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Adolescents' awareness of cancer risk factors and associations with health-related behaviours

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Abstract

Increasing adolescents' awareness of the contribution of modifiable lifestyle factors to cancer risk may influence life-long patterns of healthy behaviour. However, little is known about adolescents' awareness of cancer risk factors and the effectiveness of awareness-raising interventions. This study assessed adolescents' cancer awareness and the effectiveness of an existing cancer-specific school-based intervention delivered by Teenage Cancer Trust. The Cancer Awareness Measure was completed by 478 adolescents (male: 250, 52.3%) aged 11–17 years (mean: 13.8, standard deviation: 1.24) in four UK schools; 422 adolescents provided paired data 2 weeks before and 2 weeks after the intervention delivered in 3 schools, and twice 4 weeks apart in the fourth (control) school. Adolescents recognized on average 4.4 (of 11) cancer risk factors. With the exception of smoking, adolescents' awareness of cancer risk factors was low. Awareness significantly increased after the intervention (4.6–5.7, $P < 0.001$). There was no significant change in the control school. Intervention effect was greater among females. This educational intervention is an effective way to raise adolescents' awareness of cancer risk factors. However, further cross-sectional and experimental studies are required to definitively assess adolescents' awareness of cancer risk factors and the effectiveness of this educational intervention.

Introduction

Awareness of the contribution of modifiable risk factors to the onset of disease is a necessary precursor to the promotion of positive health-related behaviours (HRBs) and as such is a public health priority [1]. It is conservatively estimated that two in five cancers (43%) in the United Kingdom can be attributed to lifestyle factors [2]. However, a nationally representative study of British adults using the recently developed Cancer Awareness Measure (CAM) found that awareness of known cancer risk factors among British adults was poor, especially for modifiable factors including alcohol use, physical activity, dietary factors and human papillomavirus (HPV) infection [3]. On average adults recognized 4.9 (out of 11) cancer risk factors [3]. Although adult awareness of cancer risk factors has been benchmarked [3], an equivalent study with adolescents has not yet been conducted.

Cancer is rare in teenagers and young adults aged 15–24, accounting for around 2000 (0.6%) cancer registrations in the United Kingdom annually [4]. Although few of these diagnoses can be attributed to lifestyle factors, providing adolescents with information about increased cancer risk associated with certain behaviours may be one way to encourage protective behaviours to provide the foundation for a healthy adulthood. Adolescence brings significant physical, psychological and social development [5]. Risk-taking behaviour and susceptibility to social influence

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increase [6] at a time when young people are becoming more independent in decision making and action [7]. Initiation and persistence of risk behaviour is influenced by adolescents' perception of the conditional risk associated with specific behaviours [8], as well as understanding of the potential short-term and long-term health consequences associated with such behaviours [9]. Interventions which address adolescents' risk awareness may therefore be particularly useful and influence HRBs in adolescence and adulthood [10]. However, little is known about British adolescents' awareness of cancer risk factors.

Research conducted outside the United Kingdom indicates that many adolescents are aware that sun exposure is a risk factor but few are aware of the association between HPV infection and cervical cancer. An Italian study of students (aged 15–19 years) found that 66% believed that sun exposure and 59% believed that sunburn increased skin cancer risk [11], whereas a Greek study of adolescents (aged 15–18 years) found higher levels of awareness of the association between sun exposure and skin cancer risk (89%) [12]. Awareness of risk factors associated with breast cancer was low among Turkish students, and the most widely known were personal (69%) and family (67%) history of the disease [13]. A nationally representative study of Australian adolescents (median age 15 and 17 years) found that 25% knew about the association between HPV infection and cervical cancer, yet 72% were unsure [14].

There is a need to concurrently examine adolescents' awareness of cancer risk factors and associations with linked HRBs to inform interventions that seek to increase risk awareness. Our aims were therefore to (i) address the relative lack of evidence by providing an initial indication of adolescents' awareness of known cancer risks; (ii) enable preliminary comparison between adolescents' awareness of cancer risk factors and benchmark data for British adults; (iii) evaluate the effectiveness of an existing cancer-specific educational intervention delivered in UK schools by Teenage Cancer Trust.

