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Patterns and correlates of multiple risk factors for adult-onset cancer among adolescents

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Abstract

We investigated patterns and correlates of multiple, adult-onset cancer risk factors (MCRFs) among adolescents. Baseline data from an intervention efficacy trial were analyzed to examine patterns of co-occurring MCRFs and sociodemographic and theoretical (e.g., prevention self-efficacy) correlates of MCRFs among adolescents ($N = 50$) age 13 – 21. The mean total MCRFs was 4.6 (SD = 1.6; range 0–9). The most common risk factors were intentions to use alcohol ($n = 40$, 80%), < 5 daily servings of fruits/vegetables ($n = 40$, 80%), and lifetime alcohol use ($n = 38$, 76%). MCRFs commonly co-occurred, suggesting a clustered risk profile. Greater age ($B = 0.19$ 95% CI 0.01, 0.38) and lower prevention self-efficacy ($B = -0.16$, 95% CI −0.02, −0.30) were significantly ($p < 0.05$) associated with MCRFs. Multiple health behavior change interventions are needed to prevent accumulation of risk factors as youth mature. Self-efficacy may be an important target for prevention interventions.

Keywords

multiple cancer risk factors; multiple health behavior change; adolescents; self-efficacy; cancer prevention

Introduction

Cancer is a leading cause of global mortality, accounting for an estimated 7 million deaths each year worldwide (Parkin et al., 2005; World Health Organization, 2011). Significant

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geographic variability cancer morbidity and mortality exists worldwide, due in part to variation in exposure to factors influencing cancer risk (Parkin et al., 2005; World Health Organization, 2011). While many factors contribute to risk for cancer, such as inherited traits and environmental influences, most forms of cancer have been linked to lifestyle and behavioral risk factors, including tobacco and alcohol use, poor diet, and physical inactivity (Ezzati et al., 2002). Indeed, a substantial proportion of cancer deaths among adults are preventable by modifying these and other behavioral risk factors (Danaei et al., 2005; Ezzati et al., 2002; Mokdad et al., 2005).

In the U.S. cancer accounts for nearly 23% of all adult deaths annually (Jemal et al., 2005). Recent estimates suggest that greater than 50% of cancer-related morbidity and mortality in the U.S. is preventable by modifying behavioral and lifestyle risks, making primary prevention of cancer a leading national public health priority (U.S. Department of Health and Human Services, 2000). U.S. Healthy People 2020 objectives focus on primary prevention of cancer-related morbidity and mortality through modification of lifestyle and behavioral risks (U.S. Department of Health and Human Services, 2010). Primary preventive health care is also central to the Patient Protection and Affordable Care Act of 2010, which includes provisions to improve access to preventive services (Koh and Sebelius, 2010).

Evidence increasingly suggests that behavioral and lifestyle risks for cancer often co-occur (Prochaska et al., 2008) and this clustering of unhealthy behaviors may initiate and/or accelerate the disease processes associated with tumor development (Berrigan et al., 2003). Furthermore, many behavioral risk factors for adult-onset cancer originate early in life (Institute of Medicine, 2008; Tercyak and Tyc, 2006; Werch, 2007). During childhood habits including smoking, alcohol use, diet, and physical activity are often formed, and many persist into adulthood (Institute of Medicine, 2008; Tercyak and Tyc, 2006; Werch, 2007). These data strongly suggest that childhood—and adolescence in particular—represents an important window of opportunity for primary prevention of adult-onset cancer by encouraging multiple health-promoting behaviors before unhealthy habits become established (Tercyak and Tyc, 2006; Werch, 2007).

Our understanding of patterns and correlates of risk factors for adult-onset cancer among adolescents to inform cancer prevention efforts targeting multiple behavioral risk factors remains extremely limited (Prochaska et al., 2008). Research has focused largely on co-occurring risk factors which are immediately relevant to the leading causes of morbidity and mortality among young people –substance use, sexual risk taking, and personal injury (Brener and Collins, 1998; Everett et al., 2000; Kulbok and Cox, 2002; Zweig et al., 2002). Few studies have examined patterns of multiple risk factors for adult-onset cancer during adolescence, and those doing so have focused on behaviors related to diet and physical activity (Driskell et al., 2008; Keller et al., 2008; Sanchez et al., 2007) or tobacco and alcohol use (Duhig et al., 2005; Lai et al., 2000). Our knowledge of psychosocial correlates of multiple cancer risk factors (MCRFs) among adolescents, which may be important targets for preventive interventions, remains especially limited (Driskell et al., 2008; Keller et al., 2008).

