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

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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

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interruption in schooling during or after cancer treatment because of treatment-related toxicities or cancer recurrence, childhood cancer survivors might be less likely to reach a high educational level than healthy individuals. In addition, functional limitations related to amputations or surgeries, especially after osteosarcoma or soft tissue sarcoma, as well as treatment-related late effects such as hearing loss or cognitive disability, especially after cranial irradiation, can limit the ability to perform certain tasks, limiting choice of occupation or work ability. Occupational achievement is closely related to educational attainment (Breen and Jonsson, 2005). Thus, childhood cancer can prevent occupational achievement, because of its impact on educational attainment and/or because of physical limitations resulting from late effects of treatment.

Regarding education, several European and American studies have underscored educational deficits in survivors of central nervous system (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, to a lesser extent, in survivors of leukaemia (Mitby *et al*, 2003; Mody *et al*, 2008; Lancashire *et al*, 2010). However, besides data from the US cohort, which is based on sibling comparisons (Gurney *et al*, 2009), only a few European studies have controlled for the socioeconomic status of survivors' parents (Koch *et al*, 2004; Lorenzi *et al*, 2009), although it is a well-known predictor of educational achievement (Breen and Jonsson, 2005) and a factor possibly related to survival of childhood cancer, even in developed countries (Gupta *et al*, 2014).

Several European studies have assessed the impact of childhood cancer on employment (de Boer *et al*, 2006; Boman *et al*, 2010; Dieluweit *et al*, 2011) but these studies did not make the distinction between unemployment (i.e., seeking work) and health-related unemployment (i.e., unable to work and not seeking work), even though this latter outcome is a key issue for assessing the impact of cancer on work ability. In one US study making such a distinction, childhood cancer survivors reported more often health-related unemployment than siblings (Kirchhoff *et al*, 2010). Regarding occupational attainment, US survivors have been found to be less often in higher-skilled occupations than their sibling counterparts (Kirchhoff *et al*, 2011). No study outside the North American continent has been dedicated to the impact of childhood cancer on occupational attainment. Besides, most of the studies were limited in their follow-up: survivors were around 20 years of age on average at the time of study (de Boer *et al*, 2006), so that very little is known on the long-term impact of childhood cancer on occupational outcomes.

Large-scale studies are necessary to inform tailored interventions that can reduce the impact of treatment-related toxicities on social outcomes in adult life. These studies need to be conducted in different settings given that social outcomes such as education or employment can depend on social and labour market policies, which vary sharply across countries (Ward *et al*, 2007). As these studies are dedicated to the analysis of social outcomes, their design needs to control for the role of the socioeconomic background of participants. In this study, we compared the educational and occupational outcomes of French childhood cancer survivors with the one expected in a cohort of the same age and gender, according to general population statistics. Educational and work-related outcomes were considered altogether given their correlation (Breen and Jonsson, 2005). Adjustment on paternal occupation was made to control for the role of survivors' socioeconomic backgrounds on their achievement. Internal analyses within the survivors' cohort were conducted to examine the association between clinical characteristics and educational or occupational achievement.

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=-sources/ope-enq-emploi-continu.htm). Occupation was extracted from the 2007 French census, which is based on a sample of 14% of the French population (approximately nine million people). Please go to http://www.insee.fr/en/methodes/default.asp?page=sources/ope-rp.htm for more information on the French census. Educational level adjusted on paternal occupation was compared with data of the 2003 Training and Vocational Skills Survey, a 10-yearly survey dedicated to the magnitude of intergenerational social mobility in the French society, and with the effectiveness of the French educational system. In the latest edition (2003), almost 40 000 people were surveyed (http://www.insee.fr/en/methodes/default.asp?page=sources/ope-enq-fqp.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), χ^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

