JSO JOURNAL of STEM OUTREACH

Vol. 5, Issue 2, August 2022

The Impact of the Appalachian Career Training in Oncology (ACTION) Program on High School Participants

Carol D. Hanley[1], Chris Prichard[2], and Nathan L. Vanderford[2,3]

[1]International Programs for Agriculture, College of Agriculture, Food, and Environment; [2]Markey Cancer Center; and [3]Department of Toxicology and Cancer Biology, College of Medicine, University of Kentucky, Lexington, KY

Keywords: Appalachia, Research Education, Cancer Research, Workforce Development, Community Outreach

Publication Date: August 20, 2022

DOI: https://doi.org/10.15695/jstem/v5i2.04

ABSTRACT: Kentucky ranks first in the nation in cancer incidence and mortality. The Appalachian region of the state experiences the highest cancer disparities due to inequities in many social determinants of health as well as poor health behaviors. As a strategy for addressing cancer and education disparities in the region, the Appalachian Career Training in Oncology (ACTION) Program at the University of Kentucky Markey Cancer Center engages Appalachian-native high school students in cancer education, research, and outreach activities. Entry and exit surveys were administered to participants. Classical test theory and exploratory factor analysis were used to examine the instruments used for program evaluation, whereas repeated measures ANOVA was used to determine if there were significant differences in means between entry and exit timepoints. Results demonstrated that there was an increase in students' understanding and comfort with cancer-related topics between entry and exit survey administrations. Students indicated that the program improved their research skills and career planning skills. Furthermore, students had positive perceptions of all aspects of the program.

INTRODUCTION

Appalachian Kentucky has significant challenges associated with health, socioeconomic, and education disparities. This predominantly rural region has the highest cancer incidence and mortality rates in the United States (US), but it is also one of the most economically disadvantaged, medically underserved, and poorly educated regions of the country. In 2022, cancer was estimated to result in over 600,000 deaths in the United States, making it the second leading cause of death (Siegel et al., 2022). There will be an estimated 1.9 million new cancer cases in 2022 in the US, and over 30,000 new diagnoses will originate in Kentucky (Siegel et al., 2022). Kentucky experiences the highest cancer incidence and mortality rates in the country (CDC, 2016; NCI, 2019; Siegel et al., 2022). The Appalachian region, which makes up 54 of 120 counties in the state (ARC, 2020), carries the heaviest cancer burden. In rural, Appalachian Kentucky, residents are 8% more likely to develop a preventable, cancerous malignancy than those living outside the region (Blake et al., 2017). The cancer disparity is caused by various factors, including obesity, poor diet and exercise habits, tobacco use, and smoking (ARC, 2019; Charlton et al., 2015; Rodriguez et al., 2018). Social determinants of health, such as a lack of access to health care facilities and low socioeconomic status, also contribute to the high cancer rates in Appalachia (Crosby et al., 2012; Rodriguez et al., 2018).

These disparities create the need for targeted educational and scientific workforce preparedness and cancer literacy intervention. Therefore, the University of Kentucky's (UK) Markey Cancer Center developed the *Appalachian Career Training In ONcology* (ACTION) *Program*, a National Cancer Institute Youth Enjoy Science R25 program, which focuses on early stage cancer career training. Through the ACTION Program, the team at the Markey Cancer Center created a model for science, technology, engineering, and mathematics (STEM) education focused on cancer-related topics. The model improves the pipeline for the next generation of cancer-focused professionals emerging from Appalachian Kentucky and demonstrates how the

education and science communities can develop and deliver advanced research, education, and workforce development programming to students from rural and low-socioeconomic communities.

The programs' overarching goals are to enhance cancer-focused biomedical workforce diversity in a high-risk, rural population and to increase communities' cancer-related literacy. The programmatic goals are accomplished through three objectives, including 1) developing participants' cancer research knowledge and research skills through cross-disciplinary faculty-mentored experiences; 2) enhancing students' cancer-focused career preparation by providing cancer education and career development activities; and 3) conducting outreach activities in participant communities.

Raising awareness of cancer symptoms and modifiable risk factors among school-aged students through education programs can provide a foundation for healthy behaviors (Hudson et al., 2020; Hudson et al., 2021). As such, many awareness programs focus on increasing awareness of cancer symptoms and addressing negative beliefs about cancer to reduce barriers to help-seeking (Hudson et al., 2020; Kutner M, 2006). The research literature supports critical features of cancer education through short-term and long-term programming. For example, Marek et al., Ampofo et al., and Kyle et al. implemented brief interventions with adolescents to change their knowledge, beliefs, and attitudes (Ampofo et al., 2020; Kyle et al., 2013; Marek et al., 2012). Results indicated significant increases in cancer awareness and knowledge and reductions in barriers to cancer screening among senior high school students. Al-Hosni, Chan, and Al-Azri conducted a systematic review of interventional cancer education studies, focusing on educational or health intervention programs related to any type of cancer applied in elementary or high schools (Al-Hosni et al., 2021). Twelve studies met their criteria, six of which focused on general cancer knowledge, two focused on cervical cancer, and four on breast cancer. Evidence indicated that the interventions enhanced short-term knowledge, attitudes, self-efficacy, and behavioral intentions; however, there was less evidence regarding their long-term effectiveness, particularly help-seeking barriers. Markowitz investigated a longer-term summer science program's impact on high school students' perceived abilities in higher-level science courses and the program's impact on student interest in pursuing science careers (Markowitz, 2004). Students who attended the program indicated that it positively influenced their performance in advanced science courses, their decision to participate in other science programs, and their desire to pursue a career in science.

