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Health-Risk Behaviours Among Adolescent Survivors of Childhood Cancer

Catherine Bauld, PhD,[1]* J.W. Toumbourou, PhD,[1] V. Anderson, PhD,[2]
C. Coffey, Grad Dip Epi,[1] and C.A. Olsson, PhD[1]

Background. The purpose of the study was to investigate smoking, alcohol use, illicit drug use and sexual risk taking among adolescent survivors of childhood cancer treated in Australia. ***Procedure.*** A comparison study selecting on exposure (cancer vs. healthy) and administering a branched computerised questionnaire assessing health-risk behaviour, predominately by telephone interview. One hundred fifty-three adolescent survivors of childhood cancer were compared with age matched healthy adolescents drawn from one of two Australian population based surveys of adolescent health. Behaviours assessed were tobacco use, alcohol use, binge drinking, cannabis use, pain reliever use, other illicit drug use and unprotected sex. ***Results.*** Compared to their healthy peers, younger survivors (13- to 17-years) were at an increased risk of reporting pain reliever use (OR = 2.1) for non-medical purposes, but lower risk of binge drinking (OR = 0.20), cannabis use (OR = 0.25), other illicit drug use (OR = 0.31), tobacco use (OR = 0.38) and alcohol use (OR = 0.44). Older survivors (18- to 24-years) were at an increased risk of reporting alcohol use (OR 1.5), but at lower risk of reporting cannabis use (OR = 0.27), other illicit drug use (OR = 0.44) and tobacco use (OR = 0.47). Survival analysis using the full adolescent survivor cohort (13- to 24-years) showed that the age of onset of tobacco use was later for cancer survivors (hazard ratio HR = 0.65). ***Conclusion.*** Adolescent cancer survivors show reduced involvement in most health-risk behaviours, with the exception of pain reliever use among younger survivors and alcohol use among the older survivors. Although risks were reduced a substantial proportion of survivors engage in these behaviours. Pediatr Blood Cancer 2005;45:706–715. © 2005 Wiley-Liss, Inc.

Key words: adolescents; cancer survivors; health-risk behaviours; substance use

The purpose of the study was to investigate tobacco use, alcohol use, illicit drug use and sexual behaviour among adolescent cancer survivors diagnosed during childhood and healthy adolescents drawn from the general population. Previous published research has shown minimal difference in the prevalence of health-risk behaviours in cancer survivors and healthy populations [1,2]. However, there are important theoretical reasons to believe that exposure to cancer in childhood may have important implications for later involvement in health-risk behaviours. More specifically, the *Health Belief Model* [3–5] predicts that the experience of illness and the resultant desire to be free of future illness will result in a marked reduction in any behaviour likely to compromise health.

The most recent Australian paediatric cancer statistics were collected in 1997 and reported 576 children aged 0- to 14-years and 871 adolescents aged 15- to 24-years were diagnosed with cancer [6]. The most recent Victorian Statewide paediatric cancer statistics were collated in 1999 and reported cancer diagnoses in 145 children (0- to 14-years) and 221 adolescents (15- to 24-years) [7]. Victorian survival rates (1982 through 1993) show that 68% of cancer patients 10- to 14-years of age, 76% of patients 15- to 19-years of age and 82% of patients 20- to 24-years of age live 5 years or more [8]. With advances in treatment, the challenge confronting many survivors is one of adaptation to the impact of treatment rather than for life itself [9].

There has been growing research interest in potential medical late effects of chemotherapy and radiotherapy. Such effects have, however, been difficult to quantify due to continual refinement in therapeutic agents used to treat disease [10]. Medical late effects that have been reported include cardiac abnormalities [11], kidney damage [12], fertility complications [13] and second primary cancers [14]. Regardless of the current lack of knowledge surrounding medical late effects, it has been reported that

[1]Centre for Adolescent Health, Murdoch Childrens Research Institute, Royal Children's Hospital, University of Melbourne (Department Paediatrics), Victoria, Australia

[2]Department of Psychology, Royal Children's Hospital, School of Behavioural Science, University of Melbourne, Victoria, Australia

*Correspondence to: Dr. Catherine Bauld, Home and Community Care, Royal Children's Hospital, Flemington Road, Parkville 3052, Victoria, Australia. E-mail: catherine.bauld@mcri.edu.au

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few adolescent survivors will escape the burden of long-term treatment-related problems [15]. Specifically illness variables such as treatment intensity are important considerations in survivors' psychosocial outcomes that must not be ignored. An association has been identified between the intensity of treatment received by childhood ALL survivors, neuropsychological functioning and health-risk behaviours [16]. In particular, higher treatment intensity in childhood predicted greater involvement in health-risk behaviours during adulthood as a consequence of lower educational achievement. With medical late effects emerging as a relevant concern for survivors, it is important to more fully understand the health behaviour of adolescent survivors in order to quantify the extent to which their health-risk behaviours might constitute a broader risk to their longer-term health outcomes.