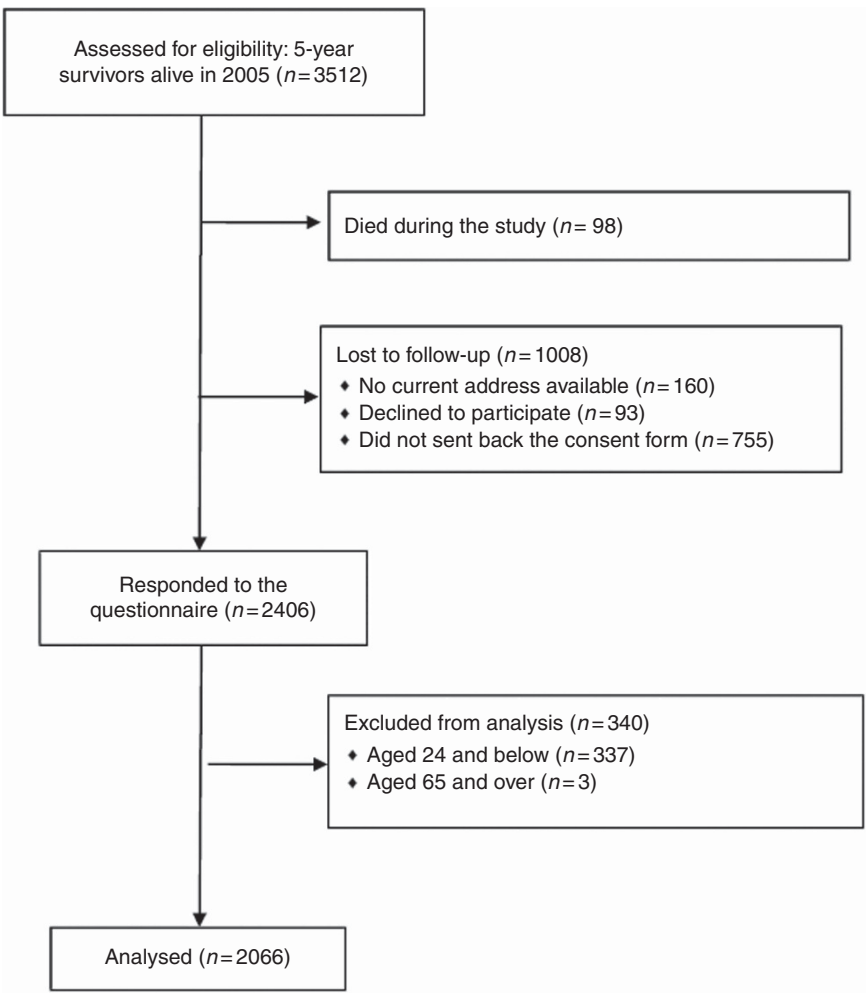

Figure 1. Flow diagram.

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) *N* (%)	Non-respondents (*N* = 1008) *N* (%)	*P*-value[a]
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 cancer[b]	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.
[a]*P*-values of χ^2-tests comparing the distribution of characteristics between respondents and non-respondents.
[b]Retinoblastoma, gonadal tumour, thyroid tumour and other types of carcinoma.