While the ACTION Program has features in common with the critically reviewed papers discussed above, some features of the ACTION Program are unique. For example, the ACTION Program is a two-year program for high school youth, a much longer program than those described above. Whereas the ACTION Program includes instruction on awareness of cancer symptoms and modifiable risk factors, it also includes instruction on cancer research skills tied to students' school-based science curricula. ACTION students have opportunities for career development throughout the program, an important yet often neglected area of science education programs. Sadler, Sonnert, Hazari, and Tai, found that among a subset of students from a large national study interested in STEM careers, four times as many males as females maintained an interest in a STEM career from the start to the end of high school (Sadler et al., 2014). Given that 60% of the ACTION high school students are female, this program provides a unique opportunity to keep girls engaged in the STEM pipeline. Most importantly, the ACTION Program serves a distinctive group of Kentucky students with unique socioeconomic needs.

The ACTION Program focuses on underserved students from Appalachian Kentucky and engages them in cancer-related education activities. These students' underserved nature might not be well appreciated without understanding the culture and geographic region these students call home. Nine of the counties from which these students hail are classified as distressed, which is the lowest classification applied to counties ranking in the bottom 10% of counties nationwide (ARC, 2021a). The Appalachian region is poorer than the national average, with Appalachian rural areas being poorer than their respective state averages. Despite improvements in income and poverty, Appalachia's median household income is 82.6% of the nation's average median household income. The share of residents in poverty is 15.2%, and in the Appalachian region of Kentucky, it is 24.5% (ARC, 2021c). Educational attainment in the region is also below the national average. Only 54.7% of Appalachia's workforce hold only a high school diploma, and only 24.7% hold a bachelor's degree or more compared to the national average of 32%. While not all jobs require a bachelor's degree, these statistics indicate the lag in educational attainment in the region (ARC, 2021b; Hale et al., 2017).

In this paper, we provide evidence for the effectiveness of the ACTION Program to reach two of its objectives (developing participants' cancer research knowledge and research skills and enhancing students' cancer-focused career preparation) using data from the first cohort of high school students enrolled in the program from 2018 to 2020. While the second cohort of students has been enrolled, evaluation of the program's impact on this group is ongoing. Progress on the outreach objective is also ongoing: the COVID-19 pandemic hampered travel plans to Appalachian communities and pushed some outreach activities into the future. The findings herein contribute to the literature regarding a diversified, comprehensive, and integrated cancer education program for rural, underserved high school students.

METHODS

Participants. This study examined the impact of the ACTION Program on 20 high school students from rural Appalachia. Data were collected from one cohort throughout 2018-2020. Upon entry, most students were sophomores (70%), and the remainder were freshmen (30%). Most students were female (60%), White (90%), first-generation (40%), low-income (75%), and from rural counties (100%). Table 1 shows student demographics for the first cohort, whereas Table 2 (ARC, 2021a, 2022; Kentucky Department of Education, 2018) shows socioeconomic and math proficiency details for the first cohort of students' home school districts.

Procedures. Students applied to the program through an electronic application hosted on REDCap (Research Electronic Data Capture), reporting basic demographic information and GPA (Harris et al., 2009). The students also provided a current transcript, a short essay on their interest in the program and cancer-related careers, and two letters of support that were separately submitted to the ACTION program coordinator. A selection committee scored the applicants based on interest in the program, interest in cancer, need based on underrepresented group status in the scientific workforce, and academic abilities. Students completed surveys at two points: program entry (T1) and program completion when students completed two years in the program (T2). This report represents longitudinal analyses of data from 2018 to 2020. All instruments were administered electronically through REDCap.

ACTION Program activities included faculty-mentored research training experiences, clinical observations with faculty mentors, educational activities, community outreach projects, peer-to-peer mentoring and social support, and career mentorship and training. Each activity contributed to the program's objectives of increasing participants' biology and cancer knowledge; promoting participants' eventual employment in science- and cancer-focused careers; and providing cancer-focused outreach to Appalachian communities. For more information on the ACTION Program, see (McConnell Parsons et al., 2021). ACTION is an integrated program that is meant to influence the participants synergistically across the elements. Therefore, no one activity is likely responsible for influencing participants' cancer knowledge or cancer career preparation, for example.

