Educational attainment among survivors of childhood cancer: a population-based cohort study in Denmark

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We identified 2384 patients in the Danish Cancer Register in whom cancer had been diagnosed in 1960–1996 before they reached the age of 20 and compared them with 53,143 sex- and age-matched controls identified from the Register of Population Statistics. Complete education records and demographic and socioeconomic information for the period 1980–2000 were obtained for both cohorts from Statistics Denmark. The rate ratio (RR) for educational attainment was estimated by discrete-time Cox regression analyses. An overall reduction in attaining basic education was found (RR, 0.90; 95% confidence interval, 0.83–0.96). Female survivors of central nervous system (CNS) tumours showed the largest educational deficit (RR, 0.55; 95% confidence interval, 0.37–0.82). Non-CNS tumour survivors attained education as controls at most levels. When the analyses were conditioned on completion of youth education, further educational attainment was not reduced for any group of survivors. These findings confirm that only survivors of CNS tumours in childhood experience significant educational deficits. The deficit was mainly seen among persons whose tumour was diagnosed before they reached the level of secondary education.

British Journal of Cancer (2004) 91, 923–928. doi:10.1038/sj.bjc.6602085 www.bjcancer.com
Published online 3 August 2004 © 2004 Cancer Research UK

Keywords: childhood cancer; population-based cohort study; registry; Cox regression; educational attainment; central nervous system tumour

Improvements in the treatment of cancer in children and adolescents since the 1970s mean that today more than two-thirds of childhood cancer patients survive (de Nully et al., 1995; Berrino et al., 2001). The psychosocial implications of living after cancer have therefore increasing relevance. Educational level is an important indicator of a person’s capabilities and motivation; it is also an indicator of socioeconomic status and a predictor of health outcomes (Lynch and Kaplan, 2000).

Reintegration into daily life at school is one of the main challenges after diagnosis and treatment of cancer because of long absences from school (Charlton et al., 1991). Cancer survivors may face emotional difficulties, lack of energy, adjustment problems, social isolation, and restrictions on physical activity (Mancini et al., 1989; Adamoli et al., 1997; Glaser et al., 1997; Eiser and Vance, 2002). Treatment with cranial radiation therapy can affect academic performance by significantly decreasing the IQ or by more subtle neuropsychological effects (Jankovic et al., 1994; Dongen-Melman et al., 1997; Reimers et al., 2003).

Some previous studies found that the overall educational attainment of survivors was equivalent to that of comparison groups, except for survivors of central nervous system (CNS) tumours and of acute lymphoblastic leukaemia who had received cranial radiotherapy (Kelaghan et al., 1988; Haupt et al., 1994; Pastore et al., 2001). Other studies concluded that survivors of childhood cancers more generally had significant deficits in educational outcome (Teta et al., 1986; Langeveld et al., 2003; Mitby et al., 2003). Although well conducted, most previous studies were subject to incomplete participation, with rates as low as 61%, and suboptimal comparison groups, including siblings (Teta et al., 1986; Kelaghan et al., 1988; Haupt et al., 1994; Mitby et al., 2003) and population values (Pastore et al., 2001); healthy controls were used in only one study (Langeveld et al., 2003).

To explore educational attainment after childhood cancer we established a nationwide, population-based cohort of persons who had had cancer in childhood or adolescence and compared them with controls sampled from the general population (Koch et al., 2004).

MATERIALS AND METHODS

Study population

We identified all cancer survivors: (i) in whom the disease was diagnosed in Denmark between 1960 and 1996 before they reached the age of 20 years; (ii) who had had a benign CNS tumour or a cancer other than myelodysplastic syndrome; (iii) who were born in Denmark in 1960–80, to ensure sufficient data quality and maximal follow-up time; (iv) who had at least one parent who was a citizen of Denmark, Finland, Iceland, Norway or Sweden, to...
reduce cultural heterogeneity; (v) who were 13 years of age or older at the start of follow-up; and (vi) who were alive at least once on 31 December in the period of follow-up from 1980 to 2000, where the socioeconomic data were available.

