Risk Perception and Risk Communication for Cancer Screening Behaviors: a Review

Sally W. Vernon

This review summarizes and synthesizes research findings on risk perception and risk communication related to cancer screening behaviors. The focus is on cancers for which there is evidence that screening reduces mortality, i.e., cervical, breast, and colorectal cancers. The following questions are addressed: 1) Is perceived risk associated with relevant cancer screening behaviors? 2) What factors are associated with perceived risk? 3) Is the relationship between perceived risk and cancer screening behaviors modified by other factors? 4) Have interventions to change perceived risk been effective in modifying risk perceptions? 5) Are these changes related to subsequent cancer screening behaviors? Methodologic issues are discussed, and future research needs are identified. There was consistent evidence that perceived risk was associated with mammography screening, but there were insufficient data on these associations for cervical or colorectal cancer screening behaviors. There was some evidence that perceived risk mediated the association between other variables and screening behaviors; however, because of the small number of studies, the findings are best viewed as hypothesis generating. Studies of interventions to modify risk perceptions provided some support for the view that they are modifiable, but there was conflicting evidence that these changes were related to subsequent cancer screening. Methodologic studies of how best to measure perceived risk are needed. Because most data on the correlates of perceived risk were cross-sectional, it is difficult to determine whether perceived risk is a cause or an effect in relation to cancer screening. Longitudinal studies that measure perceived risk in defined populations with different cancer screening histories and that include follow-up for screening and repeated measurements of risk perception are needed to clarify this relationship. [Monogr J Natl Cancer Inst 1999;25:101–19]

The purpose of this review is to summarize and synthesize research findings on risk perception and risk communication as they relate to cancer screening behaviors. The focus is on cancers for which there is evidence that screening reduces mortality, i.e., cervical, breast, and colorectal cancers. In the case of screening tests or procedures with established efficacy and effectiveness, the goal of risk communication is to encourage or persuade persons to be tested. For screening procedures in which the risks and benefits are uncertain, e.g., mammography screening for women in their forties or prostate-specific antigen testing, the goal is informed decision making. Risk communication about screening behaviors will take different forms, depending on the strength of the scientific evidence establishing the risks and benefits associated with the tests or procedures in question. Over the past decade, there have been many efforts by public health professionals to persuade age-appropriate women to have mammograms and Pap tests. Many federally funded research projects have developed, implemented, and evaluated theory-based educational interventions to promote the initiation and maintenance of those behaviors (1–9). Table 1 shows data from the Behavioral Risk Factor Surveillance System (BRFSS) on the prevalence of cervical, breast, and colorectal cancer screening behaviors for 1995 (10). The prevalence of “ever” and “recent” Pap testing and mammography screening is relatively high, indicating that efforts to promote screening for breast and cervical cancers have been reasonably successful overall. Because guidelines for colorectal cancer screening have only recently been recommended (11), the dissemination of this information in the population has yet to occur.

Recent reviews have summarized the literature on interventions to promote breast (12–15), cervical (14,16), and colorectal (17) cancer screenings. Therefore, the literature on educational interventions to promote cancer screening behaviors is not a focus of this review. Rather, the focus is on risk perception because, as noted by several authors (18,19), perceived risk is a central construct in a number of theories of health behavior [e.g., the Health Belief Model (20), the Precaution Adoption Model (21,22), the Transactional Model of Stress and Coping (23,24), the Self-regulation Model of Health Behavior (25,26), and the Protection Motivation Theory (27)]. Risk perception derives from threat appraisal, which is considered to be a major motivating factor in preventive and protective health behaviors. Threat appraisal is based on beliefs about disease risk and severity (28). As defined by Weinstein and Klein (29), perceived risk is one’s belief about the likelihood of personal harm. Because risk perception may be an important motivator of a number of health-related behaviors, it is important to understand both the determinants of risk perception and the patterns of association between perceived risk and specific health-related behaviors to develop effective risk communication messages to encourage the adoption of behaviors that will improve health status.

Perceived risk has been used to explain cancer screening behaviors as well as in interventions to promote cancer screenings. However, the literature on perceived risk as it relates to cancer screening behaviors has not been examined systematically across cancer sites. The following terms have been used synonymously in the literature on cancer screening behaviors and are used synonymously here: perceived risk, risk perception, perceived susceptibility, perceived vulnerability, and subjective risk. Data on other social (e.g., socioeconomic status), cognitive (e.g., perceived barriers), and affective (e.g., worry) constructs are discussed as they relate to the relationship between perceived risk and cancer screening, i.e., as mediating or confounding variables. Specifically, the following questions are addressed: 1) Is perceived risk for various cancers associated with relevant

Correspondence to: Sally W. Vernon, Ph.D., School of Public Health, The University of Texas Health Science Center at Houston, P.O. Box 20186, Houston, TX 77225 (e-mail: sv Vernon@utsph.sph.uth.tmc.edu).

See “Note” following “References.”

© Oxford University Press
The average effect size was \( r = 0.16 \), adjusted for sample size and was smaller for prospective \( (r = 0.10) \) compared with cross-sectional studies \( (r = 0.19) \). There was no support for the hypothesis that there was a curvilinear relationship between perceived risk and screening, i.e., that high and low perceived risk are negatively associated with screening \( (30) \). Worry also was positively associated with mammography screening (average weighted effect size was \( r = 0.14 \)), although there were only six studies and the effect sizes ranged from \( r = -0.22 \) to 0.45 \( (30) \). There were few studies of the association between perceived risk and mammography screening among women at increased risk of breast cancer. Generally, the study populations were self-selected \( [e.g., (31–33)] \), and the results were inconsistent.

In a review of the literature on colorectal cancer screening adherence, Vernon \( (17) \) found that two \( (34,35) \) of eight studies reported a positive association between perceived risk and completion of fecal occult blood test (FOBT), whereas six studies \( (36–41) \) reported no association. Three studies \( (35,42,43) \) examined this association for sigmoidoscopy, and all found a positive association.

Three studies \( (44–46) \) performed multivariate analysis of a number of cognitive and attitudinal variables, including perceived risk, and cervical cancer screening. After controlling for other variables, one study \( (46) \) found a positive association with cervical screening, and two studies \( (44,45) \) found no association.

At this point, there are not enough data to draw firm conclusions about the pattern or magnitude of the associations between perceived risk and cervical cancer screening or any type of colorectal cancer screening. Although the magnitude of the overall effect size was small, studies have found a consistent and positive association between perceived risk and mammography screening in women at average risk of breast cancer \( (30) \).

### What Factors Are Associated With Perceived Risk for Cancer?

Twelve studies examined correlates of perceived risk for breast cancer \( (18,47–54) \), colorectal cancer \( (19,55) \), or “any” type of cancer \( (56) \). There were no studies of correlates of perceived risk of cervical cancer. Five studies \( (19,47,49,52,53) \) were of persons at increased risk on the basis of a family history of cancer. Ten \( (19,47–52,54–56) \) used a cross-sectional design; two \( (18,53) \) conducted both baseline and follow-up surveys.

Measures of perceived risk showed some similarity across studies (Table 2). Six studies \( (18,19,47,49,50,55) \) asked respondents to compare their risk with a reference group, e.g., other women their age. Other measures included asking persons to rate their perceived lifetime chance of developing a specific cancer or asking respondents to rate their risk over a defined time period. Most response formats were Likert-style with 4- to 6-point rating scales.

In studies that examined the association between perceived risk and objective measures of risk \( (e.g., \text{number of relatives with cancer}) \), one \( (47) \) found no association; four \( (18,49–51) \) found a positive association with some, but not all, indicators of objective risk; and two \( (49,56) \) found inconsistent patterns across subgroups. Three studies \( (52–54) \) of women at increased risk of breast cancer compared a respondent’s subjective risk with an objective risk estimate. Among women at increased risk for breast cancer, two studies \( (52,54) \) found that over 60\% overestimated their breast cancer risk compared with Gail model scores \( (57) \), whereas another study \( (53) \) found that only 8\% overestimated their breast cancer risk with the use of a method developed by Carter et al. \( (58) \) to assign objective medical risk. These marked differences may be because of differences in how subjective risk and objective risk were measured, or they may be because of differences in how women were recruited.