This leaves a critical gap in our understanding of the risk for preventable, adult-onset cancer during adolescence, which is a unique period of development characterized by risk and exploration (Institute of Medicine, 2008). Improving our knowledge of the patterns and correlates of MCRFs among adolescents will help identify critical points for interventions designed to move youth toward healthy behaviors. To address these research gaps, we examined the patterns and correlates of MCRFs among a sample of adolescents age 13 to 21.

Methods

Design

We analyzed pre-treatment data from a small-scale randomized controlled trial designed to evaluate the efficacy of a multiple health behavior change cancer preventive intervention, in addition to standard medical care. A detailed description of the study has been published previously (Mays et al., 2011). The setting was an adolescent medicine clinic within a large, urban tertiary care hospital with a large and diverse population of patients seen for routine well-visit check-ups. Adolescents presented for clinic well-visits for a variety of reasons (e.g., annual preventive care, physical examination for school or sports), but typically did so at their own volition. All study procedures were approved by the host institution's Institutional Review Board.

Participant Recruitment

Clinic and research staff members were trained to screen potential participants for eligibility. Inclusion criteria were: adolescents age 13–21 years who read and spoke English, had access to a telephone, and were free of illness/disability limiting participation. Adolescents were informed about the study at the time of their well-visits and, if interested, were provided additional information and answers to any questions. Those interested in participating were given an enrollment packet by a research staff member, which included an eligibility screening form and two copies of adolescent consent form (for those ≥ 18 years of age) or a parental consent and adolescent assent forms (for those < 18 years of age), consistent with age-based informed consent requirements in the U.S. (McGuire-Dunn and Chadwick, 2004). Eligible, consented participants completed a baseline telephone interview within 2 weeks of enrollment. Commensurate with current practices and recommendations for research among adolescents within this context (Rice and Broome, 2004), participants were offered a modest incentive to complete the baseline assessment (i.e., $10 gift card).

Theoretical Framework

This work was guided by Social Cognitive Theory (Bandura, 1997) and the Health Belief Model (Janz et al., 2002), which specify that behaviors can be influenced by multiple factors including behavioral intentions, knowledge, skills, self-efficacy, and other determinants. Due to the age range of participants, intentions to engage in risk (i.e., alcohol use, tobacco use) and long-term preventive (i.e., cancer screening) behaviors commonly associated with cancer prevention were assessed in order to capture behaviors that (1) may not be present during adolescence but may emerge later in life (i.e., alcohol use, tobacco use); and (2) to assess adolescents' intentions to engage in preventive behaviors that may not be relevant during adolescence but may be important for prevention and early detection of cancer later in life (e.g., screening).

Measures

Multiple Cancer Risk Factors—Similar to prior research (Emmons et al., 1994; Emmons et al., 2005; Lopez et al., 2007; Tercyak et al., 2006), the total cancer risk factors were operationalized using a continuous variable reflecting nine risk factor indicators: < 5 fruit and vegetable servings each day, < 3 days per week with vigorous physical activity, overweight or obese status, lifetime alcohol use, alcohol use intentions, lifetime smoking, smoking intentions, no or low cancer screening intentions, and family history of cancer (immediate or extended family member). Each risk factor was operationalized using a dichotomous variable (1 = risk factor, 0 = no risk factor) and the total cancer risk factors was computed (range 0 – 9).

Items assessing behavioral risk factors for fruit and vegetable consumption, physical activity, smoking, and alcohol behaviors use were measured using psychometrically-sound assessments of adolescent health risk behaviors (Brener et al., 2004). Overweight/obese status was defined as BMI ≥ 25, calculated based on self-reported height and weight (Ogden et al., 2008). Behavioral intentions items were created for the purposes of this study and informed by prior adolescent behavioral intentions research (Pierce et al., 1996) and theory-based behavioral intentions measurement research (Ajzen, 1991; Francis et al., 2004). Smoking intentions were assessed by asking "Do you think you will smoke a cigarette at any time during the next year?" Responses ranged from "Definitely Not" to "Definitely Yes," with "Probably Yes" and "Definitely Yes" coded as at risk for smoking. Alcohol use intentions were assessed using a similar item.

Cancer screening intentions were also measured using similar items tailored specifically to males and females. Males were asked how likely they would be to participate in screening for skin and testicular cancer as adults; females were asked how likely they would be to participate in screening for breast and cervical cancer as adults. Responses of "Not at All Likely" and "Somewhat Likely" were coded as having no or low cancer screening intentions. Family history of cancer was assessed using two items which measured whether any immediate (i.e., parents, siblings) or extended (e.g., grandparents, aunts, uncles) family members had ever been diagnosed or treated for cancer. Participants responding 'yes' to either item were coded as having a family history of cancer.