Table 1. *ACTION High School Student Demographics (N = 20).*

Parameter	Category	Frequency	Percent
Academic Level	Freshman	6	30
	Sophomore	14	70
Gender	Male	8	40
	Female	12	60
Race/Ethnicity	White	18	90
	African American/Black	0	0
	Asian	1	5
	American Indian/Alaska Native	0	0
	Hispanic	1	5
	Not Hispanic or Latino	19	95
Disparity Status	1st Generation	8	40
	Low Income *	15	75
	Rural **	20	100

** Low SES students were identified through self-reported taxable income. Low-income levels are those defined by the US Census Bureau. ** Rural areas are designated by the Health Resources and Services Administration.*

Table 2. *Socioeconomic (SES) and Education Proficiency Information for ACTION High School Students' School Districts.*

Participating Counties and Number of Students	Distressed County Status	% Economically Disadvantaged State: 60.7%	% Proficient in Math	
			Low SES State: 22.5%	High SES State: 50.2%
Bath - 1	✓	68.3	21.8	35.1
Carter - 4	✓	59.7	27.8	36.7
Clay - 1	✓	73.3	18.2	49.1
Elliott - 2	✓	75.5	24.2	38.9
Garrard - 1	Transitional	61.5	28.0	42.9
Laurel - 1	At-Risk	66.7	26.1	56.1
Lawrence - 1	✓	64.4	25.7	36.5
Letcher - 3	✓	70.9	26.5	37.3
Pulaski - 1	At-Risk	61.8	31.1	55.2
Rowan - 2	✓	57.8	24.4	52.8
Russell - 1	✓	62.8	15.1	37.2
Whitley - 2	✓	78.4	33.3	62.8

Data are from the Appalachian Regional Commission and the Kentucky Department of Education.

Measures. The original entry and final instruments were developed by the ACTION Program director in 2016, using examples from related literature. Since then, the items have been modified only slightly so data can be tracked over time. The entry instrument consisted of two demographic-type questions, eight Likert-type items, and one question related to the completeness of the survey; however, two Likert-type items were removed because of the double-barreled nature of the item. The final instrument contained the same items as in the entry instrument; however, it also contained 24 other items, which included items related to the acquisition of research skills, career preparation, and perceptions of the program. When appropriate, responses were reverse coded, ensuring higher scores indicated more of the construct. Items, associated subscales, and response options are shown in Table 3.

Data Analysis. All data were checked for normality, influential points, and outliers, using stem and leaf plots, Q-Q plots, Shapiro-Wilk Test, Cook's D. Repeated measures ANOVA

Table 3. *Subscales, Items, and Response Options.*

Understanding and Comfort with Cancer-Related Topics Subscale (6 items)	
Which of the following best describes your cancer-related knowledge?	a. Very knowledgeable b. Knowledgeable c. Somewhat knowledgeable d. Not very knowledgeable
Which of the following best describes your comfort level regarding engaging in cancer-related discussions?	a. Very knowledgeable b. Knowledgeable c. Somewhat knowledgeable d. Not very knowledgeable
Which of the following best describes your comfort level regarding Clinical observations Outreach Conducting experiments Cancer-related discussions	a. Very comfortable b. Comfortable c. Somewhat comfortable d. Not very comfortable
Improved Research Skills Subscale (6 items)	
Which of the following best describes your learning experience with MCC ACTION? Improved your scientific thinking Improved your experimentation skills Enhanced your scientific communication skills Enhanced your critical thinking skills Enhanced your teamwork skills Enhanced your trouble-shooting skills	a. Agree b. Somewhat agree c. Neutral d. Somewhat disagree e. Disagree
Career Decisions Subscale (3 items)	
Which of the following best describes your learning experience with MCC ACTION? Enhanced your career development skills Enhanced your interest in public health sciences Enhanced your interest in pursuing a cancer-related career	a. Agree b. Somewhat agree c. Neutral d. Somewhat disagree e. Disagree
Perceptions of the Program Subscale (6 items)	
Which of the following best describes your feelings toward the quality of each component of each component of MCC ACTION? Research Clinical shadowing Education Outreach Quality of your faculty mentor Overall experience with MCC ACTION	a. Very positive b. Positive c. Neutral d. Negative e. Very negative

was used to determine if there were significant differences in means between entry and exit timepoints. All results were evaluated at $\alpha = .05$, and procedures were conducted using SPSS (IBM, 2020).

Classical Test Theory (CTT) item analyses were conducted in SPSS. Inter-item correlations and item-to-total correlations were used to determine the strength of relationships among items and the appropriateness of using them as one scale. Item-to-total correlation guidelines of 0.3 or more were considered acceptable. In addition, if results indicated that Cronbach's alpha would improve by removing an item, that item was removed. Inter-item correlations provided information on item redundancy or the extent to which items on a scale assessed the same content (Cohen and Swerdlik, 2005). Values between 0.20 to 0.50 are generally considered acceptable, suggesting that while items are reasonably homogenous, they do contain sufficiently unique variance, so they are not isomorphic (Piedmont, 2014). Internal consistency was assessed by Cronbach's alpha (α). Nunnally suggests a minimum level of .70 for basic research (Nunnaly and Bernstein, 1978).

