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ORIGINAL ARTICLE

Lay Awareness of the Relationship between Age and Cancer Risk

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Abstract

Background Cross-sectional studies suggest many people are unaware that cancer risk increases with age, but this misbelief has rarely been studied prospectively, nor are its moderators known.

Purpose To assess whether people recognize that cancer risk increases with age and whether beliefs differ according to gender, education, smoking status, and family history of cancer.

Methods First, items from the cross-sectional Health Information National Trends Survey ($n = 2069$) were analyzed to examine the association of age and perceived cancer risk. Second, the prospective National Survey of Midlife Development in the United States ($n = 3896$) was used to assess whether perceived cancer risk changes over a decade. Third, beliefs about the age at which cancer occurs were analyzed using the US Awareness and Beliefs about Cancer survey ($n = 1080$). As a comparator, perceived risk of heart disease was also examined.

Results Cross-sectionally, older age was associated with *lower* perceived cancer risk but *higher* perceived heart disease risk. Prospectively, perceived cancer risk remained stable, whereas perceived heart attack risk increased. Seventy percent of participants reported a belief that cancer is equally likely to affect people of any age. Across three surveys, women and former smokers/smokers who recently quit tended to misunderstand the relationship between age and cancer risk and also expressed relatively higher perceived cancer risk overall.

Conclusions Data from three national surveys indicated that people are unaware that age is a risk factor for cancer. Moreover, those who were least aware perceived the highest risk of cancer regardless of age.

Keywords Age · Risk perceptions · Cancer · Heart disease · Gender · Education · Family history

Introduction

Awareness of disease risk may be important for adoption of appropriate preventive and screening behaviors, and accordingly, is a component of many health behavior theories [1–3]. Epidemiological studies indicate that cancer incidence increases substantially with age [1, 2]. However, cross-sectional surveys find that *younger* adults think their risk of cancer is higher than do older adults [3]. This study reports secondary analyses of three national surveys of US adults to extend prior findings concerning the lack of awareness that cancer risk increases with age.

Lay beliefs about cancer risk and its association with age can be assessed in multiple ways. One approach is to look at the association of age with perceived personal risk cross-sectionally. This type of study has found that either older adults report lower cancer risk than do younger adults [3–7] or older and younger adults hold comparable risk perceptions [8, 9]. Prior evidence is limited because most studies focused on women's perceived risk of breast and/or ovarian cancer [3], although the pattern has been shown in a few mixed-gender samples for perceived risk

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of colon cancer [10], skin cancer [11], and cancer in general [12]. However, compared to the many studies that have focused on women exclusively, relatively little is known about whether the negative association of age with perceived risk of cancer extends to perceived risk of cancer in general (i.e., not specific to a particular type of cancer) or to men. A related limitation is the virtual absence of information about moderators of the age-cancer risk association. To address these limitations, we tested whether demographic factors—gender, level of education, smoking status, and family history of cancer—differentiated between persons who report more or less awareness that age is a risk factor for cancer.

Gender was examined because women generally perceive their risk of cancer to be higher than do men [12], and one study found that men were more aware of age as a risk factor for cancer than were women [13]. Education was examined because prior evidence showed that women with less education report greater perceived risk for breast cancer [3] and because people with more education might have greater awareness that age is a risk factor for cancer. Smoking status was examined because smoking is a widely publicized risk factor for cancer and current and former smokers have reported greater perceived risk of cancer [12, 14], and one study showed that former smokers' perceived risk of cancer decreased over a 2-year period [15].

Family history of cancer was included because it is also a well-known risk factor for cancer and a strong predictor of perceived risk [3, 5, 16–18]. A family history of cancer might make cancer risk more salient across the lifespan and thereby buffer against a reduction in perceived risk with age. Alternatively, absent-exempt beliefs, or thinking one is exempt from future risk if the negative event has not occurred yet [6, 9, 19, 20], might produce the opposite effect. As an illustration, in a study of women at high risk for breast cancer, one woman "had passed the age at which her relatives were diagnosed and felt at low risk because 'if I was going to get it, I would have gotten it by now, surely'" ([21], p. 7). In another study [22], participants who believed they had aged out of the risk period for cancer "typically referenc[ed] the age at which their family members had been diagnosed with cancer" (p. 8). Thus, there are alternative hypotheses about how family history of cancer affects the age-risk association. *Personal* history of cancer was not assessed as a moderator as perceived risk of cancer is typically not asked of cancer survivors.

A third limitation of prior work is that nearly all previous studies are cross-sectional, leaving uncertain whether younger adults reported greater perceived risk of cancer because of their age or because of generational effects. The few prospective studies examining changes in perceived risk involved provision of cancer-relevant information. Of note, women in one study (who did not receive such information), showed slight decreases in perceived breast cancer risk over 1 year [16]. In another study, men's perceived risk of colorectal cancer declined over 2 years regardless of information provision condition [23].

Moving beyond cross-sectional and prospective surveys of perceived personal risk of cancer, a more direct way to assess awareness of age as a risk factor for cancer is to elicit "timeline risk beliefs" [24]. Timeline risk beliefs can be assessed as perceptions of how likely same-aged peers are to develop disease. These beliefs are associated with health cognitions such as worry, perceived control, and intentions to engage in preventive behaviors [24]. When asked directly, both men and women are unaware that age increases cancer risk [25]. Less than 30 % of women in one study believed that aging increases risk for breast, cervix, or colon cancer [26]. Among men, one third endorsed age as a risk factor for colon cancer and half endorsed age as a risk factor for prostate cancer [13]. Knowledge may differ by age: more older women knew that breast carcinoma is more common among women age 65 vs. age 40 (32 %) than younger women (21 %) [27]. Thus, we examined timeline beliefs as well as moderators of these beliefs.