Methods

Study design

The study reported in this article comprised two discrete parts. First, a cross-sectional analysis of adolescents' cancer awareness in four UK schools was conducted. Further details about the design and additional findings of this analysis are published elsewhere [15]. Second, in the same four UK schools, pre-test–post-test analysis was conducted to assess the effectiveness of an educational intervention delivered by Teenage Cancer Trust. Thus, data collected for cross-sectional analysis of adolescents' awareness of cancer risk factors provided the baseline measures for assessment of changes in awareness following delivery of the intervention. This pragmatic approach was adopted to facilitate the first UK cross-sectional study of adolescents' cancer awareness and initial evaluation of the effectiveness of an existing educational intervention to inform the development of future larger scale intervention studies. This article, therefore, reports both cross-sectional and pre-test–post-test analysis of adolescents' awareness of cancer risk factors by gender and linked HRBs.

Data collection

Data were collected from adolescents aged 11–17 years, recruited from four schools in England and Scotland between August and October 2011. Schools with an existing relationship with Teenage Cancer Trust were purposively sampled to maximize geographic and age distribution and to ensure both male and female adolescents were included (i.e. single-sex schools were excluded), as there are known differences in their health behaviours [16]. Therefore, the sampling strategy incorporated elements of both convenience and purposive sampling. Consequently, none of the schools that were approached to participate in the study refused to participate.

Data were collected during a single day 2 weeks before (T_0) and again 2 weeks after (T_1) the intervention in three schools, and twice 4 weeks apart in the fourth (control) school. There were

Table I. *Study response rates*

School (English Education System Year)	School roll (SR) *n*	Study participants T_0 *n*	T_0 % (of SR)	T_1 *n*	T_1 % (of SR)	T_1 % (of T_0)
A (Year 11)	175	155	88.6	124	70.9	80.0
B (Year 10)	174	156	89.7	138	79.3	88.5
C (Year 12)	44	29	65.9	28	63.6	96.6
D (Year 8)	165	138	83.6	132	80.0	95.7
Total	558	478	85.7	422	75.6	88.3

558 adolescents on the school roll, of whom 478 (86%) provided data at T_0 and 422 (76%) provided data at both T_0 and T_1 (Table I).

Intervention

Currently, cancer awareness education is not a statutory component of curricula delivered in UK schools. However, the charity Teenage Cancer Trust have provided cancer awareness education in UK schools since 1995 and currently deliver an educational intervention, 'Let's talk about it', in approximately 10% of UK schools each year ($n = 600$). Yet, there has been no previous evaluation of the effectiveness of this existing educational intervention to inform wider roll-out or integration into school curricula.

'Let's talk about it' is an hour-long oral presentation delivered by a single Teenage Cancer Trust educator to adolescents in a classroom or assembly setting. Each presentation includes the same agreed content to ensure consistency and intervention fidelity between educators; although presentation style may vary by educator, and in response to the needs of the audience. Intervention content is linked to outcomes from the 'Health and Well-being' section of the Curriculum for Excellence in Scotland, such as 'assess and manage risk and understand the impact of risk-taking behaviour' and 'participate in a wide range of activities which promote a healthy lifestyle' [17], and to key concepts for Personal, Social, Health and Economic Education in England and Wales, including 'recognising that healthy lifestyles, and the wellbeing of self and others, depend on information and making responsible choices' and 'understanding risk in both positive and negative terms and understanding that individuals need to manage risk to themselves and others in a range of situations' [18]. Hence, the presentation includes information about known cancer risk factors as well as messages to encourage young people to adopt healthy lifestyle habits, and specifically, healthy eating, physical exercise and avoiding risk behaviours such as smoking and alcohol consumption. Further details about the intervention are available online (http://teenagecancertrust.myresourcecloud.net/).

'Let's talk about it' was delivered in three schools which were also provided with Teenage Cancer Trust booklets designed specifically for adolescents after delivery. A fourth (control) school did not receive the intervention or booklets. There were no additional cancer awareness raising initiatives in place in any of the schools at the time of the study.

Survey instrument

Teachers administered a paper questionnaire to a whole class. Students were asked to complete the questionnaire in complete silence but were informed that it was not a test. Teachers encouraged students to complete as much of the questionnaire as they could. Students were allowed as much time as they needed within the 55-min lesson, although most completed the questionnaire within 20 min. In the three intervention schools, the questionnaire was completed 2 weeks before (T_0) and again by the same adolescents 2 weeks after (T_1) the intervention.