Two studies \( (47,49) \) of first-degree relatives of breast cancer

---

**Table 1. Median percentage reporting cancer screening tests or procedures, Behavioral Risk Factor Surveillance System, 1995**

<table>
<thead>
<tr>
<th>Test or procedure</th>
<th>Median %</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pap test†</td>
<td>Ever</td>
<td>93.6</td>
</tr>
<tr>
<td></td>
<td>Past 3 y</td>
<td>83.6</td>
</tr>
<tr>
<td>Mammogram</td>
<td>Ever‡</td>
<td>81.8</td>
</tr>
<tr>
<td></td>
<td>Past 2 §</td>
<td>69.2</td>
</tr>
<tr>
<td>Clinical breast examination</td>
<td>Ever‡</td>
<td>89.9</td>
</tr>
<tr>
<td></td>
<td>Past 2 §</td>
<td>73.8</td>
</tr>
<tr>
<td>Proctoscopy (ever!)</td>
<td>Men</td>
<td>41.9</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>32.9</td>
</tr>
</tbody>
</table>

*Data are from \( (10) \).
†Women with an intact uterine cervix who were \( \geq 18 \) years old.
‡Women \( \geq 40 \) years old.
§Women \( \geq 50 \) years old.
¶Women and men \( \geq 50 \) years old.

---

**IS PERCEIVED RISK FOR VARIOUS CANCERS ASSOCIATED WITH RELEVANT CANCER SCREENING BEHAVIORS?**

McCaul et al. \( (30) \) performed a meta-analysis of the relationship between perceived breast cancer risk and mammography screening and found that perceived risk was positively associated with mammography screening in 18 of 19 studies. Most of these studies were of women at average risk for breast cancer. The average effect size was \( r = 0.16 \), adjusted for sample size and was smaller for prospective \( (r = 0.10) \) compared with cross-sectional studies \( (r = 0.19) \). There was no support for the hypothesis that there was a curvilinear relationship between perceived risk and screening, i.e., that high and low perceived risk are negatively associated with screening \( (30) \). Worry also was positively associated with mammography screening (average effect size was \( r = 0.14 \)), although there were only six studies and the effect sizes ranged from \( r = -0.22 \) to 0.45 \( (30) \). There were few studies of the association between perceived risk and mammography screening among women at increased risk of breast cancer. Generally, the study populations were self-selected \( [e.g., (31–33)] \), and the results were inconsistent.

In a review of the literature on colorectal cancer screening adherence, Vernon \( (17) \) found that two \( (34,35) \) of eight studies reported a positive association between perceived risk and completion of fecal occult blood test (FOBT), whereas six studies \( (36–41) \) reported no association. Three studies \( (35,42,43) \) examined this association for sigmoidoscopy, and all found a positive association.

Three studies \( (44–46) \) performed multivariate analysis of a number of cognitive and attitudinal variables, including perceived risk, and cervical cancer screening. After controlling for other variables, one study \( (46) \) found a positive association with cervical screening, and two studies \( (44,45) \) found no association.

At this point, there are not enough data to draw firm conclusions about the pattern or magnitude of the associations between perceived risk and cervical cancer screening or any type of colorectal cancer screening. Although the magnitude of the overall effect size was small, studies have found a consistent and positive association between perceived risk and mammography screening in women at average risk of breast cancer \( (30) \).
### Table 2. Factors associated with perceived risk*

<table>
<thead>
<tr>
<th>Author (reference No.)</th>
<th>Study design</th>
<th>Study population</th>
<th>Dependent variable(s) (reference No.)</th>
<th>Independent variable(s) (reference No.)</th>
<th>Results</th>
<th>Comments (reference No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken et al. (18)</td>
<td>Cross-sectional and prospective surveys in 1987–1989 and in 1991. Women’s community group in the Phoenix area identified through lists of community organizations and networking; 253 groups were invited to participate in an educational intervention to increase mammography screening and BSE; 44 groups accepted. n = 335; 37–77 y old.</td>
<td>Perceived susceptibility to BC measured with two items: “What do you believe is the chance you will contract BC in your lifetime?” and “How susceptible do you feel you are to BC?” Responses were on a 6-point scale from low to high susceptibility. The mean of the two items measured perceived susceptibility. Risk estimate: “What do you believe are your chances of getting BC compared with other women your age?” Responses were on a 5-point scale from a lot lower to a lot higher. Women were then asked an open-ended question about what factors led them to rate their chances of getting BC as (rating from prior question). Factors were classified as risk increasing or decreasing: personal actions, heredity, physiology, environment, psychology, and chance.</td>
<td>Objective risk measures at follow-up: Age MD found lump (past 4 mo) MD told them of BC symptom (past 4 y) Mother or sister had BC All variables except age scored “yes” or “no.” Participation in the intervention was controlled. Compliance with 1989 ACS and NCI guidelines.</td>
<td>$r = 0.61$ between perceived susceptibility and risk measure estimate. Both were positively correlated at follow-up with all objective risk factors except age. Compared with other women their age: lower = 49%; same = 35%; higher = 16%. Mean risk rating was 2.56 (SD = 0.94) and was significantly below the “equal” risk value of 3.0. In cross-sectional analysis at baseline and at follow-up, perceived susceptibility was modestly associated with mammography compliance at baseline ($r = 0.12$) and at follow-up ($r = 0.06$). Mean scores of perceived susceptibility did not change over time (mean = 2.7 and 2.8 for baseline and follow-up). In longitudinal analysis, initial compliance predicted perceived susceptibility at follow-up ($r = 0.16$) controlling for perceived susceptibility at baseline, but perceived susceptibility at baseline was not associated with compliance at follow-up ($r = −0.05$).</td>
<td>Women were a subset of those studied by Aiken et al. (63). In 1991, re-interviews were attempted with 556 of the 615 women in the original study. Of the 520 still eligible (alive, no BC, and had not moved out of state), 352 were reinterviewed; 333 of them answered the question on subjective risk. Predominantly white, middle-class women.</td>
<td></td>
</tr>
<tr>
<td>Audrain et al. (47)</td>
<td>Cross-sectional telephone interview. Year of study not given. FDRs of BC patients recruited through five major cancer centers. Of 532 FDRs, 438 were contacted; 395 were eligible and interviewed.</td>
<td>“In your opinion, compared with other women who do not have a close relative with BC, what are your chances of getting BC someday?” (lower; about the same; a little higher; much higher). Women who answered “lower” or “about the same” were classified as “unaware” of their increased BC risk. 25% were unaware of their increased BC risk.</td>
<td>Age† Race (black vs. white) Marital status Education No. of FDRs with BC Age at menarche Age at 1st live birth No. of previous breast biopsies Relative’s age at diagnosis Relative’s stage at diagnosis Time between diagnosis and survey Risk notification (no/yes) Time since last mammogram Alcohol consumption Cigarette smoking (yes/no)</td>
<td>NA† OR = 5.5; CI = 2.5–12.0 NA NA NA NA NA NA NA NA NA NA NA OR = 2.2; CI = 1.1–4.2 NA NA OR = 4.0; CI = 1.9–8.3</td>
<td>Multivariate analysis reported here (ORs and 95% CIs). Because of missing data on cancer stage, only 247 of 395 women were included in the analysis. Rerunning the analysis without stage did not essentially change the results.</td>
<td></td>
</tr>
</tbody>
</table>