The patients were identified in the Danish Cancer Register, which covers virtually all incident cases of cancer that have occurred in Denmark since 1943 and has been described in detail elsewhere (Storm et al., 1997). From this Register, we obtained information on diagnosis, tumour type, date of diagnosis, tumour location, vital status and the unique personal identification number that has been assigned to all residents in Denmark since 1 April 1968. The personal identification number includes sex and date of birth and permits accurate linkage of information between registers. Diagnoses were classified according to the International Agency for Research on Cancer classification of childhood cancers (Ritch and Marsden, 1987). No reliable treatment variables were available from the Danish Cancer Register for this study.

A randomly sampled control cohort, frequency matched on sex and date of birth, was identified in the Register of Population Statistics (Eurostat/Statistics Denmark, 1995), which contains basic demographic information on the total Danish population. The information in this Register is derived from the Central Population Register, and it is the source of personal and population statistics for other registers (Eurostat/Statistics Denmark, 1995; Thygesen, 1995). The parents and siblings of all the study subjects were also identified through this Register.

Of the sampled controls, 0.2% were excluded because they were not registered at 31 December in 1980–2000. A further 0.1% of the controls were excluded from the control cohort because they were also identified in the cancer cohort. A total of 2384 individuals who had had childhood cancer and 53 143 controls were eligible for analysis, contributing 30 792 and 803 644 person-years, respectively.

### Estimation of educational attainment

Information on all persons in the two cohorts and their parents was linked to the Integrated Database for Labour Market Research, which contains annually (by 31 December) updated information on the total Danish population from 1980 onwards (Statistics Denmark, 1991). From this Database, we obtained demographic and socioeconomic variables for the end of each year between 1980 and 2000, including type and level of education, family structure, labour market participation and income. The Database holds information only on the level of education completed and not on graduation, marks or use of special education services.

All education in Denmark is free of charge, and the Danish State provides economic support during studies to facilitate the education of persons of lower socioeconomic status (SU, 2004). The levels of education used in this study were those of the Danish educational system, shown in Table 1, and educational attainment was estimated for each level. Education higher than basic school was analysed in both unconditional analyses, that is, including all persons in both cohorts, and conditional on attainment of the previous educational level.

Person-years at risk were calculated from the age (in years) before the age of the first actual or possible attainment of each educational level: 13 years for basic school, 16 years for youth education, 18 years for short-, 20 years for medium- and 21 years for long-cycle higher education. All study subjects were followed until the level of education under investigation was attained or until death, emigration or the end of study period (31 December 2000), whichever came first. As persons could first be followed from 1980, we restricted the analyses to persons born after 1967 for basic school, 1964 for youth education and 1962 for short-cycle higher education. Thus, only the analyses of medium- and long-cycle higher education included all the birth cohorts. To ensure that the cancer and its treatment had a chance of influencing educational outcome, only patients whose cancer was diagnosed before possible attainment of a given educational level were included; thus, analysis of basic education was restricted to patients in whom cancer was diagnosed before they were 13 years of age. This approach is a modification of previous methods (Kelahgh et al., 1988; Haupt et al., 1994; Jensen et al., 1997).

### Data analyses

All multiple regression analyses included adjustment by current age and year of birth, and also for socioeconomic factors, comprising mean parental income (father’s plus mother’s annual income/2), highest educational level attained by either the father or the mother, number of biological siblings, whether the child lived with one or both biological parents or other new family combinations at the end of the year he or she turned 15, and the percentage unemployment experienced by the father during the current year. These adjustments did not alter the estimates significantly. Restriction of the analyses to persons who survived long enough to attain a given educational level, in order to

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**Table 1** Danish educational system

| Age (years) | Level | Subcategory | Description | ISCED code |
|-------------|-------|-------------|-------------|------------|
| 6           | Preschool (optional) |                    |             | 0          |
| 7–16        | Basic  | Years 1–9   | Compulsory  | 1 (years 1–7) |
|             |        | Year 10     | Optional    | 2 (years 8–10) |
| 17–19       | Youth  | Upper secondary school | Traditional, or vocational, higher technical or higher commercial examination | 3 |
|             |        | Vocational training | Leads to jobs like: skilled craftsman, service function in business and trade, assistant social worker, assistant nurse, waiter, cook | 3 |
| 20–24       | Higher education | Short cycle (2 years) | Leads to jobs like: programmer, bachelor in commerce, laboratory technician, caterer, policeman | 4 |
|             |        | Medium cycle (4 years) | Leads to jobs like: kindergarten teacher, basic school teacher, nurse, journalist, social worker, midwife, engineer | 5 |
|             |        | Long cycle (3–5 years) | Leads to masters or jobs in: language, literature, dentistry, medicine, social science, law, theology, natural sciences | 5 |
| 25–27       | PhD    |                    | Leads to jobs in same as 5 | 6 |