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

	All				Men				Women			
	Observed (O)	Expected (E)	O/E		Observed (O)	Expected (E)	O/E		Observed (O)	Expected (E)	O/E	
Outcome	***N* (%)**	***N* (%)**	**(95% CI)**	***P*-value[a]**	***N* (%)**	***N* (%)**	**(95% CI)**	***P*-value[a]**	***N* (%)**	***N* (%)**	**(95% CI)**	***P*-value[a]**
Educational level				<0.001				<0.001				<0.001
<Middle school	223 (11.4)	329 (16.8)	0.7 (0.6–0.8)	[b]	107 (10.7)	169 (17.0)	0.6 (0.5–0.8)	[b]	116 (12.0)	160 (16.6)	0.7 (0.6–0.9)	[b]
Middle school	123 (6.3)	133 (6.8)	0.9 (0.8–1.1)		58 (5.8)	65 (6.5)	0.9 (0.7–1.2)		65 (6.7)	69 (7.2)	0.9 (0.7–1.2)	
Vocational school	510 (26.0)	472 (24.1)	1.1 (1.0–1.2)		274 (27.5)	275 (27.6)	1.0 (0.9–1.1)		236 (24.5)	197 (20.5)	1.2 (1.1–1.4)	[c]
High school	340 (17.4)	367 (18.7)	0.9 (0.8–1.0)		167 (16.8)	179 (18.0)	0.9 (0.8–1.1)		173 (18.0)	187 (19.4)	0.9 (0.8–1.1)	
College	763 (38.9)	657 (33.5)	1.2 (1.1–1.3)	[b]	390 (39.2)	308 (30.9)	1.3 (1.1–1.4)	[b]	373 (38.7)	349 (36.2)	1.1 (1.0–1.2)	
Employment status				<0.001				<0.001				<0.001
Employed	1551 (79.1)	1558 (79.5)	1.0 (1.0–1.1)		844 (83.6)	860 (85.1)	1.0 (0.9–1.1)		707 (74.4)	698 (73.5)	1.0 (0.9–1.1)	
Unemployed seeking work	139 (7.1)	186 (9.5)	0.7 (0.6–0.9)	[c]	70 (6.9)	86 (8.5)	0.8 (0.6–1.0)		69 (7.3)	100 (10.5)	0.7 (0.5–0.9)	[c]
Unemployed because of health	128 (6.5)	82 (4.2)	1.6 (1.3–1.9)	[b]	57 (5.6)	40 (4.0)	1.4 (1.1–1.9)	[c]	71 (7.5)	42 (4.4)	1.7 (1.3–2.1)	[b]
Other situation	142 (7.2)	135 (6.9)	1.1 (0.9–1.2)		39 (3.9)	25 (2.5)	1.6 (1.1–2.1)	[c]	103 (10.8)	110 (11.6)	0.9 (0.8–1.1)	
Occupational class				<0.001				<0.001				<0.001
Manual workers	287 (17.1)	399 (23.8)	0.7 (0.6–0.8)	[b]	210 (23.6)	322 (36.2)	0.7 (0.6–0.8)	[b]	77 (9.8)	75 (9.5)	1.0 (0.8–1.3)	
Farmers, craftsmen, shopkeepers	96 (5.8)	111 (6.6)	0.9 (0.7–1.1)		68 (7.7)	82 (9.2)	0.8 (0.6–1.1)		28 (3.5)	30 (3.7)	0.9 (0.6–1.4)	
Clerks, service and sales workers	491 (29.3)	476 (28.4)	1.0 (0.9–1.1)		195 (21.9)	120 (13.5)	1.6 (1.4–1.9)	[b]	296 (37.6)	359 (45.6)	0.8 (0.7–0.9)	[b]
Technicians and associate professionals	415 (24.7)	433 (25.8)	1.0 (0.9–1.1)		179 (20.1)	209 (23.5)	0.9 (0.8–1.0)		236 (30.0)	223 (28.4)	1.1 (0.9–1.2)	
Professionals and managers	388 (23.1)	258 (15.4)	1.5 (1.4–1.7)	[b]	238 (26.7)	157 (17.7)	1.5 (1.3–1.7)	[b]	150 (19.1)	101 (12.8)	1.5 (1.3–1.7)	[b]

Abbreviation: CI = confidence interval.
[a] *P*-values of χ^2-tests comparing observed and expected distributions.
[b] <0.001 *P*-values of χ^2-tests comparing observed and expected proportions for each level of the variable.
[c] <0.05 *P*-values of χ^2-tests comparing observed and expected proportions for each level of the variable.

cranial irradiation. CNS tumour survivors were significantly more likely to have no or little education (40.6% *vs* 17.5%; $P<0.001$), whereas they were less likely to be high school graduates (6.9% *vs* 18.4%; $P<0.001$) or college graduates (15.4% *vs* 32.8%; $P<0.001$). In contrast, the educational deficit of leukaemia survivors was restricted to college graduation (Table 3).