The current literature also leaves unresolved whether lack of awareness of age as a risk factor is unique to cancer; people may believe risk for all diseases decreases with age. Although several studies found that older women rate their risk of cardiovascular disease higher than do younger women [8, 28, 29], consistent with epidemiological evidence that age increases risk for heart disease [2], some studies have not shown this positive association [6, 9]. We treated heart disease risk as a comparative referent and examined whether associations of perceived risk with age, and change in perceived risk over time, differed between cancer and heart disease.

In sum, our aims were to examine the association of age with perceived personal risk of cancer and timeline risk beliefs in three national samples of US adults using both prospective and cross-sectional data, to conduct exploratory analyses systematically examining moderators of this association, and to test whether patterns in findings extended to perceived heart disease risk.

Study 1

Using cross-sectional data from a nationally representative survey, study 1 allowed us to (1) replicate the negative association between age and perceived risk of cancer previously shown (including studies that used previous iterations of this survey [10, 11, 30], and more importantly, to (2) examine moderators of this association.

Methods

Data were obtained from the Health Information National Trends Survey (HINTS 4, Cycle 3), a cross-sectional nationally representative survey of 3185 US adults. This assessment of HINTS was chosen because it included multiple measures of risk perception for cancer and heart disease. Data were collected from September through December 2013. Full study details are available elsewhere [31, 32]. The complete survey is online at http://hints.cancer.gov/docs/Instruments/HINTS_4_Cycle_3_English_Annotated_508c_3_21_2014.pdf. The survey included three types of perceived risk items. Perceived *absolute risk of cancer* was assessed with the item, "How likely are you to get cancer in your lifetime?" from 1 (very unlikely) to 5 (very likely). Perceived *comparative risk of cancer* was assessed with, "Compared to other people your age, how likely are you to get cancer in your lifetime?" from 1 (much less likely) to 5 (much more likely). Perceived *experiential risk of cancer* was assessed with, "I feel like I could easily get cancer in my lifetime" from 1 (I feel very strongly that this will NOT happen) to 5 (I feel very strongly that this WILL happen). Perceived *absolute risk of heart disease* was assessed with, "How likely are you to get heart disease in your lifetime?" from 1 (very unlikely) to 5 (very likely).

Age was treated as continuous. Participants reported their level of education (treated as categorical: less than high school, high school, some college, college degree or higher); race (1 = non-White, 0 = White); and gender (1 = male, 0 = female). Smoking status was assessed with two questions: "Have you smoked at least 100 cigarettes in your entire life?" and "How often do you now smoke cigarettes?" Participants who said "no" to the first question were coded as never smokers. Those who said "yes" to the first question and "not at all" to the second were coded as former smokers. Those who said "yes" to the first question and "everyday" or "some days" to the second were coded as current smokers. These variables were coded into former smokers (1 = yes, 0 = no) and current smokers (1 = yes, 0 = no). Family history of cancer was assessed with, "Have any of your family members ever had cancer?" (1 = yes, 0 = no; "not sure" was coded as missing).

Analyses were restricted to 2069 respondents who provided their age, race, gender, and education and who completed absolute perceived risk of cancer and heart disease, and did not have a personal history of cancer or heart disease. The sample size differs across analyses due to missing data on other risk measures, smoking status, and family history. A set of 50 jackknife replicate weights was used to account for the complex sampling design and to obtain nationally representative parameter estimates [32]. All frequencies are unweighted and all percentages are weighted. Data were analyzed in SAS version 9.3 and SAS-callable SUDAAN version 11.0.0. Significance level was set at $p < .05$; we report but do not discuss results for which $p < .10$.

Results and Discussion

Of the 2069 participants, most were White (80.0%), half were male (49.1%), and one third had a college education or higher (35.5 %; 7.8 % < high school, 31.7 % completed high school, 25.0 % some college). The average age was 44.1 years (SE = 0.29; range = 18 to 105). Over half (56.7 %) were never smokers, 22.6 % were former smokers, and 20.7 % were current smokers; 74.2 % reported a family history of cancer. Perceived absolute (M = 3.11, SE = 0.03); comparative (M = 2.76, SE = 0.03); and experiential risk (M = 2.73, SE = 0.03) of cancer fell around the midpoint of the scale, as did perceived risk of heart disease (M = 2.92, SE = 0.04).

The association of age with perceived risk of cancer or heart disease was assessed in four linear regression analyses controlling for race, education, and gender (Table 1). In contrast to epidemiological data, older age was associated with *lower* perceived absolute ($\beta = -0.006$, SE = 0.002, $t = -3.50$, 95 % confidence interval (CI) = −0.009 to −0.002, $p = .001$) and experiential ($\beta = 0.005$, SE = 0.002, $t = -2.50$, CI = −0.0091 to −0.0009, $p = .016$) risk of cancer but was not significantly associated with perceived comparative risk of cancer ($\beta = -0.003$, SE = 0.002, $t = -1.59$, CI = −0.006 to 0.0007, $p = .118$). However, consistent with epidemiological data, older age was associated with *greater* perceived risk of *heart disease* ($\beta = 0.006$, SE = 0.003, $t = 2.38$, CI = 0.001 to 0.012, $p = .021$). Table 1 presents main effects of gender, education, and race in these analyses, which differ somewhat according to risk measure. Specifically, women reported greater perceived absolute and experiential risk than men. White individuals reported greater perceived risk than non-White individuals. There were no main effects of education. Current and former smokers and those with a family history of cancer reported higher perceived cancer risk than never smokers and those without a family history, respectively.

