Epidemiol Community Health 61(7): 597–604.

Spieglar BJ, Bouffet E, Greenberg ML, Rutka JT, Mabbot DJ (2004) Change in neurocognitive functioning after treatment with cranial radiation in childhood. J Clin Oncol 22(4): 706–713.

Ward T, Grammenos S, Huber M (2007) Study of compilation of disability statistical data from the administrative registers of the member states: APPLICA, Centre for European Social and Economic Policy. Academic Network of European Disability Experts, 128pp.

This work is published under the standard license to publish agreement. After 12 months the work will become freely available and the license terms will switch to a Creative Commons Attribution-NonCommercial-Share Alike 4.0 Unported License.