In the control school, the questionnaire was completed on two occasions 4 weeks apart (T_0 and T_1). The instrument incorporated the CAM [19], questions from the cross-national Health Behaviour in School-aged Children (HBSC) survey [16] and sociodemographic questions. Validity testing of the survey instrument prior to its use with adolescents in this study is described in detail elsewhere [15].

Cancer awareness

Adolescents' awareness of known cancer risk factors was assessed through a closed question from the CAM: 'These are some of the things that can increase a person's chance of developing cancer. How much do you agree that each of these can increase a person's chance of developing cancer?' Eleven cancer risk factors were listed in this order: 'smoking any cigarettes at all'; 'exposure to another person's smoke'; 'drinking more than one unit of alcohol a day'; 'eating less than five portions of fruit and vegetables a day'; 'eating red or processed meat once a day or more'; 'being overweight (BMI over 25)'; 'getting sunburnt more than once as a child'; 'being over 70 years old'; 'having a close relative with cancer'; 'infection with HPV'; 'doing less than 30 minutes of moderate physical activity five times a week'. Responses ranged from 'strongly disagree' to 'strongly agree' on a five-point Likert scale. For analysis, responses were dichotomized (i.e. 'strongly agree'/'agree' versus 'not sure'/'disagree'/'strongly disagree'). 'Agree' and 'strongly agree' responses were combined and summed to create an overall risk factor score (out of 11).

Health-related behaviours

Adolescents' HRBs were assessed using questions from the HBSC survey. Categories in the following variables were dichotomized for analysis using HBSC methodology [16]: alcohol consumption (weekly/less often); current smoker (yes/no); sunbed user (yes/no); sun protection while (i) sunbathing and (ii) outdoors (yes/no); moderate physical activity outside school hours [7] (four or more/less than four times a week).

Sociodemographic characteristics

Sociodemographic questions were included to gather data on age, gender, ethnicity (using census categories) and cancer experience (i.e. whether the student, a relative or friend had been diagnosed with cancer).

Statistical analysis

Descriptive statistics were calculated for sociodemographic variables, CAM and HBSC items.

Cross-sectional analysis

Cross-sectional analyses were conducted using data collected at T_0. Pearson's chi-square (χ^2) tests were used to assess: (i) differences in sociodemographic characteristics and HRBs between the intervention and control groups and (ii) associations between awareness of cancer risk factors and (i) gender and (ii) linked HRBs (e.g. current smoking status and awareness of smoking as a cancer risk factor). Independent samples *t*-tests were used to examine differences in the mean number of cancer risk factors recognized by gender.

Pre-test–post-test analysis

Pre-test–post-test analysis was conducted using data collected at T_0 and T_1. McNemar's chi-square (χ^2_M) tests for matched paired categorical data were used to examine change in recognition of known cancer risk factors within the intervention and control schools between T_0 and T_1 by gender and linked HRBs (e.g. agreement that smoking was a cancer risk factor among smokers and non-smokers). In addition, Pearson's chi-square (χ^2) tests were used to assess differences in recognition at T_0 and T_1 by gender. Paired samples t-tests were used to examine differences in the mean number of cancer risk factors recognized between T_0 and T_1 for all adolescents and by gender.

Data were analysed using SPSS 19.0. Significance tests were two-sided; $P < 0.05$ was considered statistically significant.

Ethical considerations

Approval for the study was obtained from the Research Ethics Committee in the School of

Nursing, Midwifery and Health, University of Stirling. Parents/carers were informed of the study by letter and could opt their child out of the research, although none did. Written informed consent was obtained from each adolescent before completion of the questionnaire.

Results

Sample

The sample included 478 adolescents (male: $n = 250$, 52.3%) aged 11–17 years [mean = 13.8, standard deviation (SD) = 1.24], of whom 422 (88%) provided paired data (male: $n = 221$, 52.4%; mean age = 13.8, SD = 1.26). HRBs of adolescents in this study were comparable with those of similarly aged Scottish and English adolescents reported in the nationally representative HBSC surveys [5, 16]. Participants' sociodemographic characteristics and HRBs are provided in Table II.