Next, the moderating effects of gender, education, smoking status, and family history of cancer were tested, controlling for the set of sociodemographic covariates reported previously (16 total regressions). Age did not significantly interact with any factor to predict perceived heart disease risk (all ps >.63). Of the 12 interactions involving perceived cancer risk, three met the $p < .05$ criterion and two met the $p < .10$ criterion; we describe only these five analyses. The three significant interactions are shown in Fig. 1, which includes notation on the significance of simple slopes [33]. A significant interaction between age and gender predicted perceived experiential risk ($\beta = 0.008$, SE = 0.004, $t = 2.19$, CI = 0.0006 to 0.015, $p = .033$; Fig. 1a), such that age and perceived risk were negatively correlated for women ($\beta = -0.008$, $p < .001$) but not men ($\beta = -0.0060$, $p = .869$). The interaction for absolute

Table 1 Results of linear regression analyses testing main effects of age and gender, education, smoking status, and family history of cancer as predictors of perceived risk in cross-sectional HINTS 4, cycle 3 data (study 1)

	Absolute perceived risk of cancer			Comparative perceived risk of cancer			Experiential perceived risk of cancer			Absolute perceived risk of heart disease		
	β	SE	95 % CI	β	SE	95 % CI	β	SE	95 % CI	β	SE	95 % CI
Model 1												
Age	−.006*	.002	−.009, −.002	−.003	.002	−.006, .001	−.005*	.002	−.009, −.001	.006*	.003	.001, .012
Male	−.123*	.055	−.233, −.012	−.081	.049	−.179, .017	−.119*	.051	−.222, −.017	−.068	.062	−.192, .056
Education (REF = less than high school)												
High school	.094	.124	−.155, .343	.144	.124	−.106, .393	.133	.122	−.111, .378	.098	.107	−.117, .313
Some college	.139	.128	−.117, .396	.161	.128	−.097, .419	.072	.109	−.147, .291	.036	.129	−.224, .295
College	.106	.103	−.101, .314	.002	.118	−.234, .239	.073	.111	−.150, .296	−.106	.119	−.345, .132
Non-White race	−.366*	.071	−.510, −.223	−.297*	.072	−.442, −.151	−.402*	.073	−.549, −.255	−.191*	.091	−.374, −.008
Model 2[a]												
Smoking status (REF = never smoker)												
Former smoker	.121^	.061	−.002, .245	.141*	.028	.025, .257	.005	.068	−.133, .142	−.011	.079	−.170, .149
Current smoker	.197^	.102	−.007, .402	.473*	.102	.268, .677	.301*	.082	.136, .466	.097	.099	−.101, .296
Model 3[a]												
Family history of cancer	.483*	.063	.357, .609	.435*	.061	.313, .558	.480*	.056	.367, .593	.099	.075	−.052, .250

Dichotomous variables were coded as follows: gender (male = 1; female = 0); Race (non-White = 1, White = 0); Family history of cancer (yes = 1, no = 0)

[a] Analysis controls for age, gender, education, and race

*$p < .05$; ^$p < .10$

risk was not significant (β = 0.007, SE = 0.004, t = 1.20, CI = −0.00004 to 0.014, p = .051) but the pattern of correlations of age with perceived risk for women (β = −0.009, p < .001) compared to men (β = −0.002, p = .554) was similar to that seen for experiential risk. To test the interaction of education and age, education was coded into three variables; education did not significantly interact with age to predict any of the three risk measures. For absolute (β = −0.012, SE = 0.004, t = −3.49, CI = −0.019 to −0.005, p = .001; Fig. 1b) and comparative (β = −0.014, SE = 0.004, t = −3.81, CI = −0.022 to −0.007, p < .001; Fig. 1c) risk, the association of perceived risk and age differed between former and never smokers (as indicated by significant former smoker by age interactions). For comparative risk, the association of perceived risk and age also differed between current and never smokers (as indicated by the current smoker by age interaction: β = −0.009, SE = 0.003, t = −2.61, CI = −0.015 to −0.002, p = .012; Fig. 1c). In these analyses, age and perceived risk were negatively correlated for former smokers (absolute risk: β = −0.015, p < .001; comparative risk: β = −0.011, p < .001) and marginally so for current smokers (comparative risk: β = −0.007, p = .097). The interaction of family history of cancer with age was marginally significant only for absolute risk (β = −0.006, SE = 0.003, t = −1.85, CI = −0.013 to 0.0006, p = .071) such that age and perceived risk were negatively correlated for those with a family history

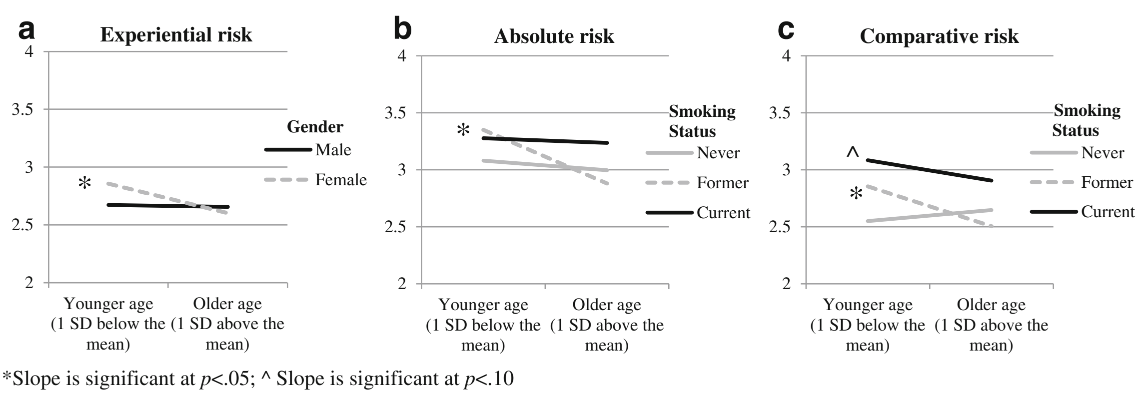

Fig. 1 Interaction of age with gender and smoking status predicting multiple types of perceived cancer risk assessments in cross-sectional HINTS 4, cycle 3 data (study 1). *Slope is significant at $p < .05$; ^Slope is significant at $p < .10$

of cancer ($\beta = -0.007$, $p < .001$) but not for those without ($\beta = -0.001$, $p = .774$).