*Table continues*
Table 2 (continued). Factors associated with perceived risk

<table>
<thead>
<tr>
<th>Author</th>
<th>Study design</th>
<th>Study population</th>
<th>Dependent variable(s)</th>
<th>Independent variable(s)</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blalock et al. (19)</td>
<td>Case-comparison study with telephone interviews conducted in 1984–1986.</td>
<td>Two groups of siblings: high risk and average risk. High risk were siblings of CRC patients hospitalized in 1984–1986 (n = 124). Average risk were siblings (matched to CRC siblings on age, race and sex) of patients hospitalized for surgery for nonmalignant conditions during the same time period. n = 171; 40–75 y old.</td>
<td>Absolute perceived susceptibility: How likely are you to get CRC sometime in your lifetime? Rated on a 5-point scale from very unlikely to very likely. Relative perceived susceptibility: What are your chances of getting CRC compared with others your age? Rated on a 5-point scale from a lot lower to a lot higher. Collapsed into “lower,” “same,” or “higher.”</td>
<td>Risk factor perceptions: Why had they rated their chances of getting CRC as they had: personal actions, heredity, physiology, environment, and psychologic attributes. Factors were classified as risk increasing or decreasing, following Weinstein (22).</td>
<td>Absolute perceived susceptibility mean scores for CRC and non-CRC siblings: 3.1 and 2.8 (NS). Relative perceived susceptibility mean scores for CRC and non-CRC siblings: 2.9 and 2.6 (P&lt;0.01). For the categorical measure, 29% of CRC siblings believed themselves to be at lower risk, and 44% rated themselves as the same as others their age. This distribution was not reported for non-CRC siblings. Completion of FOBT was regressed on risk status (CRC or non-CRC sibling) and relative perceived susceptibility. The latter was associated with FOBT, and the association between risk status and FOBT completion was reduced, but it was still significant. In another model, absolute perceived susceptibility was not associated with FOBT use.</td>
<td>CRC siblings were informed in a letter before the telephone interview that, as a close relative of someone with CRC, they were “somewhat more likely to get this cancer.” Although mean scores differed statistically for relative perceived susceptibility, the mean scores for the CRC siblings were at the average; i.e., they saw themselves as “about the same” as others their age. There was little evidence of an optimistic bias operating differentially among CRC and non-CRC siblings. Sibs in both groups showed an optimistic bias regarding their personal actions related to assessing their relative perceived susceptibility to CRC.</td>
</tr>
<tr>
<td>Bowen et al. (54)</td>
<td>Cross-sectional survey, Year of the study not given.</td>
<td>African-American women were recruited through religious organizations and media channels. n = 113; 18–74 y old.</td>
<td>Accuracy of BC risk status measured by dividing actual medical risk calculated with the use of the model of Gail et al. (57) by perceived risk. “On a scale of 0–100, what do you think your chances of getting BC are, where 0 is no chance of getting BC and 100 means you will definitely get it?” Women were categorized into underestimators, overestimators, or extreme overestimators. Intention to get a mammogram measured on a point–point scale.</td>
<td>Demographics: age, ethnic identity (African-American, Black, Afro-American, other), education, marital status, and income. Psychologic: cancer worry, anxiety, depression, coping, and five categories of mental representations as defined by Leventhal and Cameron (26) (labels of BC risk, causes of BC risk, symptoms of BC risk, timeline, and consequences). Attitudes towards doctors.</td>
<td>The average Gail score was 8% (SD = 3), and the average perceived risk was 30% (SD = 29%). 41% underestimated, 23% overestimated, and 36% extremely overestimated their BC risk. In univariate analysis of accuracy of perceived risk, there was no consistent pattern in terms of a dose–response association across the three risk groups. Compared with underestimators, the other two groups had higher scores on measures of depression, anxiety, and coping. Intention to have a mammogram was associated with ethnic identity reported as African-American, cancer worry, and anxiety but not with accuracy of risk perception.</td>
<td>Same study population as that in Bowen et al. (64). Study population was composed of volunteers recruited through community organizations and the media who were at low to moderately increased risk for BC or ovarian cancer (&lt;2 FDRs with BC); 46% had more than a college education.</td>
</tr>
</tbody>
</table>

(Table continues)
Table 2 (continued). Factors associated with perceived risk

<table>
<thead>
<tr>
<th>Author (reference No.)</th>
<th>Study design</th>
<th>Study population</th>
<th>Dependent variable(s)</th>
<th>Independent variable(s)</th>
<th>Results</th>
<th>Comments (reference No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Champion (48)</td>
<td>Cross-sectional, population-based mail survey, Year of study not given.</td>
<td>Women &gt;40 y old who participated in a prospective intervention study to increase mammography screening. Of 2822 eligible women, 1404 agreed during a phone call to participate; 581 returned surveys, and 541 were followed up at 1 y. Of the 541 subjects, 404 were ≥40 y old.</td>
<td>Stage of mammography adoption based on the transtheoretical model (59) and measured following the method of Rakowski et al. (61).</td>
<td>1) Stage of mammography adoption on a five-item scale: e.g., “I am likely to get BC in the future.” Other items were not reported.</td>
<td>Perceived susceptibility to BC was measured with a five-item scale: e.g., “I am likely to get BC in the future.”</td>
<td>Women in action or maintenance scored higher on perceived susceptibility (mean = 16.7, SD = 4.7) than women in precontemplation (mean = 15.4, SD = 5.3) or contemplation (mean = 15.1, SD = 4.8). Although perceived susceptibility was not statistically associated with self-reported past use, women who met ACS guidelines scored higher on perceived susceptibility (mean scores were 16.6 and 16.3 for nonadherent and adherent women). Women who intended to have a mammogram viewed themselves as more susceptible to BC (mean scores were 16.4 and 14.9 for intend and do not intend).</td>
</tr>
</tbody>
</table>

(Data continues)
### Table 2 (continued), Factors associated with perceived risk

<table>
<thead>
<tr>
<th>Author (reference No.)</th>
<th>Study design</th>
<th>Study population</th>
<th>Dependent variable(s) (reference No.)</th>
<th>Independent variable(s) (reference No.)</th>
<th>Results</th>
<th>Comments (reference No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fries et al. (55)</td>
<td>Cross-sectional and prospective. Year of study not given.</td>
<td>Women &gt;40 y old at increased risk for BC, who were members of Group Health Cooperative of Puget Sound, n = 659.</td>
<td>Perceived risk was measured on a 4-point scale: none, borderline, moderate, or high. Women also were asked to rate their perceived chance of getting BC on a scale from 0% to 50%. Mammography status was ascertained through medical records within 6 mo after a survey measuring perceived risk, intentions and beliefs about mammography, and mammography history.</td>
<td>Objective risk was based on BC risk factors and classified into no increased risk, borderline risk, moderate risk, or high risk (58). SOC based on the transtheoretical model (59) and measured following the method of Rakowski et al. (61).</td>
<td>The distribution of perceived risk was none (15%), borderline (31%), moderate (34%), or high (20%). 55% accurately identified, 38% underestimated, and 8% overestimated their risk. In hierarchic regression analysis, higher perceived risk was associated with older age ($r^2 = 0.01$), objective risk ($r^2 = 0.21$), prior mammography ($r^2 = 0.04$), and SOC ($r^2 = 0.01$). Education and income were NS. In logistic regression analysis, mammography use at 6 mo was associated with higher perceived risk (OR = 1.2), SOC (OR = 23.4, 15.9, and 12.2 for contemplation, action, and maintenance vs. precontemplation, respectively). Objective risk was NS. Women who had accurate perceived risk were more likely to obtain a mammogram than those who had inaccurate perceptions in all categories of objective risk.</td>
<td>A baseline risk factor survey was sent to 946 women at increased risk of BC. The sample was stratified to include an equal number of women in each of three risk categories (high, moderate, or borderline). Personalized recommendation letters were mailed to 823 women who returned the survey. Letters included BC risk status, benefits of early detection, an invitation to obtain a free mammogram, and how and where to obtain it. Within 2 wk, a follow-up survey on perceived risk and other factors was mailed, and 659 women returned it. 95% were white. Only 10% had less than a high school education, and 37% were college graduates or more. 65% obtained a mammogram within 6 mo. P values (&lt;.05), but not confidence intervals, were given for the logistic regression analysis.</td>
</tr>
<tr>
<td>Helsdouer et al. (56)</td>
<td>Cross-sectional survey in 1991–1992.</td>
<td>Employees at the Johns Hopkins Oncology Center. n = 509; 19–66 y.</td>
<td>Risk of developing any cancer in the next 20 y and the next 40 y from 0% to 100%. Analyzed as mean scores and categorically based on tertiles: high, medium, and low. Mean perceived risk in the next 20 y: men (21%) and women (31%). Actual risk of developing cancer in the next 20 y for a 30- y-old ranged from 2.9% to 4.9% on basis of age and sex. Age† Current smoker Duration of employment (&gt;5 y) Relative with cancer Friend with cancer Relative and friend with cancer Self-rated health (fair or poor)</td>
<td>NA either group† + men and women + men; NA women + women; NA men NA either group† + women; NA men NA either group† + women; NA men NA either group† + women; NA men No associations between 20-y risk based on tertiles of risk and mammography (ever or past 2 y), Pap test (past 3 y), FOBT, or sigmoidoscopy (past 3 y).</td>
<td>Multivariate results reported here for 20-y risk using mean risk scores. Analyses were stratified by sex. No attempt to relate an individual’s rating of his or her perceived risk to his or her actual age- and sex-specific risk. High base rates of breast (778%) and cervical (888%) cancer screenings. Response rate was 65%.</td>
<td></td>
</tr>
<tr>
<td>Hughes et al. (49)</td>
<td>Cross-sectional telephone survey. Year of study not given.</td>
<td>FDRs &gt;35 y old BC patients who were eligible for a randomized trial of BC risk counseling. Patients were from Duke and Fox Chase Cancer Centers. n = 375 (224 white, 125 black).</td>
<td>Impact of relative’s BC diagnosis on FDRs’ perception of their own risk of BC. Relative’s diagnosis made me feel my own risk was lower, the same, a little higher, or much higher. Classified as “higher/much higher” vs. “lower/same.” 39% of blacks and 18% of whites were classified as lower/same.</td>
<td>Age† Education Relative type (mother or sister) Age at 1st live birth Relative’s stage at diagnosis BSE in past 3 mo Notified about their risk Worries affect mood Worries affect functioning Impact of Event Scale (72) Involved in relative’s care Personal BC concern Worries about relative</td>
<td>NA either group† NA either group NA either group + whites (later age); NA blacks + whites (later stage); NA blacks NA either group NA either group NA either group NA either group + women; NA blacks + blacks; NA whites + both groups (“sometime” vs. “high or low” worry)</td>
<td>Multivariate results reported here were stratified by race. No measures of association given, only $P$ values (&lt;.05). Matched on education and age. No. of eligible subjects not given.</td>
</tr>
</tbody>
</table>

(Table continues)
Lipkus et al. (55) Cross-sectional telephone surveys at baseline and at 3 mo. Year of study not given.