Cancer Knowledge—Cancer knowledge was assessed using 22 true/false items developed in prior research (Price et al., 1988). A continuous variable was computed by summing responses, with higher scores reflecting greater cancer knowledge (range 0–22, Kuder-Richardson 20 = 0.71).

Prevention Self-Efficacy—Cancer prevention self-efficacy was evaluated through seven 4-point Likert scale response items derived from earlier research (Friedman et al., 1994). Responses were summed into an overall self-efficacy score, with higher values indicating greater prevention self-efficacy (range 7–28, Cronbach's $\alpha = 0.71$).

Perceived Barriers and Benefits—Perceived benefits of adopting cancer-protective health behaviors were assessed using five items with a 4-point Likert scale response and adapted to be age- and content-appropriate for adolescents (Yeomans-Kinney et al., 1995). Items were introduced by the statement: "Here are some possible benefits of leading a healthier lifestyle now (while you are young). Indicate how strongly you agree or disagree with each of the following possible benefits." Examples included: "Prevent cancer and heart disease in the future" and "Stay healthy now and in the future." A summary score was created, with higher scores reflecting greater perceived benefits (range 5–20, Cronbach's $\alpha = 0.68$).

Similarly, five 4-point Likert scale response items adapted from prior research (Friedman et al., 1994) measured perceived barriers of adopting healthy behaviors and participating in cancer screening upon reaching adulthood. Examples included "Don't have enough time" and "Don't believe it is important." Responses were summed into an overall score, with higher values reflecting more perceived barriers (range 5–20, Cronbach's $\alpha = 0.70$). A final variable reflecting the ratio of perceived cancer prevention benefits to barriers was analyzed (Janz and Becker, 1984).

Response Bias—Response bias was assessed using 14 true-false items adapted from the Lie Scale of the Minnesota Multiphasic Personality Inventory-Adolescent (Hays and McCallum, 2005). "True" responses indicate honest reporting and were summed to create a

continuous score, with higher values indicating more honest reporting (range 0 – 14, Kuder-Richardson 20 = 0.61).

Sociodemographics—Sociodemographics included gender, age, and race. Household income was estimated using zip-code level median household income values for participants' home address (Federal Financial Institutions Examination Council, 2010).

Statistical Analysis

Our analytic approach was informed by broader cancer control research literature, which takes into consideration a combination of genetic, behavioral, and epidemiological approaches to understanding patterns of cancer risk (McPherson et al., 2000; Weir et al., 2003). This includes consideration of diverse cancer risk factors (i.e., behavioral/lifestyle risks, family cancer history, participation in cancer screening) and examining the interrelationships among these factors (McPherson et al., 2000; Weir et al., 2003). To determine patterns of co-occurring MCRFs, we cross-tabulated dichotomous risk factor variables to create a frequency matrix of the number and proportion of participants reporting each pair of co-occurring risk factors. Bivariate analyses (i.e., Pearson's r correlations, t tests) were then used to examine relationships between sociodemographic and psychosocial factors and total MCRFs. Finally, a linear regression model was created where sociodemographic and theoretical predictors associated with total MCRFs ($p < 0.10$) in bivariate analyses were regressed onto MCRFs.

Results

Study Sample

Table 1 displays characteristics of the sample ($n = 50$). Participants had scores reflecting relatively high cancer knowledge, prevention self-efficacy, and perceived benefits, few perceived barriers, and tended to respond honestly (Table 1). For example, participants correctly answered an average of 17 of 22 (77%) cancer prevention knowledge questions, similar to adolescents' knowledge with respect to cancer prevention in general (Price et al., 1988) and specific cancers (e.g., skin cancer) (Gerend and Magloire, 2008; Gerhardt et al., 2000; Lowe et al., 1999; Reynolds et al., 1998). Participants' average perceived benefits to cancer prevention nearly doubled perceived barriers, reflecting a strong decisional-balance in the direction of cancer preventive lifestyles (Prochaska et al., 1994). More than half (58%) of participants answered ≥70% of response bias questions with "true" responses, indicating honest reporting.

Patterns of Multiple Cancer Risk Factors

The mean number of MCRFs reported was 4.6 (SD = 1.6) out of nine risk factors assessed, suggesting the collective adolescent risk burden was nearly 50%. All participants reported ≥ 1 cancer risk factor, and 90% reported ≥ 3 risk factors. The most commonly reported risk factors were intentions to use alcohol (80%), < 5 daily servings of fruits/vegetables (80%), and lifetime alcohol use (76%; Table 1). Patterns of pairs of co-occurring cancer risk factors are displayed in Table 2. The most commonly co-occurring risk factor pairs were reporting < 5 daily servings of fruits vegetables by participants who also expressed intentions to use alcohol (66%), a positive family cancer history (50%), lifetime cigarette smoking status (38%), and have < 3 days per week with vigorous physical activity (34%). Half (50%) of participants reported both lifetime alcohol use and a family history of cancer; nearly two-thirds (66%) reported intentions to use alcohol in the future and a family history of cancer. Finally, 38% reported both intentions to use alcohol in the future and lifetime cigarette smoking, while 44% reported both lifetime alcohol use and lifetime cigarette smoking.