In sum, moderator analyses indicated that older age was typically associated with lower perceived cancer risk among women and former smokers. These patterns were unique to cancer risk, as older adults *did* report greater perceived risk of heart disease than did younger adults.

Study 2

The results of study 1 are limited by the cross-sectional design because generational, rather than age effects, may account for the lack of a positive association between age and perceived risk of cancer. Study 2 used a longitudinal data-set to determine whether perceived risk of cancer and heart attack increases or decreases over time, and for whom.

Methods

Data from the longitudinal National Survey of Midlife Development in the US (MIDUS), which included two assessments approximately 10 years apart (wave 1 in 1995–1996 and wave 2 in 2004–2006), were used. Random digit dialing was used to establish the cohort. Seven thousand one hundred ninety respondents aged 25–74 years completed wave 1, and 4963 were retained in wave 2. Data for the present study involved a telephone-administered questionnaire at waves 1 and 2. Additional information about survey methodology, data, and codebooks is available at midus.wisc.edu.

Those who reported "yes" or "do not know" to "Have you ever had cancer?" or "a heart attack" at either waves 1 or 2 were excluded from analyses. Because the responses of "skin cancer" and "melanoma" were combined in the follow-up item assessing type of cancer, we excluded participants who gave either of these responses. The functional sample size was 3896 respondents without a personal history of cancer or heart attack who completed perceived cancer and heart attack risk at waves 1 and 2.

Perceived comparative risk was assessed at waves 1 and 2 (absolute perceived risk was not assessed). Perceived risk of cancer was queried with, "Do you think your risk of cancer is higher, lower, or about the same as other (men/women) your age?" Those who said "higher" were asked "Would you say a lot higher, somewhat higher, or only a little higher?" and a parallel question was posed for those who said "lower." Responses to these three questions were compiled into one item with responses ranging from 0 (lowest risk) to 6 (highest risk). "A heart attack" replaced "cancer" in similar items assessing perceived comparative risk of heart attack.

Age at wave 1 was measured by subtracting participants' birthday from the date they completed the survey. Age was coded into six categories (20–29, 30–39, 40–49, 50–59, 60–69, 70+) so that it could be entered as a factor in an analyses of variance (ANOVA). Gender and highest level of education (less than high school, high school, some college, college degree or higher) were assessed at wave 1. Participants reported their race, which was coded as White vs. non-White. Family history of cancer was only assessed at wave 2 with the item, "Who in your immediate biological family—that is, your biological parents, brothers, sisters, or children—have ever had cancer?" Reporting at least one family member with cancer was classified as having a family history of cancer; those who marked "do not know" were excluded from analyses involving this variable.

Smoking status was assessed with three items at waves 1 and 2. Participants were asked, "At what age did you have your very first cigarette?" If respondents said "I don't smoke," they were asked "At what age did you have your very FIRST cigarette, if EVER?" If they said "never," they were coded as a never smoker. Participants who gave an age for their first cigarette were then asked "Have you ever smoked cigarettes regularly —that is, at least a few cigarettes every day?" If respondents said "no" they were coded as a never smoker and those who said "do not know" were excluded from these analyses. Of note, this item may overestimate the number of never smokers. Participants who said "yes" were then asked, "Do you smoke cigarettes regularly NOW?" If necessary, the interviewer clarified with "By regularly I mean at least a few cigarettes every day." Participants who said "yes" to smoking regularly now were coded as current smokers, those who said "no" were coded as former smokers, and those who said "do not know" were excluded from these analyses.

Participants' smoking classification at waves 1 and 2 was used to code "smoking status change." Never smokers were those classified as never smokers at waves 1 and 2. Former smokers were those classified as former smokers at waves 1 and 2. Current smokers were those classified as current smokers at waves 1 and 2. A "quit smoking" classification was given to participants who were current smokers at wave 1 and former smokers at wave 2. A "started smoking" classification was given to participants who were never or former smokers at wave 1 and current smokers at wave 2.

Repeated-measures analyses of variance (ANOVA) tested changes in perceived risk as a function of time (waves 1, 2) and risk type (perceived risk of cancer and heart attack). We tested the moderating role of five categorical factors that were treated as between-groups factors in separate analyses: age group, gender, education, smoking status change, and family history of cancer. The sample size differed across analyses because of missing moderator data.

Results and Discussion

Participant Characteristics Of the 3896 respondents, most were White (85.4 %), half were female (52.9 %; 46.4 % male), and one third reported having a college education or higher (35.7 %; 6.3 % less than high school, 27.5 % completed high school, 30.4 % some college). The average age was 44.3 years (SD = 11.86, range = 20–74 years). Half (50.5 %) reported a family history of cancer. In terms of smoking status, 23.2 % were former smokers, 50.4 % were never smokers, 7.9 % quit smoking, 2.7 % started smoking, and 13.1 % were current smokers.

Approximately half of the sample (55.1 %) showed no change in cancer risk perceptions, whereas 23.6 % reported decreases and 21.4 % reported increases. Forty-six percent of the sample showed no change in heart attack risk perceptions, whereas 25.0 % reported decreases and 28.9 % showed increases. A repeated-measures ANOVA revealed a significant time by risk type interaction ($F(1,3895) = 22.12$, $p < .001$), showing a trend for perceived cancer risk to decrease between wave 1 ($M = 3.03$, SD = 1.40) and wave 2 ($M = 2.99$, SD = 1.37; $p = .054$), consistent with the study 1 cross-sectional associations. In contrast, perceived risk of heart attack significantly increased from wave 1 ($M = 2.58$; SD = 1.53) to wave 2 ($M = 2.67$, SD = 1.52; $p < .001$), again, consistent with study 1. Perceived risk of cancer ($M = 3.01$) was higher than perceived risk of heart attack ($M = 2.63$), as indicated by a main effect of risk type ($F(1,3895) = 275.90$, $p < .001$). The main effect of time was not significant ($F(1,3895) = 2.17$, $p = .141$).