Modified from Statistical Yearbook 2002 (Statistics Denmark 2004); ISCED = International Standard Classification of Education.
investigate a possible effect of on-going disease, also showed no difference in educational pattern from that of all survivors. Survival analyses, with calendar time as the underlying scale, were based on discrete-time Cox regression models, which facilitate time-varying covariates and offer the same interpretation of the estimated hazard ratio parameters as Cox models for continuous survival time (Allison, 1982; Breslow, 1992). The estimates given are rate ratios (RR) of attaining a given educational level. The models were fitted by the GENMOD procedure in SAS 8.2.

The study was approved by the Danish Data Protection Agency (Record # 2001-41-1354).

RESULTS

All cancers

Table 2 shows the characteristics of eligible persons in the cancer cohort. Overall, 92% of cancer patients and 98% of controls had completed 9 years of compulsory basic education, corresponding to a RR of 0.90 (95% confidence interval (CI): 0.83–0.96) for all survivors of childhood cancer (both sexes). Youth education was completed by 60% of the cancer patients and 74% of controls, corresponding to a RR of 0.73 (95% CI: 0.68–0.78). Overall, equal proportions of cancer patients and controls attained some level of higher education (17 and 18%, respectively); however, these results cover differences by sex, as male survivors managed to complete all levels of higher education equally well as or even slightly better than control males (RR: 1.13, 95% CI: 0.97–1.32), whereas female cancer survivors had a reduced chance (0.75, 95% CI: 0.62–0.90).

CNS tumours

Detailed regression analyses showed that survivors of non-CNS tumours completed most educational levels at a frequency and age similar to those of control persons (Table 3). In contrast, survivors of CNS tumours had reduced chances of attaining education at most levels, the RR of attaining all levels of higher education being 0.77 (95% CI: 0.55–1.07) for men and 0.55 (95% CI: 0.37–0.82) for women. When the analyses were conditioned on completion of youth education, no reduction in further educational attainment was found for any group of cancer survivors. In these analyses, male survivors of non-CNS tumours had a RR of 1.36 (95% CI: 1.14–1.61) and survivors of CNS tumours had a RR of 1.13 (95% CI: 0.81–1.57) of completing all levels of higher education, and the equivalent figures for women were 0.89 (95% CI: 0.72–1.09) for non-CNS tumours and 0.88 (95% CI: 0.59–1.32) for CNS tumours.

Characteristic differences in educational choices between diagnostic groups are also shown in Table 3. Male survivors of non-CNS tumours more frequently chose theoretical than practical education (vocational training and short-cycle higher education). In contrast, female survivors of non-CNS tumours had a smaller chance, of borderline significance, of completing upper secondary school than males (RR: 0.83, 95% CI: 0.68–1.01) and were more likely to complete short- and medium-cycle higher education than long-cycle higher education. Survivors of CNS tumours generally showed a preference for short, practical education, although the probability that the women in this group completed long-cycle higher education was close to normal. Subgroup analyses of survivors of CNS tumours showed that those who had survived infratentorial nonmedulloblastomas did not have a significantly reduced chance of attaining medium- or long-cycle higher education (RR: 0.72, 95% CI: 0.43–1.22, n = 109), whereas the RR for survivors of other CNS tumours was 0.58 (95% CI: 0.42–0.79, n = 415); however, these results did not differ significantly from each other.