Women ≥50 y old who were members of Kaiser Foundation Health Plan in North Carolina and who were participating in a telephone counseling intervention to increase mammography screening. n = 364.

Subjective risk: chance of getting BC within the next 10 y, compared with other women their age: below average (40%), average (43%), or above average (17%).

Model 1:
- Age (≥70 vs. 50–59)
- Sex
- Ever smoked
- Current smoker
- Self-rated health
- Accuracy of beliefs (none/all)
- Attributions of risk (personal actions, hereditary, psychological, vs. don’t know)

Model 2:
- Age
- Sex
- Ever smoked (yes/no)

**Table 2 (continued). Factors associated with perceived risk***

**Author (reference No.)**  
Lipkus et al. (55)

**Study design**  
Cross-sectional telephone survey. Year of study not given.

**Study population**  
Adults ≥50 y old who used a community health center in North Carolina. 1318 were in the original sampling frame. n = 547.

**Dependent variable(s) (reference No.)**  
Chance of getting CRC sometime in your life: lower than average (36%), average (21%), higher (4%), or don’t know (37%).

**Independent variable(s) (reference No.)**  
Also asked about attributions of risk: hereditary, physiology, personal actions, psychology, and environment.

**Results**  
Model 1: 
- “don’t know” vs. “any”:
- OR = 2.0, CI = 1.20–3.17

Model 2: 
- “below average” vs. “average/above average”:
- OR = 0.49, CI = 0.27–0.88

**Comments (reference No.)**  
No multivariate analysis was done on subjective risk. The OR for Gail score is for a 0.10-unit change, e.g., going from a 10% to 20% a risk (95% CIs).

Women who answered “don’t know” were not included in the analysis for SOC.

Subjective risk served as the primary mediator of SOC.

Subjective risk and SOC measured at 3-mo interview. All other data collected at baseline. Not clear if any intervention contacts occurred between baseline and the 3-mo interview. Pros and cons measured using “agreement” rather than “importance.”

Additional multivariate models were run with subjective risk and either pro, con, or decisional balance.

Subjective risk was associated with SOC when cons or decisional balance, but not pros, were in the model, but the ORs were of similar magnitude in all three models (ORs = 1.34, 1.32, and 1.29).

**Note:** independent variables listed separately for each of the two models.

Correlation between objective and subjective risk was r = 0.21.

Univariate results for subjective risk:
- OR = 2.7, CI = 1.65–4.56
- OR = 5.9, CI = 2.91–12.11
- OR = 1.3, CI = 0.86–1.91
- OR = 0.85, CI = 0.60–1.23
- OR = 0.88, CI = 0.71–1.09
- OR = 1.2, CI = 1.25–2.72

2) Univariate/multivariate results for SOC:
- Gail score:
  - OR = 1.8, CI = 1.09–2.86
  - OR = 1.4, CI = 0.86–2.34
- No. relatives with BC
  - OR = 1.9, CI = 1.01–3.70/NA
  - OR = 1.4, CI = 0.94–2.03/NA
- Age at menarche
  - OR = 1.02, CI = 0.72–1.44/NA
  - OR = 1.02, CI = 0.83–1.25/NA
- Age at 1st live birth
  - OR = 1.6, CI = 1.08–2.22/NA
  - OR = 1.4, CI = 0.96–1.97
- Self-report of breast problems
  - OR = 1.5, CI = 1.13–1.91/NA
  - OR = 1.4, CI = 1.04–1.79

Attributions of risk were ascertained for perceived risk and were classified following the method of Weinstein (22) with the use of the following categories: hereditary, physiology, personal actions, psychology, environment, and chance.

**Downloaded from https://academic.oup.com/jncimono/article-abstract/1999/25/101/897787 by guest on 01 January 2019**
patients found that African-American women were less likely than white women to be aware that they might be at increased risk of breast cancer because of a family history (Table 2). In an analysis stratified by race, Hughes et al. (49) found different correlates for perceived risk in the two groups. In studies that included cigarette smoking, all (47,51,56) but one (55) found a positive association with perceived risk.

Very few studies have examined psychologic or psychosocial measures in relation to perceived risk (Table 2). Three studies (48,50,53) found that subjective risk was positively associated with later stages of change based on the transtheoretical model (59–61). Bowen et al. (54) examined the associations between a number of psychologic variables and accuracy of risk perception. Compared with women who underestimated their breast cancer risk, women who overestimated or extremely overestimated their risk had higher scores on measures of depression, anxiety, and coping abilities (54).

Four studies (18,19,50,55) asked respondents to state why they rated their risk as they did, and responses were categorized as risk-increasing or risk-decreasing with the use of a classification scheme developed by Weinstein (22). Lipkus et al. (50) and Aiken et al. (18) examined attributions of perceived risk for breast cancer. Both studies found that heredity was the most frequently cited cause, followed by physiology and personal actions. In both studies, hereditary and physiology were frequently mentioned as risk-increasing factors (by women who perceived their risk as above average) and as risk-decreasing factors (by women who perceived their risk as below average). Environment, psychology, and chance were not frequently mentioned in either study. In Aiken et al. (18), personal actions were cited as a risk-decreasing factor by women who perceived their risk as lower than average but were rarely mentioned as risk-increasing factors in either study.

Blalock et al. (19) and Lipkus et al. (55) examined attributions for perceived risk of colorectal cancer. Siblings of colorectal cancer patients (high-risk group) and siblings of general surgical patients (low-risk group) were more likely to view their personal actions as decreasing rather than increasing their risk, indicating that an optimistic bias was not operating differentially between the two groups (19). Physiology was mentioned with equal frequency by both groups as a risk-increasing and risk-decreasing factor. High-risk siblings were more likely to mention heredity as a risk-increasing than as a risk-decreasing factor, whereas low-risk siblings mentioned it with about equal (and low) frequency as risk increasing or risk decreasing. In multivariate analysis of heredity as a risk-increasing factor in the high-risk group, race was the only statistically significant predictor; 29% of white high-risk siblings cited heredity as a risk-increasing factor compared with 6% of African-American high-risk siblings.

In contrast to other studies of attributions (18,19,50), Lipkus et al. (55) found that, in a group of older, predominantly African-American clinic users, most persons attributed their risk to psychologic causes; however, consistent with the other studies, very few respondents cited environmental factors. In multivariate analysis, attributions of risk were associated with perceived risk.
Compared with persons who did not know why they evaluated their risk as they did, persons who cited psychologic causes, heredity, or personal actions were more likely to rate their risk as below average (Table 2).

Measures of perceived risk showed some similarity across studies. However, differences in the composition study populations, in the variables measured, and in the analytic approaches taken made it difficult to compare findings. In most studies, perceived risk was modestly associated with objective measures of risk; however, in three studies of women at increased risk of breast cancer, women were found to greatly overestimate (52,54) or underestimate (53) their objective risk. Very few studies examined psychologic or psychosocial correlates, but consistent patterns were found in the three studies that examined the association between stages of change based on the theoretical model and perceived risk (48,50,53). Other correlates were not examined in enough studies to provide a basis for generalization.

**IS THE RELATIONSHIP, IF ANY, BETWEEN PERCEIVED RISK AND CANCER SCREENING BEHAVIORS MODIFIED BY OTHER FACTORS?**

Four reports (28,46,62,63) evaluated the direct and mediating effects of perceived risk on screening compliance or on outcomes related to compliance, e.g., intention (Table 3). Two reports by Aiken et al. (62,63) used the same study population to examine the relationship of four Health Belief Model constructs with past mammography screening (63) and with prospective compliance (62). In cross-sectional analysis, they found an interaction between perceived susceptibility and perceived barriers with compliance (63). In longitudinal analysis, Aiken et al. (62) tested hypotheses about the direct and mediating effects of Health Belief Model constructs on steps to compliance, a variable composed of actions related to scheduling and completing a mammogram, including obtaining one. They hypothesized that high scores on perceived susceptibility and severity would lead to perceived benefits and that greater benefits and fewer perceived barriers would lead to compliance with mammography screening. Intention to obtain a mammogram was hypothesized to link health beliefs and compliance. These hypotheses were confirmed (Table 3).

