

Do tailored behavior change messages enhance the effectiveness of health risk appraisal? Results from a randomized trial

Matthew W.Kreuter and Victor J.Strecher¹

Abstract

Health risk appraisal (HRA) remains one of the most widely used health promotion tools despite only equivocal evidence for its effectiveness. Theories of behavior change predict conventional HRA's ineffectiveness because risk information alone is seldom sufficient to change complex behaviors. In this study, a randomized trial compared the effects of feedback from an enhanced HRA with a typical HRA and a control group among adult patients from eight family medicine practices. The enhanced HRA assessed behavior-specific psychosocial factors and provided patients with computer-generated, individually-tailored behavior change information in addition to typical HRA risk feedback. Changes in seven behaviors were assessed at a 6 month follow-up. Overall, patients receiving enhanced HRA feedback were 18% more likely to change at least one risk behavior than were patients receiving typical HRA feedback or no feedback (OR = 1.18, 95% CI = 1.00, 1.39). The enhanced HRA feedback appeared to promote changes in cholesterol screening, dietary fat consumption and physical activity, but not in smoking, seat belt use, mammography and Pap smears. We conclude that the addition of theory-based, individually-tailored behavior change

information may improve the effectiveness of HRA.

Introduction

Health risk appraisal (HRA) is probably the most widely used health education tool for promoting individual behavior change (Becker and Janz, 1987; DeFries and Fielding, 1990). According to a 1986 estimate, as many as 5-15 million Americans had participated in HRA or HRA-like programs in worksites, universities, community wellness programs, health fairs and health care organizations (Schoenbach, 1987). A random sample survey of US worksites showed that in the late 1980s, HRA activities took place at nearly 30% of all worksites (Fielding, 1989). However, despite HRA's pervasiveness, reviews of the research literature have found little evidence for HRA's efficacy in changing individual behavior (Wagner *et al.*, 1982; Beery *et al.*, 1986; Schoenbach *et al.*, 1987). One explanation for this apparent failure has been that HRA does not provide individuals with sufficient information about how to make the behavior changes it recommends.

HRA collects epidemiologic risk factor information from its users, calculates their mortality risks and provides them with feedback about those risks. Implicit in the use of HRA alone for individual health promotion is the belief that provision of risk information alone will help people make changes in unhealthy behaviors. This assumption is inconsistent with most established theories of health-related behavior change [e.g. Health Belief Model (Becker, 1974), Theory of Reasoned Action (Fishbein and Ajzen, 1975) and Precaution Adop-

Department of Community Health, Division of Behavioral Science and Health Education, School of Public Health, St Louis University, St Louis, MO 63108 and ¹Health Communications Research Laboratory, Department of Health Behavior and Health Education, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-7400, USA

tion Model (Weinstein, 1988)]. As Becker and Janz (1987) have noted, because HRA gives no consideration to psychosocial and other factors which mediate individual behavior change, its feedback should not be expected to do more than transmit information or alter health beliefs.

According to the Health Belief Model, behavior change is a function of perceived threat of a negative health outcome and the perceived benefits minus barriers to taking some course of preventive action. When perceived threat is high, the relative balance of benefits and barriers determines the likelihood of change occurring. The risk information provided in typical HRA feedback might influence a user's perceived susceptibility, but it has no means of addressing perceived benefits and barriers. What is the effect of heightening perceived risk without addressing the barriers to reducing the risk? People with high risk perception but low efficacy for changing are not likely to change (Strecher *et al.*, 1985).