Overall, childhood cancer survivors showed a significantly increasing trend in attaining youth education with increasing age at diagnosis (non-CNS tumours, RR per year: 1.02, 95% CI: 1.01–1.04, P-value = 0.003; CNS tumours, RR per year: 1.06, 95% CI: 1.03–1.10, P-value = 0.0004); however, this trend was not significant for higher education. Neither treatment era nor time since diagnosis appeared to have a strong influence on educational outcome.

During the decades investigated, the educational pattern in Denmark changed. Thus, multiple regression analyses of data for the control cohort showed a shift in educational choices over time, from vocational training to upper secondary school. Vocational education was most likely to be attained by persons from nuclear families, with one sibling and parents who earned middle incomes and had basic education or vocational training. The probability of being educated in general decreased with increasing number of siblings, degree of father’s unemployment, living in a broken family and low parental income and education. These factors had similar effects in both cohorts.

The influence of social background, measured as the highest parental education, was tested in interaction regression analyses, where the pattern of the control cohort served as the standard. Survivors of CNS tumours whose parents had had higher education were more likely to finish vocational training than those whose parents had lower educational levels (RR 2.12, 95% CI: 1.36–3.31); however, male survivors of CNS tumours whose
父母的高等教育程度与没有预期的高等教育（RR 0.37, 95% CI: 0.18–0.78）。非-CNS肿瘤的幸存者似乎比父母受过高等教育的幸存者更可能获得长周期高等教育（RR 1.61, 95% CI: 0.94–2.74）。

讨论

我们发现，非-CNS儿童癌症幸存者的一般教育水平与对照组相似，显示出没有明显的延迟，而CNS肿瘤的幸存者在教育水平上的成就降低了。

社会经济和家庭风险因素对癌症幸存者与健康对照的影响相似，但女性幸存者显示出更多教育成就的缺陷。这可能部分归因于丹麦的性别差异（Jensen et al., 1997; Statistics Denmark, 2004）。我们的结果与其他人（Kelaghan et al., 1988; Langeveld et al., 2003; Mitby et al., 2003）一致。教师对癌症患者的学术表现的期望可能较低，因为女性也更常因病缺课（Charlton et al., 1991），这可能表明学校对两性不同的期望。

表3 非-CNS儿童癌症幸存者获得不同教育水平的比率（不考虑先前教育水平），与对照组比较

| 教育水平   | 男性 |  |  | 女性 |  |  |  |
|------------|-----|----|---|-----|----|---|---|
|            | No. of eligible in each category | Persons who completed education (%) | Median age at completion (years) | RRb (95% CI) | P-value | No. of eligible in each category | Persons who completed education (%) | Median age at completion (years) | RRb (95% CI) | P-value |
| 水平1：基础教育 |         |                     |                  |          |          |         |                     |                  |          |          |
| 控制组       | 23,644 | 98 | 15.1 | 1 | 16,657 | 99 | 15.0 | 1 |
| 非-CNS肿瘤组 | 355    | 92 | 15.0 | 0.97 (0.87–1.08) | NS | 277  | 97 | 15.0 | 0.98 (0.86–1.10) | NS |
| CNS肿瘤组   | 128    | 88 | 15.2 | 0.80 (0.66–0.96) | 0.02 | 107  | 87 | 15.2 | 0.66 (0.54–0.81) | 0.0001 |
| 水平2：青年教育 |         |                     |                  |          |          |         |                     |                  |          |          |
| 控制组       | 27,629 | 72 | 19.2 | 1 | 19,413 | 77 | 18.9 | 1 |
| 非-CNS肿瘤组 | 510    | 65 | 19.2 | 0.94 (0.84–1.05) | NS | 429  | 69 | 18.9 | 0.85 (0.76–0.95) | 0.005 |
| CNS肿瘤组   | 207    | 45 | 19.6 | 0.45 (0.37–0.55) | 0.0001 | 172  | 42 | 18.9 | 0.40 (0.32–0.51) | 0.0001 |
| 水平3：高中教育 |         |                     |                  |          |          |         |                     |                  |          |          |
| 控制组       | 28,460 | 16 | 24.3 | 1 | 20,783 | 21 | 24.4 | 1 |
| 非-CNS肿瘤组 | 692    | 19 | 24.0 | 1.29 (1.09–1.54) | 0.004 | 532  | 18 | 24.5 | 0.82 (0.67–1.01) | 0.06 |
| CNS肿瘤组   | 264    | 13 | 24.7 | 0.77 (0.55–1.07) | NS | 208  | 12 | 24.3 | 0.55 (0.37–0.82) | 0.003 |
| 水平3：中等周期 |         |                     |                  |          |          |         |                     |                  |          |          |
| 控制组       | 29,456 | 10 | 24.2 | 1 | 20,895 | 17 | 24.6 | 1 |
| 非-CNS肿瘤组 | 904    | 11 | 24.3 | 1.22 (1.00–1.48) | 0.05 | 657  | 15 | 25.0 | 0.87 (0.71–1.06) | NS |
| CNS肿瘤组   | 293    | 7  | 24.7 | 0.63 (0.41–0.98) | 0.03 | 231  | 10 | 24.3 | 0.64 (0.43–0.95) | 0.03 |
| 水平3：长期周期 |         |                     |                  |          |          |         |                     |                  |          |          |
| 控制组       | 27,788 | 5  | 26.1 | 1 | 19,758 | 5  | 26.4 | 1 |
| 非-CNS肿瘤组 | 846    | 5  | 26.0 | 1.12 (0.83–1.49) | NS | 619  | 3  | 26.5 | 0.55 (0.35–0.88) | 0.01 |
| CNS肿瘤组   | 273    | 4  | 25.9 | 0.56 (0.30–1.04) | 0.07 | 214  | 4  | 26.9 | 0.89 (0.44–1.79) | NS |