There has been a paucity of research examining health-risk behaviours among teenage survivors of childhood cancer. More rigorous examination has been directed towards young adult survivors of childhood cancer, especially those between 18- to 30-years of age [17–23]. Findings from the majority of the young adult population studies indicated lower reporting of health-risk behaviours among survivors. Of the three studies examining adolescent survivor risk taking behaviours [1,2,24], only two employed control groups [1,2]. Findings from case-control studies have shown no major differences between healthy adolescents and survivors for tobacco, alcohol and illicit drug use. However, small samples sizes and problematic control series definitions means that such findings needed to be interpreted with caution. There has been no published research investigating sexual risk taking among adolescent survivors.

The *Health Belief Model* [3–5] provides one approach to understanding health-risk behaviours of adolescent cancer survivors. The *Health Belief Model* assumes that engagement in health protective behaviours is dependent upon, (a) the desire to avoid illness, or if ill, to get well (i.e., the individuals estimate of the threat of illness) and (b) the belief that a specific action will ameliorate illness (i.e., the likelihood of reducing threat) [25,26]. The model proposes that, perceptions of susceptibility (or vulnerability), severity of a health outcome, benefits of health behaviours and barriers to health practices all interact to determine decision-making and motivation around health practices.

It might be expected that adolescent cancer survivors (a) have a heightened sense of vulnerability as a result of their previous illness experiences than healthy adolescents, (b) are more likely to view any ailment or illness in a negative way because of direct experiences with hospitalisation, specific treatment procedures and other aversive treatment events, (c) believe in the importance of not engaging in health-risk behaviours and (d) perceive few barriers to engaging in health-protective behaviours (e.g., not smoking or drinking). Based on such perceptions, it could be hypothesised that survivors of cancer might be less likely to engage in health-risk behaviours, such as substance use, that would compromise health.

Previous empirical research findings largely support the null hypothesis of no difference in the prevalence of health-risk behaviours between adolescents exposed to cancer and those not exposed (healthy adolescents). The *Health Belief Model* proposes an alternative hypothesis: that the prevalence of cancer survivor involvement in health-risk behaviours will be lower than for healthy adolescents. The primary aim of this study is to evaluate the *Health Belief Model* hypothesis that those exposed to cancer in childhood will have lower participation in health-risk behaviours than those not exposed.

METHOD

Participants

Adolescent survivors of cancer were recruited through the Royal Children's Hospital, Melbourne (Australia). Names of survivors were identified using clinic lists and medical records obtained through the Departments of Haematology and Oncology. For inclusion in the study, survivors were required to be (a) off treatment for 12 months or more, (b) between 13- and 24-years of age at the time of interview, (c) provide written informed consent (and if aged 17 or younger parental consent) prior to completing the survey and (d) have no pre-existing developmental, psychiatric or neurological history. The Royal Children's Hospital Human Research Ethics Committee approved the research. No time period for inclusion in the study was specified.

Participation rate, based on those eligible from review of medical records (341) was 44%. However, many of the potential participants could not be contacted (n = 99), due to out of date address details. As a result, of those survivors aged between 13- and 24-years contacted with valid details (242), 69% agreed to participate (168). Computer error resulted in the loss of 15 completed questionnaires. The study is therefore based on 63% of survivors, who could be contacted and agreed to participate, who provided complete survey information (153).

Comparison of responders and non-responders. Analyses were conducted to determine whether there were differences between the responders (153 study participants), the non-responders (74 who declined the offer to participate) and the 99 lost to follow up. Clinical record data were used to compare age, sex, estimated weekly household income [27] and the six most prevalent cancer diagnoses (leukaemia, Hodgkins disease, non-Hodgkins lymphoma, Wilms tumour, bone cancers and neuroblastoma). Weekly income at time of diagnosis was estimated using postcodes (postal addresses) from the medical records. Address details were linked to the Australian

Bureau of Statistics (1996) census data to obtain locality information pertaining to household income and sorted by geographic postcode. Median weekly household income from the Australian Bureau of Statistics income data [27] were then attributed to each participant as an estimate of the combined household income.