In a cross-sectional study designed to examine the relationship between social structure and social cognition, Orbell et al. (46) examined the effects of perceived susceptibility and a number of other social, cognitive, and attitudinal variables on cervical cancer screening (Table 3). In path analysis, perceived susceptibility was directly and indirectly associated with screening status (Table 3). In another report that used data from a subset of the same population, i.e., women who were up to date on cervical cancer screening, Orbell (28) examined the role of personal moral obligation (“I think I should have a screening test”) and other independent variables, including perceived susceptibility, on the likelihood that women expected to have a screening test in the future. Among women who were up to date on screening, perceived susceptibility was not directly or indirectly associated with future expectations about having a Pap test (Table 3).

These studies provide some evidence for the indirect or mediating role of perceived risk in cancer screening behaviors; however, because there are so few studies and because of limitations in the study designs [all but one (62) were cross-sectional], the findings are probably best viewed as hypothesis generating.

**HAVE INTERVENTIONS TO CHANGE PERCEIVED RISK BEEN EFFECTIVE IN CHANGING OR MODIFYING CANCER RISK PERCEPTIONS? ARE THESE CHANGES, IF ANY, RELATED TO SUBSEQUENT CANCER SCREENING BEHAVIORS?**

There have been few educational interventions explicitly designed to change cancer risk perceptions; however, several interventions used persuasive messages to increase mammography screening and also examined the effect of those messages on risk perceptions or other cognitive factors believed to influence cancer screening decisions. The study populations included community-based participants (62,64), volunteers from work sites (65), patients in general practice settings (66,67), and women at increased cancer risk (68–71). Three studies of women at increased risk were based on the same study population (69–71). All but one study (67) targeted breast cancer screening behaviors (62,64–66,68–71). Some studies used a theoretic model of behavior change to communicate risk information (62,63), whereas others (67–71) provided feedback about actual or objective risk on the basis of statistical models of risk, such as the Gail model (57). Theories and models of behavior change that were used as a basis for intervention development included the Health Belief Model (62,66) and prospect theory (65).

Aiken et al. (62) developed an intervention to increase mammography screening on the basis of four constructs from the Health Belief Model (Table 4). Pretest and posttest scores on perceived susceptibility showed that scores on the posttest measure increased in both intervention groups compared with the pretest measure of susceptibility in the control group. Similarly, both intervention conditions showed a significant increase from pretest to posttest scores on perceived susceptibility before and after controlling for demographic factors. Compliance with mammography at 3 and 6 months was similar in the two intervention groups and was modestly higher than that in the control group after controlling for covariates (Table 4). Siero et al. (66) also used the Health Belief Model to evaluate the effect of four messages that manipulated perceived susceptibility and perceived severity on knowledge, attitudes, intention, and behavior related to breast self-examination. One month after the intervention, there were no differences among groups on perceived susceptibility or on other Health Belief Model constructs (Table 4). Banks et al. (65) developed intervention messages on the basis of prospect theory to increase mammography screening (Table 4). Two groups of women employed by a large northeastern utility company were randomly assigned to view videos at the work site that emphasized either the gains or the benefits associated with getting a mammogram or the losses or the risks associated with not getting a mammogram. At 12-month follow-up, a higher percentage of women who viewed the video emphasizing loss-framed messages had obtained a mammogram compared with women who viewed the video emphasizing gain-framed messages, and the intervention effect remained when other variables were controlled (Table 4). Scores on perceived risk of breast cancer, however, did not differ in the two groups immediately after the intervention.

Lerman and colleagues (69–71) compared the effects of an educational intervention on breast cancer risk comprehension
### Table 3. Factors that modify the association between cancer risk perceptions and cancer screening behaviors*

<table>
<thead>
<tr>
<th>Author</th>
<th>Study design</th>
<th>Study population</th>
<th>Dependent variable</th>
<th>Independent variable(s) (reference No.)</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken et al.</td>
<td>Cross-sectional survey in 1987–1989.</td>
<td>Women’s community groups in the Phoenix area identified through lists of community organizations and networking. 253 groups were invited to participate in an educational intervention to increase mammography screening and 44 accepted. n = 615 women; ≥35 y old.</td>
<td>Perceived susceptibility to BC measured with four items rated on a 6-point scale: chance contract BC, susceptible compared with other diseases, type person who gets BC, feel susceptible to BC. Other independent variables: benefits, barriers, physician recommendation, regular source of medical care, knowledge, FDR with BC, lump, income, and age.</td>
<td>There was an interaction between perceived susceptibility and barriers. When barriers were low, susceptibility was positively associated with compliance. When barriers were high, there was no association between perceived susceptibility and compliance. In hierarchical regression analysis in which all variables except the HBM constructs were entered in step 1, the addition of the HBM constructs to the model led to a 7% gain in prediction, and both benefits and barriers were statistically significant predictors of compliance, but perceived susceptibility and severity were not. In a separate model that included two measures of objective risk, perceived susceptibility was an independent predictor of compliance.</td>
<td>This was the only study to that date that included all of the HBM components and had multiple-indicator measures of the constructs. The hierarchical approach to regression analysis provides a conservative estimate of the association between the HBM components and compliance. Same study population as that in Aiken (18,62).</td>
<td></td>
</tr>
<tr>
<td>Aiken et al.</td>
<td>Cross-sectional survey in 1987–1989 with 3- and 6-mo telephone follow-up.</td>
<td>Subset of the study population in Aiken et al. (18,63) Data on 295 women 35–74 y old were collected at baseline. 221 were reinterviewed at 3 mo; and 168 were reinterviewed at 6 mo.</td>
<td>Self-reported compliance with guidelines based on age-appropriate screening according to ACS and NCI at the time the study was conducted.</td>
<td>Perceived susceptibility to BC measured with four items rated on a 6-point scale: chance contract BC, susceptible compared with other diseases, type person who gets BC, feel susceptible to BC. Other independent variables: benefits, barriers, physician recommendation, regular source of medical care, knowledge, FDR with BC, lump, income, and age.</td>
<td>The association between the intervention and benefits was accounted for by both a direct path (r = 0.23) and an indirect path (r = 0.26) through susceptibility. The indirect path through severity was NS. The association between susceptibility (r = 0.20) and severity (r = 0.13) with intentions was largely accounted for by the significant indirect paths through benefits (r = 0.36). The direct paths from susceptibility and severity to intentions were NS. The association between susceptibility, severity, and benefits and steps to compliance was largely mediated by intentions. None of the direct paths was significant.</td>
<td>This was the only prospective study evaluating the mediating effects of perceived risk.</td>
</tr>
</tbody>
</table>

*(Table continues)*
and related outcomes including mammography completion. The intervention group received an individualized probability estimate of the risk of developing breast cancer on the basis of the Gail model (57), whereas the control group received general information about guidelines for preventive health behaviors, including breast cancer screening (Table 4). There was no statistically significant difference in risk comprehension between the groups at 3-month follow-up, and approximately two thirds of women in both groups continued to overestimate their lifetime risk following risk counseling (69). The effectiveness of this intervention in reducing breast cancer-specific distress as measured by Impact of Event Scale intrusion scores (72) and general psychologic distress (73) also was evaluated (70). For breast cancer-specific distress, there was a statistically significant interaction between treatment group and education (Table 4). Furthermore, perceived risk (measured by perceived lifetime risk and by improved accuracy of subjective risk estimates) was not found to mediate the effect of the intervention on Impact of Event Scale scores among less educated participants. In a report (71) on the effect of the intervention on mammography compliance, there also was an interaction between treatment group and education. Among women with less education, the intervention led to decreased mammography use; the intervention had no effect on mammography use among more educated women (Table 4).