Correlates of Multiple Cancer Risk Factors

At the bivariate level, only age (Pearson's $r = 0.26$, $p = 0.07$) and prevention self-efficacy (Pearson's $r = -0.29$, $p = 0.04$) were associated with total MCRFs. In the linear regression model greater age ($B = 0.19$, 95% CI 0.01, 0.38) and lower prevention self-efficacy ($B = -0.16$, 95% CI −0.30, −0.02) were significantly ($p < 0.05$) associated with total MCRFs, after accounting for one another in the model. The model explained 16% of the variance in total MCRFs and suggests that MCRFs tend to accumulate as adolescents grow older, but MCRFs also decrease as self-efficacy to lead a healthy lifestyle increases.

Discussion

Risk for adult-onset cancer is linked to multiple factors, including behavioral and lifestyle risks, as well as family cancer history and engaging in recommended cancer screening (Ezzati et al., 2002; Mokdad et al., 2005). Our findings suggest adolescents report multiple risk factors for adult onset cancer across these domains, indicating a profile of co-occurring risk and highlighting important directions for future research. These results underscore the need for primary prevention strategies for adult onset cancer that target young people and are designed to concurrently address multiple cancer risk factors in order to maximize impact.

Ecological intervention frameworks suggest primary cancer prevention efforts should address multiple risk factors at the social, interpersonal, and individual levels, intervene across diverse contexts (e.g., community, family), and target critical behavior change mediators (Black, 2002; Fuemmeler, 2004; Tercyak, 2008). In terms of intervention contexts, pediatric primary care may be an especially important venue for prevention efforts targeting MCRFs among young people (Black, 2002; Tercyak and Tyc, 2006). In the U.S., a majority of adolescents visit a primary care provider annually for routine care (U.S. Department of Health and Human Services et al., 2009), and annual screening and counseling for multiple risk factors for cancer is recommended (Elster, 1997). A primary care-based approach to primary cancer prevention is consistent with U.S. public health objectives (Koh and Sebelius, 2010), and may also be applicable to international contexts.

Pediatric health care providers can play a vital role in developing and implementing MCRF preventive interventions offered within pediatric primary care settings (Black, 2002; Fuemmeler, 2004). Multidisciplinary research seeking to understand the myriad biological, social, environmental, and psychological processes influencing risk for adult-onset cancer is critically needed to inform prevention efforts targeting young people, and pediatric health care providers are well-positioned to advance this domain of prevention science (Tercyak, 2008). Core preventive interventions that are critical to primary preventive health services include patient education and counseling and individualized motivation-enhancing interventions to foster healthy lifestyles, among other approaches (Fuemmeler, 2004; Tercyak, 2008).

Unfortunately, very little evidence exists to inform the implementation of primary cancer prevention interventions targeting MCRFs in pediatric primary care settings. Our findings highlight important areas for future research to inform the development of such interventions. The most commonly-reported behavioral risk factors contributing to cancer risk included low fruit and vegetable consumption and alcohol-related risk factors. Moreover, risk factors for inadequate fruit and vegetable consumption, alcohol use intentions, physical inactivity, and cigarette smoking commonly co-occurred. Prior investigations among adolescents have largely focused on behaviors related to diet and physical activity (Driskell et al., 2008; Keller et al., 2008; Sanchez et al., 2007) or tobacco, alcohol, and other substance use (Duhig et al., 2005; Lai et al., 2000). Consequently,

researchers have independently called for interventions targeting physical activity and nutrition for obesity prevention (Driskell et al., 2008; Sanchez et al., 2007) or co-occurring substance use behaviors (Duhig et al., 2005). Our results highlight the need for a perspective that considers co-occurrence of risk behaviors across these domains, examines common underlying determinants, and develops targeted interventions accordingly.

MCRF interventions may be especially warranted among potentially high-risk groups. Adolescents reporting a family history of cancer were also likely to report MCRFs, such as poor diet and tobacco and alcohol use risk factors. A family history of cancer is an indicator of potentially increased personal risk for certain inheritable forms of cancer. Young peoples' awareness of history of cancer in their family may represent an important opportunity to intervene and reduce their cancer risk by encouraging healthy, cancer preventive choices (Perera, 2000). Adolescents with co-occurring tobacco and alcohol use risk behaviors may also require specialized intervention approaches, as these behaviors have been demonstrated to cluster among adults (Berrigan et al., 2003) and the stage for such patterns appears to be set early in life.