FACTOR 11.05.01 (Lorenzo-Seva and Ferrando, 2019) was used to perform a categorical exploratory factor analysis (EFA), and hot-deck multiple imputation data were used to handle missing values (Lorenzo-Seva and Van Ginkel, 2016). Robust unweighted least squares (RULS) was used to extract factors based on polychoric correlation matrices. Three methods were used to determine the number of

common factors to retain. First, parallel analysis (PA) based on minimum rank factor analysis (Timmerman and Lorenzo-Seva, 2011) with 1,000 random correlation matrices and permutation of the raw data (Buja and Eyuboglu, 1992) were used to assess dimensionality. Second, the Hull method (Lorenzo-Seva et al., 2011) based on the comparative fit index (CFI) was used. Finally, a visual inspection of the scree plot was conducted. A promin (oblique) rotation was used if more than one factor was selected. A multiple factor solution was retained if the factor solution was interpretable. Items were determined to be salient on a factor if the pattern coefficient was at least 0.32 or higher, which suggests that the factor accounts for 10% or more of the variance in the item (Tabachnick and Fidell, 2011). Parallel analyses and visual inspections of the scree plots pointed to a single factor solution. Consequently, we retained and interpreted single-factor solutions representing *Understanding and Comfort with Cancer-Related Topics* (i = 6), *Improved Research Skills* (i = 6), *Career Decisions* (i = 3), and *Perceptions of the Program* (i = 6). Table 4 displays the final one-factor solutions for all subscales with salient items (range = 0.36-0.83) all above the 0.32 factor loading threshold.

All qualitative data were analyzed through template analysis. In a template analysis, the researcher uses a template of themes developed a priori to do an initial coding. The coding template is iteratively revised and refined (Brooks et al., 2015).

RESULTS

Demographics. As shown in Table 1, most students were White (90%), female (60%), low income (75%), sophomores (70%), and all are from counties designated as rural by the US Health Resources and Services Administration (HRSA, 2021). Table 2 indicates that 85% of participating students were from distressed or economically disadvantaged areas of the state or country (ARC, 2021a, 2022; Kentucky Department of Education, 2018). Furthermore, the percent of economically disadvantaged residents in participants' home counties ranged from 57.8% to 78.4%, and six students re-

Table 4. *Factor Loadings and Communalities for Subscale Items.*

Subscales and Items	Loadings	Communalities
Understanding and Comfort with Cancer-Related Topics Subscale		
Which of the following best describes your cancer-related knowledge?	0.453	0.205
Which of the following best describes your comfort level regarding engaging in cancer-related discussions?	0.441	0.194
Which of the following best describes your comfort level regarding		
Clinical observations	0.678	0.459
Outreach	0.587	0.344
Conducting experiments	0.699	0.488
Cancer-related discussions	0.357	0.128
Improved Research Skills Subscale		
Which of the following best describes your learning experience with MCC Action?		
Improved your scientific thinking	0.782	0.611
Improved your experimentation skills	0.719	0.517
Enhanced your scientific communication skills	0.785	0.617
Enhanced your critical thinking skills	0.829	0.686
Enhanced your teamwork skills	0.697	0.486
Enhanced your trouble-shooting skills	0.775	0.601
Career Decisions Subscale		
Which of the following best describes your learning experience with MCC Action?		
Enhanced your career development skills	0.641	0.411
Enhanced your interest in public health sciences	0.885	0.784
Enhanced your interest in pursuing a cancer-related career	0.785	0.616
Perceptions of the Program Subscale		
Which of the following best describes your feelings toward the quality of each component of each component of MCC Action?		
Research	0.679	0.462
Clinical shadowing	0.615	0.378
Education	0.795	0.632
Outreach	0.763	0.582
Quality of your faculty mentor	0.762	0.581
Overall experience with MCC ACTION	0.792	0.627

Table 5. *Cronbach's Alpha and Other Scale and Item Analysis Statistics.*

Subscale	Number of Students	Number of items	Cronbach's alpha	Corrected item-total correlations
Understanding and Comfort with Cancer-Related Topics T1	19	6	0.681	0.283 - 0.597
Understanding and Comfort with Cancer-Related Topics T2	17	6	0.827	0.336 - 0.836
Career Decisions T2	17	3	0.776	0.333 - 0.891
Improved Research Skills T2	17	4	0.767	0.205 - 0.825
Perceptions of the Program T2	17	4	0.700	0.080 - 0.830

side in counties in which the percent of economically disadvantaged citizens are below the state's average. Students in the counties represented by ACTION participants tend to score below state levels in educational proficiencies such as in math.

Item Analysis. Cronbach's alphas and other item analysis data for subscales are shown in Table 5. All Cronbach's alphas were considered adequate near or above an $\alpha = 0.700$. Although results indicated it was possible to remove some items, all were retained because of the few numbers of items. Table 6 displays the means of each item at entry and final time points for the *Understanding and Comfort with Cancer-Related Topics Subscale*. The mean increased from entry to final administrations on the *Understanding and Comfort with Cancer-Related Topics Subscale* from 18.88 to 23.65 (n=17). Differences between these means shows an increase from entry to final administrations, $F(1, 16) = 0.989$, $p = 0.335$. The effect size ($\eta 2 = 0.058$), or the size of the difference between the groups, was considered small (Lakens, 2013). The questions with the largest increases from entry to final administrations were "Which of the following best describes your cancer-related knowledge?" (Difference in means = 1.04), "Which of the following best describes your comfort level regarding outreach?" (Difference in means = 0.25), and "Which of the following best describes your comfort level regarding engaging in cancer-related discussions?" (Difference in means = 0.14).