No differences were observed between survivors in the responder group (n = 153) and the group declining to participate (n = 74) on age, gender, median weekly household income and cancer diagnosis. Minimal differences were observed between the responder group (n = 153) and those lost to follow up (n = 99) for age and cancer diagnosis. Those lost to follow up were slightly older (17.8 years vs. 17.0 years $p = 0.04$) and had a higher proportion of survivors diagnosed with Wilms tumour (OR = 2.3: 95% CI: 1.1, 4.7). The socio-demographic and illness demographic similarities between the responder sample and the two non-participant groups indicates that the study sample could be considered to be representative of Victorian adolescent survivors of cancer diagnosed and treated between 1976 and 1987 at the Royal Children's Hospital, Melbourne, the major tertiary hospital for oncology children in Victoria.

Healthy adolescent populations. Two pre-existing population based survey sets were selected to provide an age match comparison sample. The Victorian Adolescent Health and Wellbeing Survey [28] was used as a comparison sample for school aged adolescent survivors. Selected records (by relevant age) from The 1998 National Drug Strategy Household Survey [19] was used as a comparison sample for post-school aged survivors (young adults).

The Adolescent Health and Wellbeing Survey (AHWS). The AHWS was a pen-and-paper survey administered by the Centre for Adolescent Health (Royal Children's Hospital, Melbourne, Australia) to a representative sample of 8,984 students from 535 secondary schools across Victoria. A range of health-risk behaviours was assessed but only those questions assessing tobacco use, alcohol use, illicit drug use and sexual risk taking behaviours were relevant for the aims of the current study. To match the adolescent survivor age range of 13- to 17-years, AHWS participants 18 years of age or over were omitted from the comparison group. The final sample size was 6,377. Full details of the outcome measures in the AHWS are described in another publication [28].

The 1998 National Drug Strategy Household Survey (NDSHS). The NDSHS was conducted during 1998 and involved 10,030 Australians. The NDSHS was administered using a pen-and-paper survey booklet that was delivered to homes throughout Australia. Drug use was the main focus of the NDSHS. Sexual risk taking behaviour was not assessed. A sub-group of 465 participants 18- to 24-years were identified for the purpose of comparison with older survivors. Outcome measures are outlined elsewhere [29].

Measures

The Health Behaviour Questionnaire (HBQ). The Health Behaviour Questionnaire (HBQ) was developed specifically for use with adolescent survivors of cancer. Pre-pilot and pilot studies were conducted. The final computer based version of the HBQ was 124 items that took approximately 30 min to complete. The branched design ensured that participants were only exposed to a sub-set of questions relevant to their life experiences. The HBQ measured alcohol use (recent use), binge drinking (5 or more alcoholic drinks within a few hours over a 2 week period), tobacco use (recent use), cannabis use (lifetime), pain reliever use (lifetime), other illicit drugs (i.e., any use of cannabis, ecstasy, LSD, heroin, cocaine, amphetamines (speed), designer drugs, solvents, pain relievers or sleeping pills) and unprotected sex.

Procedure

For survivors under 18 years of age, initial contact was made with parents to obtain approval for contact with the young person. A letter of introduction, including an explanation of the study and a consent form, were posted to potential participants seeking their informed consent to participate. For those under 18 years, this took place once parental approval was gained. Upon the return of consent forms, telephone contact was made to organise a meeting time to complete the survey. Participants chose one of three methods to complete the survey: group setting, non-group setting (on their own) or telephone. Telephone was the preferred method (60%). The first author personally supervised the completion of all surveys.

