Predicting and Modifying Substance Use in Childhood Cancer Survivors: Application of a Conceptual Model

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Purpose/Objectives: To identify factors that predict or modify substance use in childhood cancer survivors and to describe how a risk-counseling intervention reduced young survivors' substance use.

Design: Secondary analysis of clinical trial data and primary analysis of medical record data.

Setting: Outpatient clinic.

Sample: 149 females and 118 males 12–18 years of age whose cancer had been in remission for at least two years were randomly assigned to intervention (n = 132) and standard care (n = 135) groups.

Methods: Self-report questionnaires, abstracted medical record data, confirmatory factor analysis, and structural equation modeling.

Main Research Variables: Smoking, alcohol consumption, knowledge, risk perceptions, motivation, and worry about cancer and treatment effects.

Findings: Three factors directly predicted substance use at baseline: being in a higher grade in school (independent of age), feelings of being more susceptible to late effects of cancer therapy, and worrying more about cancer and its treatment. At follow-up a year later, grade in school and worry predicted increased substance use. In addition, a desire to change health behavior, influenced by the intervention and gender, predicted decreased substance use. The mechanism of influence of the intervention was evident: The intervention led to a need to change, which precipitated a desire to change and ultimately resulted in decreased substance use.

Conclusions: Young survivors' worries and concerns about their cancer and treatment-related late effects are a new intervention target. Motivation is sensitive to behavioral change interventions and positively affects risk reduction.

Implications for Nursing: Two new intervention strategies to address the impact of survivors' concerns about their cancer and its treatment are implied: (a) Replace substance use with new coping methods to reduce fear and anxiety, and (b) tailor motivation-based interventions to age and gender to communicate graphically and realistically to survivors the personal importance of behavioral change in modifying the risks of late effects.

Key Points . . .

- Adolescent survivors of childhood cancer who smoke and consume alcohol compound their risks for late effects of treatment.
- Survivors' worry about cancer exerts a negative and positive impact on behavior: Higher levels of worry predict substance use as well as increase survivors' awareness of the need to change their behavior.
- Tailoring interventions to gender, age, and individuals' motivation for change likely will be more effective than a traditional knowledge-based health education approach.

Five-year survival rates for patients with childhood cancer are 77% (Ries et al., 2002), and an estimated one in every 640 young adults aged 20–39 in the United States will be a childhood cancer survivor by the year 2010 (Hewitt, Weiner, & Simone, 2003). The life-extending therapies credited for the high survival rate, however, are associated with multiple late effects, including cardiotoxicity, second malignancy, organ damage, neurocognitive and psychological impairment, osteoporosis, diabetes, obesity, and related sequelae (Bhatia & Sklar, 2002; Glover et al., 2003; Hoffmeister, Storer, & Sanders, 2004). The late effects of therapy contribute to significant morbidity among survivors and a mortality rate that is 10.8 times greater than the general U.S. population's (Mertens et al., 2001).

Survivors' elimination of health-risk behaviors and participation in health-protective behaviors are the primary defenses against late effects of cancer treatment (Eshelman et al., 2004). Despite the risks, childhood cancer survivors continue to engage in behaviors that threaten their health and well-being significantly (Butterfield et al., 2004; Hollen & Hobbie, 1996; Tao et al., 1998). To modify survivors' risks of

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late effects significantly, clinicians must advance their knowledge of the factors associated with survivors' risk behaviors and develop new behavioral change interventions to target identified factors.

Background

Although smoking rates among teenage childhood cancer survivors have declined (Hobbie & Ogle, 2001; Tao et al., 1998), 32% of the Childhood Cancer Survivors' Study (CCSS) cohort (18–49 years old and diagnosed from 1970–1986) reported having initiated smoking at some time during their lives, and 17% are current smokers (Emmons et al., 2003). Overall, young adult survivors of cancer are less likely than their sibling controls to experiment with smoking but are less likely to quit after having started (Tao et al.). Some characteristics of cancer survivors who smoke have been identified and include not being African American, not having graduated from high school, having a yearly household income less than $20,000, aged 10 years or older at cancer diagnosis, exposure to brain irradiation, and having members in their immediate social network who smoke (Emmons et al., 2002; Hollen, Hobbie, Finley, & Hiebert, 2001).

Although the literature reports a lower incidence of alcohol consumption (Larcombe, Mott, & Hunt, 2002; Mulhern et al., 1995; Verrill, Schafer, Vannatta, & Noll, 2000) among pediatric cancer survivors than among siblings or case control peers, alcohol consumption among young survivors is cause for concern because early onset of drinking robustly predicts lifetime drinking (Grant, 1998). Hollen and Hobbie (1996) noted that survivors began drinking at approximately the same age as their peers (10–19 years of age versus 11–21 years of age, respectively); 44% of teen survivors and 58% of their peers reported having had five or more drinks on one occasion within the previous 12 months; and teens with poor decision-making skills were more likely to abuse substances (Hollen et al., 2001).