When adjusted on paternal occupation, the observed rate of survivors with a college degree remained significantly higher than expected (42.2% *vs* 35.3% expected; $P<0.001$). This difference was even higher when leukaemia and CNS tumour survivors were excluded from the analysis (45.3% *vs* 34.9% expected; $P<0.001$) (Table 4).

In multivariable logistic regression, cranial irradiation reduced by 52% the odds of attaining college (OR = 0.48; 95% CI = 0.35–0.66). Even when accounting for cranial irradiation, odds of attaining college were significantly lower for patients treated for CNS tumour (OR = 0.47; 95% CI = 0.26–0.84). In contrast, soft tissue sarcoma survivors were more likely to be college graduates (OR = 1.48; 95% CI = 1.03–2.14) (Table 5).

Employment status. Unemployment was less frequent than expected from national statistics (7.1% *vs* 9.5% expected; $P<0.05$). In contrast, health-related unemployment (i.e., individuals unable to work because of illness) was higher than expected (6.5% *vs* 4.2% expected; $P<0.001$) (Table 2). When the analysis was stratified by type of diagnosis, significant differences were restricted to CNS tumour survivors: 28.1% of them reported health-related unemployment *vs* 4.3% expected ($P<0.001$) (Table 3). In multivariable logistic regression (Table 5), health-related unemployment was significantly associated with cranial irradiation (OR = 3.23; 95% CI = 1.95–5.37) and with diagnosis of CNS tumour (OR = 4.63; 95% CI = 2.07–10.34).

Occupational attainment. Both male and female survivors were more likely to hold managerial/professional jobs (i.e., to belong to the higher occupational class) than expected from the French population statistics: 23.1% were managers/professionals *vs* 15.4% expected ($P<0.001$). Male survivors were less likely to be manual workers (23.6% were *vs* 36.2% expected; $P<0.001$), whereas no significant difference was observed at this level for females (Table 2). This higher occupational achievement was not observed for leukaemia or CNS tumour survivors. The latter were significantly less likely to hold managerial/professional jobs (6.2% *vs* 15.6% expected; $P<0.05$) (Table 3). In multivariable logistic regression (Table 5), when the sex, the age and the socioeconomic background of survivors 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).

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

Table 3. Educational level, employment status and occupation of survivors, by childhood cancer group, compared with the French population of the same age and gender