Data Analysis

Variable Construction. Binary variables were created from HBQ scales for the purpose of logistic regression analysis using Stata [30]. Participants were classified as a ''smoker'' if they responded ''yes'' to being an ''occasional smoker,'' ''light smoker,'' ''medium smoker'' or a ''heavy smoker.'' If participants reported that they were a ''light drinker,'' ''medium drinker'' or ''heavy drinker'' they were considered to have used alcohol in the last 30 days. Participants were characterised as a ''binge drinker'' if they reported that they had consumed five or more alcoholic drinks in a drinking session over a 2-week period. Low frequency of illicit drug use (other than cannabis and pain relievers) and missing data in both healthy populations necessitated the creation of a composite illicit drug variable described as ''other illicit drug use.'' Cannabis and pain reliever use were assessed separately because both drugs had sufficiently high prevalence

to enable reliable analysis, an observation consistent with previous literature [31]. A binary variable labelled ''unprotected sex'' was created to allow comparison of those who used condoms (most times/always) and those who inconsistently used condoms (never/sometimes). The same cut-points (or as close as possible) were used to create equivalent variables using data from the two general population studies from which the healthy peer controls were drawn.

Univariate and multivariate logistic regression was used to compare health-risk behaviours between survivors (exposed) and healthy adolescents (non-exposed) by age group, with allowance for study design and chance sampling variation in the comparison datasets. Data from the AHWS were clustered by school and weighted to adjust for regional under-sampling. Data from the NDSHS were clustered by area and weighted for age, gender, region and households (size and type). Multivariate estimates were adjusted for age and sex. Only observations with complete data on variables included in each logistic regression were analysed. Survival analysis using Cox regression hazard ratios was also conducted to investigate whether there was a difference in the age of initiation of alcohol use and tobacco use between survivors and healthy adolescents. Two examples of questions used in the three surveys are highlighted in Table I.

RESULTS

Demographics

Illness demographics. The age of adolescent survivors ranged from 13- to 24-years, with a mean age of 18.2-years (standard deviation (SD) = 3.2). The mean age at diagnosis was 6.2 years (SD = 4.1, range 1- to 20-years). All cancer survivors meeting the inclusion criteria were eligible to participate. From the 153 survivors agreeing to participate, the most prevalent cancer diagnosis was leukaemia (53%) followed by bone cancer (14%), Wilms tumour (10%) and non-Hodgkins lymphoma (7%). The remaining low frequency diagnoses included Hodgkins lymphoma (5%), neuroblastoma (4%), soft tissue sarcoma (3%), other lymphomas (1%), brain tumour (1%), benign tumour (1%) and bowel cancer (1%).

The three conventional methods of treatment received by survivors were chemotherapy (98%), surgery (50%) and radiotherapy (48%). Approximately one-fifth of survivors received all three treatment modalities, being chemotherapy, surgery and radiotherapy (18%). One-fifth of survivors were on treatment for less than 12 months (19%) and one-quarter had been on treatment for more than 3 years (23%), with a mean of 1.8 years (SD = 1.0, range less than 1 month to 5 years) on treatment. The period of time survivors were off treatment ranged

TABLE I. Comparison of Health-Risk Behaviour Questions (Alcohol) in the HBQ (Cancer Survivors) and Healthy Adolescent Surveys (AHWS & NDSHS)

Risk behaviour	Health Behaviour Questionnaire	Adolescent Health & Wellbeing Survey	1998 National Drug Strategy Household Survey
Current alcohol use (last 30 days)	At the present time are you a...	During the past 30 days, have you had any beer, wine, alcoholic soda or spirits?	How often do you have an alcoholic drink of any kind?
	Light drinker	Yes, once	Everyday
	Medium drinker	Yes, twice	4 to 6 days a week
	Heavy drinker	Yes, 3–5 times	2 to 3 days a week
	Non-drinker	Yes, 6–9 times	About 1 day a week
		Yes, 10–19 times	2 to 3 days a month
		Yes, 20–39 times	About 1 day a month
		Yes, 40 or more times	Less often
		No	No longer drink alcohol
Age started drinking	How old were you when you started drinking alcohol?	How old were you when you first drank alcohol (more than a sip or two)?	About what age were you when you had your first glass of alcohol?
	Age specified	Age specified	Age specified
Binge drinking	How many times in the last 2 weeks have you had 5 or more alcoholic drinks within a couple of hours?	Think back over the last 2 weeks. Have you had 5 or more alcoholic drinks in a row?	In the last 2 weeks, did you ever have 7 (males)/5 (females) or more standard drinks on one occasion?
	One or more times	Yes, once	Yes
	No	Yes, twice	No
		Yes, 3–5 times	
		Yes, 6–9 times	
		Yes, 10–19 times	
		Yes, 20–39 times	
		Yes, 40 or more times	
		No	