Impact of Smoking and Drinking on Childhood Cancer Survivors

Cancer

Survivors' risk of a second malignancy is three to six times greater than those in the general population's risk of developing any malignancy (Bhatia & Sklar, 2002). A second malignancy represents the second-leading cause of death among survivors (Mertens et al., 2001). In addition, female survivors who receive mantle, abdominal, or craniospinal radiation and who fail to enter puberty or who enter premature menopause face an increased risk for developing breast cancer (Hewitt et al., 2003). The already significant treatment-related cancer risks may be compounded further by the alcohol- and smoking-related risk of developing breast cancer faced by those in the general population (Benassi & Fenech, 2004; Hecht, 2002; Talamini et al., 2002; Zeka, Gore, & Kriebel, 2003).

Cardiovascular Disease

Survivors face premature cardiovascular morbidity and mortality from earlier-onset atherosclerosis (Berry & Jorden, 2005) and associated late cardiotoxicity from the use of anthracyclines or radiation to the heart during cancer treatment (Adams et al., 2004). Drug and radiation therapy predisposes survivors to asymptomatic left ventricular dysfunction, congestive heart failure, and sudden cardiac death from dysrhythmia or pump failure (Lipshultz & Colan, 2004). Because of survivors' compromised cardiovascular status secondary to treatment, the effects of smoking and excessive alcohol consumption significantly compound the risks of cardiovascular morbidity and death (Kurth et al., 2003; Magyar et al., 2003; Mahmud & Feely, 2003; Saremi, Hanson, Tulloch-Reid, Williams, & Knowler, 2004; Teng, Catherwood, & Melby, 2000).

Osteoporosis

Peak bone mass is laid down during adolescence (Root, 2002). Adolescent cancer survivors face significant risks for developing osteoporosis as a result of glucocorticoid and radiation therapy (Gilsanz, Carlson, Roe, & Ortega, 1990; Gronowicz & McCarthy, 1995) in addition to other common risk factors (e.g., family history of cancer, being female, diet deficient in calcium, inactivity). Alcohol consumption and smoking exacerbate the risks by lowering bone mineral density and increasing bone loss (Gong & Wezeman, 2004; Krall & Dawson-Hughes, 1999; Sewon, Laine, Karjalainen, Doroguinskaia, & Lehtonen-Veromaa, 2004; Turner, 2000).

Obesity

Childhood cancer survivors face an increased risk of obesity, especially if they are female, were treated at a young age (0–4 years), and received cranial radiation (≥ 20 Gy) (Oeffinger et al., 2003). Among adults, obesity is associated with insulin resistance, hypertension, type II diabetes, and atherosclerosis and is responsible for one in seven deaths as a result of cancer in men and one in five in women (Calle & Thun, 2004). The increased risk among survivors may result from receiving glucocorticoid therapy in childhood, which encourages central distribution of fat (Bray, 2004) and increases appetite with resultant weight gain (Reilly et al., 2001). Survivors who consume alcohol increase their risk because alcohol contributes directly to obesity (Laitinen, Power, & Jarvelin, 2001) by inhibiting lipid oxidation, indirectly favoring the storage of dietary fats, and compromising factors that control appetite (Jequier, 2002; Yeomans, Caton, & Hetherington, 2003).

Diabetes

Type I diabetes, reported at rates three times higher among childhood cancer survivors than in the general U.S. population (Hoffmeister et al., 2004), exacerbates survivors' risk of developing cardiovascular disease and breast cancer (Bray, 2004; Calle & Thun, 2004). Several factors predispose young survivors to diabetes: chemotherapy (e.g., asparaginase, vincristine, cytarabine, methotrexate) and corticosteroid use (Weiser et al., 2004), a diagnosis of acute or chronic leukemia (Hoffmeister et al.), abdominal radiation, and growth hormone therapy (Cicognani et al., 1997; Cutfield et al., 2000). In the general population, alcohol use has been shown to increase gamma-glutamyltransferase, a predictor of type II diabetes (Lee, Steffen, & Jacobs, 2004). Among diabetic patients, smoking significantly accelerates the course of cardiovascular disease (Tavani, Bertuzzi, Gallus, Negri, & La Vecchia, 2002; Weitz et al., 1996).

Theoretical Framework

The Interaction Model of Client Health Behavior (IMCHB) (Cox, 1982, 2003) guided this secondary analysis by identifying potentially important variables in the original data to be examined and specifying the relationships between variables. Briefly, the model (see Figure 1) comprises three elements: client singularity (i.e., the unique intrapersonal and contextual configuration of the individual), client-professional interaction (i.e., the therapeutic content and process that occurs between clinicians and patients), and health outcomes (i.e., the behavior or behaviorally related outcome subsequent to a client-provider interaction). The model's working hypothesis is that the potential for positive patient health outcomes increases as the provider intervention or interaction is tailored to the uniqueness of each patient (e.g., background, cognitive, affective, and motivational manifestations). Table 1 describes the relationship between the conceptual model and the variables examined in this study. The overall purpose of the study was to use the model to identify important predictors of substance use as well as new approaches for interventions to reduce substance use in adolescent childhood cancer survivors.