Bowen et al. (64) evaluated the effects of an educational intervention designed to make women’s risk perceptions more congruent with medical risk as assessed by the Gail model (57) and to increase breast cancer screening intentions. The interven-

### Table 3 (continued). Factors that modify the association between cancer risk perceptions and cancer screening behaviors*

<table>
<thead>
<tr>
<th>Author (reference No.)</th>
<th>Study design</th>
<th>Study population (reference No.)</th>
<th>Dependent variable</th>
<th>Independent variable(s) (reference No.)</th>
<th>Results</th>
<th>Comments (reference No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbell et al. (46)</td>
<td>Case-comparison interviews. Year of study not given.</td>
<td>Women aged 20–64 y were selected at random from 23 general practices in Scotland on the basis of cervical cancer screening status (up-to-date or never screened). n = 307 in each group.</td>
<td>Had a cervical cancer screening test within the past 3 y vs. never had cervical cancer screening as identified through medical records.</td>
<td>Perceived susceptibility was measured by three statements: “I think I am personally at risk of cervical cancer.” “I think most women my age should have a smear test,” and “I don’t think it is necessary for me to have a smear test” (scored on a 5-point Likert scale from strongly agree to strongly disagree). Other independent variables: perceived severity, aversiveness of test procedure, aversiveness of test result, benefit of peace of mind, benefit of cure, barriers, physician cue, age, number of sexual partners, marital status, and social class.</td>
<td>In multivariate analysis, perceived susceptibility was strongly associated with screening status (β = 0.48; SE = 0.11). Path analysis showed that perceived susceptibility had a direct effect on screening status (β = 0.25) and that several factors were mediated by perceived susceptibility, including number of sexual partners (β = 0.37) and social class (β = −0.12).</td>
<td></td>
</tr>
<tr>
<td>Orbell (28)</td>
<td>Cross-sectional survey. Year of study not given.</td>
<td>Women were a subset of (46). 276 women age 20–60 y with an up-to-date screening history.</td>
<td>Behavioral expectation: “How likely is it that you will have a test in the future?” Response format not given but appears to have been measured on a 5-point scale.</td>
<td>Perceived risk measured as two separate items: “I am at risk of cervical cancer” and “I am at least risk of cervical cancer than some women.” Other independent variables: personal moral obligation, worry about cervical cancer, efficacy of treatment, previous screening experience (embarrassment or pain), prior positive test result, and a risk index based on number of sexual partners and smoking status. Additional variables were the same as those in Orbell et al. (46) above.</td>
<td>In multivariate analysis, only age (β = −0.20), personal moral obligation (β = 0.38), and aversiveness of the test procedure (β = −0.15) were associated directly with behavioral expectation to repeat the test, accounting for 22% of the variance. Social class also was positively associated with a belief that one was at lower risk compared with other women (β = 0.15).</td>
<td>The coefficients in the text and on the figure differ. Coefficients in the figure are reported here. The authors suggest that the lack of an association between perceived risk and future expectation could be because women in the study population had recently engaged in a risk-reduction behavior for a preventable cancer that allayed concerns and led to decreased risk perceptions.</td>
</tr>
</tbody>
</table>

*ACS = American Cancer Society; BC = breast cancer; FDR = first-degree relative; HBM = Health Belief Model; NA = no association; NCI = National Cancer Institute; NS = not statistically significant; SE = standard error.
### Table 4. Interventions to change cancer risk perceptions and cancer screening behaviors

<table>
<thead>
<tr>
<th>Author (reference No.)</th>
<th>Study design (reference No.)</th>
<th>Study population (reference No.)</th>
<th>Intervention description (reference No.)</th>
<th>Intervention effect (reference No.)</th>
<th>Comments (reference No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aiken et al. (62)</td>
<td>Randomized controlled trial with constraints on randomization conducted during 1987–1989. Baseline telephone survey with 3- and 6-mo follow-up.</td>
<td>Women’s community groups in the Phoenix area identified through lists of community organizations and networking. 253 groups were invited to participate, and 44 accepted. There were 615 women ≥35 y old; 348 were not in compliance with ACS guidelines.</td>
<td>Groups were assigned to one of three conditions. The educational program (E) contained components that specifically targeted four HBMC constructs (perceived susceptibility, perceived severity, benefits, and barriers). To increase perceived susceptibility, information was provided on prevalence rates and risk factors for BC. The educational plus psychological (EP) program included the E program plus a series of compliance exercises drawn from the social psychological literature. Women in the E and EP groups completed a pretest, viewed one of the programs, and immediately completed a posttest. They were interviewed at 3 mo and 6 mo. Control group (C) participants completed a pretest and were interviewed at 3 mo and 6 mo.</td>
<td>After controlling for covariates, posttest means of both the E and EP groups were significantly higher than the C pretest mean on knowledge, susceptibility, benefits, and intention to obtain a mammogram. After controlling for covariates, both E and EP groups showed a significant increase from pretest to posttest in knowledge, susceptibility, benefits, and intention, and a significant decline in barriers. Compliance at 3 mo and 6 mo was higher in the E and EP groups compared with C, but E and EP did not differ from each other. In logistic regression that controlled for demographics and HBMC constructs, the intervention OR (E and EP combined) was 1.5 (CI = 1.04–2.04) at 3 mo and 1.4 (CI = 1.03–1.93) at 6 mo.</td>
<td>Perceived susceptibility was measured with four items using a 6-point Likert-type format; coefficient alpha was 0.93. The intervention did not have an effect on barriers. The program did not remove the barrier of cost. Cost and access cannot be addressed by educational programs. This raises a question about increasing perceived susceptibility without removing these barriers. This was a subset of the study population in Aiken et al. (18,63).</td>
</tr>
<tr>
<td>Alexander et al. (68)</td>
<td>On group pretest and posttest. Year of the study not given.</td>
<td>Women assessed their perceived risk using the U-Titer questionnaire and then met with an MD who instructed them about their objective risk on the basis of their Gail score. The MD shared the result of each participant’s Gail score both visually and verbally and discussed the risk factors in the Gail formula. Immediately after the educational session, the U-Titer was re-administered. 29 women completed the U-Titer again 2–11 mo later.</td>
<td>Before the educational session, none of the women’s perceived risks matched their calculated risk. 54/59 women overestimated their risk, 38 by a factor of 3 or more. Initial perceived risk was higher for women under 50 y old than for women ≥50 y old. Median absolute difference in risk score and perceived risk was 39% before education and 1% after. At follow-up, the median difference was 4%.</td>
<td>The U-Titer questionnaire was developed for utility assessment. It is an interactive questionnaire designed to minimize biases, such as “anchoring,” “framing,” or avoidance of small numbers. Because women were at increased risk of BC, they may have been self-selected on the basis of high perceived risk and worry about BC.</td>
<td></td>
</tr>
<tr>
<td>Banks et al. (65)</td>
<td>Randomized controlled trial conducted during 1992–1993. Included preintervention and postintervention measures of BC attitudes and beliefs including perceived risk. Posttest measures were completed immediately after viewing a video.</td>
<td>Women ≥40 y old who were not adhering to national guidelines for mammography and who were employees of a large northeastern utility company. Of 181 eligible women who expressed interest in the program, 133 were randomly assigned.</td>
<td>Women were randomly assigned to one of three groups. Used prospect theory to develop intervention messages. Prospect theory predicts that risk-averse options are preferred in the domain of gains and riskier options are preferred in the domain of losses. Detection behaviors are believed to be a riskier choice than prevention behaviors; thus, loss-framed messages are believed to be more persuasive in promoting detection behaviors than gain-framed messages. Women viewed a video at the work site with the same factual content, but the persuasive messages related to mammography screening were framed either in terms of loss (risks incurred by not getting a mammogram) or gain (the benefits of getting a mammogram).</td>
<td>According to prospect theory, loss-framed messages may increase perceived risk, causing persons to be more willing to perform risky behaviors, but perceived susceptibility scores were similar in groups receiving loss (mean = 3.3; SD = 1.1) or gain (mean = 3.0; SD = 1.3) messages. There was a nonstatistically significant difference in compliance at 6 mo: 34% for gain-framed and 45% for loss-framed messages. At 12 mo, the difference was 52% for gain-framed and 66% for loss-framed messages (P &lt; 0.05, one-tailed test). In logistic regression that controlled for the effects of other variables, the ORs and (CIs) for loss-framed vs. gain-framed messages at 6 mo and 12 mo were 1.7</td>
<td>The measure of perceived risk of BC was a mean score based on two items (seven response categories from not at all likely to very likely: 1) the likelihood that they would develop BC and 2) the likelihood that they would die. Women were volunteers, most of whom were well educated, and employed. No. of eligible women in the target population was not reported.</td>
</tr>
</tbody>
</table>
Table 4. Interventions to change cancer risk perceptions and cancer screening behaviors*

