Effectiveness of an Educational Program on Awareness of Cancer Risk Factors, Symptoms, and Barriers to Medical Help-Seeking Among Adolescent Omani Students: an Interventional Study

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Abstract

Cancer is the second leading cause of death worldwide, with attributable mortality expected to continue increasing over time. High school students are often targeted to enhance awareness of cancer risk factors and symptoms and promote early medical help-seeking behaviors. This study aimed to evaluate the effectiveness of a cancer education program among Omani adolescents. A total of 12 public schools were randomly selected from three governorates and assigned to either the intervention or control group. Students attending grades 10 and 11 at the selected schools were targeted. The Cancer Awareness Measure tool was used to evaluate knowledge of cancer risk factors and symptoms, perceived barriers to seeking medical help, and anticipated time to consult a doctor for cancer warning symptoms at baseline (T0) and after 4 weeks (T1). After T0, the intervention group participated in a 1-h cancer education program involving a slideshow presentation and group discussion; they also received a leaflet and online access to program materials and videos. A total of 1716 students were enrolled in the study, including 886 (51.6%) assigned to the control group and 830 (48.4%) to the intervention group. Recognition of cancer risk factors ($Z = 24.86$; $p < 0.001$) and cancer symptoms ($Z = 24.91$; $p < 0.001$) significantly improved in the intervention group between T0 and T1, and compared to the control group at T1 ($U = 33.28$; $p < 0.001$, and $U = 34.55$; $p < 0.001$, respectively). In addition, anticipated time to help-seeking ($Z = 20.15$; $p < 0.001$) and barriers to help-seeking ($Z = 10.33$; $p < 0.001$) decreased significantly between T0 and T1, and compared to the control group at T1 ($U = 19.00$; $p < 0.001$, and $U = 3.58$; $p < 0.001$, respectively). The intervention effectively increased knowledge of cancer risk factors and symptoms and promoted early medical help-seeking behaviors among school-aged Omani adolescents. Integration of cancer education within high school curricula can aid cancer prevention and early intervention efforts. However, additional follow-up is required to confirm the long-term effectiveness of such programs.

Keywords Cancer knowledge · Barriers · Education · School students · Intervention · Oman

Introduction

Cancer remains a leading cause of death globally, responsible for approximately 10 million deaths in 2020 [1]. Despite the lower incidence of cancer in low- and middle-income countries (LMICs), the burden of total cancer-related deaths is significantly greater (~5 million per year), primarily due to increase in cancer risk factors, the lack of access to healthcare, unavailability of cancer screening programs, and delays in cancer diagnosis [2]. While early diagnosis is known to improve cancer survival rates and outcomes, this relies heavily on recognition of cancer warning symptoms and prompt medical help-seeking behaviors on the part of affected patients [3]. Poor knowledge of cancer symptoms and negative beliefs and attitudes to seeking early medical help are considered one of the main reasons for delays in presentation and diagnosis, thereby leading to poor outcomes [4]. The patient interval period (i.e., the time between symptom recognition and seeking medical help) has been found to represent the lengthiest interval of time between symptom recognition and the start of treatment within the cancer care pathway [5].

Patients diagnosed earlier with cancer were more likely to survive, have lower treatment morbidity, and experienced better care and good quality of life compared with those

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diagnosed late [1, 6]. Thus, cancer education programs that raise awareness of specific risk factors and symptoms and promote healthy lifestyles are fundamental initiatives in primary cancer prevention [7]. High school students (i.e., those between 12 and 19 years of age) are often deemed a suitable target for cancer education interventions to increase cancer-related knowledge and improve attitudes toward cancer prevention [8]. Various studies have shown that increased knowledge of cancer at this stage helps to encourage preventative daily habits and help-seeking behaviors and increase positive health-related attitudes in later life, which is particularly important as cancer risk increases with age and as a result of modifiable risk factors [9]. A recent systematic review concluded that interventional education programs are important to increase cancer knowledge among adolescent students and that decision-makers should consider and support cancer education within high school curricula as part of their long-term cancer prevention efforts [8].

Oman is a developing country in the Arabian Peninsula with a total population of 4.5 million (35.7% under 15 years of age) [10]. In Oman, cancer remains as one of the most frequent causes of death, with cancer patients often presenting at a younger age and more advanced stage at the time of diagnosis [4, 11]. As with other LMICs, the burden of cancer in Oman is expected to increase as a result of rapid socioeconomic development and corresponding lifestyle changes [12]. Previous studies conducted in Oman have shown that both adults and adolescents demonstrate poor knowledge of common cancer risk factors and symptoms, with participants reporting various physical and emotional barriers that hinder early medical help-seeking for possible cancer symptoms [4, 13].

The researchers concluded that there is an urgent need for a cancer education program to be included in the school curricula to target adolescent students [4, 13]. Indeed, the school system is a privileged place for socialization that has the capability and necessary tools to make a positive impact on students' health knowledge [7]. Furthermore, adolescents can be easily reached through schools to raise cancer awareness, address health misinformation and barriers to medical help-seeking, and measure the effectiveness of adopted strategies to combat these factors [8]. The aim of this study was therefore to evaluate the effectiveness of an interventional education cancer program to enhance knowledge and awareness of cancer risk factors and symptoms and reduce barriers to seeking early medical help among Omani adolescent students.

Methods

Study Design and Location

This study was conducted in three governorates of Oman, including Muscat, Al-Batinah, and Ad Dakhiliyah. The selection of these governorates was based on convenience and was also intended to cover a variety of students from different geographic areas (i.e., urban, semi-urban, and rural areas). Four public schools were selected randomly from each governorate, for a total of 12 public schools. Subsequently, two schools from each governorate were randomly assigned to the control group, with the remaining two schools assigned to the intervention group. Different schools were selected for the control and intervention groups to avoid undue peer influence on the students' responses. Private schools enrolling non-Omani students and schools for students with special needs were excluded to avoid potential confounders and because the majority of public schools in Oman follow a pre-determined national curriculum set by the Ministry of Education (MOE).