Methods

Design and Procedures

The data for the secondary analysis were derived from a longitudinal (T_0 = baseline; T_1 = one year later), controlled, randomized trial designed to evaluate the ability of a multicomponent risk counseling intervention to increase the frequency of health-promotion behaviors and decrease the frequency of health-risk behaviors in adolescent survivors of childhood cancer (Hudson et al., 2002). The original study and the secondary analysis were approved by the St. Jude Children's Research Hospital Institutional Review Board in Memphis, TN. Patients randomly assigned (Zelen, 1974) to the control arm received standard care, which included instruction in breast or testicular self-examination, targeted late effects screening based on patients' clinical history of treatment exposure, a thorough clinical assessment, and counseling about the risk of late effects. The multicomponent test intervention was comprised of standard care, written and verbal guidance for modification of patients' health and risk behaviors, and reinforcement by telephone follow-up three and six months postintervention.

Table 1. Correspondence of Model Concepts With Study Variables and Measures

Model Concept and Variable	Measure
Demographic characteristics	
Age	Age at last birthday
Gender	Male = 0, female = 1
Mother's highest grade completed	Years
Father's highest grade completed	Years
Area of residence	Rural to large urban
Patient's grade	Current grade in school
Cognitive appraisal	
Susceptibility	Perceived vulnerability to late effects of cancer treatment
Seriousness	Perceived seriousness of late effects of cancer treatment
Efficacy	Perceived efficacy of health behavior to reduce risk of late effects of cancer treatment
Intrinsic motivation	
Knowledge	Correct knowledge about the disease and treatment
Need to change	Perceived need to change health behaviors
Desire to change	Desire to change health behaviors
Hard	Perception that doing things to improve health is difficult
Trouble	Perception that a lot of effort is needed to stay healthy
Affective response	
General fear of cancer	General fears about cancer
Physical problems	Worries about physical problems
Symptoms	Total number of symptoms experienced
Appearance	Worries about appearance
Healthcare costs	Worries about paying for health care
Health outcomes	
Smoking	Amount smoked weekly and daily
Drinking	Amount of alcohol consumed weekly and daily

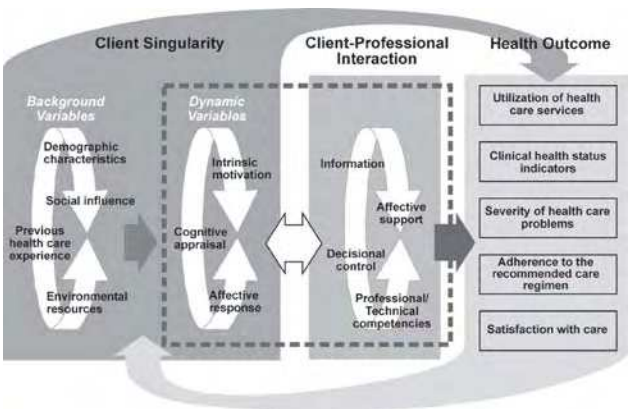


Figure 1. The Interaction Model of Client Health Behavior

Note. From "A Model of Health Behavior to Guide Studies of Childhood Cancer Survivors," by C.L. Cox, 2003, *Oncology Nursing Forum, 30,* p. E93. Retrieved December 6, 2005, from http://www.ons.org/publications/journals/ONF/Volume30/Issue5/pdf/762.pdf. Copyright 2003 by the Oncology Nursing Society. Reprinted with permission.

Sample and Setting

The target population consisted of survivors of childhood cancer seen for follow-up care in a children's research hospital outpatient clinic. To be eligible for the original study, patients had to be 12–18 years of age with their disease in continuous remission for two years or longer post-treatment, cognitive function had to be sufficient to understand the intervention counseling and to complete the written questionnaires, and English had to be patients' primary language.

Instruments

The instruments used in the original study measured only variables specifically related to the Health Belief Model (HBM) (Janz & Becker, 1984). Most of the variables correspond to the cognitive appraisal (i.e., knowledge, risk

perceptions) portion of the IMCHB. Because the IMCHB gives such a prominent role to emotions and motivation as predictors of behavior (in addition to knowledge, beliefs, and attitudes), the secondary analysis also included items from an annual questionnaire in the medical record (completed at the same time as the original study questionnaires) in which patients indicated their medical history, symptoms, and fears, worries, and concerns about their cancer and treatment.