TABLE II. Crude Socio-Demographics for Survivors and Healthy Adolescents by Age Group

	Younger age group				Older age group			
Socio-demographics	N[a]	n[b]	%[c]	95% CI	N[a]	n[b]	%[c]	95% CI
Male								
Healthy peers	6329	2917	46	45–47	465	208	45	40–49
Survivors	81	44	54	43–65	72	35	49	37–61
Non-metropolitan location								
Healthy peers	6338	1829	29	28–30	465	139	30	26–34
Survivors	81	23	28	19–40	72	18	25	16–37
Family not intact								
Healthy peers	6344	1541	24	23–25	263	77	29	24–35
Survivors	80	23	29	19–40	66	15	23	13–35

[a]Total number in sample with valid data.
[b]Sub-sample coded positively on variables.
[c]Crude prevalence estimates.

from 12-months to 22-years, with a mean of 9.3 years (SD = 4.1). Twelve percent of survivors had relapsed at some stage.

Socio-demographics. Table II provides a breakdown of the socio-demographic variables for the two adolescent survivor cohorts (younger vs. older) and their comparison samples. In addition to the variables in Table II age distributions were also compared. Young survivors were more likely to be male (OR 1.6: 1.3, 1.9) and slightly older than their healthy peers (OR 1.5: 1.5, 1.6). No differences were observed for metropolitan/non-metropolitan residential location (OR 1.2: 0.91, 1.6) and family status (OR 1.1: 0.99, 1.3). No differences between older survivors and older healthy adolescents were observed for any socio-demographic variable.

Health-Risk Behaviours

For each age group, relationships were examined between cancer status (survivor vs. healthy) and alcohol use, binge drinking, tobacco use, cannabis use, pain reliever use and other illicit drug use. Relationships between unprotected sexual intercourse and cancer status could only be examined in the young adolescent population.

Younger age group comparisons. Crude estimates of association indicate a lower prevalence of binge drinking (16% vs. 25%), tobacco use (16% vs. 31%), cannabis use (21% vs. 26%), other illicit drug use (7% vs. 15%) and unprotected sexual intercourse (7% vs. 30%) among survivors compared to healthy adolescents. Pain reliever use was higher among survivors compared with healthy adolescents (20% vs. 9%) while alcohol use was similar (56% vs. 55%). After adjustment for age and sex, there was between a 2- and 5-fold reduction in odds of young survivors reporting binge drinking, cannabis use, other illicit drug use, tobacco use and alcohol use (see Table III). Only one survivor reported unprotected sexual intercourse in the young survivor sample.

Older age group comparisons. Crude estimates indicate a lower prevalence of tobacco use (29% vs.

TABLE III. Associations Between Cancer Status and Health-Risk Behaviours in the Younger Adolescent Age Group

	Younger adolescent survivors						
				Univariate[d]		Multivariate[e]	
Health risk behaviour	N[a]	n[b]	%[c]	OR	95% CI	OR	95% CI
Alcohol use	3624	44	55	0.56	0.51–0.62	0.44	0.39–0.49
Binge drinking	3624	12	15	0.32	0.29–0.36	0.20	0.18–0.23
Tobacco use	3624	13	16	0.45	0.41–0.50	0.38	0.34–0.43
Cannabis use	3624	16	20	0.39	0.35–0.43	0.25	0.22–0.29
Pain reliever use	3624	16	20	2.0	1.8–2.3	2.1	1.8–2.4
Other illicit drug use	3624	6	8	0.32	0.29–0.36	0.31	0.27–0.35

[a]Total number in both samples with valid data. Total in survivor population for drug use behaviour was 80.
[b]Sub-sample in survivor population coded positively on variables.
[c]Crude prevalence.
[d]Univariate analysis.
[e]Multivariate analysis adjusted for age and sex.

43%), cannabis use (49% vs. 66%), pain reliever use (15% vs. 17%) and other illicit drug use (24% vs. 31%) among older survivors compared with healthy older adolescents. Survivors reported higher rates of alcohol use (90% vs. 75%) and similar rates of binge drinking (53% vs. 53%). After adjustment for age and sex, there was between a 2- and 3½-fold reduction in odds of older survivors reporting cannabis use, other illicit drug use and tobacco use (see Table IV). There was an elevated risk of older survivors drinking alcohol (1½-fold increase in the odds). No group differences were identified for binge drinking and pain reliever use.