Sample Size Calculation

The necessary sample size was calculated using PASS software (NCSS LLC, East Kaysville, UT). Based on a power analysis, data reported from a previous study [9], and an expected small effect size (0.14) between the intervention and control groups, the minimum sample size for each group was calculated to be 800 ($N = 1600$) in order to achieve 80% power at 5% types I error. Considering a 5% drop-out rate, a minimum of 846 students were therefore deemed necessary per group ($N = 1692$).

Data Collection Tool

A validated Arabic-language version of the Cancer Awareness Measure (CAM) questionnaire was used to collect data. The original English-language CAM questionnaire was developed by Cancer Research, King's College London, and University College London in the UK and is a validated, standardized tool to measure cancer awareness in the general population [14]. The questionnaire is divided into several sections to determine awareness of known risk factors for common types of cancer, possible cancer symptoms, and the perceived barriers to seeking medical help for cancer symptoms or warning symptoms. The internal reliability and test–retest reliability of the original English-language version of the CAM questionnaire is high (Cronbach's $\alpha = 0.77$; $r = 0.81$) [14]. Previous researchers in Oman have forward-translated the original CAM questionnaire into Arabic and then back-translated the tool into English and the resulting Arabic-language version demonstrated high internal reliability (Cronbach's $\alpha = 0.817$) [13, 15, 16].

For the purposes of the present study, the Arabic-language version of the CAM questionnaire was distributed and completed online by students in both groups under

direct observation. Three-digit codes were assigned to all students to guarantee anonymity. All students completed the CAM questionnaire at baseline pre-intervention (T0) and at 4 weeks post-intervention (T1). An invitation letter that included information regarding the purpose of the study was given to each of the students to be passed on to their respective parents or guardians. The invitation letter asked the parents or guardians to read the information and to sign the consent form if they agreed for their children to participate in the study.

Cancer Education Intervention

The program included a slideshow presentation as well as a group discussion focusing on general knowledge of cancer, the incidence of cancer both globally and in Oman, various cancer risk factors and warning symptoms, cancer prevention strategies, and the importance of seeking timely medical help. In addition, a leaflet summarizing important information about cancer was distributed and students were encouraged to ask questions and discuss their thoughts. Students were advised to visit a webpage (https://sites.google.com/student.squ.edu.om/cancereducation) created by the research team at which they could access the program materials as well as an informational video about cancer. In contrast, students in the control group did not participate in the cancer education program, received no educational material, and were not advised to visit any website.

Data Analysis

Descriptive statistics (e.g., means, standard deviations) were used to describe the demographic characteristics of each group. A chi-squared test was used to determine if there were any significant demographic differences between the groups to ensure homogeneity. The CAM scores were not normally distributed, so a Wilcoxon signed-rank test was used to compare scores between T0 and T1 for each group, while a Mann–Whitney U test was used to compare scores between groups at T0 and T1. For variables with binary outcomes (i.e., yes/no or agree/disagree responses), McNemar test was used to examine within-group differences at T0 and T1, while a chi-squared test was used to examine between-group differences at T0 and T1. All statistical analyses were conducted using the IBM SPSS v26 (IBM Corp., Armonk, NY) and test significance was set at $p < 0.05$.

Ethical Considerations

The study was approved by the local medical research ethics committee of the College of Medicine & Health Sciences, Sultan Qaboos University, Muscat, Oman (MREC#2440). In addition, permission to conduct the study was obtained from the MOE, the respective principals of each of the selected schools, and each student's respective parents and/or legal guardians.

Results

Sociodemographic Characteristics of the Participants

A total of 1716 students attending grades 10 and 11 of the selected schools agreed to participate in the study, of which 50.8% were male and 40.5% were aged 15 years. Overall, there were 886 students (51.6%) in the control group and 830 students (48.4%) in the intervention group. There were slightly more female students in the control group (51.4%) compared to the intervention group (47.0%). A total of 149 students (16.8%) in the control group and 137 (16.5%) in the intervention group declared that they had health-related issues, while 195 (22.0%) and 176 (21.2%) reported having relatives with cancer, respectively. No significant differences between the intervention and control group were observed in terms of sociodemographic characteristics (Table 1).

Recognition of Cancer Risk Factors

In the control group, mean total CAM scores for the recognition of cancer risk factors did not change significantly between T0 and T1 (4.03 ± 2.0 versus 4.02 ± 2.0; $Z = 5.88$; $p = 0.556$). In contrast, the mean total CAM scores in the intervention group increased from 4.21 ± 2.0 at T0 to 8.61 ± 1.4 at T1, thereby indicating a significant improvement following participation in the cancer education program ($Z = 24.86$; $p < 0.001$). Moreover, recognition of all 11 specific cancer risk factor increased significantly between T0 and T1 ($p < 0.001$) for the intervention group. Furthermore, students in the intervention group demonstrated a significant improvement at T1 compared to the control group in terms of both their overall recognition of cancer risk factors ($U = 33.28$; $p < 0.001$), and for 11 specific risk factors: smoking ($\chi^2 = 9.21$; $p < 0.001$), exposure to smoke ($\chi^2 = 12.62$; $p < 0.001$), alcohol consumption ($\chi^2 = 10.57$; $p < 0.001$), eating insufficient fruit ($\chi^2 = 22.57$; $p < 0.001$), eating processed meat ($\chi^2 = 25.59$; $p < 0.001$), being overweight ($\chi^2 = 20.30$; $p < 0.001$), sunburn ($\chi^2 = 19.97$; $p < 0.001$), being over 70 years old ($\chi^2 = 18.05$; $p < 0.001$), having a relative with cancer ($\chi^2 = 17.66$; $p < 0.001$), HPV infection ($\chi^2 = 19.48$; $p < 0.001$), and insufficient physical activity ($\chi^2 = 20.34$; $p < 0.001$) (Table 2).