Cognitive outcome measures: Survivors' health knowledge was assessed with 30 "yes" or "no" questionnaire items regarding their treatment and its risks (e.g., "Did you receive surgery as a part of your treatment for cancer?"). The accuracy of patients' responses was verified by comparing their answers with healthcare providers' notes in patients' medical records. Possible scores ranged from 0–30, with higher scores reflecting greater knowledge. Three scales based on the HBM (Janz & Becker, 1984) assessed survivors' perceived risks of developing future health problems related to cancer treatment. Patients rated eight items on a five-point Likert scale as very unlikely to very likely (Cronbach's alpha at $T_0 = 0.85$ and $T_1 = 0.83$) to be a health risk as a result of cancer. Similarly, survivors' perceptions of the seriousness of eight potential treatment-related problems were measured on a four-point Likert scale from 1 (not serious at all) to 4 (very serious) (Cronbach's alpha at $T_0 = 0.92$ and $T_1 = 0.91$). Finally, the perceived efficacy of selected behaviors in reducing the risk of treatment-related health problems was measured by nine items on a four-point Likert scale from 1 (strongly disagree) to 4 (strongly agree) (Cronbach's alpha at $T_0 = 0.75$ and $T_1 = 0.79$).

Motivation measures: In the original study, four items measured barriers to changing health behaviors. Two items asked survivors whether they agreed or disagreed with the following statements: "I need to change my health behaviors to be healthy," and "I want to change my health behaviors to be healthy." The other two items were scored on a Likert scale from 1 (strongly disagree) to 5 (strongly agree): "It is a lot of trouble to stay healthy," and "Improving your health is hard work." Because the wording of these items closely resembled items in one of the investigator's previous motivation studies (Cox, Cowell, Marion, & Miller, 1990; Cox & Wachs, 1985), they were selected for inclusion in the secondary analysis to represent the concept of motivation in the IMCHB.

Affective response (worry and concern) measures: An annual questionnaire kept as part of patients' medical records contained 15 items (19 items for females) that represented a full array of symptoms (e.g., shortness of breath, fatigue, chest pain) that might be associated with patients' cancer or its treatment. The number of positively marked symptoms was tallied to measure symptoms at T_0 and T_1. Patients also were asked whether they had general fears about cancer and worries about physical problems, appearance, cancer recurrence, paying for health care, or finding a local physician. Because the original study relied only on the HBM to guide analysis, no analyses were completed using any of the questionnaire items derived from the medical records. The IMCHB stresses the role of emotions and feelings as determinants of behavior; therefore, in the secondary analysis, the data from the annual questionnaire were used to determine whether emotions were related to patients' health behaviors.

Behavioral outcome measures: The frequency of smoking and drinking behavior was measured in the original study using four-point Likert scales. As shown in Table 2, the frequency of smoking ranged from 0–1 pack or more daily and drinking ranged from 0–2 drinks daily. The majority of survivors did not smoke or drink (n = 231, 87%), and nine survivors smoked regularly, but did not drink (0.03%). Of the nine regular smokers, seven smoked 1–3 cigarettes daily, and two smoked one or more packs daily. Among the eight survivors who drank alcohol, one consumed 1–2 drinks daily but did not smoke; seven drank 1–2 times weekly and smoked 1–3 times daily. Drinking and smoking were not independent of one another ($\chi^2 = 30.223$, df = 4, $p < 0.001$), a finding consistent with previously reported research.

Results

Patient Characteristics

Of the 318 patients eligible to participate in the study, 272 (86%) were enrolled; five later were removed from the study for medical reasons or for failure to provide informed consent. Of those remaining, 132 were randomly assigned to the intervention group and 135 to the standard care group. The random assignment resulted in similar distributions across groups (i.e., intervention, standard care) in regard to gender, race, primary diagnosis, age, and time elapsed since diagnosis (see Table 3). Significant correlations were demonstrated between the independent variables and substance use variables at T_0 and T_1 (see Table 4).

Modeling Analyses

To determine the direct and indirect influences of all study variables on substance use, structural equation modeling (SEM) was used as the primary analytic technique (Bollen, 1989). SEM allows for the simultaneous evaluation of the fit of the data with all paths within a model. Additionally, by combining related, directly observed variables (e.g., mother's education, father's education, and family income), higher-level latent (unobserved) variables (e.g., socioeconomic status [SES]) can be created that substantially decrease measurement error variance. Table 5 shows the correspondence and fit between directly measured variables and their corresponding latent measures. The strength of the relationships between latent measures and each directly observed variable is shown in Figures 2 and 3. To determine the fit of the models to the observed data, the χ^2 statistic (Bollen) and the root mean square error of approximation (RMSEA) were used (Steiger, 1990). An χ^2 statistic that is not significant (i.e., $p > 0.05$) indicates a good fit because the model does not differ significantly from the data. A RMSEA of 0.05–0.08 indicates a good fit, and a RMSEA less than 0.05 indicates an excellent fit (Browne & Cudeck, 1993). Parameter estimates (PE) represent the strength of the path between two variables and are read as a standardized regression coefficient.