Tobacco and alcohol initiation. The crude rate for smoking initiation was 1.2 per 100 years of life for survivors (95% CI: 0.88, 1.7) and 0.9 per 100 years of life for healthy adolescents (95% CI: 0.88, 0.99). After adjustment for age and sex the rate of smoking initiation was lower among survivors compared to healthy adolescents (HR 0.65: 0.45, 0.92). Rates of alcohol use initiation were 4.6 per 100 years of life for survivors (95% CI: 3.8, 5.6) and 3.4 per 100 years of life for healthy peers (95% CI: 3.3, 3.5) and were similar for the two groups after adjusting for age and sex (HR 1.0: 0.84, 1.2).

Quantifying bias. A comparison of socio-demographic factors between study groups was made for those included and excluded from analyses due to incomplete data. For healthy adolescents drawn from the AHWS (younger age group), marginal differences between those included and excluded were observed. Specifically, AHWS participants excluded from the analysis were more likely to be male (OR 1.2: 1.1, 1.4), but less likely to be from broken families (OR 0.70: 0.62, 0.80). No other differences were noted. For healthy adolescents drawn from the NDSHS, no differences between included and excluded participants were observed. For the young cancer survivor group only (13- to 17-years), one survivor was removed from the sample due to an incomplete data set. Complete data sets were available for all older survivors (18- to 24-years).

Illness demographics and health-risk behaviours. No relationships were identified between health-risk behaviours and age at diagnosis (diagnosed in childhood ($\leq$12 years)), length of time on treatment (on treatment $\leq$2 year) and length of time off treatment (off treatment $\leq$5 years) among adolescent survivors (see Table V).

DISCUSSION

The primary aim of the study was to compare the prevalence of health-risk behaviours between adolescent cancer survivors and healthy adolescents. The focus on current age of survivors reflects developmental stage, which is the critical variable of interest in this study (i.e. do survivors of childhood cancers behave the same as healthy adolescents with respect to risk taking behaviours—are their behaviours advanced/delayed compared with age-matched peers). Our findings are largely inconsistent with previous research that has reported minimal differences between survivor health-risk behaviour and healthy controls [1,2]. Adolescents surveyed in this research generally reported lower levels of health-risk behaviour than their healthy peers, an observation consistent with the expectations of the *Health Belief Model* [3]. Younger survivors were at a reduced risk of reporting alcohol use, binge drinking, tobacco use, cannabis use and other illicit drug use, but at greater risk of reporting pain reliever use. Older survivors were at reduced risk of reporting tobacco use, cannabis use and other illicit drug use, but greater risk of reporting alcohol use.

One explanation for lower reporting of health-risk behaviours such as tobacco and illicit drug use may be the role of early childhood illness on the nature of the parent-child relationship. Anecdotally, it is not uncommon for parents of children with significant illness to become over-

TABLE IV. Associations Between Cancer Status and Health-Risk Behaviours in the Older Adolescent Age Group

	Older adolescent survivors						
				Univariate[d]		Multivariate[e]	
Health risk behaviour	N[a]	n[b]	%[c]	OR	95% CI	OR	95% CI
Current alcohol use	326	65	90	1.5	1.0–2.3	1.5	1.0–2.2
Binge drinking	201	38	53	1.2	0.96–1.6	1.2	0.99–1.6
Current tobacco use	175	21	29	0.49	0.38–0.64	0.47	0.37–0.60
Cannabis use	272	35	49	0.28	0.21–0.39	0.27	0.20–0.36
Pain reliever use	67	11	15	0.91	0.59–1.4	0.94	0.62–1.4
Other illicit drug use	136	17	24	0.46	0.39–0.55	0.44	0.35–0.55

[a]Total number in both samples with valid data. Total in survivor population was 72.
[b]Sub-sample coded positively on variables.
[c]Crude prevalence.
[d]Univariate analysis.
[e]Multivariate analysis adjusted for age and sex.