Recognition of Cancer Symptoms

As with recognition of cancer risk factors, the control group demonstrated no significant change between T0 and T1 with

Table 1 Sociodemographic characteristics of the participants ($N = 1716$)

Characteristic		Control group ($n = 886$) n (%)	Intervention group ($n = 830$) n (%)	χ^2 (p value)
Gender	Male	431 (48.6)	440 (53.0)	3.269 (0.710)
	Female	455 (51.4)	390 (47.0)	
Age (years)	15	379 (42.8)	316 (38.1)	7.607 (0.220)
	16	337 (38.0)	312 (37.6)	
	17	170 (19.2)	202 (24.3)	
Health issues	No	737 (83.2)	693 (83.5)	0.030 (0.863)
	Yes	149 (16.8)	137 (16.5)	
Reported health conditions*	Obesity	57 (38.3)	61 (44.5)	6.971 (0.137)
	Respiratory disease	23 (15.4)	14 (10.2)	
	Blood disease	57 (38.3)	46 (33.6)	
	Diabetes	13 (8.7)	4 (2.9)	
	Other	35 (23.5)	22 (16.1)	
Relative with cancer	No	521 (58.8)	474 (57.1)	1.650 (0.438)
	Unsure	170 (19.2)	180 (21.7)	
	Yes	195 (22.0)	176 (21.2)	
Degree of relationship with relative^	First	28 (14.4)	27 (15.3)	4.911 (0.178)
	Second	104 (53.3)	109 (61.9)	
	Third	36 (18.5)	26 (14.8)	
	Other	27 (13.8)	14 (8.0)	
Type of cancer of relative^	Breast	43 (22.1)	35 (19.9)	2.571 (0.632)
	Lung	18 (9.2)	13 (7.4)	
	Colon	22 (11.3)	26 (14.8)	
	Other	31 (15.9)	36 (20.5)	
	Unsure	81 (41.5)	66 (37.5)	

*Percentages calculated out of the number of students who reported having health issues; percentages do not add up to 100% as the students may have had more than one health condition. ^Percentages calculated out of the number of students who reported having a relative with cancer

regard to their mean total CAM scores for the recognition of cancer symptoms (2.53 ± 1.9 versus 2.71 ± 2.01; $Z = 7.04$; $p = 0.071$). However, mean total CAM scores in the intervention group increased significantly from 2.69 ± 1.9 at T0 to 7.91 ± 1.04 at T1 ($Z = 24.91$; $p < 0.001$). In addition, the intervention group showed a significant ($p < 0.001$) improvement between T0 and T1 for all 9 symptoms. A comparison of mean total CAM scores between groups at T1 indicated that the intervention group had significantly higher scores for the recognition of cancer symptoms compared to the control group ($U = 34.55$; $p < 0.001$). Moreover, students in the intervention group were significantly more able to correctly identify specific symptoms at T1 compared to the control group: lump or swelling ($\chi^2 = 17.24$; $p < 0.001$), unexplained pain ($\chi^2 = 26.66$; $p < 0.001$), unexplained bleeding ($\chi^2 = 26.94$; $p < 0.001$), cough or hoarseness ($\chi^2 = 27.28$; $p < 0.001$), change in bowel habits ($\chi^2 = 27.87$; $p < 0.001$), difficulty in swallowing ($\chi^2 = 27.31$; $p < 0.001$), change in mole appearance ($\chi^2 = 19.90$; $p < 0.001$), a sore that does not heal ($\chi^2 = 21.83$; $p < 0.001$), and unexplained weight loss ($\chi^2 = 20.22$; $p < 0.001$) (Table 2).

Barriers to Seeking Medical Help for Cancer Symptoms

There was no significant change between T0 and T1 for the control group in terms of their mean total CAM scores relating to perceived barriers to seeking medical help for cancer symptoms (5.10 ± 2.3 versus 5.01 ± 2.2; $Z = 1.66$; $p = 0.097$). In contrast, students in the intervention group demonstrated a significant reduction in their mean scores between T0 and T1 (5.13 ± 2.1 versus 4.66 ± 2.1; $Z = 10.33$; $p < 0.001$). Moreover, they reported significant reductions between T0 and T1 with regard to the reporting of several specific barriers, including emotional barriers such as feeling embarrassed ($\chi^2 = 5.12$; $p < 0.001$) and not feeling confident enough talking about their symptoms ($\chi^2 = 5.07$; $p < 0.001$), practical barriers like having other things to worry about ($\chi^2 = 6.40$; $p < 0.001$), being too busy ($\chi^2 = 5.75$; $p < 0.001$), and having difficulty arranging transport ($\chi^2 = 3.73$; $p < 0.001$), and the service-related barrier of being worried about wasting the

Table 2 Recognition of cancer risk factors and symptoms* among the participants at baseline (T0) and 4 weeks post-intervention (T1) (N=1716)