Students were asked about improvement in their research skills, career decisions, and perceptions of the program at time point T2; therefore, only descriptive statistics and no pre-/post-test means-testing could be provided. The data are summarized in Table 7. Students reported the program improved all research skills measured, including scientific thinking, experimental skills, scientific communication, critical thinking, teamwork, and trouble-shooting, with scientific and critical thinking skills having the highest means (M = 4.83) followed by experimental and scientific communication skills (M = 4.78). Students thought their career development skills (M = 4.88) improved more than other career related skills. Students had favorable impressions of their mentors (M = 4.83).

Qualitative Data. Open-ended questions were placed at the end of the *instrument*, giving students opportunities to provide feedback about the program. Six students provided comments about the ACTION Program, two-thirds of which were positive, using descriptors such as amazing and incredible. One student made the following comment:

> *This program might have given me the best opportunity of my life. I am ready for anything medically that comes at me. Away from the medicine and research they never skipped a beat when it came to real life skills. I have never been in better time with my future. My understanding of finances has helped me in ways that I would never have thought about and I am positive it will help me in the future considering I have most of it planned out thanks to this program.*

Another student said, "The MCC ACTION Program has been the most rewarding experience of my life. I have gained knowledge and experience I would have never imagined possible." Only two negative comments were received and were related to the accessibility of activities to every student. The two comments were: "Make every opportunity accessible for all individuals" and "The lab experience re-

Table 6. *Means of T1 and T2 for* Understanding and Comfort with Cancer-Related Topics *subscale.*

Item	Responses		Mean	
	T1	T2	T1	T2
Which of the following best describes your cancer-related knowledge?	20	18	2.35	3.39
Which of the following best describes your comfort level regarding engaging in cancer-related discussions?	20	18	3.30	3.44
Which of the following best describes your comfort level regarding conducting experiments?	20	18	3.55	2.89
Which of the following best describes your comfort level regarding understanding manuscripts?	19	17	2.89	2.65
Which of the following best describes your comfort level regarding clinical observations?	20	17	3.35	3.12
Which of the following best describes your comfort level regarding outreach?	20	18	3.25	3.50

Table 7. *Descriptive Statistics for Improved Research Skills, Career Decisions, and Perceptions of Program Subscale Items at Final Administration T2.*

Subscale and Item	N	Mean	SD	Range	Sum
Improved Research Skills Subscale					
Scientific Thinking	18	4.83	0.383	1	87
Experimental Skills	18	4.78	0.428	1	85
Scientific Communication Skills	18	4.78	0.548	2	86
Critical thinking skills	18	4.83	0.383	1	87
Teamwork Skills	18	4.50	1.043	4	81
Trouble-shooting Skills	18	4.56	0.984	4	82
Career Decisions Subscale					
Enhanced career development skills	17	4.88	0.485	2	83
Enhanced interest in biomedical sciences	17	4.53	1.068	4	77
Enhanced interest in pursuing a cancer-related career	17	4.35	1.222	4	74
Perceptions of the Program Subscale					
Research	18	4.72	0.575	2	85
Clinical Shadowing	17	4.35	1.222	4	74
Education	18	4.61	0.778	3	83
Outreach	18	4.67	0.970	4	84
Mentors	18	4.83	0.383	1	87
Overall Experience	18	4.83	0.383	1	87

ally differed for a lot of people. Maybe this summer would have been different, but some students were running their own experiments while I was shadowing all day and using the pipette once-an-experiment."

DISCUSSION

Appalachian Kentucky has significant challenges associated with health, socioeconomic, and education disparities and has the highest cancer incidence and mortality rates in the United States (US), and is also one of the most economically disadvantaged, medically underserved, and poorly educated regions of the country. These disparities are what motivated the creation of the ACTION Program as a National Cancer Institute Youth Enjoy Science R25 program. The program's objectives include 1) developing participants' cancer research knowledge and research skills, 2) enhancing students' cancer-focused career preparation, and 3) conducting outreach activities in participant communities.

This mixed-methods evaluation shows that the ACTION Program effectively reached objectives 1 and 2 for this cohort of high school participants, developing participants' cancer research knowledge and research skills and enhancing students' cancer-focused career preparation. Although conducting outreach activities remains a crucial objective, the COVID-19 pandemic has disrupted some outreach plans, and ongoing outreach activities will be evaluated at a later date. More specifically, although not statistically significant, students' scores on the *Understanding and Comfort with Cancer-Related Topics Subscale* showed an increase from entry to final administrations with a small effect size. Moreover, students reported that the program enhanced their career development, improved their research skills, and they had positive feelings towards every aspect of the program. Evaluation of students' career paths is ongoing, as the ACTION leadership team tracks students' after they graduate from the program.

Kitchen et al. (2018) collected data from colleges and universities participating in the National Science Foundation's STEM Talent Expansion Program and examined the impact of high school STEM summer programs on career aspirations among program participants and control students. Results showed that students who participated in a STEM summer program had 1.4 times the odds of wanting to pursue a STEM career, controlling for background characteristics. The study also revealed that students experiencing real-world STEM situations had 1.8 times the odds of aspiring to STEM careers at the end of high school compared with control groups. Faculty and researchers who bring real-life STEM experiences to budding scientists provide life-altering experiences and immeasurable benefits to those who participate.