The finding that MCRFs increase with age is consistent with prior research (Driskell et al., 2008; Sanchez et al., 2007) and recent population-level data (Eaton et al., 2010). Given that behavioral habits tend to originate early in life and subsequently track into adulthood (Institute of Medicine, 2008), this result highlights the need to develop multiple health behavior change primary cancer prevention strategies targeting children and younger adolescents. This will help to establish healthy behavioral habits early in life before behavioral risk factors for cancer accumulate (Tercyak and Tyc, 2006; Werch, 2007).

With respect to self-efficacy, our investigation represents a unique contribution to this area of research, as we are not aware of another study that has examined the relationship between adolescents' cancer prevention self-efficacy and MCRFs. Cancer prevention self-efficacy may be an important mediating mechanism of behavior change and a critical target for multiple health behavior change preventive interventions seeking to move young people in the direction of healthy behaviors (Driskell et al., 2008). Nevertheless, evidence regarding the optimal psychosocial targets for multiple health behavior change interventions among youths remains limited. Research is needed to advance our understanding of theory-driven approaches to multiple health behavior change among young people, including mixed methods approaches to understand in greater depth the role of psychosocial factors in adolescent MCRF interventions.

Limitations

Our findings should be interpreted in light of important study limitations. The small sample of adolescents reduces generalizability of findings to broader populations and prohibited a formal statistical analysis of MCRF clusters (i.e., cluster analysis). We included only adolescents from the U.S. who spoke English and were presenting for well-visit appointments; future research examining these issues among diverse populations is warranted. Participants were also adolescents of an age range that likely spanned developmentally distinct groups, which may have influenced the findings. Finally, we employed brief, self-report measures of MCRFs, and while the results did not indicate that participants were prone to response bias, they should be interpreted with this methodological consideration in mind.

Conclusions

Our results suggest a profile of co-occurring risk factors for adult onset cancer among adolescents and indicate a need for early multiple health behavior change interventions to

prevent the accumulation of cancer risk factors as adolescents grow older. Pediatric health care providers can play a critical role in such efforts by screening young patients for multiple cancer risk factors and offering individualized interventions to foster healthy lifestyles and avoid cancer risk (Fuemmeler, 2004; Tercyak, 2008). Our findings specifically suggest self-efficacy – one's confidence to engage in a healthy, cancer preventive lifestyle– is an important intervention target.

This study also highlights several important avenues for future research to improve our understanding of patterns and correlates of risk factors for adult onset cancer among adolescents and inform preventive interventions. The study sample consisted of English-speaking U.S. adolescents, and research among larger, more diverse populations is needed. Research in contexts outside of the U.S. is needed to inform screening and intervention strategies for adolescent MCRFs in pediatric health care settings internationally. Finally, additional research is also needed to examine more closely the role of self-efficacy and other psychosocial factors in multiple health behavior change cancer preventive interventions for young people.

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Abbreviations

MCRFs Multiple cancer risk factors

References

Ajzen I. The theory of planned behavior. Organizational Behavior and Human Decision Processes. 1991; 50(2):179–211.

Bandura, A. Self-efficacy: The Exercise of Control. New York: W.H. Freeman; 1997.

Berrigan D, Dodd K, Troiano RP, Krebs-Smith SM, Barbash RB. Patterns of health behavior in U.S adults. Preventive Medicine. 2003; 36(5):615–623. [PubMed: 12689807]

Black MM. Society of pediatric psychology presidential address: opportunities for health promotion in primary care. Journal of Pediatric Psychology. 2002; 27(7):637–646. [PubMed: 12228335]

Brener ND, Collins JL. Co-occurrence of health-risk behaviors among adolescents in the United States. The Journal of Adolescent Health. 1998; 22(3):209–213. [PubMed: 9502008]

Brener ND, Kann L, Kinchen SA, Grunbaum JA, Whalen L, Eaton D, Hawkins J, Ross JG. Methodology of the youth risk behavior surveillance system. Morbidity and Mortality Weekly Report. 2004; 53(RR-12):1–13.