A series of repeated-measure ANOVAs were conducted to test five potential moderators of the time by risk type interaction. Figure 2 shows the significant interactions. Statistics for the main effects of time, risk type, and the time by risk type interactions are not reported as they are almost identical to those reported previously. One exception was a significant main effect of time when smoking status change was the moderator.

Age There was a significant age by time interaction ($F(1,3890) = 2.58$, $p = .025$), such that perceived risk increased among those 18–29 years ($p = .021$) and 30–39 years ($p = .015$) but did not change for the older adult groups (all *p*s > .10; see Fig. 2a; this interaction remains significant when age is treated as continuous). The age by time by risk type interaction was not significant ($F(1,3890) = 0.99$, $p = .424$). Overall, younger adults expressed higher perceived risk of cancer than older adults (age by risk type interaction: $F(1,3890) = 9.25$, $p < .001$; Fig. 2a); specifically, for perceived risk of cancer, all age groups significantly differed from each other with the exception of three groups (18–29 and 30–39; 50–59 and 60–69; and 60–69 and 71+).

Gender There was a three-way interaction of gender by time by risk type ($F(1,3868) = 6.44$, $p = .011$), such that women's perceived cancer risk showed a decreasing trend over time ($p = .070$), whereas their perceived risk of heart attack increased ($p < .001$; see Fig. 2b). Men's perceived risk of cancer or heart attack did not change (all *p*s > .30). Women ($M = 2.95$) expressed higher perceived risk of cancer and heart attack than men ($M = 2.66$; main effect of gender, collapsed across risk type: $F(1,3868) = 76.47$, $p < .001$).

Education The three-way interaction of education by time by risk type was nonsignificant ($F(1,3888) = 1.02$, $p = .382$). Perceived risk of cancer was significantly lower among individuals with a college degree ($M = 2.90$) than for individuals with less than high school ($M = 3.15$), high school ($M = 3.08$), and some college ($M = 3.06$), with no differences among the latter three groups (education by risk type interaction: $F(1,3888) = 7.45$, $p < .001$).

Smoking Status Change There was a significant smoking status by time interaction ($F(1,3785) = 17.84$, $p < .001$); but the absence of an interaction with risk type (smoking status by time by risk type: $F(1,3785) = 0.16$, $p = .960$) indicated that changes in perceived risk over time were similar for cancer and heart attack (see Fig. 2c). Specifically, former smokers showed no change in perceived risk ($p = .184$), whereas never and current smokers showed marginal increases (*p*s <.10), those who started smoking showed significant increases ($p < .001$), and those who quit showed significant decreases ($p < .001$). Perceived risk of cancer was highest among current smokers ($M = 3.75$), intermediate among those who quit ($M = 3.28$) or started smoking ($M = 3.37$), lower among never smokers ($M = 2.88$), and lowest among former smokers ($M = 2.77$; smoking status by risk type interaction: $F(1,3785) = 5.12$, $p < .001$).

Family History of Cancer There was a significant three-way interaction of time by risk type by family history ($F(1,3882) = 5.63$, $p = .018$; see Fig. 2d). Both those with ($p = .024$) and without ($p = .001$) a family history showed increases in perceived heart attack risk. However, those without a family history showed significant decreases in cancer risk ($p = .003$), whereas those with a family history showed no change ($p = .789$). These data are inconsistent with the absent-exempt bias, which predicts those *with* a family history should show decreases in perceived risk. A significant family history by risk type interaction ($F(1,3882) = 183.77$, $p < .001$) indicated that respondents with a family history reported higher perceived risk of cancer ($M = 3.32$) than those without a family history ($M = 2.70$; $p < .001$) but not of heart attack ($p = .995$).

Of particular interest (see Table 2), only gender and family history of cancer moderated change in cancer and heart attack risk over time differently. Women and those *without* a family history perceived their cancer risk to decrease over time, whereas men and those with a family history did not. With respect to age, adults under the age of 40 showed increases in