Kitchen's group provided an analysis of STEM summer programs dating back to the 1950s, which "aimed to provide students with science and mathematics training beyond what was available in high school classes—and ultimately to promote interest in STEM" (p. 2). Summer programs were conducted in chemistry, physics, mathematics, engineering, and science. Kitchen et al. observed program activities from hands-on research experiences, uniquely tailored coursework, and science subject instruction. Program evaluations showed impacts in the following four areas: (a) knowledge,

skills, and preparation; (b) STEM attitudes; (c) college enrollment; and (d) STEM career interest.

The ACTION Program for high school students might be described as a STEM summer program, but it differs from other programs in substantive ways. First, it offers unique opportunities in cancer education, a topic unusual to the suite of STEM summer programs, at least of those most frequently described in the literature. Second, it allows students to conduct research, participate in clinical shadowing, and conduct community outreach - opportunities rarely offered to high school students. Reflecting upon the scores from the Likert items shown in Table 7, we see that students scored scientific thinking and critical thinking at a mean of 4.83 out of 5.0, indicating they developed these skills to a high degree. Furthermore, although all programmatic features were rated highly, students perceived mentors (mean of 4.83 out of 5.0) and research (mean of 4.72 out of 5.0) as especially beneficial aspects of the program. This student input points to features of the ACTION Program that keep students engaged and make the program distinctive among other STEM summer programming.

Perhaps most importantly, the ACTION Programs' greatest impact may come in the socioeconomic arena. Three subregions designated by the ARC as North Central, Central, and South-Central Appalachia are collectively referred to as "middle Appalachia." Of the 90 Appalachian counties designated by the ARC as "distressed," 75% are in the region called "middle Appalachia." Central Appalachia, which encompasses 53 counties in eastern Kentucky, Tennessee, Virginia, and West Virginia, represents "the place of poverty in the United States' consciousness" (Obermiller and Couto, 2004). Kannapel and Flory reviewed research from 1995 to 2015 regarding postsecondary transitions for adolescents in middle Appalachia, the region targeted by the ACTION Program (Kannapel and Flory, 2017). They found that as middle Appalachian students transitioned from high school, their college and career aspirations were influenced by available opportunities, which have historically been limited. Bottia et al. (2015) examined how high school student experiences related to choosing a STEM major in college and recommended increasing the availability of STEM-related extracurricular experiences accessible to high school students (Bottia et al., 2015). Moreover, labor data indicated that employment opportunities in the middle Appalachian region are challenging: Unemployment rates are higher in Central and South-Central Appalachia, and middle Appalachia has a lower percentage of adults in the labor force.

> *This challenging economic context suggests a need for creative, strategic career guidance and preparation for middle Appalachian students. However, three studies, though limited in scope, suggested that students' career opportunities may be hampered by misalignment between K-12 career and technical education (CTE) programs and workforce needs in the Appalachian areas of Tennessee and Kentucky.* (Kannapel and Flory, 2017)

Hargis (2011) reported that Appalachian Kentucky high schools might be emphasizing programs in traditional vocational fields, such as automotive technology, electricity, and horticulture that do not match the labor market, at the expense of higher-demand fields such as accounting, finance, and industrial maintenance (Hargis, 2011). Given these issues, there is a significant need for programs like ACTION to provide advanced STEM-focused educational opportunities to students from Appalachian Kentucky. The opportunities offered by the ACTION Program addressed the socioeconomic needs of high school students in Appalachian Kentucky in three respects: 1) it offered a comprehensive, high-quality extracurricular STEM programming opportunity for high school students in a region where few exist, 2) it offered a "creative, strategic career guidance and preparation" STEM program for middle Appalachian students, and 3) it offered high-quality career preparation opportunities for careers of the future, not the past. The impacts of ACTION in this regard will be measured over time through the students' academic and career trajectories.

Limitations and Future Research Opportunities. The current investigation made valuable contributions to empirical research on cancer outreach to high school students. However, some limitations should be noted. First, the small sample sizes should be recognized. An appropriate sample makes research more efficient and directly influences research findings, and small samples undermine the internal and external validity of a study. Using a smaller sample increases the chance of assuming as true a false premise, and smaller sample sizes get decreasingly representative of the entire population. The ACTION Program is limited to enrolling small cohorts based in part on funding constraints and so each student can receive individualized mentoring, education, and research opportunities. Second, this study does not include any control groups that could be used for comparisons. Third, this study used students' self-reported questionnaires as the primary data source, which carries associated risks based on variable respondent knowledge, comprehension, and interpretation of scale items.

Conclusion. In 2002, Elam authored an essay that described the relationship between poverty and education in Appalachian Kentucky (Elam, 2002). Although almost 20 years old, Elam's fundamental principles have not changed. She states, "Appalachian Kentucky has a long history of systemic pov-

erty and inadequate education; the two seem forever bound to one another (p. 4)." Understanding these two cultural attributes is vital because outside educators often try to impose programs on the region without considering the value system or needs of the Appalachian culture—that approaches appropriate for urban or suburban youth may not be appropriate or beneficial to the people in the Appalachian Mountains. The members of the ACTION leadership team have taken a decidedly Appalachian approach for the specific needs of Appalachian students, and the evidence provided in this paper strongly suggests it works for this unique group.