CI = confidence interval; NS = not significant at 5% level. *Number of persons in each cohort who met the restrictions on year of birth and age at diagnosis, as described in Materials and Methods section. **Adjusted for current age, birth cohort, mean parental income, parents’ highest educational level, number of siblings, type of family of child at age 15 and father’s degree of unemployment.

父母的高等教育程度与没有预期的高等教育（RR 0.37, 95% CI: 0.18–0.78）。非-CNS肿瘤的幸存者似乎比父母受过高等教育的幸存者更可能获得长周期高等教育，因为他们的父母有高等教育。CNS肿瘤的幸存者显示有较低的教育水平（RR 1.61, 95% CI: 0.94–2.74）。

讨论

我们发现，非-CNS儿童癌症幸存者一般有相似的机会获得某一教育水平，类似健康对照组，没有显著的延后。CNS肿瘤的幸存者在教育成就水平上有所降低。

社会经济和家庭风险因素对教育成就的影响类似于癌症幸存者和对照组，但女性幸存者显示出更多的教育成就的缺失，可能部分因为在丹麦的性别特定差异上。教育期望可能对癌症幸存者较低，因为女性也更常因病缺课（Charlton et al., 1991），这可能显示不同的文化期望。
Male survivors of CNS tumours tended to complete short, less than other persons (Mancini et al, 1994; Pastore et al, 2001; Mitby et al, 2003). Cranial radiotherapy is known to be a strong risk factor for reduced educational attainment (Kelaghan et al, 1988; Haupt et al, 1994; Pastore et al, 2001; Langeveld et al, 2003; Mitby et al, 2003). This was reflected in our study by the better educational attainment level after infratentorial nonmedulloblastomas, probably treated with surgery only, in contrast to survivors of other brain tumours, who were more likely to have been treated with cranial radiotherapy. However, an internal comparison did not reach significance, which could be due to the analyses being based on small numbers in relation to this rather infrequent event. The finding that male survivors of CNS tumours had a reduced chance of completing basic education probably reflects the well-known risk for neuropsychological sequelae after cranial radiotherapy (Lannering et al., 1990; Jankovic et al., 1994; Langer et al., 2002; Reimers et al., 2003) and the subsequent learning difficulties, which cannot be compensated fully by special educational programmes (Peckham, 1991; Haupt et al., 1994; Dongen-Melman et al., 1997; Mitby et al., 2003). The finding that female survivors of CNS tumours had a reduced chance of attaining education at most levels may support the suggestion that the developing female brain is more vulnerable to cranial radiation (Schlieper et al., 1989; Bleyer et al., 1990). Deviation from the pattern of social heritage (Jensen et al., 1997; Lynch and Kaplan, 2000) only among survivors of CNS tumours also suggests a physiological rather than a psychosocial explanation for the reduced overall educational attainment.