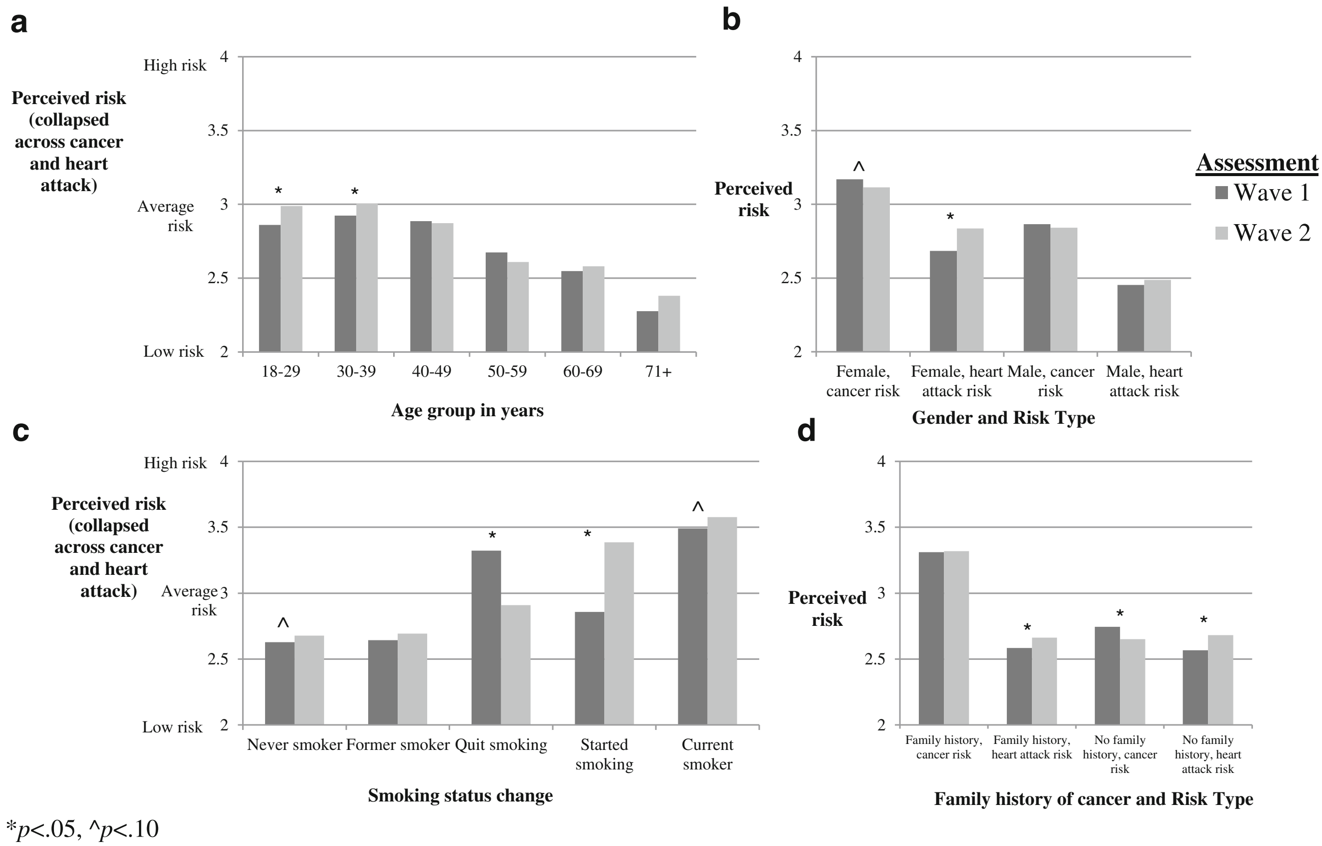

Fig. 2 MIDUS prospective data (study 2) showing changes in perceived risk from waves 1 to 2 as a function of **a** age group, **b** gender and risk type, **c** smoking status change, and **d** family history of cancer and risk type. *$p < .05$, ^$p < .10$

perceived risk (collapsed across cancer and heart attack) whereas those over 40 showed no changes—results generally consistent with study 1.

Study 3

Secondary data analysis of a cross-sectional survey (study 1) found a negative association of age with perceived cancer risk and a prospective survey (study 2) showed that overall, perceived risk of cancer does not increase over time. In study 3, awareness that age is a risk factor for cancer was gauged by asking people at what age they thought people are most likely to be diagnosed with cancer, thereby focusing on population risk rather than personal risk.

Methods

Data were collected in fall 2014 as part of the National Cancer Institute's Awareness and Beliefs about Cancer (ABC) survey of US adults aged 50 years and older. The ABC survey was developed by the International Cancer Benchmarking Partnership and administered in Australia, Canada, and six European countries [34, 35]. The US version was nearly identical to the UK version, with minor language changes. Adults (n = 1425) completed the survey through a landline (n = 1325) or a cell phone (n = 100); cancer timeline beliefs did not differ by response mode.

Timeline beliefs were assessed with, "Over the next year, which of these groups of people do you think is most likely to be diagnosed with cancer?" with the options "30 year olds," "50 year olds," "70 year olds," "people of any age are equally likely to be diagnosed with cancer," and "do not know." The correct answer is "70 year olds." Participants also reported their gender; age in years; level of education (coded as less than high school, high school, some college, college degree or higher); and race (coded as White vs. not White).

Smoking status was assessed with: "Have you ever smoked cigarettes, including hand-rolled ones, pipes or cigars?" and "Do you smoke at all these days, either cigarettes, including hand-rolled ones, pipes or cigars?" Responses were coded as follows: never smokers responded "no" to both items, former smokers responded "yes" to the former and "no" to the latter item, and current smokers responded "yes" to the latter item. Those who responded "do not know" or had missing data for either item were excluded from analyses with smoking status.

Family/friend history of cancer was assessed with the item, "Have you, or any friends or family members that are close to

Table 2 Summary of moderator and main effects across studies

Moderator	Study 1 (HINTS 4, cycle 3) Cross-sectional data	Study 2 (MIDUS) Prospective data	Study 3 (ABC Survey) Cross-sectional data assessing timeline risk beliefs
Age	• Older age was significantly associated with lower perceived absolute and experiential risk of cancer (but not with comparative risk of cancer)	• There was a marginally significant decrease in perceived risk of cancer over time • Younger adults (ages 18–39) showed increases in perceived risk of cancer over time • Older adults' (ages 40–71+) perceived risk of cancer did not change over time.	• Only 11.6 % of the sample knew that 70 year olds are at the highest risk of cancer • 69.5 % of the sample endorsed a belief that cancer is equally likely at any age • Endorsement of "cancer at any age" did not differ by age (all participants were 50 years of age or older)
Gender	• There was a significant interaction such that older age was associated with lower perceived risk among women but not men for experiential risk. A similar but not statistically significant pattern was shown for absolute risk • Women reported greater perceived risk of cancer than men (for absolute and experiential risk)	• Women showed a trend toward decreasing perceived risk over time, whereas men showed no change • Women reported greater perceived risk (collapsed across cancer and heart attack) than men	• Women were more likely than men to endorse "cancer at any age"
Education	• No significant effects	• Education did not influence whether perceived risk changed over time • Those with less education perceived their risk to be higher than those with greater education (i.e., college)	• Those with less education were more likely to endorse "cancer at any age"
Smoking status	• There were significant interactions such that older age was associated with lower perceived risk among former smokers (observed for absolute and comparative risk). Current and former smokers reported greater perceived risk of cancer than never smokers (effects differed somewhat by risk measure and were more consistent for current smokers)	• Those who quit smoking showed decreases in perceived risk, former smokers showed no change, never and current smokers tended to show increases, and those who started smoking showed increases • Current smokers reported highest perceived risk of cancer, followed by those who quit or started smoking	• Current smokers were most likely to select "cancer at any age" (78.1 %), with never smokers the least likely (63.6 %) and former smokers at an intermediate frequency (72.6 %)
Family history of cancer	• Those with a family history of cancer reported greater perceived risk of cancer than those without a family history	• Those with no family history showed decreases in perceived risk, whereas those with a family history showed no change • Those with family history of cancer reported higher perceived risk of cancer than those without a family history	• Those without family/friend with cancer more likely to endorse "cancer at any age"