	Hodgkin's lymphoma				Bone or soft tissue sarcoma				Central nervous system tumour				Leukaemia				Other diagnosis[a]			
	Observed	Expected			Observed	Expected			Observed	Expected			Observed	Expected			Observed	Expected		
	(O)	(E)	O/E		(O)	(E)	O/E		(O)	(E)	O/E		(O)	(E)	O/E		(O)	(E)	O/E	
	N (%)	*N* (%)	(95% CI)	*P*-value[b]	*N* (%)	*N* (%)	(95% CI)	*P*-value[b]	*N* (%)	*N* (%)	(95% CI)	*P*-value[b]	*N* (%)	*N* (%)	(95% CI)	*P*-value[b]	*N* (%)	*N* (%)	(95% CI)	*P*-value[b]
Educational level				0.066				<0.001				<0.001				<0.001				<0.001
<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 (11.5)	19 (12.2)	0.9 (0.6–1.5)		96 (8.4)	190 (16.6)	0.5 (0.4–0.6)	[d]
Middle school	11 (9.1)	9 (7.4)	1.2 (0.6–2.2)		22 (6.0)	26 (7.1)	0.8 (0.5–1.3)		12 (6.7)	12 (7.0)	1.0 (0.5–1.8)		26 (16.6)	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 (25.6)	1.0 (0.7–1.4)		93 (25.5)	95 (26.0)	1.0 (0.8–1.2)		53 (30.3)	42 (24.2)	1.3 (1.0–1.7)		21 (13.4)	30 (19.4)	0.7 (0.4–1.1)		313 (27.4)	274 (24.0)	1.1 (1.0–1.3)	[c]
High school	25 (20.7)	21 (17.7)	1.2 (0.8–1.8)		54 (14.8)	63 (17.3)	0.9 (0.6–1.1)		12 (6.9)	32 (18.4)	0.4 (0.2–0.7)	[d]	52 (33.1)	35 (22.2)	1.5 (1.1–2.0)	[c]	197 (17.2)	215 (18.8)	0.9 (0.8–1.1)	
College	44 (36.4)	37 (30.7)	1.2 (0.9–1.6)		168 (46.2)	112 (30.9)	1.5 (1.3–1.7)	[d]	27 (15.4)	57 (32.8)	0.5 (0.3–0.7)	[d]	40 (25.5)	63 (40.3)	0.6 (0.5–0.9)	[d]	484 (42.4)	386 (33.8)	1.3 (1.1–1.4)	[d]
Employment status				0.518				0.450				<0.001				0.518				0.008
Employed	97 (81.5)	94 (78.8)	1.0 (0.8–1.3)		288 (81.8)	279 (79.4)	1.0 (0.9–1.2)		96 (53.9)	141 (79.0)	0.7 (0.6–0.8)	[d]	127 (80.9)	125 (79.6)	1.0 (0.9–1.2)		943 (81.7)	919 (79.6)	1.0 (1.0–1.1)	
Unemployed and seeking work	9 (7.6)	11 (9.1)	0.8 (0.4–1.6)		24 (6.8)	32 (9.1)	0.8 (0.5–1.1)		21 (11.8)	17 (9.3)	1.2 (0.8–1.9)		9 (5.7)	17 (10.6)	0.5 (0.2–1.0)		76 (6.6)	110 (9.5)	0.7 (0.5–0.9)	[c]
Unemployed because of health	7 (5.9)	5 (4.3)	1.4 (0.6–2.9)		17 (4.8)	15 (4.4)	1.1 (0.7–1.8)		50 (28.1)	8 (4.3)	6.3 (4.6–8.2)	[d]	4 (2.5)	6 (3.8)	0.7 (0.2–1.7)		50 (4.3)	48 (4.2)	1.0 (0.8–1.4)	
Other situation	6 (5.0)	9 (7.8)	0.7 (0.2–1.5)		23 (6.5)	25 (7.2)	0.9 (0.6–1.4)		11 (6.2)	13 (7.4)	0.9 (0.4–1.5)		17 (10.8)	10 (6.1)	1.7 (1.0–2.7)	[c]	85 (7.4)	77 (6.7)	1.1 (0.9–1.4)	
Occupational class				0.061				<0.001				0.008				0.515				<0.001	
Manual workers	16 (14.4)	27 (24.1)	0.6 (0.3–1.0)		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)		26 (20.2)	30 (22.9)	0.9 (0.6–1.3)		161 (16.1)	237 (23.7)	0.7 (0.6–0.8)	[d]
Farmers, craftsmen, shopkeepers	10 (9.0)	8 (7.2)	1.3 (0.6–2.3)		20 (6.1)	25 (7.7)	0.8 (0.5–1.2)		3 (2.7)	8 (7.0)	0.4 (0.1–1.1)		4 (3.1)	5 (3.9)	0.8 (0.2–2.1)		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)		84 (25.8)	88 (27.1)	1.0 (0.8–1.2)		47 (41.6)	32 (28.0)	1.5 (1.1–2.0)	[c]	52 (40.3)	40 (30.7)	1.3 (1.0–1.7)		272 (27.2)	286 (28.6)	1.0 (0.8–1.1)	
Technicians and associate professionals	25 (22.5)	28 (25.1)	0.9 (0.6–1.3)		84 (25.8)	81 (25.0)	1.0 (0.8–1.3)		19 (16.8)	29 (25.6)	0.7 (0.4–1.0)		27 (20.9)	36 (28.0)	0.8 (0.5–1.1)		260 (26.0)	258 (25.8)	1.0 (0.9–1.1)	
Professionals and managers	24 (21.6)	17 (15.6)	1.4 (0.9–2.1)		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)		247 (24.7)	153 (15.3)	1.6 (1.4–1.8)	[d]

Abbreviation: CI = confidence interval.