Male survivors of non-CNS cancers seemed to do better than controls in attaining most educational levels and had a better chance of completing theoretical, longer education rather than shorter, technical courses. The reason is unclear. Previous studies showed that cancer survivors tend to undertake physical activity less than other persons (Mancini et al., 1989; Adamoli et al., 1997; Glaser et al., 1997) and that cancer survivors who have sequelae are more likely to have a high-school or college degree than those without sequelae (Pastore et al., 2001). The motivation of cancer survivors themselves, heightened awareness and support from parents or teachers (Peckham, 1991) or enrollment in special educational programmes (Mitby et al., 2003) might also play a role. Thus, in our study, support from well-educated parents tended to increase the probability of achieving the highest educational levels. Another study also found that the educational level of survivors of non-CNS tumours exceeded that of the general population (Pastore et al., 2001), and childhood cancer survivors have been described as more mature, with greater appreciation of parental support, than healthy controls (Maggiolini et al., 2000).

Our study confirms previous findings that only the survivors of childhood CNS tumours experience problems in achieving long-term educational outcomes (Kelaghan et al., 1988; Haupt et al., 1994; Pastore et al., 2001). The study of Langeveld et al. (2003) accorded with our findings but lacked statistical power, which might explain the authors’ more pessimistic conclusions of reduced educational attainment among cancer survivors in general, as also in another study (Teta et al., 1986). Mitby et al. (2003) found educational deficits not only among survivors of CNS tumours and leukaemia, who had been treated with cranial radiotherapy, but also of non-Hodgkin’s lymphoma and neuroblastoma. Their study was very large, but methodological limitations due to selection (only 12 431 of 20 276 eligible patients participated) and self-reporting of educational data may have influenced the results substantially.

To some extent, our study addressed these methodological problems. We included all cancer patients in Denmark, with no loss of follow-up or refusal to participate. All information on socioeconomic parameters, for both the cancer cohort and the randomly sampled control population, had been registered prospectively for administrative purposes, years before the current study was hypothesised, excluding information bias.

Our study also had limitations, however, including lack of treatment data and qualitative data that might have identified the mechanisms responsible for the educational patterns observed. Even though this was one of the largest cohort studies on educational attainment, some of our subanalyses lacked statistical power. In addition, not all persons could be followed to an age at which they were likely to have completed their education. Substantial delays during higher education could have underestimated ultimate educational attainments, especially in short- and long-cycle higher education. Future studies are required to identify interventions that might improve the outcome for survivors of CNS tumours.

REFERENCES

Adamoli L, Deasy-Spinetta P, Corbetta A, Jankovic M, Lia R, Locati A, Fraschini D, Masera G, Spinetta J (1997) School functioning for the child with leukemia in continuous first remission: screening high-risk children. Pediatr Hematol Oncol 14: 121 – 131

Allison PD (1982) Discrete-time methods for analysis of event histories. In Sociological Methodology, Leihardt S (ed) pp 61 – 98, San Francisco, CA/ London: Jorrey-Bass

Berrino F, Gatta G, Sant M, Capocaccia R (2001) The EUROCARE study of survival after childhood cancer in Denmark, 1943 – 87: a population-based study. Acta Paediatr 90: 1217 – 1222

Birch JM, Marsden HB (1987) A classification scheme for childhood cancer. Int J Cancer 40: 620 – 624

Bleyer WA, Fallavollita J, Robison L, Balsom W, Meadows A, Heyn R, Sitarz A, Ortega J, Miller D, Constine L (1990) Influence of age, sex, and concurrent intrathecal methotrexate therapy on intellectual function after cranial irradiation during childhood: a report from the Children’s Cancer Study Group. Pediatr Hematol Oncol 7: 329 – 338

Breslow N (1992) Use of the logistic and related models in longitudinal studies of chronic disease risk. Application: coronary heart disease and related intracranial and concurrent intrathecal methotrexate therapy on intellectual function after cranial irradiation during childhood: a report from the Children’s Cancer Study Group. Pediatr Hematol Oncol 7: 329 – 338