The present study tested the effectiveness of an enhanced HRA which assessed users' perceived benefits, barriers and other psychosocial factors influencing health-related behaviors, then provided users with individualized feedback designed to facilitate self change. For example, where conventional HRA assesses only the user's smoking status, the enhanced HRA goes on to assess a variety of theory-based predictors of smoking cessation, including readiness to quit [i.e. 'stage of change' (Prochaska and DiClemente, 1983)], benefits and barriers (Becker, 1974), and relapse history (Marlatt and Gordon, 1980), as well as level of addiction to nicotine, motives for wanting to quit, and perceived health risks of continued smoking and health benefits of quitting. In developing the enhanced HRA feedback, we created a different text message to address each possible response option to each of these questions. The enhanced HRA computer program reads the user's data and merges the appropriate text messages into a cogent, single-page plan for changing each problem behavior. This process is described in greater detail elsewhere (Campbell *et al.*, 1994; Skinner *et al.*, 1994; Strecher *et al.*, 1994). The computer program

can generate 4608 different combinations of messages for smoking alone and nearly 450 000 different combinations of messages when considering all 11 behaviors assessed by the enhanced HRA. Recent studies have found statistically significant changes in smoking cessation (Strecher *et al.*, 1994), dietary fat consumption (Campbell *et al.*, 1994) and mammography (Skinner *et al.*, 1994) among patients who received computer-tailored print messages compared with controls who received untailored messages.

This study compared the effectiveness of the enhanced HRA to that of a typical HRA and to a control condition receiving no feedback, among a sample of adult family practice patients. We hypothesized that patients receiving feedback from the enhanced HRA would be more likely to have made risk-reducing changes in behavior at a 6 month follow-up than would patients who received typical HRA feedback or no feedback.

Methods

Enrollment and characteristics of study sample

Subjects were 1317 adult patients from eight family medical practices in North Carolina. Practices were selected based upon their status as independent community-based group family practices and upon their geographic proximity to the University. All practices invited to participate in the study agreed to do so. Most patients were female (65%), white (86%) and had completed high school (90%); the mean age of the sample was 40 years. There were no significant differences among the three intervention groups on any demographic variables (see Table I). To participate, eligible patients (ages 18–75) were asked to complete a self-administered questionnaire while they waited to be seen by their doctor. Eighty percent of eligible patients agreed to participate. Refusers were more likely to be male relative to the final sample and most cited lack of interest (64%) or acute illness (17%) as reasons for not participating. Of the 1396 patients who completed a baseline questionnaire, 79 (5.6%) were disqualified due to missing personal identi-

fication information, yielding the final sample of 1317 patients.

Questionnaire

The questionnaire included 27 HRA questions from *Healthier People*, the Carter Center of Emory University Health Risk Appraisal Program. HRA questions assessed patients' risk factors, including age, sex, height, weight, body frame size, diabetes status, systolic and diastolic blood pressure, total and HDL cholesterol, use of cigarettes and other tobacco products, alcohol consumption, car size, seat belt use, car miles traveled annually, average driving speed, drunk driving, and, for women only, family history of breast cancer, age at menarche, age at first child birth and hysterectomy status. Actual questionnaire items used to measure these variables are published elsewhere (Amler *et al.*, 1989). The *Healthier People* HRA evolved from the Centers for Disease Control (CDC) HRA, which had been shown by several studies (Foxman and Edington, 1987; Smith *et al.*, 1991) to be a relatively accurate predictor of future mortality. Recent changes to the CDC HRA reflected in *Healthier People* include updated (1989–1990) population mortality tables, inclusion of new risk factors (e.g. HDL cholesterol) and deletion of others (e.g. race), using new cancer risk estimation models developed by the National Cancer Institute, and replacing actuarial risk estimation methodology with multivariate statistical techniques (Amler *et al.*, 1989). A recent study compared the CDC HRA and *Healthier People* and found their mortality risk predictions to be highly correlated (Gazmararian *et al.*, 1991).

The questionnaire also included multi-item assessments of seven health-related behaviors (smoking, exercise, seat belt use, alcohol consumption, dietary fat intake, fruit and vegetable consumption, and safe gun storage), three preventive screening practices (mammography, Pap smear and cholesterol testing) and a battery of questions screening for depressive symptomatology. For each behavior and screening practice, three determinations were made: (1) the patient's risk status attributable to the behavior, (2) the patient's interest

in changing the behavior to reduce the associated risk (i.e. stage of change), and (3) the psychosocial and other factors that influence changing the behavior for that person (e.g. perceived barriers and benefits). Demographic and personal identification information were also collected.