you, ever been diagnosed with cancer?" with response options of "Yes, self," "Yes, someone close," "Yes, both self and someone close," "Yes, but would prefer not to say who," "No," and "Do not know." Participants were coded as having a family/friend history of cancer if they selected "Yes, someone close". Participants who selected "Yes, self," "Yes, both self and someone else," or "Yes, but would prefer not to say who" were excluded from all analyses to maintain conceptual similarity to the samples in studies 1 and 2, which did not include cancer survivors. Those who indicated "do not know" or had missing data for the item were excluded from analyses involving this variable. No item specifically assessing family history of cancer was included in the survey.

Data were analyzed in SAS v9.3 using one set of weights. Respondents were removed from analyses if they selected "do not know" for (n = 18) or did not answer (n = 4) timeline beliefs, if they were or could have been cancer survivors (n = 299), and if they had missing data for age, education, or gender, resulting in a sample of 1080.

Results and Discussion

Most respondents were White (81.7 %), half were female (53.3 %), and one quarter (28.2 %) reported having a college education or higher (6.6 % less than high school, 40.0 % completed high school, 25.2 % some college). Average age was 63.4 years (SD = 10.1, range = 50 to 96). Most (78.8 %) reported someone close to them had had cancer. Smoking status was distributed as: 43.9 % former smokers, 42.0 % never smokers, and 14.1 % current smokers.

As shown in the second column of Table 3, only 11.6 % of the sample answered correctly that 70 year olds are most likely

Table 3 Cancer timeline beliefs as a function of age, gender, education, family/friend history of cancer, and smoking status in ABC survey data (study 3)

	Beliefs about age at which cancer is most likely			
	30 year olds, %	50 year olds, %	70 year olds, %	People of any age are equally likely to be diagnosed with cancer, %
Total	2.52	16.31	11.63	69.53
Age				
50–59 (n = 385)	2.71	19.71	10.84	66.74
60–69 (n = 362)	2.11	14.14	13.48	70.27
70+ (n = 333)	2.68	12.76	10.87	73.69
Gender				
Male (n = 364)	2.27	22.00	13.35	62.38
Female (n = 716)	2.75	11.32	10.13	75.80
Education				
Less than high school (n = 28)	2.44	8.22	8.31	81.03
High school (n = 195)	2.87	9.83	6.08	81.23
Some college (n = 351)	2.42	20.59	7.65	69.34
College degree or higher (n = 506)	2.15	23.59	23.88	50.37
Family/friend history of cancer				
Yes (n = 855)	1.75	17.44	12.82	68.00
No (n = 225)	5.40	12.11	7.25	75.24
Smoking status				
Never smoker (n = 519)	2.17	18.77	15.50	63.56
Former smoker (n = 425)	2.14	15.65	9.63	72.58
Current smoker (n = 131)	4.84	10.86	6.20	78.10

Sample sizes are unweighted and proportions are weighted. Proportions sum to 100 % across each row

to be diagnosed with cancer in the next year, with the majority (69.5 %) selecting "people of any age are equally likely." A minority selected 30 year olds (2.5 %) or 50 year olds (16.3 %). Thus, most respondents were unaware that population cancer risk increases with age, consistent with studies 1 and 2 results for personal cancer risk.

Table 3 reports the proportion of respondents listing each cancer timeline belief response as a function of gender, education, family/friend history of cancer, and smoking status. Of particular interest were respondents who believed people of any age are equally likely to be diagnosed with cancer; we refer to this response as "cancer at any age." We tested whether endorsement of this belief vs. the other three options combined differed according to age, gender, education, family/friend history of cancer, and smoking status. Those who endorsed cancer at any age (M = 63.6, SD = 10.5) vs. those who did not (M = 62.9, SD = 9.5) did not differ in age ($t(1078) = -0.95$, p = .344), although all were 50+ years. Women (75.8 %) were more likely than men (62.4%) to endorse "cancer at any age" ($\chi^2(1)$=23.3, p<.001). Those with less than a high school (81.0 %) or a high school degree (81.2 %) were most likely to select cancer at any age, compared to those with some college education (69.3 %) and those with a college degree or higher (50.4 %; $\chi^2(3) = 86.93$, $p < .001$). Respondents who reported having a family/friend with cancer (68.0 %) were less likely to select cancer at any age than those without a history (75.2 %; $\chi^2(1) = 4.6$, $p = .033$). Current smokers were most likely to select cancer at any age (78.1 %), followed by former smokers (72.6 %) and nonsmokers (63.6 %; $\chi^2(2) = 15.4$, $p < .001$).

In sum, participants most likely to select cancer at any age were women, those with less education, those without a family/friend history of cancer, and current and former smokers (see Table 2). In studies 1 and 2, women and former smokers/smokers who had quit during the study period also tended to express greater perceived risk of cancer in general and were the same groups for whom age and perceived risk were negatively associated.