AUTHOR INFORMATION

Corresponding Author

Nathan L. Vanderford. nathan.vanderford@uky.edu

Author Contributions

The manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

FUNDING SOURCES

This study was supported by the University of Kentucky's Appalachian Career Training in Oncology (ACTION) Program [NCI R25CA221765] and the Cancer Center Support Grant [NCI P30CA177558]. The authors have no financial disclosures and no conflicts of interest to report.

ABBREVIATIONS

ACTION: Appalachian Career Training in Oncology Program; CFI: Comparative Fit Index; ARC: Appalachian Regional Commission; CTE: Career and Technical Education; CTT: Classical Test Theory; EFA: Exploratory Factor Analysis; HRSA: Health Resources and Services Administration; PA: Parallel Analysis; REDCap: Research Electronic Data Capture; RULS: Robust Unweighted Least Squares; STEM: Science, Technology, Engineering, and Mathematics; UK: University of Kentucky; US: United States

REFERENCES

Al-Hosni, K., Chan, M. F., and Al-Azri, M. (2021). The effectiveness of interventional cancer education programs for school students aged 8-19 years: A systematic review. Journal of Cancer Education, 36, 229-239. doi:10.1007s13187-020-01868-1

Ampofo, A. G., Gyamfuaah, S. A., Opoku, N. S., Owusu, S. O., and Ibitoye, M. B. (2020). A pilot study of a video-based educational intervention and knowledge of cervical cancer among senior high school students in Ghana: A before-after study. Journal of Cancer Policy, 24, 100220. doi:10.1016/j.jcpo.2020.100220

ARC. (2019). Health Disparities Related to Smoking in Appalachia: Practical Strategies and Recommendations for Communication. Retrieved from https://healthinappalachia.org/issue-briefs/smoking/

ARC. (2020). Appalachian Counties Served by ARC. Retrieved from https://www.arc.gov/appalachian-counties-served-by-arc/

ARC. (2021a). Distressed Designation and County Economic Status Classification System. Retrieved from https://www.arc.gov/distressed-designation-and-county-economic-status-classification-system/

ARC. (2021b). Education in Appalachia. Retrieved from https://www.arc.gov/education-in-appalachia/

ARC. (2021c). Income and poverty in Appalachia. Retrieved from https://www.arc.gov/income-and-poverty-in-appalachia/

ARC. (2022). County Economic Status and Number of Distressed Areas in Appalachian Kentucky, Fiscal Year 2022 Retrieved from https://www.arc.gov/wp-content/uploads/2021/06/CountyEconomicStatusandDistressAreas-FY2022Kentucky.pdf

Blake, K., Gaysynsky, A., Srinivasan, S., and Croyle, R. T. (2017). Making the case for investment in rural cancer control: An analysis of rural cancer incidence, mortality, and funding trends. Cancer Epidemiology, Biomarkers and Prevention, 10, 992-997.

Bottia, M. C., Stearns, E., Mickelson, R. A., Moller, S., and Valentino, L. (2015). Growing the roots of STEM majors: Female math and science high school faculty and the participation of students in STEM. Economics of Education Review, 45, 14-27. doi:10.1016/j.econedurev.2015.01.002

Brooks, J., McCluskey, S., Turley, E., and King, N. (2015). The utility of template analysis in qualitative psychology research. Qualitative Research in Psychology, 12, 202-222. doi:10.1080/14780887.2014.955224

Buja, A., and Eyuboglu, N. (1992). Remarks on parallel analysis. Multivariate Behavioral Research, 27, 509-540. doi:10.1207s15327906mbr2704_2

CDC. (2016). Rates of New Cancers in the United States. US Cancer Statistics: The Official Federal Cancer Statistic. Retrieved from https://www.cdc.gov/cancer/dcpc/data/

Charlton, M., Schlichting, J., Chioreso, C., Ward , M., and Vikas, P. (2015). Challenges of rural cancer care in the United States. Oncology (Williston Park), 29, 633-640.

Cohen, R. J., and Swerdlik, M. E. (2005). Psychological testing and assessment: An introduction to tests and measurement (Vol. 6). New York: McGraw-Hill.

Crosby, R., Wendel, M., Vanderpool, R., and Casey, B. (2013). Rural populations and health: Determinants, disparities, and solutions. Prevention of Chronic Disease, 10, E104.

Elam, C. (2002). Culture, poverty and education in Appalachian Kentucky. Education and Culture, 18, 10-13.

Hale, E. L., Malone, H. J., and McCann, H. J. (2017). Opening Doors, Changing Futures: The Appalachian Higher Education Network, 2011–2016: Institute for Educational Leadership and Appalachian Higher Education Network.