Item	Control group (n=886)				Intervention group (n=830)				Control vs. intervention group	
	T0 n_0 (%)	T1 n_1 (%)	Diff n_1-n_0 (%)	T0 vs. T1 Test (p value)	T0 n_0 (%)	T1 n_1 (%)	Diff n_1-n_0 (%)	T0 vs. T1 Test (p value)	T0 Test (p value)	T1 Test (p value)
Risk factors^										
Smoking	745 (84.1)	734 (82.8)	−11 (−1.2)	1.72^a (0.086)	698 (84.1)	801 (96.5)	+103 (+12.4)	9.21^a (ˆ0.001)	0.01^b (0.995)	9.21^b (ˆ0.001)
Exposure to smoke	448 (50.6)	451 (50.9)	+3 (+0.3)	0.51^a (0.612)	440 (53.0)	664 (80.0)	+224 (+27.0)	14.97^a (ˆ0.001)	1.01^b (0.311)	12.62^b (ˆ0.001)
Alcohol	565 (63.8)	569 (64.2)	+4 (+0.5)	0.67^a (0.505)	566 (68.2)	714 (86.0)	+148 (+17.8)	12.17^a (ˆ0.001)	1.93^b (0.053)	10.57^b (<0.001)
Eating insufficient fruit	116 (13.1)	122 (13.8)	+6 (+0.7)	1.50^a (0.134)	135 (16.3)	557 (67.1)	+422 (+50.8)	22.18^a (ˆ0.001)	1.86^b (0.063)	22.57^b (ˆ0.001)
Eating processed meat	133 (15.0)	123 (13.9)	−10 (−1.1)	1.41^a (0.157)	132 (15.9)	624 (75.2)	+492 (+59.3)	20.45^a (ˆ0.001)	0.51^b (0.609)	25.59^b (ˆ0.001)
Being overweight	303 (34.2)	304 (34.3)	+1 (+0.1)	0.26^a (0.796)	296 (35.7)	687 (82.8)	+391 (+47.1)	19.77^a (ˆ0.001)	0.64^b (0.525)	20.30^b (ˆ0.001)
Sunburn	218 (24.6)	227 (25.6)	+9 (+1.0)	1.88^a (0.061)	213 (25.7)	613 (73.9)	+400 (+48.2)	20.00^a (ˆ0.001)	0.51^b (0.614)	19.97^b (ˆ0.001)
Being over 70 years old	266 (30.0)	267 (30.1)	+1 (+0.1)	0.18^a (0.857)	256 (30.8)	612 (73.7)	+356 (+42.9)	18.82^a (ˆ0.001)	0.37^b (0.712)	18.05^b (ˆ0.001)
Having a relative with cancer	303 (34.2)	298 (33.6)	−5 (−0.6)	1.15^a (0.251)	265 (31.9)	632 (76.1)	+367 (+44.2)	18.80^a (ˆ0.001)	1.00^b (0.318)	17.66^b (ˆ0.001)
HPV infection	289 (32.6)	283 (31.9)	−6 (−0.7)	0.76^a (0.446)	306 (36.9)	654 (78.8)	+348 (+41.9)	19.48^a (ˆ0.001)	1.85^b (0.065)	19.48^b (ˆ0.001)
Insufficient PA	185 (20.9)	191 (21.6)	+6 (+0.7)	1.73^a (0.083)	188 (22.7)	585 (70.5)	+397 (+47.8)	19.83^a (ˆ0.001)	0.89^b (0.374)	20.34^b (<0.001)
Total score# (mean±SD)	4.03±2.0	4.02±2.0		5.88^c (0.556)	4.21±2.0	8.61±1.4		24.86^c (<0.001)	1.62^d (0.105)	33.28^d (<0.001)
Symptoms~										
Lump or swelling	487 (55.0)	491 (55.4)	+4 (+0.5)	0.43^a (0.667)	458 (55.2)	766 (92.3)	+308 (+37.1)	17.55^a (<0.001)	0.099^b (0.929)	17.24^b (<0.001)
Unexplained pain	264 (29.8)	269 (30.4)	+5 (+0.6)	0.43^a (0.762)	257 (31.0)	774 (93.3)	+517 (+62.3)	22.65^a (<0.001)	0.54^b (0.599)	26.66^b (<0.001)
Unexplained bleeding	245 (27.7)	258 (29.1)	+13 (+1.5)	1.32^a (0.187)	218 (26.3)	771 (92.9)	+553 (+66.6)	23.43^a (<0.001)	0.66^b (0.518)	26.94^b (<0.001)
Cough or hoarseness	171 (19.3)	189 (21.3)	+18 (+2.0)	1.37^a (0.172)	143 (17.2)	723 (87.1)	+580 (+69.9)	24.00^a (<0.001)	1.11^b (0.267)	27.28^b (<0.001)
Change in bowel habits	206 (23.3)	197 (22.2)	−9 (−1.0)	0.77^a (0.492)	205 (24.7)	741 (89.3)	+536 (+64.6)	22.57^a (<0.001)	0.70^b (0.482)	27.87^b (<0.001)
Difficulty in swallowing	160 (18.1)	168 (19.0)	+8 (+0.9)	1.16^a (0.248)	143 (17.2)	705 (84.9)	+562 (+67.7)	23.62^a (<0.001)	0.45^b (0.652)	27.31^b (<0.001)
Change in mole appearance	335 (37.8)	344 (38.8)	+9 (+1.0)	1.21^a (0.225)	339 (40.8)	693 (83.5)	+354 (+42.7)	18.82^a (ˆ0.001)	1.29^b (0.199)	19.90^b (<0.001)
Sore that does not heal	246 (27.8)	258 (29.1)	+12 (+1.4)	1.26^a (0.208)	222 (26.7)	675 (81.3)	+453 (+54.6)	21.28^a (<0.001)	0.47^b (0.636)	21.83^b (<0.001)
Unexplained weight loss	349 (39.4)	356 (40.2)	+7 (+0.8)	0.61^a (0.544)	300 (36.1)	725 (87.3)	+425 (+51.2)	20.57^a (<0.001)	1.39^b (0.166)	20.22^b (<0.001)
Total score+ (mean±SD)	2.53±1.9	2.71±2.01		7.04^c (0.071)	2.69±1.9	7.91±1.04		24.91^c (<0.001)	1.52^d (0.128)	34.55^d (<0.001)