Baseline: The baseline model of substance use, although complex, demonstrated an excellent fit with the data ($\chi^2 = 105.323$, df = 115, $p = 0.73$; RMSEA < 0.0001). Three factors directly predicted substance use: current grade level in school (PE = 0.412, $p < 0.001$), perceptions of susceptibility to late effects of cancer treatment (PE = 0.283, $p = 0.003$), and worry (PE = 0.375, $p = 0.006$). Survivors who were in higher grades (independent of age) were more likely to engage in substance use than those in lower grades. Survivors

Table 2. Means and Standard Variations for Study Variables at Baseline and Follow-Up

Variable	$\bar{X}$		SD		Range	
	Baseline	Follow-Up	Baseline	Follow-Up	Baseline	Follow-Up
Demographics						
Mother's highest grade completed	13.350	13.4200	2.383	2.552	4–18	4–18
Father's highest grade completed	13.320	13.3500	2.705	2.628	3–18	4–18
Area of residence[a]	4.050	4.0200	1.978	1.900	1–8	1–8
Patient's grade in school	8.830	9.7200	2.113	2.007	1–14	5–14
Health risk perceptions and knowledge						
Susceptibility	26.422	26.0600	7.422	7.326	11–44	11–47
Seriousness	32.426	33.4320	8.147	7.440	11–44	11–44
Efficacy	26.306	26.3650	2.785	2.904	20–32	16–32
Knowledge	23.600	24.1100	4.115	4.204	10–34	11–36
Motivation						
Need to change	1.420	1.5800	0.494	0.495	1–2	1–2
Desire to change	1.580	1.5200	0.495	0.500	1–2	1–2
Improving health is difficult.	2.940	2.9400	0.614	0.644	1–4	1–4
Much effort is needed to stay healthy.	2.950	2.0600	0.714	0.720	1–4	1–4
Worries and concerns						
General fears about cancer	0.110	0.1600	0.312	0.372	0–1	0–1
Physical problems	0.130	0.1400	0.342	0.351	0–1	0–1
Appearance	0.180	0.2100	0.388	0.406	0–1	0–1
Symptoms	0.895	1.1506	1.305	1.524	0–8	0–9
Healthcare costs	0.080	0.0800	0.270	0.273	0–1	0–1
Substance use						
Smoking	1.070	1.1100	0.280	0.413	1–3	1–4
Drinking	1.100	1.1000	0.310	0.324	1–3	1–3

[a] 1—rural; 2—rural, nonfarming; 3—small town (population < 2,500); 4—town (population 2,500–10,000); 5—large town (population 10,000–50,000); 6—city (population 50,000–1 million); 7—suburb near city (population 50,000–1 million); 8—large metropolitan area (population > 1 million)

who believed that they were more susceptible to late effects of cancer therapy were more likely to drink and smoke as survivors with more worries or concerns about their cancer and treatment effects.

Ten variables contributed to substance use indirectly through susceptibility and worry. The three previously identified direct contributors (i.e., higher grade in school, perceived susceptibility, and worry) were also indirect contributors to substance use, and seven additional indirect contributors included motivation, efficacy, gender, knowledge, SES, and perceptions about wanting and needing to change behavior. Motivation (PE = −0.288, $p < 0.001$) predicted susceptibility, which in turn predicted the need to change behavior (PE = −0.119, $p = 0.038$). Female gender predicted perceptions about wanting to change behavior (PE = 0.173, $p = 0.004$), which in turn predicted the need to change (PE = −0.714, $p < 0.001$) as well as worry (PE = −0.357, $p < 0.025$).

Five variables in the baseline model (two latent, three directly observed) were reciprocal in their influence. Knowledge negatively predicted efficacy (PE = −0.506, $p < 0.001$), and efficacy positively predicted knowledge (PE = 0.676, $p < 0.001$). Efficacy predicted perceptions about the difficulty of improving health and staying healthy (i.e., motivation) (PE = 0.280, $p < 0.044$), and motivation positively predicted efficacy (PE = 0.606, $p < 0.001$). Worry positively predicted the need to change behavior (PE = 0.387, $p < 0.004$), and perceptions of needing to change behavior (PE = −0.784, $p < 0.001$) negatively predicted worry.

Postintervention: The postintervention model was far less complex than the baseline model. The fit of the data to the model was excellent ($\chi^2 = 47.979$, df = 42, $p = 0.243$, RMSEA = 0.023). Consistent with the baseline model, grade level in school (PE = 0.488, $p < 0.001$) and worry (PE = 0.492, $p < 0.001$) predicted substance use. Additionally, perceptions of wanting to change health behavior (PE = −0.232, $p = 0.021$) directly predicted decreased substance use. Four variables (one latent) indirectly influenced substance use through the

Table 3. Patient Characteristics of the Intervention and Standard Care Groups

Characteristic	Standard Care (N = 135)		Intervention (N = 132)	
	$\bar{X}$	SD	$\bar{X}$	SD
Age (years)	14.96	1.97	15.09	1.90
Years since diagnosis	10.31	2.94	10.95	2.62
Characteristic	**n**	**%**	**n**	**%**
Gender				
Male	61	45	57	44
Female	74	55	74	56
Race				
Caucasian	114	84	113	86
African American	18	13	18	14
Hispanic	3	2	–	–
Primary diagnosis				
Leukemia or lymphoma	72	53	73	56
Solid tumor	63	47	58	44

Note. Because of rounding, not all percentages total 100.