<table>
<thead>
<tr>
<th>Author</th>
<th>Study design</th>
<th>Study population</th>
<th>Intervention description</th>
<th>Intervention effect</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowen et al.</td>
<td>Randomized controlled trial.</td>
<td>African-American women aged 18-74 y were recruited through religious organizations and media channels.</td>
<td>Women were randomly assigned either to a group psychosocial counseling intervention of 4 weekly sessions (n = 49) or to a delayed counseling arm (n = 64). The four major components of the intervention were BC risk assessment and perception, education, stress management and problem solving, and social support. 6 mo after randomization, women were mailed a follow-up survey; 92 returned the follow-up survey.</td>
<td>The treatment group decreased their perceived risk from baseline (mean = 34.4; SD = 29.6) to follow-up (mean = 20.1; SD = 23.4), but the control group did not (mean = 31.3; SD = 28.0 at baseline and mean = 32.6; SD = 24.3 at follow-up). The intervention had no effect on intentions to obtain a mammogram, to perform clinical breast examination, or to perform breast self-examination.</td>
<td>Perceived risk was measured with a single item, rating the chances of ever getting breast cancer from 0% to 100%. Medical risk was assessed using the Gail model (57). On the basis of these two scores, women were classified as underestimators, overestimators, or extreme overestimators. The study population was composed of volunteers. Of the eligible volunteers, 65% participated in the intervention, and 53% completed the final survey.</td>
</tr>
<tr>
<td>Keuter and Strecher</td>
<td>Randomized controlled trial conducted in August 1992.</td>
<td>1317 patients 18-75 y old from eight family medicine practices in North Carolina. Patients were approached in the waiting rooms and asked to complete a self-administered survey; 80% agreed. A follow-up survey was mailed after 6 mo; 86% (n = 1131) completed it.</td>
<td>Patients were randomly assigned within each practice to one of three groups: 1) enhanced Health Risk Appraisal (HRA) feedback consisting of personal risk information derived from the Healthier People algorithms and individually tailored behavioral change messages that addressed perceived barriers to and benefits from changing risky behaviors; 2) typical HRA feedback consisting of personal risk information derived from the Healthier People algorithms; or 3) no feedback. Feedback was mailed to patients 2–4 wk after completion of the baseline survey.</td>
<td>16% had optimistic biases, 36% had accurate perceptions, and 48% had pessimistic biases. The intervention reduced pessimistic bias for perceived cancer risk but did not reduce optimistic bias. Patients who had pessimistic biases at baseline and who received either enhanced or typical HRA feedback that their risk was lower than average were 36% more likely to have decreased perceived risk at follow-up compared with control patients.</td>
<td>Risks of heart disease, stroke, cancer, and motor vehicle crash were assessed. Only cancer results are reported here. Risk of “any” or “all” cancer was assessed. Results may have differed for specific cancer sites. Perceived and actual risk of 10-y mortality was measured. Perceived risk was measured by asking “Compared with others your same age and sex, how would you rate your risk of having cancer within the next 10 years” (much lower, lower, about average, higher, or much higher than average). Actual risk was assessed with the Carter Center HRA (75) program. A patient’s risk was classified as higher than average (&gt;10% higher than the population average), lower (&lt;10% lower), or average (within 10%). Analyses were conducted for all patients and for the subset that remembered receiving the intervention. The authors report results for the latter.</td>
</tr>
<tr>
<td>Lerman et al.</td>
<td>Randomized controlled trial.</td>
<td>FDRs ≥35 y old of BC patients treated at Fox Chase or Duke University Cancer Centers. Of 438 women invited, 227 completed the baseline interview, and 200 of those completed the 3-mo interview.</td>
<td>Women were randomly assigned to receive either individualized breast cancer risk counseling (BCRC) or general health education (GHE) to increase risk comprehension. The interventions included an educational session with a nurse educator and print materials.</td>
<td>26% in the BCRC group compared with 17% in the GHE group improved their risk comprehension (P = .10). Similar proportions of women in both groups (about two thirds) extremely overestimated their BC risk both before and after the intervention.</td>
<td>Risk comprehension was measured by asking women to rate their chances of getting BC during their lifetime on a scale from 0 (definitely will not get it) to 100 (definitely will get it). It was categorized as the difference between perceived subjective risk and objective risk.</td>
</tr>
</tbody>
</table>

*Table continues*
### Table 4 (continued), Interventions to change cancer risk perceptions and cancer screening behaviors*

<table>
<thead>
<tr>
<th>Author (reference No.)</th>
<th>Study design (reference No.)</th>
<th>Study population (reference No.)</th>
<th>Intervention description (reference No.)</th>
<th>Intervention effect (reference No.)</th>
<th>Comments (reference No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lerman et al. (70)</td>
<td>Same as Lerman et al. (69)</td>
<td>Same as Lerman et al. (69)</td>
<td>The central element of BCRC was the provision of individualized probability estimates of developing BC on the basis of the Gail model (57). The uncertainty associated with risk data was emphasized. Both absolute risk and relative risks were presented. GHE consisted of presentation of guidelines for preventive health-related behaviors, including BC screening, based on the U.S. Preventive Services Task Force and Healthy People 2000.</td>
<td>There was a statistically significant change in risk comprehension from baseline to 3 mo in the BCRC group but not in the GHE group.</td>
<td>and the Gail score into accurate, underestimator, overestimator, or extreme overestimator. Women were classified as “improved” if their risk comprehension category changed to a category in the direction of accurate or stayed in the accurate category. Women in the treatment group who showed improved risk comprehension had significantly lower baseline levels of BC worry (mean = 3.6) compared with control subjects (mean = 7.5), indicating that BCRC was less effective among women with higher baseline levels of BC worry. Women who agreed to participate in the trial were more educated and scored higher on a measure of anxiety than those who declined.</td>
</tr>
<tr>
<td>Schwartz et al. (71)</td>
<td>Same as Lerman et al. (69)</td>
<td>Same as Lerman et al. (69)</td>
<td>Women were followed up after 1 y to ascertain mammography status.</td>
<td>For IES, there was an interaction between education and treatment group. Women in the treatment group with less education showed a reduction in IES scores compared with less educated women in the control group. There was no effect of the intervention among more educated women. For the POMS, treatment group was not a significant predictor of 3-mo distress. Perceived risk [measured as in (69)] was not found to mediate the effect of BCRC on IES scores among the less educated participants.</td>
<td>Women in the GHE group had lower levels of perceived risk for BC at baseline and had relatives that were diagnosed at a younger age compared with women in the BCRC group. The authors suggest that by reducing BC-specific distress among women with less education, it may be possible to increase their adherence to mammography. They also suggest that more complex measures of perceived risk may be needed to elucidate changes in risk perception that result from BCRC.</td>
</tr>
</tbody>
</table>

(The table continues)
Gail model scores (57) and perceived risk was 39% before the education session and 1% about a woman’s individual risk of developing breast cancer. The U-Titer questionnaire assessed objective risk (Table 4). The median absolute difference between the Gail model risk score and perceived risk was 39% before the education session and 1% after (Table 4).

Kreuter and Strecher (67) conducted a randomized controlled trial in family practice patients to evaluate the effectiveness of providing feedback about risk of cancer (any type), heart disease, stroke, and motor vehicle crash (Table 4). Feedback was based on a comparison of an individual’s objective risk on the Carter Center’s Health Risk Appraisal (75) with perceived risk for each cause of death so that persons could be classified as overestimating (pessimistic bias) or underestimating (optimistic bias) their risk on the basis of an objective criterion. In comparison with actual risk, perceived risk of cancer was characterized by pessimistic bias. The intervention reduced pessimistic bias for perceived cancer risk but did not reduce optimistic bias (Table 4).

Collectively, these findings provide some support for the effectiveness of persuasive educational messages to change risk perceptions. Six (62,64,66–69) of seven studies were successful in changing risk perceptions in the hypothesized direction. Two studies (62,65) found some support for the effect of the intervention on cancer screening behaviors (at least in the short term). However, three studies (64,66,71) found no effect of the intervention on breast cancer screening intentions or on self-reported behavior.

**Future Research Needs**

At present, we do not know what are the “best” measures of perceived risk. Therefore, we do not have good estimates of the prevalence of perceived risk for different types of cancer or for groups at different levels of risk, e.g., population risk, family history, or genetic risk. We also do not have good estimates of the extent to which persons overestimate or underestimate their risk and whether these patterns vary by cancer site, by different measures of objective risk status, or by the context in which risk information is conveyed, e.g., clinical or research settings and media coverage. As Slovic (76,77) pointed out, perceptions of risk are determined not only by unidimensional statistics of risk but also by qualitative characteristics of a particular risk. For instance, risk for preventable cancers may be perceived differently from those that are not. Although a number of recent studies (29,78–83) examined whether the method of presenting risk estimates affected responses to questions about risk perception, only two (82,83) examined risk estimates for cancer. One other study (84) examined the effects of numeracy on women’s understanding of the benefits of mammography screening with the use of four quantitative formats and found that accuracy was strongly related to numeracy regardless of the format used to present information. Methodologic studies that included a variety of measures of perceived risk and that examined their relationship to measures of objective risk would contribute to our understanding of how best to measure this construct as well as to our knowledge about the prevalence of perceived risk and the extent to which it is underestimated or overestimated. These studies will be more informative if they are conducted in defined populations at different levels of cancer risk.