*Using a validated Arabic-language version of the Cancer Awareness Measure questionnaire [23]. ^Counting those who selected "agree" for each risk factor. #Total score, with a score of 1 given for each risk factor identified (range: 0–11). ~Counting those who selected "yes" for each symptom. +Total score, with a score of 1 given for each symptom identified (range: 0–9). ^{a}McNemar's test. ^{b}χ^2 test. ^{c}Wilcoxon signed-rank test. ^{d}Mann-Whitney U test; T0, baseline/pre-intervention; T1, 4 weeks post-intervention; Diff., difference between T1 and T0; HPV, human papillomavirus; PA, physical activity; SD, standard deviation

doctor's time ($\chi^2 = 5.00$; $p < 0.001$). Overall, the intervention group reported significantly lower mean total CAM scores at T1 compared to the control group (4.66 ± 2.1 versus 5.01 ± 2.2; $U = 3.58$; $p < 0.001$). There were also significant differences between the two groups at the T1 stage with regard to the reporting of several specific barriers, including feeling embarrassed ($\chi^2 = 2.24$; $p = 0.025$), not feeling confident talking about symptoms ($\chi^2 = 2.17$; $p = 0.030$), having other things to worry about ($\chi^2 = 2.04$; $p = 0.042$), being too busy ($\chi^2 = 2.28$; $p = 0.023$), facing difficulty arranging transport ($\chi^2 = 2.33$; $p = 0.020$), and being worried about wasting the doctor's time ($\chi^2 = 2.56$; $p = 0.011$) (Table 3).

Anticipated Time to Seeking Medical Help for Recognized Cancer Symptoms

In terms of seeking medical help for recognized cancer symptoms within 1 week, no significant change was observed between T0 and T1 for the control group with regard to their mean total CAM scores (35.47 ± 9.0 versus 35.64 ± 9.1; $Z = 3.23$; $p = 0.103$). Conversely, students in the intervention group demonstrated a significant increase in mean total CAM scores for this aspect between T0 and T1 (35.8 ± 9.3 versus 42.27 ± 3.1; $Z = 20.15$; $p < 0.001$). Students in the intervention group demonstrated significant increases between T0 and T1 when it came to promptly consulting a doctor for all 9 specific cancer symptoms ($p < 0.001$). In addition, there was a significant difference between the intervention and control groups with regard to their mean total CAM scores at T1 (42.27 ± 3.1 versus 35.64 ± 9.1; $U = 19.00$; $p < 0.001$). In addition, compared to the control group, students in the intervention group at T1 were significantly more likely to report that they would rapidly consult a doctor for each specific cancer symptom: unexplained lump ($U = 10.00$; $p < 0.001$), unexplained pain ($U = 8.27$; $p < 0.001$), unexplained bleeding ($U = 7.90$; $p < 0.001$), persistent cough ($U = 11.67$; $p < 0.001$), change in bowel habits ($U = 13.37$; $p < 0.001$), difficulty in swallowing ($U = 10.14$; $p < 0.001$), change in mole appearance ($U = 13.20$; $p < 0.001$), a sore that does not heal ($U = 12.76$; $p < 0.001$), and unexplained weight loss ($U = 17.36$; $p < 0.001$) (Table 3).

Discussion

To the best of the authors' knowledge, this is the first interventional study conducted in Oman to evaluate the effectiveness of a cancer education program on enhancing awareness of cancer risk factors and symptoms and reducing barriers to medical help-seeking among Omani adolescent students. Previous research has reported a positive association between knowledge and health behaviors, when the source of such information stems from school-based educational programs [8]. Studies conducted in Oman have also recommended the integration of cancer education within the national curriculum in order to increase general cancer knowledge and promote early medical help-seeking practices [4, 13, 15].

The current study provides evidence that implementing a cancer education program in public high schools is an effective method of increasing recognition of cancer risk factors and symptoms and reducing barriers to seeking medical help following recognition of cancer symptoms. Previous studies conducted in the USA, Germany, and South Korea have reported similar findings which support the effectiveness of cancer education programs in increasing knowledge of cancer risk factors and symptoms, as well as in bolstering self-efficacy and positive behavioral intentions to seek medical help [8, 17, 18].

Omani adolescent students who participated in the intervention were significantly more likely to recognize common cancer risk factors and symptoms 4 weeks later compared to their findings at baseline, as well as post-intervention in comparison to students who did not participate in the program. Identifying cancer symptoms at an early stage can improve the survival rate and quality of life of cancer patients compared to those who are diagnosed at more advanced stages [19]. Moreover, the current study showed significant findings with regard to medical help-seeking behaviors in the intervention group; students who had taken part in the intervention were significantly more likely to rapidly consult a doctor for recognized cancer symptoms compared to their findings at baseline as well as compared to the control group post-intervention. Students who are involved in a direct teaching–learning process are more likely to start and maintain healthy behavioral changes, even after the completion of such educational programs [20]. Thus, making students aware of cancer symptoms at this stage could promote crucial help-seeking behaviors, such as promptly visiting a physician to discuss potential cancer symptoms or attending cancer screening to detect cancers before they become symptomatic [8]. Although a significant proportion of cancers in LMCs are diagnosed at advanced stages (~ 30–50%), certain types of cancer (e.g., breast and colorectal cancers) have a relatively high chance of being cured and treated if they are diagnosed sufficiently early [1]. Thus, increased public knowledge of cancer symptoms and modifiable risk factors—as well as addressing emotional barriers to seeking early medical help—should help to enhance timely diagnoses and improve patient outcomes [6]. Nonetheless, several administered stages are needed in Oman for implementing cancer education programs in the schools. Curriculum