TABLE V. Association Between Health-Risk Behaviours and Illness-Demographic Mediators Among 153 Adolescent Survivors

		Univariate[b]		Multivariate[c]	
	n[a]	OR	95% CI	OR	95% CI
Alcohol use					
Diagnosed in childhood (≤12 year)	98	0.40	0.08–1.9	0.98	0.18–5.4
On treatment ≥2 year	25	0.76	0.34–1.7	0.62	0.25–1.5
Off treatment ≤5 year	13	0.35	0.14–0.84	0.49	0.19–1.3
Binge drinking					
Diagnosed in childhood (≤12 year)	44	0.46	0.15–1.4	0.91	0.28–3.0
On treatment ≥2 year	9	0.57	0.24–1.3	0.43	0.17–1.1
Off treatment ≤5 year	6	0.58	0.22–1.6	0.94	0.32–2.8
Tobacco use					
Diagnosed in childhood (≤12 year)	30	0.69	0.20–2.3	0.95	0.27–3.4
On treatment ≥2 year	7	0.77	0.30–1.9	0.73	0.28–1.9
Off treatment ≤5 year	3	0.43	0.12–1.5	0.51	0.14–1.9
Cannabis use					
Diagnosed in childhood (≤12 year)	45	0.48	0.16–1.4	0.82	0.25–2.7
On treatment ≥2 year	9	0.55	0.24–1.3	0.47	0.19–1.2
Off treatment ≤5 year	4	0.32	0.10–0.98	0.41	0.13–1.3
Pain reliever use					
Diagnosed in childhood (≤12 year)	26	3.0	0.37–24	2.8	0.34–23
On treatment ≥2 year	7	1.1	0.43–2.9	1.2	0.45–3.1
Off treatment ≤5 year	8	2.7	1.0–7.1	2.6	0.96–7.1
Other illicit drug use					
Diagnosed in childhood (≤12 year)	18	0.27	0.08–0.89	0.43	0.12–1.5
On treatment ≥2 year	5	0.85	0.29–2.5	0.78	0.25–2.4
Off treatment ≤5 year	2	0.44	0.10–2.0	0.63	0.13–3.0

n[a], sub-sample coded positively on variables; OR[b], univariate analysis; OR[c], multivariate analysis adjusted for age and sex.

protective and increase parental involvement. An overprotective parent has been found to predict lower quality of life for survivors [32]. A consequence of parental concern, however, is that young survivors may get fewer opportunities to explore social settings (schools, parties, etc.) in which adolescent drug experimentation is more commonplace. As a consequence, survivors may go on to develop a more precautionary approach to life, continuing to limit involvement in behaviours that are new and unfamiliar or that might be met with parental disapproval or disappointment.

Another explanation of lower tobacco and illicit drug use among both younger and older survivors may be the higher salience of health messages associated with the dangers of drug use (particularly smoking) in our community. For example, many studies in Australia and in the United States have linked cigarette smoking to increased morbidity and mortality [33–38]. In recent years public health in Australia has made a large investment in media campaigns highlighting the negative aspects of tobacco and illicit drug use [39]. Although efforts have also been made to portray alcohol use as unhealthy, advertising by the alcohol industry together with loose evidence of health benefits through moderate use of alcohol may serve to soften the perceived risk of alcohol use.

Furthermore, like many healthy young people, adolescent survivors may also see drinking as an effective mechanism for peer acceptance. Given the importance of peer approval during the teen and young adult years, a primary conflict may arise between protecting health (perceived vulnerability and susceptibility to adverse health complications) and protecting social image (perceived barrier to health protective behaviour). Among older survivors of childhood cancer, it would appear that protection of social image often supersedes that of protecting health. Such an orientation is not uncommon among young people, and could be considered a feature of normal adolescent development, characterised by identity construction [40].

The higher use of pain relievers among young survivors is more difficult to interpret. One possibility is that high use reflects a heightened need for pain avoidance arising from early experiences of vulnerability due to frequent exposure to painful or unpleasant treatment regimens. Being closer (in time) to the age of diagnosis and treatment, memories and feelings of vulnerability may be more pronounced for younger survivors than for older survivors. With the passage of time, however, treatment memories may diminish and other coping skills and resources become established. The result of such a process could be a reduced sense of vulnerability as young survivors become more removed from diagnosis and treatment. The fact that young survivors might turn to pain

relievers rather than other drugs (or other avoidance strategies) may simply reflect their prior experiences of medication during treatment. More detailed research will be needed to more fully explore this effect.