Discussion

Analyses across three US national surveys, using different methods, indicated that many people are unaware that age is a risk factor for cancer. Older age was cross-sectionally associated with *lower* perceived absolute and experiential risk of cancer, consistent with prior research [3]. Although these correlations were modest, even null associations suggest mistaken beliefs. In prospective data, perceived comparative risk of cancer did not increase (and showed a trend toward decreasing) as participants aged over a decade. When asked about cancer timeline beliefs, 70 % of people incorrectly believed that cancer is equally likely to affect people of all ages.

Two subgroups showed the most consistent tendencies to misunderstand the actual relationship between older age and risk for cancer: women and former smokers/smokers who quit during the time of the study. These groups also reported relatively strong beliefs that cancer is equally likely at any age (study 3) and typically perceived cancer risk to be high at all ages compared to other groups. Of note, although women's misperceptions may be higher in magnitude, men did not show *increases* in perceived risk associated with older age, suggesting that they too are unaware that age is a risk factor for cancer. Additional research on perceived risk for different types of cancer is warranted, as we cannot know whether women's beliefs about their risk of breast or ovarian cancer drive their overall perceived risk of cancer (although evidence suggests that no specific type of cancer drives general cancer risk perceptions [36]).

Neither former smokers (studies 1, 2, and 3) nor smokers who quit during the time of the study (study 2) demonstrated knowledge that cancer risk increases with age. Former smokers showed negative associations of age with perceived risk (study 1) or no change over time (study 2), and smokers who quit during the time of the study (study 2) showed significant decreases in perceived risk over time (unsurprisingly). Former smokers reported higher perceived risk of cancer than never smokers in study 1, but not in study 2, and in study 3, they were more likely than never smokers to believe cancer is equally likely at any age. Additional research is necessary to determine how quitting affects smokers' perception of their cancer risk over time.

One implication is that certain subgroups (i.e., women and former smokers/smokers who have recently quit) should be educated about the role of age as a risk factor. However, men had lower perceived risk of cancer overall compared to women, and the pattern of results among men did not suggest that they knew age is a risk factor for cancer. Educational efforts could target increased perceived cancer risk among men of all ages and older women, and target awareness of age as a risk factor for cancer in the general public. However, before educational efforts are developed, it is necessary to establish the behavioral consequences of more accurate perceptions of cancer risk. Future research should assess whether lack of awareness predicts health outcomes such as medical care seeking and cancer screening and whether it plays different roles for younger vs. older adults. Those who believe cancer can occur at any age may be more motivated to undergo cancer screening and engage in prevention behaviors, and correcting these beliefs could have the unintended effect of reducing performance of healthy behaviors. Conversely, lack of awareness could lead to overuse of medical care among younger adults. Nevertheless, these results suggest that media campaigns may be necessary to educate all individuals that their risk of cancer increases with age. Older adults may deserve special attention, and an intervention for this purpose might assess whether individuals think they have aged out of a risk period.

Contrary to predictions, there was no evidence of the absent-exempt bias with respect to family history (see Table 3), as those with a family history of cancer were *not* more likely to show evidence of decreased risk with older age. One limitation of the present data is approximate measures of family history that differed across surveys (for example, MIDUS refers to biological family members). Consistent with arguments elsewhere [5], multiple aspects of one's experience may influence perceived risk, such as closeness and similarity to the affected person. Future research might test these factors as potential moderators of the age-cancer risk association.

The lack of awareness that disease risk increases with age was unique to cancer. People *did* seem to be aware that age is a risk factor for heart disease. Additional research is necessary to determine *why* people do not associate age with cancer risk. One possibility is that the media focuses on younger adults who get cancer and thus younger people with cancer are more salient. Another explanation is that people think cancer and heart disease develop differently. In a qualitative study, respondents reported that cancer differs from health conditions that arise as people's bodies age, such as osteoporosis and dementia; one participant stated that "Cancer does not come with old age, cancer is something that develops in your body" [37] (p. 23). People might think heart disease is caused by cumulative organ deterioration whereas cancer is largely genetically determined and could occur any time [38]. These beliefs may lead people to conclude that if cancer has not happened yet, it never will, and are consistent with data showing that absent-exempt beliefs mediated the association between age and perceived cancer risk [6].

People also may think that cancer is equally likely at any age if they view cancer as unpredictable and random. More than 90 % of participants across multiple samples believed that cancer can strike anyone at any time and 50–70 % endorsed a belief that "cancer is a random thing" [39]. Beliefs about the unpredictability of cancer likely contribute to higher perceived personal risk of cancer. Of note, it is different to believe cancer *could* occur at any age than to believe that cancer is *equally likely* at any age (as shown here in study 3)—one belief is about plausibility and the other about probability. Better understanding of reasons for these beliefs can inform intervention strategies designed to promote knowledge of age as a risk factor for cancer.

A complexity (and strength) of our analyses is the use of different types of perceived risk assessments. In study 1, the moderating effects were inconsistent across the three types of perceived risk. In study 2, risk of cancer compared to same-aged peers was assessed. Importantly, people can think that their cancer risk decreases with age, but if they think this is also true for others, their comparative risk perceptions would stay the same. Thus, stability in comparative risk perceptions is not truly informative as to whether people think their disease risk has changed over time. Another aspect of the risk perception items is that they all asked about lifetime risk (or did not specify a timeframe), rather than assessing perceived risk in a specified timeframe. Thus, older adults may have expressed lower perceived risk because they have fewer years left in which to develop cancer (although this pattern was not seen for heart disease).

In conclusion, data across three national surveys provide systematic support that people are unaware that cancer risk increases with age. In fact, certain subgroups may believe that cancer risk *decreases* with age. Additional research is necessary to examine the clinical and health implications of these beliefs and to explore the reasons underlying this misunderstanding.

Compliance with Ethical Standards

Authors Statement of Conflict of Interest and Adherence to Ethical Standards Jennifer M. Taber, William M.P. Klein, Jerry M. Suls, and Rebecca A. Ferrer declare that they have no conflict of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

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