Hargis, K. B. (2011). Career and technical education program alignment with local workforce needs (Doctoral dissertation). Eastern Kentucky University, Retrieved from http://encompass.eku.edu/cgi/viewcontent.cgi?article=1047&context=etd

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., and Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. Journal of Biomedical Informatics, 42, 377-381. doi:10.1016/j.jbi.2008.08.010

HRSA. (2021). Defining Rural Population. Retrieved from https://www.hrsa.gov/rural-health/about-us/definition/index.html

Hudson, L., Prichard, C., Weiss, L. T., and Vanderford, N. L. (2020). Evidence for cancer literacy knowledge retention among Kentucky middle and high school students after a brief educational intervention. Southern Medical Journal, 113, 541-548. doi:10.14423/SMJ.0000000000001171

Hudson, L., Samons, K. M., Dicken, H. E., Prichard, C., Weiss, L. T., Edward, J., Vanderpool, R. C., and Vanderford, N. L. (2021). A brief educational intervention enhances basic cancer literacy among Kentucky middle and high school students. Journal of Cancer Education, 36, 735-740. doi:10.1007s13187-020-01696-3

IBM. (2020). IBM SPSS Statistics for Windows (Version 27.0). Armonk, NY: IBM Corp.

Kannapel, P. J., and Flory, M. A. (2017). Postsecondary transitions for youth in Applachia's Central Subregions: A review of education research, 1995-2015. Journal of Research in Rural Education, 32, 1-17.

Kentucky Department of Education. School Report Card. Retrieved from https://www.kyschoolreportcard.com/organization/20/compare?orgIds[]=53362&year=2019

Kentucky Department of Education. (2018). KYSTATS. Proficiency Dashboard. Retrieved from https://kystats.ky.gov/Reports/Tableau/APP_2018

Kyle, R. G., Forbat, L., Rauchhaus, P., and Hubbard, G. (2013). Increased cancer awareness among British adolescents after a school-based educational intervention: a controlled before-and-after study with 6-month follow-up. BMC Public Health, 13, 190. doi:10.1186/1471-2458-13-190

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Frontiers in Psychology, 4. doi:10.3389/fpsyg.2013.00863

Lorenzo-Seva, U., and Ferrando, P. (2019). Robust Promin: A method for diagonally weighted factor rotation. Liberabit: Revista Peruana de Psicología, 25, 99-106. doi:10.24265/liberabit.2019.v25n1.08

Lorenzo-Seva, U., Timmerman, M. E., and Kiers, H. A. L. (2011). The Hull method for selecting the number of common factors. Multivariate Behavioral Research, 46, 340-364. doi:10.1080/00273171.2011.564527

Lorenzo-Seva, U., and Van Ginkel, J. R. (2016). Multiple imputation of missing values in exploratory factor analysis of multidimensional scales: Estimating latent trait scores. Annals of Psychology, 32, 596-608. doi:10.6018/analesps.32.2.215161

Marek, E., Dergez, T., Rebek-Nagy, G., Szilard, I., Kiss, I., Ember, I., Gocze, P., and D'Cruz, G. (2012). Effect of an educational intervention on Hungarian adolescents' awareness, beliefs and attitudes on the prevention of cervical cancer. Vaccine, 30, 6824-6832. doi:10.1016/j.vaccine.2012.09.012

Markowitz, D. G. (2004). Evaluation of the long-term impact of a university high school summer science program on students' interest and perceived abilities in science. Journal of Science Education and Technology, 13, 395-407. doi:10.1023/B:JOST.0000045467.67907.7b

McConnell Parsons, J. R., Hanley, C., Prichard, C., and Vanderford, N. L. (2021). The Appalachian Career Training in Oncology (ACTION) Program: Preparing Appalachian Kentucky high school and undergraduate students for cancer careers Journal of STEM Outreach, 4, 1-14.

NCI. (2019). State Cancer Profiles: Dynamic View of Cancer Statistics for Prioritizing Cancer Control Efforts Across the Nation. Retrieved from https://statecancerprofiles.cancer.gov/

Nunnaly, J. C., and Bernstein, I. H. (1978). Psychometric theory: Mcgraw-Hill

Obermiller, P. J., and Couto, R. A. (2004). Appalachia counts: The region in the 2000 Census: Introduction. Journal of Appalachian Studies, 10, 245-254.

Piedmont, R. L. (2014). Inter-item Correlations. In A. C. Michalos (Ed.), Encyclopedia of Quality of Life and Well-Being Research (pp. 3303-3304). Dordrecht: Springer Netherlands.

Rodriguez, S. D., Vanderford, N. L., Huang, B., and Vanderpool, R. C. (2018). A social-ecological review of cancer disparities in Kentucky. Southern Medical Journal, 111, 213-219. doi:10.14423/SMJ.0000000000000794

Sadler, P. M., Sonnert, G., Hazari, Z., and Tai, R. H. (2014). The role of advanced high school coursework in increasing STEM career interest. Science Educator, 23, 1-13.

Siegel, R. L., Miller, K. D., Fuchs, H. E., and Jemal, A. (2022). Cancer statistics, 2022. CA: A Cancer Journal for Clinicians, 72, 7-33. doi:10.3322/caac.21708

Tabachnick, B. G., and Fidell, L. S. (2011). Using multivariate statistics (6 ed.). Boston: Allyn and Bacon.

Timmerman, M. E., and Lorenzo-Seva, U. (2011). Dimensionality assessment of ordered polytomous items with parallel analysis. Psychology Methods, 16, 209. doi:10.1037/a0023353