Table 3 Perceived barriers to seeking medical help for and anticipated time to consult a doctor for recognized cancer warning symptoms* among the participants at baseline (T0) and 4 weeks post-intervention (T1) (N=1716)

Barriers	Control group (n=886)			Intervention group (n=830)			Control vs. intervention group	
	T0	T1	T0 vs. T1	T0	T1	T0 vs. T1	T0	T1
	n_0 (%)	n_1 (%)	Test (p value)	n_0 (%)	n_1 (%)	Test (p value)	Test (p value)	Test (p value)
Emotional barriers^								
Embarrassed	497 (56.1)	495 (55.9)	0.21[a] (0.835)	499 (60.1)	419 (50.5)	5.12[a] (<0.001)	1.69[b] (0.091)	2.24[b] (0.025)
Scared	558 (63.0)	556 (62.8)	0.22[a] (0.829)	501 (60.4)	486 (58.6)	1.12[a] (0.263)	1.08[b] (0.279)	1.78[b] (0.075)
Worried about what the doctor might find	506 (57.1)	484 (54.6)	1.80[a] (0.072)	481 (58.0)	471 (56.7)	0.83[a] (0.408)	0.35[b] (0.725)	0.88[b] (0.377)
Not confident talking about symptoms with doctor	441 (49.8)	436 (49.2)	0.65[a] (0.515)	426 (51.3)	365 (44.0)	5.07[a] (<0.001)	0.64[b] (0.521)	2.17[b] (0.030)
Practical barriers^								
Other things to worry about	464 (52.4)	462 (52.1)	0.26[a] (0.793)	452 (54.5)	392 (47.2)	6.40[a] (<0.001)	0.87[b] (0.386)	2.04[b] (0.042)
Too busy	451 (50.9)	448 (50.6)	0.39[a] (0.696)	440 (53.0)	374 (45.1)	5.75[a] (<0.001)	0.87[b] (0.382)	2.28[b] (0.023)
Difficulty arranging transport	421 (47.5)	419 (47.3)	0.13[a] (0.895)	393 (47.3)	346 (41.7)	3.73[a] (<0.001)	0.07[b] (0.945)	2.33[b] (0.020)
Service-related barriers^								
Difficulty making an appointment	399 (45.0)	398 (44.9)	0.14[a] (0.889)	357 (43.0)	351 (42.3)	0.63[a] (0.527)	0.84[b] (0.399)	1.10[b] (0.272)
Worried about wasting the doctor's time	254 (28.7)	238 (26.9)	1.26[a] (0.209)	248 (29.9)	179 (21.6)	5.00[a] (<0.001)	0.55b (0.582)	2.56[b] (0.011)
Difficulty talking to the doctor	507 (57.2)	498 (56.2)	1.62[a] (0.106)	454 (54.7)	442 (53.3)	1.10[a] (0.527)	1.05[b] (0.293)	1.23[b] (0.219)
Total score# (Mean±SD)	5.10±2.3	5.01±2.2	1.66[c] (0.097)	5.13±2.1	4.66±2.1	10.33[c] (<0.001)	0.30[d] (0.761)	3.58[d] (<0.001)
Warning sign^^	Mean±SD	Mean±SD		Mean±SD	Mean±SD			
Unexplained lump	4.29±1.3	4.32±1.3	1.10[c] (0.272)	4.35±1.3	4.85±0.5	9.92[c] (<0.001)	1.70[d] (0.089)	10.00[d] (<0.001)
Unexplained pain	4.20±1.4	4.21±1.4	0.87[c] (0.385)	4.18±1.4	4.73±0.7	10.57[c] (<0.001)	1.03[d] (0.975)	8.27[d] (<0.001)
Unexplained bleeding	4.29±1.4	4.31±1.4	1.41[c] (0.157)	4.33±1.3	4.79±0.7	9.57[c] (<0.001)	1.01[d] (0.310)	7.90[d] (<0.001)
Persistent cough	3.94±1.4	3.97±1.4	1.62[c] (0.105)	1.00±1.4	4.66±0.7	11.65[c] (<0.001)	1.60[d] (0.112)	11.67[d] (<0.001)
Change in bowel habits	3.86±1.5	3.88±1.5	1.16[c] (0.246)	3.94±1.5	4.72±0.7	12.56[c] (<0.001)	1.77[d] (0.077)	13.37[d] (<0.001)
Difficulty in swallowing	4.06±1.4	4.08±1.4	0.85[c] (0.397)	3.97±1.5	4.70±0.7	12.10[c] (<0.001)	0.70[d] (0.489)	10.14[d] (<0.001)
Change in mole appearance	3.67±1.6	3.68±1.6	0.99[c] (0.324)	3.74±1.6	4.59±0.9	13.10[c] (<0.001)	1.20[d] (0.232)	13.20[d] (<0.001)
Sore that does not heal	3.97±1.5	3.97±1.5	0.19[c] (0.853)	4.06±1.4	4.75±0.7	12.26[c] (<0.001)	1.33[d] (0.185)	12.76[d] (<0.001)
Unexplained weight loss	3.17±1.7	3.21±1.7	1.60[c] (0.110)	3.24±1.6	4.49±1.0	15.87[c] (<0.001)	0.69[d] (0.493)	17.36[d] (<0.001)
Total score~	35.47±9.0	35.64±9.1	3.23[c] (0.103)	35.8±9.3	42.27±3.1	20.15[c] (ˊ0.001)	1.61[d] (0.108)	19.00[d] (ˊ0.001)

*Using a validated Arabic-language version of the Cancer Awareness Measure questionnaire [23]. ^Counting those who selected "yes" to each barrier. #Total score, with a score of 1 given to each barrier selected (range: 0–10). [a]McNemar's test. [b]χ^2 test. [c]Wilcoxon signed-rank test. [d]Mann-Whitney U test; *T0*, baseline/pre-intervention; *T1*, 4 weeks post-intervention; ^^Each warning sign was scored from 1 to 5. ~Total scores ranged from 9 to 45; *SD*, standard deviation

changes mainly depend on the collaboration between policy makers and teachers. Therefore, more research is needed to investigate the possibility of policy makers and teachers incorporating cancer education programs into the school curriculum in Oman.