Cross-sectional analysis

Recognition of cancer risk factors

The mean number of cancer risk factors recognized was 4.41 (SD = 2.08) of 11. Most adolescents (88%) agreed that smoking was a cancer risk factor, followed by second-hand smoke (60%) and being overweight (58%). Only half agreed that sun exposure (52%) or drinking alcohol (47%) increased the chance of developing cancer. A third (31%) agreed that HPV infection was a known risk factor, and a quarter (26%) that low levels of physical activity increased cancer risk. Awareness of diet-related factors was poor; only 15% of adolescents agreed that eating red or processed meat, and 7% that low fruit and vegetable consumption, increased cancer risk. Awareness of non-modifiable cancer risk factors was also low; two-fifths (41%) agreed that having a close relative and one-fifth (22%) that being aged over 70 increased the chance of developing cancer (Table III).

Recognition of cancer risk factors by gender

There was no statistically significant difference in the mean number of cancer risk factors recognized between male and female adolescents [male: 4.41 (SD = 2.15) versus female: 4.41 (SD = 2.01); $t(476) = 0.001$, $P = 1.000$]. However, males were statistically significantly more likely to agree that second-hand smoke, low levels of physical activity and being aged over 70 were cancer risk factors. Females were significantly more likely to agree that HPV infection and family history were cancer risk factors (Table III).

Recognition of cancer risk factors by linked health-related behaviours

Adolescents who participated in physical activity four or more times a week were significantly more likely to agree that low levels of physical activity increased cancer risk [females: $\chi^2(1, 220) = 5.06$, $P = 0.025$; males: $\chi^2(1, 235) = 6.45$, $P = 0.011$]. In addition, males who participated in physical activity four or more times a week were significantly more likely to agree that being overweight [$\chi^2(1, 232) = 4.73$, $P = 0.030$] increased cancer risk.

Females who reported using sunbeds were significantly more likely to agree that sun exposure was a known cancer risk factor [$\chi^2(1, 224) = 4.79$, $P = 0.029$] than females who did not use sunbeds.

There were no statistically significant associations between agreement with cancer risk factors and linked HRBs for either gender for smoking/second-hand smoke versus current smoking status; drinking more than one unit of alcohol a day versus weekly alcohol consumption; sun exposure versus use of suncream while sunbathing or outdoors.

Pre-test–post-test analysis

Recognition of cancer risk factors

Adolescents recognized on average 1.1 more cancer risk factors after the intervention, and this increase was statistically significant [4.6 (SD = 2.12) to 5.7 (SD = 2.69); $t(289) = -6.95$, $P < 0.001$]. In the control school, there was no significant change [4.0 (SD = 1.98) to 3.7 (SD = 2.24); $t(131) = 1.64$, $P = 0.104$].

Awareness of 9 (of 11) cancer risk factors increased after the intervention, and these increases were statistically significant for 7. The greatest

Table II. *Sample sociodemographic characteristics and health-related behaviours*

	Cross-sectional analysis		Pre-test–post-test analysis						
	Total ($n = 478$)		Total ($n = 422$)		Intervention ($n = 290$)		Control ($n = 132$)		Significance (P)
	n	(%)	n	(%)	n	(%)	n	(%)	
Sociodemographic characteristics									
Gender									
Male	250	52.3	221	52.4	162	55.9	59	44.7	**0.033**[a]
Female	228	47.7	201	47.6	128	44.1	73	55.3	
Age, mean (SD)	13.8	(1.24)	13.8	(1.26)	14.5	(0.72)	12.2	(0.40)	<**0.001**[b]
Ethnicity									
White	438	91.6	386	91.5	261	90.0	125	94.7	0.193[a]
Other ethnic backgrounds	32	6.7	30	7.1	23	7.9	7	5.3	
Missing	8	1.7	6	1.4	6	2.1	0	0	
Knew someone with cancer									
Yes	292	61.1	255	60.4	179	61.7	76	57.6	0.644[a]
No	149	31.2	131	31.0	88	30.3	43	32.6	
Do not wish to answer	37	7.7	36	8.5	23	7.9	13	9.8	
School (region)									
A (Scottish Highlands)	155	32.4	124	29.4	124	42.8	—	—	
B (South West England)	156	32.6	138	32.7	138	47.6	—	—	
C (English East Midlands)	29	6.1	28	6.6	28	9.7	—	—	
D (North West England)	138	28.9	132	31.3	—	—	132	100.0	
Country									
Scotland	155	32.4	124	29.4	124	42.8	—	—	
England	323	67.6	298	70.6	166	57.2	132	100.0	
Health-related behaviours									
Current smoker									
Yes	36	7.5	24	5.7	22	7.6	2	1.5	**0.013**[a]
No	425	88.9	386	91.5	261	90.0	125	94.7	
Missing	17	3.6	12	2.8	7	2.4	5	3.8	
Weekly alcohol consumption									
Yes	72	15.1	60	14.2	48	16.6	12	9.1	0.054[a]
No	392	82.0	352	83.4	238	82.1	114	86.4	
Missing	14	2.9	10	2.4	4	1.4	6	4.5	
Sunbed use									
Yes	50	10.5	46	10.9	26	9.0	20	15.2	**0.035**[a]
No	411	86.0	363	86.0	260	89.7	103	78.0	
Missing	17	3.6	13	3.1	4	1.4	9	6.8	
Sun protection while sunbathing									
No suncream/sunscreen	52	10.9	47	11.1	36	12.4	11	8.3	0.343[a]
Uses suncream/sunscreen	307	64.2	268	63.5	187	64.5	81	61.4	
Non-sunbather	100	20.9	92	21.8	61	21.0	31	23.5	
Missing	19	4.0	15	3.6	6	2.1	9	6.8	
Sun protection while outdoors									
No suncream	176	36.8	153	36.3	116	40.0	37	28.0	**0.042**[a]
Uses suncream	284	59.4	255	60.4	169	58.3	86	65.2	
Missing	18	3.8	14	3.3	5	1.7	9	6.8	
Moderate to vigorous physical activity									
Four or more times a week	174	36.4	149	35.3	87	30.0	62	47.0	<**0.001**[a]
Less than four times a week	286	59.8	259	61.4	195	67.2	64	48.5	
Missing	18	3.8	14	3.3	8	2.8	6	4.5	