Danaei G, Vander Hoorn S, Lopez AD, Murray CJ, Ezzati M. Comparative Risk Assessment collaborating group (Cancers) . Causes of cancer in the world: comparative risk assessment of nine behavioural and environmental risk factors. Lancet. 2005; 366(9499):1784–1793. [PubMed: 16298215]

Driskell MM, Dyment S, Mauriello L, Castle P, Sherman K. Relationships among multiple behaviors for childhood and adolescent obesity prevention. Preventive Medicine. 2008; 46(3):209–215. [PubMed: 17714771]

Duhig AM, Cavallo DA, McKee SA, George TP, Krishnan-Sarin S. Daily patterns of alcohol, cigarette, and marijuana use in adolescent smokers and nonsmokers. Addictive Behaviors. 2005; 30(2):271–283. [PubMed: 15621398]

Eaton DK, Kann L, Kinchen S, Shanklin S, Ross J, Hawkins J, Harris WA, Lowry R, McManus T, Chyen D, Lim C, Whittle L, Brener ND, Wechsler H. Centers for Disease Control and Prevention

(CDC). Youth risk behavior surveillance -United States, 2009. MMWR Surveillance Summaries: Morbidity and Mortality Weekly Report. 2010; 59(5):1–142.

Elster A. The American Medical Association Guidelines for Adolescent Preventive Services. Archives of Pediatrics & Adolescent Medicine. 1997; 151(9):958–959. [PubMed: 9308880]

Emmons KM, Marcus BH, Linnan L, Rossi JS, Abrams DB. Mechanisms in multiple risk factor interventions: smoking, physical activity, and dietary fat intake among manufacturing workers. Working Well Research Group. Preventive Medicine. 1994; 23(4):481–489. [PubMed: 7971876]

Emmons KM, McBride CM, Puleo E, Pollak KI, Clipp E, Kuntz K, Marcus BH, Napolitano M, Onken J, Farraye F, Fletcher R. Project PREVENT: a randomized trial to reduce multiple behavioral risk factors for colon cancer. Cancer Epidemiology, Biomarkers and Prevention. 2005; 14(6):1453–1459.

Everett SA, Malarcher AM, Sharp DJ, Husten CG, Giovino GA. Relationship between cigarette, smokeless tobacco, and cigar use, and other health risk behaviors among U.S high school students. The Journal of School Health. 2000; 70(6):234–240. [PubMed: 10937370]

Ezzati M, Lopez AD, Rodgers A, Vander HS, Murray CJ. Comparative Risk Assessment Collaborating Group . Selected major risk factors and global and regional burden of disease. Lancet. 2002; 360(9343):1347–1360. [PubMed: 12423980]

Federal Financial Institutions Examination Council. Geocoding System. URL (consulted 25 August 2010): http://www.ffiec.gov/geocode/default.aspx

Francis, JJ.; Eccles, MP.; Johnston, M.; Walker, A.; Grimshaw, J.; Foy, R.; Kaner, EFS.; Smith, L.; Bonetti, D. Constructing Questionnaires Based on the Theory of Planned Behaviour: A Manual for Health Services Researchers. Newcastle upon Tyne, United Kingdom: Centre for Health Services Research, University of Newcastle; 2004.

Friedman LC, Nelson DV, Webb JA, Hoffman LP, Baer PE. Dispositional optimism, self-efficacy, and health beliefs as predictors of breast self-examination. American Journal of Preventive Medicine. 1994; 10(3):130–135. [PubMed: 7917437]

Fuemmeler BF. Bridging disciplines: an introduction to the special issue on public health and pediatric psychology. Journal of Pediatric Psychology. 2004; 29(6):405–414. [PubMed: 15277584]

Gerend MA, Magloire ZF. Awareness, knowledge, and beliefs about human papillomavirus in a racially diverse sample of young adults. The Journal of Adolescent Health. 2008; 42(3):237–242. [PubMed: 18295131]

Gerhardt CA, Pong K, Kollar LM, Hillard PJ, Rosenthal SL. 'Adolescents' knowledge of human papillomavirus and cervical dysplasia. Journal of Pediatric and Adolescent Gynecology. 2000; 13(1):15–20. [PubMed: 10742668]

Hays S, McCallum RS. A comparison of the pencil-and-paper and computer-administered Minnesota Multiphasic Personality Inventory-Adolescent. Psychology in the Schools. 2005; 42(6):605–613.

Institute of Medicine. Adolescent Health Services: Missing Opportunities. Washington, DC: National Academy of Sciences; 2008.

Janz NK, Becker MH. The Health Belief Model: a decade later. Health Education Quarterly. 1984; 11(1):1–47. [PubMed: 6392204]

Janz, NK.; Champion, VL.; Strecher, VJ. The Health Belief Model. In: Glanz, K.; Rimer, BK.; Lewis, FM., editors. Health Behavior and Health Education: Theory, Research, and Practice. San Francisco, CA: Jossey-Bass; 2002. p. 45-66.