Eiser C, Vance YH (2002) Implications of cancer for school attendance and behavior. Med Pediatr Oncol 38: 317 – 319

Eurostat/Statistics Denmark (1995) Statistics on Persons in Denmark. A Survey of Health, Dwyer JH, Feinleib M, Lippert P, Hoffmeister H (eds). pp 163 – 196, New York/Oxford: Oxford University Press

Glaser AW, Abdul Rashid NF, CL U, Walker DA (1997) School behaviour without sequelae (Pastore et al., 1994; Pastore et al., 2003; Mitby et al., 2003). The study of Langeveld et al. (2003) found educational deficits not only among survivors of CNS tumours and leukaemia, who had been treated with cranial radiotherapy, but also of non-Hodgkin’s lymphoma and neuroblastoma. Their study was very large, but methodological limitations due to selection (only 12 431 of 20 276 eligible patients participated) and self-reporting of educational data may have influenced the results substantially.

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REFERENCES

Adamoli L, Deasy-Spinetta P, Corbetta A, Jankovic M, Lia R, Locati A, Fraschini D, Masera G, Spinetta J (1997) School functioning for the child with leukemia in continuous first remission: screening high-risk children. Pediatr Hematol Oncol 14: 121 – 131

Allison PD (1982) Discrete-time methods for analysis of event histories. In Sociological Methodology, Leihardt S (ed) pp 61 – 98, San Francisco, CA/ London: Jorrey-Bass

Berrino F, Gatta G, Sant M, Capocaccia R (2001) The EUROCARE study of survival after childhood cancer in Denmark, 1943 – 87: a population-based study. Acta Paediatr 90: 1217 – 1222

de Nully BP, Olsen JH, Hertz H, Carstensen B, Bautz A (1995) Trends in survival after childhood cancer in Denmark, 1943 – 87: a population-based study. Acta Paediatr 84: 316 – 324

Dongen-Melman JE, De Groot A, Van Dongen JJ, Verhulst FC, Hahlen K (1997) Cranial irradiation is the major cause of learning problems in children treated for leukemia and lymphoma: a comparative study. Leukemia 11: 1197 – 1200

Eiser C, Vance YH (2002) Implications of cancer for school attendance and behavior. Med Pediatr Oncol 38: 317 – 319

Eurostat/Statistics Denmark (1995) Statistics on Persons in Denmark. A Register-based Statistical System. Brussels, Luxembourg: Office for Official Publications of the European Communities

Glaser AW, Abdul Rashid NF, CL U, Walker DA (1997) School behaviour without sequelae (Pastore et al., 1994; Pastore et al., 2003; Mitby et al., 2003). The study of Langeveld et al. (2003) found educational deficits not only among survivors of CNS tumours and leukaemia, who had been treated with cranial radiotherapy, but also of non-Hodgkin’s lymphoma and neuroblastoma. Their study was very large, but methodological limitations due to selection (only 12 431 of 20 276 eligible patients participated) and self-reporting of educational data may have influenced the results substantially.

To some extent, our study addressed these methodological problems. We included all cancer patients in Denmark, with no loss of follow-up or refusal to participate. All information on socioeconomic parameters, for both the cancer cohort and the randomly sampled control population, had been registered prospectively for administrative purposes, years before the current study was hypothesised, excluding information bias.

Our study also had limitations, however, including lack of treatment data and qualitative data that might have identified the mechanisms responsible for the educational patterns observed. Even though this was one of the largest cohort studies on educational attainment, some of our subanalyses lacked statistical power. In addition, not all persons could be followed to an age at which they were likely to have completed their education. Substantial delays during higher education could have underestimated ultimate educational attainments, especially in short- and long-cycle higher education. Future studies are required to identify interventions that might improve the outcome for survivors of CNS tumours.
Haupt R, Fears TR, Robison LL, Mills JL, Nicholson HS, Zeltzer LK, Meadows AT, Byrne J (1994) Educational attainment in long-term survivors of childhood acute lymphoblastic leukemia. JAMA 272: 1427 – 1432