Statistically significant differences between intervention and control schools at the $P < 0.05$ level are emboldened.
[a]Pearson's chi-square test. [b]Independent samples t-test.

Table III. *Recognition of cancer risk factors by gender at T_0*

		Gender ($n = 478$)		
Cancer risk factor, % agree (n)	All ($n = 478$)	Male ($n = 250$)	Female ($n = 228$)	Significance[a]
Smoking	87.8 (416)	88.2 (217)	87.3 (199)	$\chi^2(1, 474) = 0.10$ $P = 0.757$
Second-hand smoke	59.7 (283)	**65.9 (162)**	**53.1 (121)**	$\mathbf{\chi^2(1, 474) = 8.04}$ $\mathbf{P = 0.005}$
Overweight	58.4 (276)	58.8 (144)	57.9 (132)	$\chi^2(1, 473) = 0.04$ $P = 0.846$
Sun exposure	51.9 (245)	49.6 (121)	54.4 (124)	$\chi^2(1, 472) = 1.09$ $P = 0.297$
Drinking alcohol	46.5 (220)	43.9 (108)	49.3 (112)	$\chi^2(1, 473) = 1.40$ $P = 0.236$
Family history[b]	41.2 (194)	**32.9 (80)**	**50.0 (114)**	$\mathbf{\chi^2(1, 471) = 14.16}$ $\mathbf{P < 0.001}$
HPV infection	31.4 (148)	**24.5 (60)**	**38.8 (88)**	$\mathbf{\chi^2(1, 472) = 11.16}$ $\mathbf{P = 0.001}$
Low exercise	25.5 (120)	**32.8 (80)**	**17.6 (40)**	$\mathbf{\chi^2(1, 471) = 14.25}$ $\mathbf{P < 0.001}$
Older age[b]	21.8 (103)	**27.0 (66)**	**16.2 (37)**	$\mathbf{\chi^2(1, 472) = 8.09}$ $\mathbf{P = 0.004}$
Eating red meat	15.0 (71)	18.0 (44)	11.8 (27)	$\chi^2(1, 472) = 3.54$ $P = 0.060$
Low fruit/vegetable intake	6.5 (31)	8.1 (20)	4.8 (11)	$\chi^2(1, 474) = 2.12$ $P = 0.146$

Statistically significant associations at the $P < 0.05$ level are emboldened.
[a]Pearson's chi-square test for 2×2 tables (i.e. Agree versus disagree/not sure for each demographic variable). [b]Non-modifiable risk factor.

increase was for 'being over 70 years old', followed by 'eating less than five portions of fruit and vegetables a day', 'doing less than 30 minutes of moderate physical activity five times a week' and 'eating red or processed meat' (all $P < 0.001$). In the control school, there were no statistically significant changes in awareness of known cancer risk factors (Table IV).