Table 4. Significant Correlations With Smoking and Drinking Measures

	Baseline		Postintervention	
Variable	**Smoking**	**Drinking**	**Smoking**	**Drinking**
Age	–	–	–	0.160*
Grade	0.177**	0.168**	–	0.306**
Number of symptoms	–	0.195**	0.158*	–
Susceptibility	0.155*	–	–	0.166**
General fears	0.218**	0.201**	0.175**	0.174**
Smoking	–	0.228**	–	0.422**
Area of residence	–0.138*	–	–	–
Worried about healthcare costs	0.179**	–	–	–

* $p < 0.05$

** $p < 0.01$

desire to change: gender predicted the desire to change (PE = 0.154, $p < 0.001$) and the need to change (PE = 0.121, $p = 0.043$), and treatment arm and intervention (PE = –0.134, $p = 0.025$) and worry (PE = 0.323, $p < 0.001$) predicted the need to change.

Discussion

In this study, adolescent cancer survivors who smoked or drank represented a small percentage of the total sample. Three factors directly predicted substance use at baseline among those who did smoke or drink: being in a higher grade (independent of age), feeling more susceptible to the late effects of cancer, and worrying more about the impact of cancer treatment. Although SES did not directly predict substance use (Emmons et al., 2002), it was positively associated with survivors' perceptions that staying healthy requires effort and commitment, or motivation.

Worry about cancer and treatment effects strongly and positively influenced substance use at baseline and postintervention. Adolescent survivors' worry about cancer-specific and general health issues is documented (Zebrack & Chesler, 2001); however, survivors' participation in health-risk behaviors consequent to fear and feelings of susceptibility has not been reported. Health-risk behaviors are documented negative coping strategies (Bellg, 2003). For example, women with breast cancer reported tranquillizer and alcohol use as a method of coping with their diagnosis and treatment (Hurny et al., 1993), and men with prostate cancer reported consuming alcohol or taking drugs to improve their mood (Ben-Tovim, Dougherty, Stapelton, & Pinnock, 2002). To what extent young survivors use substances to reduce fear and concerns or to improve mood warrants further study.

The baseline model was substantially more complex than the postintervention model in that many more variables directly and indirectly influenced substance use. The intervention may have been effective in neutralizing several of the baseline influences on substance use (e.g., knowledge, efficacy, susceptibility, motivation, SES) through the use of counseling on risk (i.e., susceptibility), enhancing knowledge about disease and treatment, increasing realistic expectations about the efficacy of health behaviors in reducing risk, and conveying the commitment, or motivation, required to offset the risks of late effects.

At baseline, the multiple reciprocal relationships between several variables may reflect survivors' incorrect knowledge, uninformed risk perceptions, and lack of awareness of the need for behavior change. These reciprocal relationships were eliminated postintervention, suggesting that exposure to the intervention clarified knowledge, risk perceptions, and the need for behavior change.