[a] Nephroblastoma, neuroblastoma, non-Hodgkin's lymphoma, gonadal tumour, retinoblastoma, thyroid tumour and other types of carcinoma

[b] *P*-values of χ^2-tests comparing observed and expected distributions.

[c] <0.05 *P*-values of χ^2-tests comparing observed and expected proportions for each level of the variable.

[d] <0.001 *P*-values of χ^2-tests comparing observed and expected proportions for each level of the variable.

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

	All diagnoses				All but CNS tumour and leukaemia survivors				CNS tumour and leukaemia survivors			
	Observed (O)	Expected (E)	O/E		Observed (O)	Expected (E)	O/E		Observed (O)	Expected (E)	O/E	
Outcome	***N* (%)**	***N* (%)**	**(95% CI)**	***P*-value[a]**	***N* (%)**	***N* (%)**	**(95% CI)**	***P*-value[a]**	***N* (%)**	***N* (%)**	**(95% CI)**	***P*-value[a]**
Educational level[b]				<0.001				<0.001				<0.001
<Middle school	161 (9.8)	271 16.5)	0.6 (0.5–0.7)	[c]	99 (7.1)	234 (16.8)	0.4 (0.3–0.5)	[c]	62 (24.9)	37 (14.9)	1.7 (1.3–2.2)	[c]
Middle 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)	[c]	33 (13.3)	18 (7.4)	1.8 (1.3–2.6)	[c]
Vocational 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)	
High school	268 (16.3)	290 (17.7)	0.9 (0.8–1.0)		238 (17.1)	245 (17.6)	1.0 (0.9–1.1)		30 (12.0)	46 (18.5)	0.7 (0.4–0.9)	[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.
[a] *P*-values of χ^2-tests comparing observed and expected distributions.
[b] Information on level of education of survivors or on paternal occupation was missing for 425 survivors (for 112 survivors of CNS tumour and leukaemia, and for 313 survivors of other diagnoses, respectively).
[c] <0.001 *P*-values of χ^2-tests comparing observed and expected proportions for each level of the variable.
[d] <0.05 *P*-values of χ^2-tests comparing observed and expected proportions for each level of the variable.

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

	Odds of being a college graduate		Odds of being a manager		Odds of being unemployed because of health	
	***N* = (722/1641)**		**(*N* = 362/1649)**		**(*N* = 123/1812)**	
	OR	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Age at first cancer (years)						
0–4	1		1		1	
5–9	0.99	(0.75–1.31)	0.80	(0.56–1.14)	0.68	(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	1		1		1	
Leukaemia	0.70	(0.41–1.20)	1.03	(0.50–2.12)	0.51	(0.15–1.78)
Neuroblastoma	1.08	(0.76–1.54)	1.05	(0.68–1.61)	1.37	(0.68–2.77)
Hodgkin's lymphoma	0.99	(0.61–1.60)	1.03	(0.58–1.84)	1.76	(0.71–4.33)
Non-Hodgkin's lymphoma	0.93	(0.62–1.38)	0.99	(0.62–1.61)	0.90	(0.38–2.13)
Soft tissue sarcoma	1.48	(1.03–2.14)	1.27	(0.82–1.96)	1.03	(0.46–2.29)
Bone sarcoma	0.97	(0.61–1.54)	0.86	(0.49–1.50)	2.15	(0.92–5.01)
CNS tumour	0.47	(0.26–0.84)	0.31	(0.12–0.79)	4.63	(2.07–10.34)
Other solid cancer[a]	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		–	–
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.
[a] Retinoblastoma, gonadal tumour, 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).

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 (Kirchhoff *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 $\geqslant$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 socio-economic 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.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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