Intervention effect by gender

Females showed greater increases in recognition after the intervention than males. On average females recognized 1.4 more cancer risk factors after the intervention [4.6 (SD = 1.97) to 6.0 (SD = 2.56), $t(127) = -6.33$, $P < 0.001$], whereas males recognized on average 0.8 more cancer risk factors [4.6 (SD = 2.24) to 5.4 (SD = 2.77), $t(161) = -3.87$, $P < 0.001$].

Between-groups analysis identified statistically significant gender differences in recognition before the intervention for five cancer risk factors: 'having a close relative with cancer' (male: 32.1% versus female: 56.3%; $P < 0.001$), 'older age' (male: 33.3% versus female: 16.4%; $P = 0.001$), 'low levels of physical activity' (male: 34.2% versus female: 18.9%; $P = 0.004$), 'HPV infection' (male: 25.8% versus female: 40.2%; $P = 0.010$) and 'second-hand smoke' (male: 69.8% versus female: 58.6%; $P = 0.048$). After the intervention, statistically significant differences remained for two: 'HPV infection' (male: 28.0% versus female: 50.4%; $P < 0.001$) and 'having a close relative with cancer' (male: 33.5% versus female: 51.2%; $P = 0.003$), both of which had higher levels of agreement among female adolescents.

Table IV. *Change in recognition of cancer risk factors after intervention*

Cancer risk factor, strongly agree/agree, % (*n*)	Intervention (*n* = 290)				Control (*n* = 132)			
	T_0	T_1	Change	Significance (*P*)[a]	T_0	T_1	Change	Significance (*P*)[a]
Older age	**25.9 (74)**	**55.2 (158)**	**29.3 (84)**	**<0.001**	11.0 (14)	16.5 (21)	5.5 (7)	0.230
Low fruit/vegetable intake	**7.7 (22)**	**27.5 (79)**	**19.8 (57)**	**<0.001**	3.1 (4)	3.1 (4)	0 (0)	1.000
Low levels of physical activity	**27.6 (78)**	**42.4 (120)**	**14.8 (42)**	**<0.001**	19.8 (25)	13.5 (17)	−6.3 (−8)	0.169
Eating red or processed meat	**15.0 (43)**	**26.6 (76)**	**11.6 (33)**	**<0.001**	18.1 (23)	13.4 (17)	−4.7 (−6)	0.327
Drinking alcohol	**45.1 (129)**	**54.5 (156)**	**9.4 (27)**	**0.009**	51.9 (67)	43.4 (56)	−8.5 (−11)	0.126
Sun exposure	**55.4 (159)**	**62.7 (180)**	**7.3 (21)**	**0.038**	40.6 (52)	45.3 (58)	4.7 (6)	0.377
Overweight	**59.4 (170)**	**66.4 (190)**	**7.0 (20)**	**0.047**	53.9 (69)	54.7 (70)	0.8 (1)	1.000
Second-hand smoke	64.8 (186)	70.7 (203)	5.9 (17)	0.068	51.2 (66)	48.8 (63)	−2.4 (−3)	0.755
HPV infection	32.5 (92)	38.2 (108)	5.7 (16)	0.125	32.0 (40)	28.8 (36)	−3.2 (−4)	0.585
Family history	42.8 (122)	41.8 (119)	−1.0 (−3)	0.836	27.8 (35)	34.9 (44)	7.1 (9)	0.175
Smoking	87.5 (251)	86.1 (247)	−1.4 (−4)	0.636	86.7 (111)	79.7 (102)	−7.0 (−9)	0.064

Statistically significant changes at the $P < 0.05$ level are emboldened.
[a]McNemar's chi-square test for 2 × 2 tables (i.e. strongly agree/agree versus not sure/disagree/strongly disagree).