Illness demographic variables such as the age of survivors at diagnosis and the length of time off treatment are important considerations in the health-risk behaviour equation that warrant investigation. As indicated, the primary focus of the current study was a comparison of health-risk behaviours between survivors and healthy adolescents. However, from the cognitive perspective, time since treatment has not been found to effect cognition after 2 years post-treatment [41]. An age at treatment effect was identified for visuo-motor, attention and information processing skills with high level reasoning intact. In the current study, no relationships were identified between health-risk behaviours and illness demographics (i.e. age at diagnosis, time on treatment and time off treatment), suggesting alcohol use, binge drinking, smoking and drug use are mediated by factors outside the illness and treatment. With younger survivors reporting lower involvement of alcohol use (current use and binge drinking), smoking and illicit drug use and older survivors reporting lower involvement of smoking and illicit drug use, it may be suggested that the experience of childhood cancer plays a role in decisions regarding health, supporting the *Health Belief Model*. A more comprehensive account of illness demographics is detailed in another manuscript (in preparation).

Research into low prevalence conditions is difficult to conduct. Previous research has been limited by the use of small clinic based samples with uncertain relevance to a more general population of adolescent cancer survivors. Research has also been limited by absent or difficult to recruit or define control groups. To address these limitations we sought to recruit a representative sample of adolescent cancer survivors who had attended the Royal Children's Hospital (Melbourne, Australia) for treatment of childhood cancer. We also sought to recruit a larger sample than previously available, one that was representative of the entire developmental period of adolescence (i.e. 13 through 24 years) not just certain small periods within adolescence.

By studying two distinct adolescent age groups (i.e. 13- to 17-years and 18- to 24-years) our study provides some insight into the influence of social and cognitive development on health-risk behaviour. Because the *Health Belief Model* proposes that beliefs and values guide decisions about health practices, an adolescent's level of cognitive development is likely to play an important role in the way in which they conceptualise constructs such as susceptibility, severity and outcomes. Based on developments in general intelligence, reasoning and moral maturity [42–44], it might have been expected that older survivors (18- to 24-years) have a better understanding of health consequences than younger survivors (13- to 17-years), and therefore show further comparative reductions in substance use behaviour. Contrary to expectations, our results show substantially higher substance use among older adolescents, possibly reflecting greater opportunity (exposure) to use drugs with increasing age, and greater social (peer) influence on drug use in later adolescence, particularly above the legal drinking age (18-years in Australia).

The use of two large population-based studies has provided a more stable control population than previously available. The result of improved sample ascertainment has been greater precision in estimates of the prevalence of health-risk behaviours. Our case sample remains limited, however, by the heterogeneity of the cancer exposure. Survivors had a range of different cancers and received a variety of treatments. Differences in diagnosis and treatment may be related to risk of health compromising behaviours, as identified in previous studies [16] and hence potentially ''cloud'' the picture of risk for specific diagnoses. Future research embedded within multi-centre collaborations should be able to recruit sizeable homogenous study populations for more accurate estimation of the prevalence of health-risk behaviour for specific types of cancer exposure. Different questions, sampling and study design features of the two population-based comparison samples may also have introduced subtle biases. Further attention to the definition of a meaningful comparison sample in future research activities should provide greater precision risk assessment. Subtle biases may be introduced due to a large number of adolescent survivors lost to follow up. However, with demographics predominantly equivalent between the two groups and well matched, it is likely that the responder sample is representative of Victorian adolescent survivors of cancer diagnosed and treated between 1976 and 1987 at the Royal Children's Hospital (Melbourne). It cannot be presumed that survivors lost to follow up were less conscientious about health and health care and for this reason failed to provide the hospital with new contact details. Rather it may be presumed that children were ''cured'' and contact with the hospital was no longer required. Therefore, with the transient nature of families especially between primary and secondary schooling, parents have not provided the hospital with new contact details.

Although the prevalence of health-risk behaviours among survivors was found to be lower than the prevalence reported for general adolescent populations [31,33,34,45–49], use still remains unacceptably high in an absolute sense. Because of the potential of medical late effects of cancer treatments, adolescent survivors may be at increased vulnerability to the health dangers of substance use [11–15]. The approach to communicating this potential increase in risk to survivors remains unclear. One approach could be to educate young survivors about the risk of drugs in any quantity [1]. However, presuming that

such an approach was effective, an abstinence policy may have other risks, particularly to normal socio-emotional development. It is more likely that a harm minimisation approach, based on effective and adolescent friendly methods of information delivery (such as through peer education and support programs), will be an important strategy for improving health outcomes among adolescent survivors of childhood cancer.

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