The present study found that the cancer education intervention significantly reduced perceived help-seeking barriers among Omani school-aged adolescents, including specific emotional barriers such as feelings of embarrassment or a lack of confidence in talking about symptoms with a doctor. These findings were significant both when comparing baseline measurements of the intervention group with those reported 4 weeks post-intervention, as well as when comparing the findings of the intervention and control groups after 4 weeks. Although some cancer patients might be aware of the importance of an early diagnosis, most do not prioritize

seeking medical help in a timely manner [4]. The presence of emotional, practical, and service-related barriers can all play a role in delays in patient consultation and presentation, thereby potentially leading to delays in diagnosis and poor outcomes as patients are more likely to present at a more advanced stage [4, 11]. Thus, focusing on addressing cultural and emotional barriers to medical help-seeking behaviors in the curriculum could have a positive impact to promote early help-seeking for cancer symptoms in adulthood and, by extension, better prognostic outcomes [9]. Furthermore, research has shown that the information delivered to young students can be transferred successfully to parents and older generations and induce behavioral changes in these individuals as well [21].

Previous studies have indicated that both Omani adolescents and adults report several emotional barriers which prevent them from seeking early medical help for possible cancer symptoms [4, 12, 13]. Furthermore, other studies have shown that cancer patients in Oman are subject to several psychosocial stressors which could delay medical help-seeking, such as fear of death, anxiety regarding potential side effects of cancer treatment, social isolation, and concerns regarding the impact of the diagnosis on offspring and familial responsibilities [4, 22]. In addition, poor doctor-patient relationships, communication, and lack of access to support services could also prevent potential cancer patients from seeking early medical help [13]. Critically, the primary health care system in Oman, as in most other Arab countries, does not allow for ongoing doctor-patient relationships with a particular physician, a factor which might otherwise encourage patients to share sensitive or potentially embarrassing information regarding possible cancer symptoms. Thus, a continuity of care approach should be supported by promoting long-term patient-physician partnerships and developing appointment systems which prioritize the booking of non-urgent conditions with a specific physician [23].

Nevertheless, while the current study has shown that the education program was successful over a 4-week interval in increasing awareness of cancer risk factors and symptoms and reducing barriers to medical help-seeking, further research is necessary to confirm the long-term effectiveness of the intervention. Indeed, sustained changes in behavior do not occur immediately after information acquisition and additional time is required to collect follow-up measurements to determine whether the desired effects of the program can be sustained over longer periods of time [8]. Previous studies conducted in the UK have similarly shown a low level of evidence that such programs are able to change long-term help-seeking behaviors for cancer symptoms, despite these interventions being effective in increasing knowledge of cancer warning symptoms and risk factors [8, 9]. While the acquisition of such knowledge at this stage could impact decision-making with regard to cancer-related

behaviors during childhood or adolescence, additional routine booster sessions would be needed to refresh knowledge and to maintain a positive influence on cancer prevention behaviors into adulthood [8].

This study is subject to certain limitations. Although the sample consisted of students from 12 public schools in three governorates representing different geographic areas of Oman, future research should consider selecting schools from all 11 governorates of Oman in order to recruit a nationally-representative sample. In addition, we did not involve students from private schools, although this should not have a considerable impact on our findings as the number of private schools in Oman is very low in comparison to public schools. Further research is also recommended to determine the long-term effectiveness of school-based cancer education interventions and their impact on various social and cognitive factors, including lifelong cancer prevention behaviors.

In conclusion, the current study provides proof-of-concept that a school-based cancer education program is an effective method of increasing awareness of cancer risk factors and symptoms and reducing emotional and physical barriers to medical help-seeking behavior among Omani school-aged adolescents. Such measures are increasingly important as a result of the growing incidence of cancer in many LMCs, including Oman, and in light of the fact that the majority of patients with cancer in this region are diagnosed at a later stage and relatively young age. Accordingly, healthcare strategic planners and policy-makers should allocate additional financial and organizational resources to integrate cancer education into the public high school curriculum in Oman, with healthcare professionals assisting in the training of teachers to deliver such education to students.

Declarations

References

1. World Health Organization (2022) Fact sheets: cancer. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/cancer. Accessed 2 Dec 2022

2. Shah SC, Kayamba VP, Richard M Jr, Heimburger D (2019) Cancer control in low- and middle-income countries: is it time to consider screening? J Glob Oncol 5:1–8. https://doi.org/10.1200/JGO.18.00200

3. McPhail S, Johnson S, Greenberg D, Peake M, Rous B (2015) Stage at diagnosis and early mortality from cancer in England. Br J Cancer 112:S108–S115. https://doi.org/10.1038/bjc.2015.49

4. Al-Azri M, Al-Baimani K, Al-Awaisi H, Al-Mandhari Z, Al-Khamayasi J, Al-Lawati Y, Panchatcharam SM (2021) Knowledge of symptoms, time to presentation and barriers to medical help-seeking among Omani women diagnosed with breast cancer: A cross-sectional study. BMJ Open 11:e043976. https://doi.org/10.1136/bmjopen-2020-043976