Jemal A, Ward E, Hao Y, Thun M. Trends in the leading causes of death in the United States, 1970–2002. JAMA: The Journal of the American Medical Association. 2005; 294(10):1255–1259. [PubMed: 16160134]

Keller S, Maddock JE, Hannover W, Thyrian JR, Basler HD. Multiple health risk behaviors in German first year university students. Preventive Medicine. 2008; 46(3):189–195. [PubMed: 18242666]

Koh HK, Sebelius KG. Promoting prevention through the Affordable Care Act. The New England Journal of Medicine. 2010; 363(14):1296–1299. [PubMed: 20879876]

Kulbok PA, Cox CL. Dimensions of adolescent health behavior. The Journal of Adolescent Health. 2002; 31(5):394–400. [PubMed: 12401425]

Lai S, Lai H, Page JB, McCoy CB. The association between cigarette smoking and drug abuse in the United States. Journal of Addictive Diseases. 2000; 19(4):11–24. [PubMed: 11110061]

Lopez ML, Iglesias JM, del Valle MO, Comas A, Fernandez JM, de Vries H, Lana A, Garcia JB, Lopez S, Cueto A. FAPACAN Group . Impact of a primary care intervention on smoking, drinking, diet, weight, sun exposure, and work risk in families with cancer experience. Cancer Causes & Control. 2007; 18(5):525–535. [PubMed: 17450417]

Lowe JB, Balanda KP, Stanton WR, Gillespie A. Evaluation of a three-year school-based intervention to increase adolescent sun protection. Health Education & Behavior. 1999; 26(3):396–408. [PubMed: 10349576]

Mays D, Peshkin BN, Sharff ME, Walker LR, Abraham AA, Hawkins KR, Tercyak KP. Correlates of adherence to a telephone-based multiple health behavior change cancer prevention intervention for teens: The Health for Life Program (HELP). Health Education & Behavior. 2011

McGuire-Dunn, C.; Chadwick, GL. Protecting Study Volunteers in Research: A Manual for Investigative Sites. 3. Boston, MA: Thomson CenterWatch; 2004.

McPherson K, Steel CM, Dixon JM. ABC of breast diseases. Breast cancer-epidemiology, risk factors, and genetics. BMJ: British Medical Journal. 2000; 321(7261):624–628.

Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Correction: actual causes of death in the United States, 2000. JAMA: The Journal of the American Medical Association. 2005; 293(3):293–294. [PubMed: 15657315]

Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. JAMA: The Journal of the American Medical Association. 2008; 299(20):2401–2405. [PubMed: 18505949]

Parkin DM, Bray F, Ferlay J, Pisani P. Global cancer statistics, 2002. CA: A Cancer Journal for Clinicians. 2005; 55(2):74–108. [PubMed: 15761078]

Perera FP. Molecular epidemiology: on the path to prevention? Journal of the National Cancer Institute. 2000; 92(8):602–612. [PubMed: 10772677]

Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Merritt RK. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. Health Psychology. 1996; 15(5):355–361. [PubMed: 8891714]

Price JH, Desmond SM, Wallace M, Smith D, Stewart PM. Differences in black and white adolescents' perceptions about cancer. The Journal of School Health. 1988; 58(2):66–70. [PubMed: 3352228]

Prochaska JJ, Spring B, Nigg CR. Multiple health behavior change research: an introduction and overview. Preventive Medicine. 2008; 46(3):181–188. [PubMed: 18319098]

Prochaska JO, Velicer WF, Rossi JS, Goldstein MG, Marcus BH, Rakowski W, Fiore C, Harlow LL, Redding CA, Rosenbloom D. Stages of change and decisional balance for 12 problem behaviors. Health Psychology. 1994; 13(1):39–46. [PubMed: 8168470]

Reynolds KD, Raczynski JM, Binkley D, Franklin FA, Duvall RC, Devane-Hart K, Harrington KF, Caldwell E, Jester P, Bragg C, Fouad M. Design of "High 5": a school-based study to promote fruit and vegetable consumption for reduction of cancer risk. Journal of Cancer Education. 1998; 13(3):169–177. [PubMed: 10898562]

Rice M, Broome ME. Incentives for children in research. Journal of Nursing Scholarship. 2004; 36(2): 167–172. [PubMed: 15227765]

Sanchez A, Norman GJ, Sallis JF, Calfas KJ, Cella J, Patrick K. Patterns and correlates of physical activity and nutrition behaviors in adolescents. American Journal of Preventive Medicine. 2007; 32(2):124–130. [PubMed: 17197153]

Tercyak KP. Editorial: prevention in child health psychology and the Journal of Pediatric Psychology. Journal of Pediatric Psychology. 2008; 33(1):31–34. [PubMed: 17893098]