From the studies reviewed here, it is difficult to determine whether risk perception is a cause or an effect in relation to cancer screening. Aiken et al. (18) compared cross-sectional and longitudinal patterns of association between perceived risk and self-reported mammography compliance. In longitudinal analysis, perceived susceptibility at baseline was not associated with mammography compliance at follow-up ($r = -0.05$), but mammography compliance at baseline predicted perceived susceptibility at follow-up ($r = 0.16; P<0.05$) controlling for perceived behavior.
susceptibility at baseline. Studies are needed that measure perceived risk in defined populations with different cancer screening histories and that include follow-up for screening and repeated measurements of risk perception to clarify this relationship.

Only six studies (62,64,65,69–71) assessed the immediate effects of interventions on cognitive or psychologic processes as well as on subsequent screening behavior. At present, there are not enough studies of any one cancer site to draw conclusions about the direct and mediating effects of those processes in relation to screening compliance or to make comparisons across cancer sites. The effects of these processes could differ for persons at different levels of cancer risk or for cancers that may be preventable through early detection of premalignant lesions, such as cervical and colorectal cancers, and for those, such as breast cancer, where early detection confers a survival benefit but does not prevent the disease.

A potentially important factor that was not examined in relation to risk perception or cancer screening in any of the studies reviewed here is perceived behavioral control. In one of the early studies of predictors of compliance with fecal occult blood testing, DeVellis et al. (83) found that perceived behavioral control predicted completion of the test in siblings of colorectal cancer patients but not in siblings of non-colorectal cancer patients. Related concepts that were examined in only a few studies reviewed here were coping style and coping skills. Several investigators (23,25) have emphasized that, when raising awareness of a health threat, it is important to provide specific actions to reduce the threat. In a recently published study of first-degree relatives of breast cancer patients that applied this line of thought, Schwartz et al. (86) evaluated the effectiveness of an intervention based on problem-solving training (87) to reduce breast cancer-specific and general psychologic distress compared with a control group who received general health education. There was no overall effect of the intervention on cancer-specific distress as measured by Impact of Event Scale intrusion and avoidance subscale scores (72) or on the measure of general distress (73), although in a post hoc analysis, Impact of Event Scale scores decreased in women who reported that they regularly practiced problem-solving training compared with women in the control group and with women who did not regularly practice the intervention skills (86).

Fischhoff et al. (88) pointed out that, although there is evidence that risk estimates are subject to bias, there is less evidence showing that these biases result in inappropriate risk decisions or supporting the idea that people are waiting for accurate risk estimates so that they can make decisions. In relation to cancer screening decisions, we know very little about the behavioral consequences of overestimating or underestimating one’s risk. Overestimation may result in hypervigilance, leading women to engage in excessive screening behaviors (32), or it may have the opposite effect (31,89). At present, we really do not know what the goal of interventions designed to influence risk perception should be. That is, we do not know if increasing the accuracy of risk perception will lead to the behavioral outcomes we want to promote. Intervention development would benefit from longitudinal descriptive data on changes in risk perception over time in relation to measures of psychologic status, cognitive factors, and screening participation. If risk perception is related to worry, anxiety, or psychologic distress, interventions may be needed to address those affective conditions as well.

There are virtually no data on what people want to know about the risks they face. This information will become increasingly important as technology increases our ability to identify healthy persons who will inevitably, e.g., Huntington’s disease, or with a high degree of certainty, e.g., BRCA1/BRCA2 carriers, develop a disease. Identifying someone as at risk in the interest of prevention or early detection can have profound negative implications on a person’s quality of life (90,91).

A number of disciplines have made important contributions to our understanding of risk perception, including geography, sociology, political science, anthropology, and psychology (76). To fully understand risk perception and to develop effective risk communications, we need to take into consideration the perspectives represented by those disciplines, including the role of individual differences in personality, emotion, cognitions, culture, and social processes (88). The primary focus in the studies reviewed here was on individual differences in perceived risk and on factors that modify its effects. However, attitudes and beliefs do not develop in a vacuum. From one perspective, an individual’s choice is largely determined by social structural conditions. Habits, norms, and beliefs vary between different social groups and are patterned by the social structure, particularly the social class structure, producing similar views of the world (92). These patterns of socialization are reflected in beliefs and attitudes toward health and illness and health care. From a social epidemiologic perspective, there is a causal link between behavioral differences, socioeconomic circumstances, and health status (92,93). The reason socioeconomic status (SES) has been so consistently linked with disease is because it embodies resources like knowledge, prestige, money, and power that can be used to avoid risks for disease and death, for instance by adopting health innovations such as cancer screening (93). Link et al. (93) used data from the BRFSS to show how the SES distribution of mammography screening and Pap testing can have the unanticipated consequence of becoming a mechanism that links SES to cervical cancer and breast cancer mortality.

Although the social and cultural context in which risk communication messages are delivered influences not only how messages are understood but also whether or not they are acted on, other factors need to be considered as well. Rundall and Wheeler (94) showed that the effects of income on preventive services were mediated not only by perceived susceptibility but also by difficulties in access to services. Data from the BRFSS showed that the absence of insurance coverage was a significant barrier to mammography screening in the United States (95). For 1996–1997, self-reported mammography use for women 40 years old or older was 71% and 46% in women with and without insurance coverage, respectively. In a similar vein, data from the five National Cancer Institute (NCI) Breast Cancer Screening Consortium studies (96) showed that the prevalence of recent clinical breast examination and of receiving a physician’s recommendation for a mammogram was higher in the two study sites where women were recruited from health maintenance organizations compared with other settings; these women also were more likely to be in the action stage of adoption as classified by the transtheoretical model (97).

As indicated by the data in Table 1, the success of efforts to promote cervical cancer screening raises a question about when risk communication is no longer a primary consideration in promoting the adoption of health-related behaviors. Seat belt use
legislation made it unnecessary to continue the largely unsuccessful attempts at persuading the public to use seat belts by informing them of the risk of having a fatal accident. The high prevalence of cervical and breast cancer screenings may be, in part, a result of successful efforts to embed the tests in the medical care system and to provide insurance coverage for the tests. The data on mammography use by insurance status (95,96) support the view that the success of risk communication to promote cancer screening may depend on access to medical care and other factors such as cultural beliefs and values (98,99). The task at hand is to identify those factors for subgroups, like Hispanics, in which attempts to promote screening have been less successful (16).

This review has focused on studies of correlates of perceived risk, on the direct and mediating effects of perceived risk in relation to cancer screening behaviors in individuals, and on risk communications targeted at individuals. It has not addressed the issue of risk communication through the mass media. As Slovic (76) pointed out a number of years ago, most lay persons acquire their information about hazards from the news media. This observation is no less true for information about disease risks and about the benefits of health-promoting behaviors. An excellent example of the media’s depiction of breast cancer risk is provided by Lupton (100), who evaluated the messages in the Australian press about the disease from 1987 to 1990. These descriptions undoubtedly influenced many women’s risk perceptions about breast cancer (not necessarily in a positive way) both by the overt content and by the more subtle messages that were conveyed. We can infer from secular trends showing an increase in mammography screening over the past decade that public health professionals and advocacy groups have succeeded in raising awareness about breast cancer and screening, despite the largely null findings from carefully designed, community-based randomized controlled trials to promote screening (1,3,5–8).

We need simultaneously to refine risk communication messages targeted at defined subgroups in the population and to improve our ability to effectively use mass communication channels to reach a broader audience. The former approach is likely to be more effective in promoting cancer screening for cancers such as cervical and breast cancers in which the prevalence of screening is high, whereas the latter approach is likely to be more effective, at least initially, in promoting cancers such as colorectal cancer in which the prevalence of screening is low.

REFERENCES


Kelly RB, Shank JC. Adherence to screening flexible sigmoidoscopy in asymptomatic patients. Med Care 1992;30:1029–42.


Sandman PM, Weinstein ND, Miller P. High risk or low: how location on a “risk ladder” affects perceived risk. Risk Analysis 1994;14:35–45.


NOTE

I thank Colette Miesse for her contributions to many aspects of the work on this paper, including bibliographic searches and assistance with compiling data from the literature, and Brenda Brown for her assistance in preparing the final version of the manuscript.