5. Allgar VL, Neal RD (2005) Delays in the diagnosis of six cancers: analysis of data from the national survey of NHS patients: cancer. Br J Cancer 92:1959–1970. https://doi.org/10.1038/sj.bjc.6602587

6. Pedersen AF, Forbes L, Brain K, Hvidberg L, Wulff CN, Lagerlund M, Hajdarevic S, Quaife SL, Vedsted P (2018) Negative cancer beliefs, recognition of cancer symptoms and anticipated time to help-seeking: an International Cancer Benchmarking Partnership (ICBP) study. BMC Cancer 18:363. https://doi.org/10.1186/s12885-018-4287-8

7. Barros A, Moreira L, Santos H, Ribeiro N, Carvalho L, Santos-Silva F (2014) Cancer - Educate to Prevent": high-school teachers, the new promoters of cancer prevention education campaigns. PLoS One 9:e96672. https://doi.org/10.1371/journal.pone.0096672

8. Al-Hosni K, Chan MF, Al-Azri M (2020) The effectiveness of interventional cancer education programs for school students aged 8–19 years: A systematic review. J Cancer Educ 36:229–239. https://doi.org/10.1007/s13187-020-01868-1

9. Kyle RG, Nicoll A, Forbat L, Hubbard G (2013) Adolescents' awareness of cancer risk factors and associations with health-related behaviours. Health Educ Res 28:816–827. https://doi.org/10.1093/her/cyt055

10. Times of Oman (2021) Oman's population crosses 4.5 million. Oman News Agency. https://timesofoman.com/article/117268-omans-population-crosses-4.5-million-2. Accessed 30 June 2022

11. Kumar S, Burney IA, Al-Ajmi A, Al-Moundhri MS (2011) Changing trends of breast cancer survival in Sultanate of Oman. Journal of Oncology 2011:316243. https://doi.org/10.1155/2011/316243

12. Cheema S, Maisonneuve P, Lowenfels AB, Abraham A, Doraiswamy S, Mamtani R (2021) Influence of age on 2040 cancer burden in the older population of the Gulf Cooperation Council (GCC) countries: public health implications. Cancer Control 28:10732748211027158. https://doi.org/10.1177/10732748211027158

13. Al-Azri M, Al-Maskari A, Al-Matroushi S, Al-Awisi H, Davidson R, Panchatcharam SM, Al-Maniri A (2016) Awareness of cancer symptoms and barriers to seeking medical help among adult people attending primary care settings in Oman. Health Services Research and Managerial Epidemiology 3:233339281667329. https://doi.org/10.1177/2333392816673290

14. Cancer Research UK (2014) The Cancer Awareness Measure (CAM). Cancer Research UK. http://www.cancerresearchuk.org/health-professional/awareness-and-prevention/the-cancer-awareness-measures-cam. Accessed 2 Dec 2022

15. Al-Azri M, Al-Hamedi I, Al-Awisi H, Al-Hinai M, Davidson R (2015) Public awareness of warning signs and symptoms of cancer in Oman: a community-based survey of adults. Asian Pac J Cancer Prev 16:2731–2737. https://doi.org/10.7314/APJCP.2015.16.7.2731

16. Al-Azri M, Al-Rasbi K, Al-Hinai M, Davidson R, Al-Maniri A (2014) Awareness of risk factors for cancer among Omani adults: a community based study. Asian Pac J Cancer Prev 15:5401–5406. https://doi.org/10.7314/APJCP.2014.15.13.5401

17. Ayers K, Klosky J, Li Z, Villalobos VK, Aubrey. (2020) Evaluation of the St. Jude Cancer Education for Children program on cancer risk awareness, attitudes, and behavioral intentions among fourth-grade science students: comparisons between racially identifiable/high-poverty schools and racially diverse/affluent schools. J Cancer Educ 35:380–387. https://doi.org/10.1007/s13187-019-1476-3

18. Stölzel F, Seidel N, Uhmann S, Baumann M, Berth H, Hoyer J, Ehninger G (2014) Be smart against cancer! A school-based program covering cancer-related risk behavior. BMC Public Health 14:392. https://doi.org/10.1186/1471-2458-14-392

19. Neal RD, Tharmanathan P, France B, Din NU, Cotton S, Fallon-Ferguson J, Hamilton W, Hendry A, Hendry M, Lewis R, Macleod U, Mitchell ED, Pickett M, Rai T, Shaw K, Stuart N, Tørring ML, Wilkinson C, Williams B, Williams N, Emery J (2015) Is increased time to diagnosis and treatment in symptomatic cancer associated with poorer outcomes? Systematic review. Br J Cancer 112:S92–S107. https://doi.org/10.1038/bjc.2015.48

20. Arlinghaus KR, Johnston CA (2018) Advocating for behavior change with education. Am J Lifestyle Med 12:113–116. https://doi.org/10.1177/1559827617745479

21. Cassim S, Chepulis L, Keenan R, Kidd J, Firth M, Lawrenson R (2019) Patient and carer perceived barriers to early presentation and diagnosis of lung cancer: a systematic review. BMC Cancer 19:25. https://doi.org/10.1186/s12885-018-5169-9

22. Al-Azri M, Al-Awisi H, Al-Rasbi S, El-Shafie K, Al-Hinai M, Al-Habsi H, Al-Moundhri M (2014) Psychosocial impact of breast cancer diagnosis among Omani women. Oman Med J 29:437–444. https://doi.org/10.5001/omj.2014.115

23. Al-Azri MH (2016) Delay in cancer diagnosis: causes and possible solutions. Oman Med J 31:325–326. https://doi.org/10.5001/omj.2016.65