Tercyak KP, Donze JR, Prahlad S, Mosher RB, Shad AT. Multiple behavioral risk factors among adolescent survivors of childhood cancer in the Survivor Health and Resilience Education (SHARE) program. Pediatric Blood & Cancer. 2006; 47(6):825–830. [PubMed: 16333821]

Tercyak KP, Tyc VL. Opportunities and challenges in the prevention and control of cancer and other chronic diseases: children's diet and nutrition and weight and physical activity. Journal of Pediatric Psychology. 2006; 31(8):750–763. [PubMed: 16820383]

U.S. Department of Health and Human Services. Healthy People 2010: Understanding and Improving Health. Washington, DC: U.S. Government Printing Office; 2000.

U.S. Department of Health and Human Services. Healthy People 2020. U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion; Washington, DC: 2010. Publication No: B0132

U.S. Department of Health and Human Services, Health Resources and Services Administration, and Maternal and Child Health Bureau. Child Health USA 2008–2009. Rockville, MD: U.S. Department of Health and Human Services; 2009.

Weir HK, Thun MJ, Hankey BF, Ries LA, Howe HL, Wingo PA, Jemal A, Ward E, Anderson RN, Edwards BK. Annual report to the nation on the status of cancer, 1975–2000, featuring the uses of surveillance data for cancer prevention and control. Journal of the National Cancer Institute. 2003; 95(17):1276–1299. [PubMed: 12953083]

Werch CC. The Behavior-Image Model: a paradigm for integrating prevention and health promotion in brief interventions. Health Education Research. 2007; 22(5):677–690. [PubMed: 17138616]

World Health Organization. Noncommunicable Diseases Country Profiles 2011: WHO Global Report. Geneva, Switzerland: WHO Press; 2011.

Yeomans-Kinney A, Vernon SW, Frankowski RF, Weber DM, Bitsura JM, Vogel VG. Factors related to enrollment in the breast cancer prevention trial at a comprehensive cancer center during the first year of recruitment. Cancer. 1995; 76(1):46–56. [PubMed: 8630876]

Zweig JM, Phillips SD, Lindberg LD. Predicting adolescent profiles of risk: looking beyond demographics. The Journal of Adolescent Health. 2002; 31(4):343–353. [PubMed: 12359380]

Table 1

Sample characteristics ($n = 50$)

Sociodemographics	***m***	***sd***	***n***	***%***
Age	16.6	2.3		
Race/Ethnicity				
White			20	40
Non-white			30	60
Gender				
Male			16	32
Female			34	68
Annual Household Income ($)	$70,337	$45,798		
Psychosocial Predictors				
Cancer Knowledge (α = 0.71, range 0 – 22)	17.2	3.1		
Prevention Self-Efficacy (α = 0.71, range 7–28)	21.9	3.2		
Prevention Benefits:Barriers	1.9	0.7		
Cancer Risk Factors (range 0–9)	4.6	1.6		
No or Low Cancer Screening Intentions			14	28
Intentions to Smoke Cigarettes			9	18
Lifetime Cigarette Smoking			23	46
Intentions to Use Alcohol			40	80
Lifetime Alcohol Use			38	76
< 3 Days Per Week with Vigorous Physical Act.			20	40
< 5 Daily Servings of Fruit/Vegetables			40	80
Overweight/Obese Status (BMI ≥ 25)			14	28
Family History of Cancer			32	64

Table 2

Number and proportion of participants reporting co-occurring risk factors for cancer

	1	2	3	4	5	6	7	8	9
1. Overweight/Obese	14 28%								
2. Family History of Cancer	8 16%	32 64%							
3. No or Low Future Cancer Screening Intentions	5 10%	10 20%	14 28%						
4. < 3 Days Per Week with Vigorous Physical Activity	6 12%	7 14%	3 6%	20 40%					
5. < 5 Daily Servings of Fruit/Vegetables	11 22%	25 50%	12 24%	17 34%	40 80%				
6. Intentions to Smoke Cigarettes	1 2%	7 14%	3 6%	3 6%	7 14%	9 18%			
7. Lifetime Cigarette Smoking	7 14%	14 28%	10 20%	11 22%	19 38%	9 18%	23 46%		
8. Intentions to Use Alcohol	10 20%	27 54%	12 24%	16 32%	33 66%	9 18%	19 38%	40 80%	
9. Lifetime Drinking	12 24%	25 50%	11 22%	15 30%	30 60%	9 18%	22 44%	33 66%	38 76%

Values reflect the number and percentage of study participants (n = 50) reporting each pair of cancer risk factors