Table V. *Recognition of cancer risk factors at T_0 and T_1 by health-related behaviours at T_0*

Cancer risk factor, % (*n*)	Health-related behaviours	Intervention (*n* = 290)			
		T_0	T_1	Change	Significance (*P*)[a]
Sunburnt	Sunbed user				
	Yes	53.8 (14)	69.2 (18)	15.4	0.219
	No	55.4 (143)	62.8 (162)	7.4	0.050
	Use suncream while outdoors				
	No	55.2 (64)	61.2 (71)	6.0	0.311
	Yes	**55.1 (92)**	**64.7 (108)**	**9.6**	**0.044**
	Suncream while sunbathing				
	No	55.6 (20)	61.1 (22)	5.5	0.774
	Yes	56.7 (106)	64.2 (120)	7.5	0.098
Smoking	Smoker				
	Yes	**90.9 (20)**	**63.6 (14)**	**−27.3**	**0.031**
	No	87.3 (227)	88.1 (229)	0.8	0.864
Second-hand smoke	Smoker				
	Yes	50.0 (11)	50.0 (11)	0	1.000
	No	66.2 (172)	71.9 (187)	5.7	0.082
Alcohol consumption	Alcohol consumption				
	Weekly	43.8 (21)	50.0 (24)	6.2	0.629
	Less often	**45.5 (107)**	**55.7 (131)**	**10.2**	**0.012**
Low levels of physical activity (PA)	Moderate to vigorous PA				
	<4 times a week	**23.3 (44)**	**40.2 (76)**	**16.9**	**<0.001**
	≥4 times a week	39.1 (34)	48.3 (42)	9.2	0.215

Statistically significant changes at the $P < 0.05$ level are emboldened.
[a]McNemar's chi-square test for 2 × 2 tables.

Intervention effect by linked health-related behaviours

Recognition that low levels of physical activity is a cancer risk factor significantly increased after the intervention among adolescents with lower levels of physical activity ($P < 0.001$).

Recognition of alcohol consumption as a risk factor significantly increased among adolescents with lower levels of alcohol consumption ($P = 0.012$). Recognition of the cancer risk posed by sun exposure as a child significantly increased among adolescents who used suncream while outdoors ($P = 0.044$).

Awareness of smoking as a cancer risk factor significantly decreased among smokers ($P = 0.031$; Table V).

Discussion

Cross-sectional analysis showed adolescents' awareness of cancer risk factors was low, particularly for dietary factors. Adolescents in this study had comparable cancer awareness to the British population, recognizing on average 4.4 versus 4.9 (of 11) risk factors [3]. However, for certain factors, adolescents' recognition was higher than among adults and younger adults (18–24 years) [3]: smoking (88% versus 85%/84%, respectively), being overweight (58% versus 49%/54%), alcohol consumption (47% versus 25%/37%), HPV infection (31% versus 22%/19%) and low levels of physical activity (26% versus 22%/19%).

Our study showed that a cancer-specific intervention raised awareness of cancer risk factors. Two weeks after the intervention, adolescents recognized on average 5.7 (of 11) cancer risk factors, which is greater than British adults (4.9) [3]. Awareness of 9 (of 11) cancer risk factors increased after the intervention. Moreover, with the exception of second-hand smoke, awareness of every risk factor was higher among adolescents after the intervention than adults and younger (18–24 years) adults [3]. In the control school, the mean number of cancer risk factors recognized decreased, and there were decreases in recognition for six individual risk factors. Brief face-to-face presentations by experienced cancer educators are, therefore, an effective way to increase adolescents' awareness of cancer risk factors. However, raising awareness of the association with second-hand smoke may need further targeted intervention.

Intervention effect was greater among females. The intervention reduced gender disparity in recognition for certain cancer risk factors (i.e. second-hand smoke, older age, red meat, physical activity). After the intervention, statistically significant gender differences in recognition remained only for family history and HPV infection, which was higher among females.

Despite legislation prohibiting sunbed use among adolescents [20, 21], 1 in 10 in our study reported using sunbeds, and females who used sunbeds were already significantly more likely to agree that sun exposure was a cancer risk factor than females who did not. After the intervention, there were greater increases in awareness that sun exposure increased cancer risk among sunbed users than non-sunbed users. In research with college students in the United States (82% aged 17–22, 70% female), 91% of current sunbed users agreed that sunbed use increased skin cancer risk [22]. Our study demonstrates a similar relationship between risk awareness and risk behaviour among younger adolescents (aged 11–17). Sunbed use before the age of 35 increases the risk of malignant melanoma by 75%, and a national prevalence study of adolescents (aged 11–17) in the United Kingdom found that females were significantly more likely to use or intend to use sunbeds [23]. An increasing skin cancer incidence is of particular concern in the United Kingdom where incidence of malignant melanoma is rising more rapidly than for any other cancer [23]. Moreover, it is estimated that 82% of melanoma cases in men and 90% in women are linked to excess exposure to solar radiation and that these proportions are greater at younger ages [24]. Therefore, increasing awareness of skin cancer risk associated with indoor and outdoor ultraviolet (UV) exposure and encouraging sunsafe behaviours are a public health priority [25–27]. Reaching adolescents with

messages regarding the increased skin cancer risk associated with UV exposure may establish patterns of protective behaviour across the life course [10, 28].