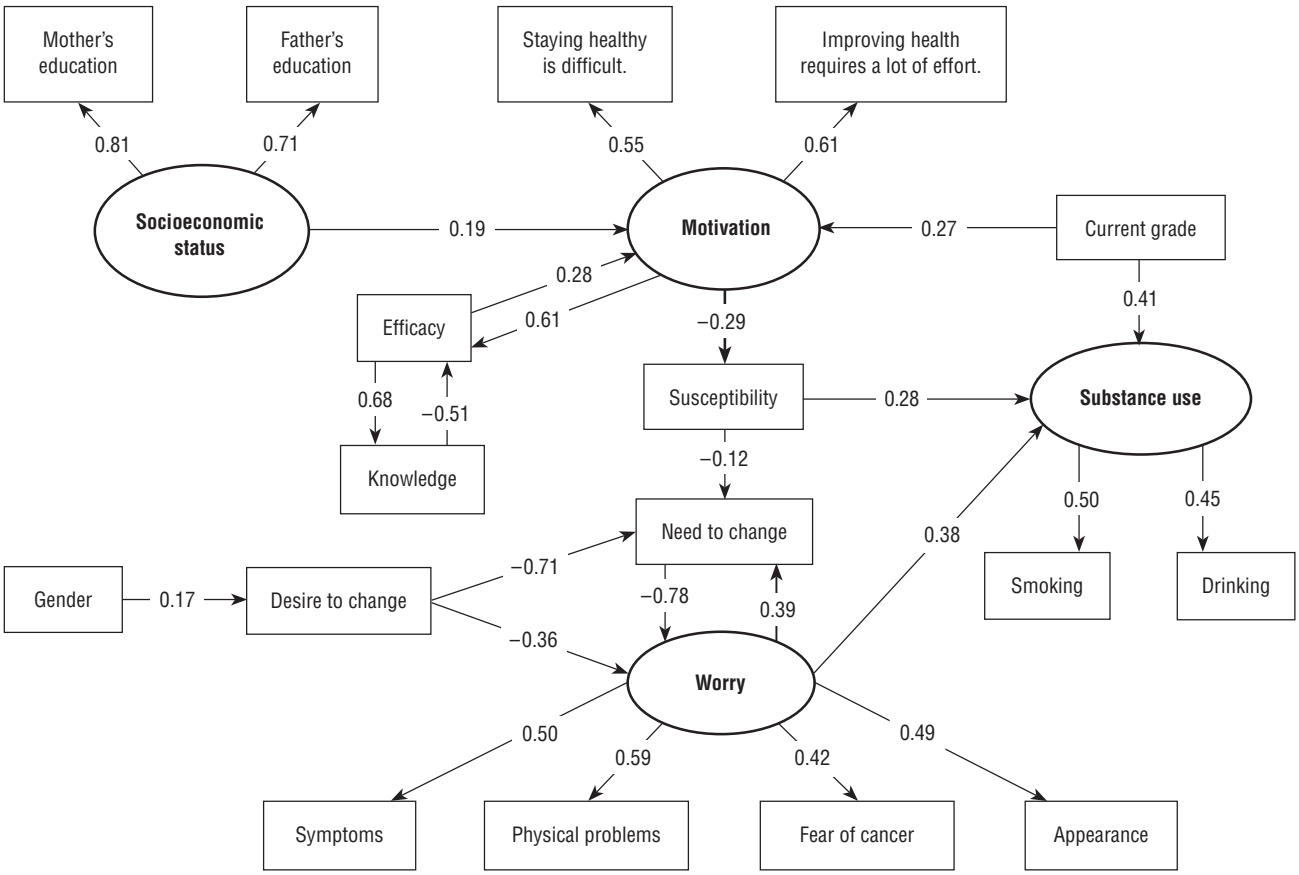
Consistent with the assumptions and hypotheses of the IMCHB (Cox, 2003) and self-determinism theory (Deci & Ryan, 1985), these findings suggest that the real impact of the intervention was to inform survivors' perceptions about needing to change their behavior. The perceptions of needing to change behavior led to survivors wanting to change behavior that, in turn, resulted in risk reduction. Emphasizing the personal importance of behavior change targets the desire to change behavior. The desire to change behavior ultimately will support and sustain long-term behavioral change.

The IMCHB, unlike the HBM that guided the original study, identifies emotions and motivation perceptions as strong determinants of behavior. For example, worry was a strong direct predictor of substance use at baseline and postintervention. Its stronger influence on substance use postintervention rather than at baseline suggests that the intervention had no impact on reducing worry. A certain degree of fear or anxiety may serve to motivate behavior change (Mullens, McCaul, Erickson, & Sandgren, 2004). For some patients, learning that they are at risk for serious health consequences creates an uncomfortable feeling; engaging in health-enhancing behaviors perceived to modify this risk reduces that feeling. If fear and worry support substance use in survivors, then interventions must focus on reducing fear and finding new coping methods. If fear is an antecedent to the need and desire to change (motivation) and these factors predict risk-behavior reduction, then interventions should incorporate nonthreatening but clear and graphic messages about patients' personal risks to motivate behavior change. The current study demonstrated that fear and worry could have a dual (positive and negative) impact on substance use, which reinforces the need to consider tailored and individualized intervention approaches to maximize behavior change (Cox, 2000; Marcus, Owen, Forsyth, Cavill, & Fridinger, 1998).

The impact of the intervention on the need to change was modified by gender: Females were more likely than males to want to change at baseline and to perceive a need for change as a result of the intervention. This finding is consistent with

Table 5. Correspondence of Directly Observed Variables With Latent Measures

Directly Observed	Variable Latent Measures	p
Smoking behavior Drinking behavior	Substance use	< 0.001
General fear of cancer Worried about appearance Worried about physical problems Total number of symptoms	Worry	< 0.001
Mother's education Father's education	Socioeconomic status	< 0.001
"It is a lot of trouble to stay healthy." "Improving your health is hard."	Motivation	< 0.001



$\chi^2 = 105.323$, df = 115, p = 0.73

Note. The numbers in the figure represent standardized regression estimates and factor loadings.