Jankovic M, Brouwers P, Valsecchi MG, Van Veldhuizen A, Huisman J, Kampfuis R, Kingma A, Mor W, Dongen-Melman J, Feronato L (1994) Association of 1800 cGy cranial irradiation with intellectual function in children with acute lymphoblastic leukaemia. ISPACC. International Study Group on Psychosocial Aspects of Childhood Cancer. Lancet 344: 224 – 227

Jensen TP, Mogensen KB, Holm A (1997) Valg og veje i ungdomssuddannelserne (Choices and Pathways in the Youth Educations). Copenhagen, Denmark: AKF forlaget

Kelaghan J, Myers MH, Mulvihill JJ, Byrne J, Connelly RR, Austin DF, Strong LC, Meigs JW, Latourette HB, Holmes GF (1988) Educational achievement of long-term survivors of childhood and adolescent cancer. Med Pediatr Oncol 16: 320 – 326

Koch SV, Kejs AMT, Engholm G, Müller H., Johansen C, Schmiegelow K (2004) Leaving home after cancer in childhood: a measure of functional independence in early adulthood, submitted

Langeveld NE, Ubbink MC, Last BF, Grootenhuis MA, Voute PA, De Haan RJ (2003) Educational achievement, employment and living situation in long-term young adult survivors of childhood cancer in the Netherlands. Psychooncology 12: 213 – 225

Lannering B, Marky I, Lundberg A, Olsson E (1990) Long-term sequelae after pediatric brain tumors: their effect on disability and quality of life. Med Pediatr Oncol 18: 304 – 310

Lynch J, Kaplan G (2000) Socioeconomic position. In Social Epidemiology, Berkman LF, Kawachi I (eds). pp 13 – 35, New York: Oxford University Press

Maggiolini A, Grassi R, Adami L, Corbeta A, Charmet GP, Provantini K, Fraschini D, Jankovic M, Lia R, Spinetta J, Masera G (2000) Self-image of adolescent survivors of long-term childhood leukemia. J Pediatr Hematol Oncol 22: 417 – 421

Mancini AF, Rosito P, Canino R, Calzetti G, Di Caro A, Salmi S, Bonsi S, Marchi N, Paolucci G, Misirioti G (1989) School-related behavior in children with cancer. Pediatr Hematol Oncol 6: 145 – 154

Mithy 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: 1115 – 1126

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: a population-based study from the childhood cancer registry of Piedmont, Italy. Tumori 87: 372 – 378

Peckham VC (1991) Educational deficits in survivors of childhood cancer. Pediatriantic 18: 25 – 31

Reimers TS, Ehrenfeels S, Mortensen EL, Schmiegelow M, Sonderkaer S, Carstenes H, Schmiegelow K, Muller J (2003) Cognitive deficits in long-term survivors of childhood brain tumors: identification of predictive factors. Med Pediatr Oncol 40: 26 – 34

Schlieper AE, Esseltine DW, Tarskis E (1989) Cognitive function in long survivors of childhood acute lymphoblastic leukemia. Pediatr Hematol Oncol 6: 1 – 9

Statistics Denmark (2004) Statistics Denmark: Yearbook 2002. Internet Communication: http://www.dst.dk/HomeUK/Statistics/Publications/Yearbook/2002.aspx → Education and culture pp1, date: 14-04-2004

Statistics Denmark (1991) IDA – an Integrated Data base for Labour Market Research. Main Report. Copenhagen, Denmark: Statistics Denmark

Storm HH, Michelsen EV, Clemmensen IH, Pihl J (1997) The Danish Cancer Registry – history, content, quality and use. Dan Med Bull 44: 535 – 539

SU, The State Education Grant and Loan Scheme in Denmark (2004) Internet Communication: http://www.su.dk/in_english/default.htm date: 14-04-2004

Teta MJ, Del Po MC, Kael SV, Meigs JW, Myers MH, Mulvihill JJ (1986) Psychosocial consequences of childhood and adolescent cancer survival. J Chronic Dis 39: 751 – 759

Thygesen L (1995) The register-based system of demographic and social statistics in Denmark – an overview. Stat J UN Econ Comm Eur 12: 49 – 55