An unexpected finding was a significant decrease after the intervention in the number of smokers who recognized smoking as a known cancer risk factor. Although this finding should be treated with caution due to the small number of smokers in intervention schools ($n = 22$), it suggests that further research is warranted as it may be that adolescent smokers and non-smokers respond to cancer awareness messages differently.

There are known limitations to the effectiveness of education only interventions to change HRBs [29, 30]. Confirming previous research [22, 31], our study suggests that legislation and awareness-raising interventions are alone not sufficient to address adolescents' cancer risk behaviours. Therefore, multi-component interventions are required that incorporate education about known cancer risk factors and also include changes to the school environment (e.g. routine provision of sun protection cream or hats) and direct challenges to societal and individual attitudes (e.g. towards tanned skin [32] and associated peer pressure to have a tan, particularly prevalent among female adolescents [6]).

However, there is an increasing recognition that changing knowledge is important alongside interventions to change HRBs and that despite inclusion of education in multi-component interventions, educational components are rarely evaluated [33]. Therefore, this study has established a foundation for both the future development and integration of this educational intervention in multi-component programmes and further research to assess the relationship between increased knowledge of cancer risk factors and HRB change.

Strengths and limitations

To our knowledge, this is the largest study of adolescents' awareness of cancer risk factors conducted in the United Kingdom. It is novel because it concurrently assesses recognition of several known cancer risk factors and examines associations between awareness and linked HRBs. Previous studies have tended to examine one risk factor and associated behaviour in isolation [11–14].

However, our study has a number of limitations. First, non-probabilistic sampling restricts the ability to make population inferences from cross-sectional analyses. Inclusion of schools with an existing relationship with Teenage Cancer Trust could have introduced selection bias as students in these schools may have higher baseline levels of cancer awareness or be more receptive to cancer awareness messages due to teacher enthusiasm or reinforcement. Second, the composition of the control school, particularly the younger age of students, limited evaluation of intervention effect by age and ethnicity. This was a further consequence of the sampling approach that was selected pragmatically to facilitate both the first cross-sectional study of adolescents' cancer awareness in the United Kingdom [15] and the initial evaluation of the effectiveness of an existing educational intervention delivered by Teenage Cancer Trust to inform the development of future larger-scale school-based intervention studies. Finally, the study design did not incorporate randomization, and clustering by school was not controlled.

Future research is needed to address these study limitations. A larger cross-sectional study is required that uses a nationally representative sample of adolescents supplemented by quota sampling of ethnic groups in accordance with established CAM practice [34] to definitively determine levels of adolescents' cancer awareness in the United Kingdom. Further intervention studies involving greater numbers of students and schools (without prior relationships with Teenage Cancer Trust) are also needed to address the limitations introduced by the sampling approach. This would also enable sub-group analysis by age, ethnicity and HRBs (e.g. to re-test the contentious finding from this study around decreased reported awareness of smoking as a cancer risk factor among smokers). These studies should include additional sociodemographic variables that may influence adolescents' awareness of cancer risk factors [e.g. socioeconomic status (derived from parent's/carer's occupation) [3], educational attainment, school ethos and family

and friends' HRBs]. In addition, future research should consider examining environmental factors, such as school and community health promotion campaigns, as potential confounders. Intervention studies would be strengthened through the use of experimental designs and multivariate analysis that will enable assessment of the relationship among these individual-, school- and network-level variables adjusted for clustering by school. Therefore, future studies should use a cluster randomized controlled trial design.

Conclusions

Our study showed that, with the exception of smoking, adolescents' awareness of cancer risk factors was low. An hour-long cancer-specific educational intervention was effective in raising adolescents' awareness of cancer risk factors, especially among females. However, adolescents' awareness of certain cancer risk factors varied after the intervention when examined by linked HRBs (i.e. sun exposure and sunbed use), and there were unexpected consequences of the delivery of intervention delivery (e.g. among smokers) that warrant further investigation. Thus, this intervention requires refinement followed by further evaluation using experimental designs to definitively determine its effectiveness.

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Conflict of interest statement

None declared.

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