Figure 2. Substance Use at Baseline

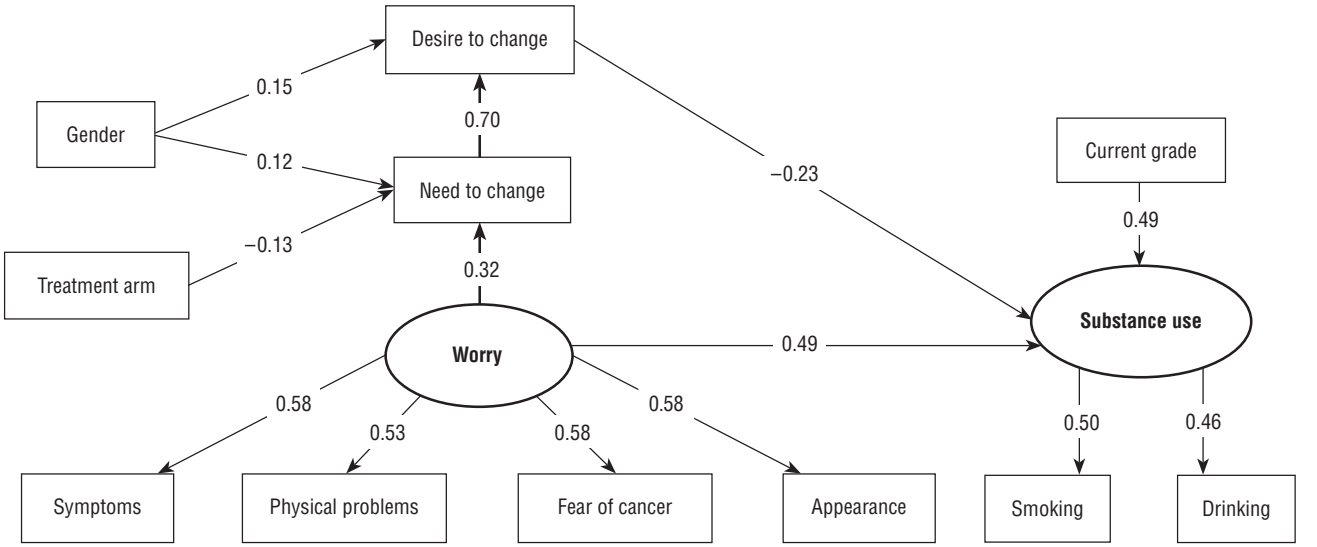
previous reports (Cox, McLaughlin, Rai, Steen, & Hudson, 2005) in which significant interaction effects were demonstrated between this intervention and gender. A growing body of health-behavior change literature for the general population suggests that gender- and age-specific strategies are needed to effect behavior change (Cox, 2003; Cullen et al., 1999; Epstein, Paluch, & Raynor, 2001; Ratner, Bottorff, Johnson, & Hayduk, 1994; Rew, Chambers, & Kulkarni, 2002; Trudeau, Spoth, Lillehoj, Redmond, & Wickrama, 2003). Finding ways to communicate the need for change differentially to boys and girls may be key to initiating and sustaining behavior change among young survivors.

Limitations

Multiple limitations in this study must be considered when interpreting the results. The data are limited to a single institution with limited racial and socioeconomic variability, and a small percentage of the sample participated in the behaviors of interest. Important measures were limited to single items and to scales developed specifically for this study; these measures potentially weakened the strength of the relationships between observed indicators and latent variables, and they may have decreased the strength of the hypothesized paths between variables.

Implications for Research and Practice

Implications for future studies include greater racial and socioeconomic diversity in the sample, more established measures to enable the comparison of survivors with the general population of adolescents, the comparison of young men with young women relative to specific factors that support or negate substance use, and the replication of the primary study findings in larger cohorts of cancer survivors across multiple age groups (e.g., CCSS data). Practice implications of the study include focused interviewing of young survivors who smoke or drink about their fears, worries, and concerns related to their disease and its treatment. For those who may be able to identify their fears as contributing to substance use, exploring new coping options to reduce anxiety about symptoms and concerns is appropriate. Open discussion to help explore patients' readiness to stop smoking or drinking is a critical first step toward decreasing substance use. When a patient is ready to modify his or her substance use, a nurse and the adolescent can develop a strategy jointly; the plan may range from additional follow-up consultation with care providers to referral to a formalized program. Using realistic, nonthreatening messages to accurately portray the specific risks of late effects for patients individually



$\chi^2 = 105.323$, df = 115, p = 0.73

Note. The numbers in the figure represent standardized regression estimates and factor loadings.

Figure 3. Substance Use Postintervention

may better inform their perceptions of needing and wanting to change their behavior than a general one-size-fits-all educational approach.

Conclusion

Despite the limitations, this study was useful in identifying new targets for decreasing substance use in adolescent survivors. Worry about disease and treatment effects exerted both positive and negative influence on substance use. Motivation and emotion showed a greater impact on reducing substance use in young survivors than beliefs and knowledge. The educational intervention was an effective indirect influence on decreasing substance use through its impact on increasing adolescents' motivation to change behavior. Sound evidence-based, behavior-change strategies grounded in models of health behavior represent a new and promising option to guide the development of interventions to modify the impact of late effects of cancer treatment.

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