Study design and intervention

A three-group randomized trial design with pre- and post-intervention measures was used. After completing the baseline questionnaire, patients were randomly assigned, within-practice, to receive either enhanced HRA feedback, typical HRA feedback or no feedback (control). Patient feedback was mailed directly to patients' homes within 2–4 weeks of their completion of the baseline questionnaire.

Enhanced HRA feedback consisted of two major components: risk information and individually-tailored behavior change information. The risk information was generated using algorithms from *Healthier People*, although the form and content of the risk feedback were modified to enhance interpretability.

The risk information included four elements: (1) a listing of the patient's positive and risky health-related behaviors; (2) a graphic and numeric illustration of which risky behaviors were most important for them to change (in terms of the magnitude of projected risk); (3) a graphic and numeric presentation of their 10-year mortality risk for heart attack, stroke, cancer and motor vehicle crash, including an explanation of why their risk was high, average or low, and what they could do to achieve or maintain low risk status; and (4) a table showing their present and ideal levels for four health status indicators (weight, blood pressure, total cholesterol and HDL cholesterol) and what they could do to achieve or maintain desirable status.

The second and unique component of the enhanced HRA feedback was individually-tailored behavior change information. Patients received a single-page of computer-generated printed information for every behavior that: (1) was a problem for them (e.g. they smoked cigarettes)

and (2) they were interested in changing. Behavior change information was tailored on a variety of variables, including perceived barriers, reasons for wanting to change, perceived health risks, perceived health benefits, self efficacy, and past attempts and failures to change the behavior. Different text messages were generated depending upon how patients responded to questions assessing these variables. For example, a patient citing concern about weight gain as a barrier to quitting smoking would receive a message providing specific strategies to keep extra weight off during cessation. Message content was derived from intervention research literature where available and also from content experts in each behavior. Examples of the types of messages provided are available elsewhere (Campbell *et al.*, 1994; Skinner *et al.*, 1994; Strecher *et al.*, 1994).

Patients in the typical HRA feedback group received the risk information, but not the tailored behavior change information. Patients in the control group received no feedback.

Attrition

Study participants completed the baseline questionnaire in their physicians' office waiting rooms during August, 1992. Six months later, a follow-up questionnaire was mailed to all patients at their homes. Follow-up questionnaires were the same as those used at baseline, but were individually-tailored by computer based on patients' baseline data, in order to reduce the number of inapplicable questions. For example, patients who reported being non-smokers at baseline were only asked about their smoking status and stage of change at follow-up, not about perceived barriers, benefits and other psychosocial factors related to smoking. After 2 weeks, non-respondents were sent a second questionnaire in the mail. For patients who did not return either mailed questionnaire, attempts were made to complete the questionnaire by telephone interview. Telephone interviews were conducted by trained graduate students. Over half of all patients returned one of the mailed questionnaires (57%, $n = 753$) and another 29% ($n = 378$) completed the questionnaire by telephone inter-

view. There were no differences between follow-up respondents and non-respondents with respect to age, race, sex and years of education, nor were there differences between patients who completed a mailed questionnaire versus a telephone interview at follow-up. In all, 1131 patients completed a follow-up questionnaire—a 6 month response rate of 86%.

Measures

The outcome of primary interest in the study was change in behavior from baseline to 6 month follow-up. To provide a fair test of the two feedback conditions, only those behaviors for which both interventions (enhanced HRA and typical HRA) provided user messages were compared. Therefore, of the 11 health-related behaviors and screening practices assessed by the questionnaire, only seven are examined here: smoking, exercise, seat belt use, dietary fat consumption, mammography screening, Pap testing and cholesterol testing. Single-item measures were used to assess smoking status ('Have you smoked a cigarette, even a puff, in the last seven days?'); exercise behavior ('Do you do aerobic exercise at least three times in a week?'); seat belt use ('Do you buckle your safety belt, both lap and shoulder strap together, every time you drive or ride in a motor vehicle?'); cholesterol testing ('When did you have your last cholesterol test?'); and, for women, breast cancer screening ('When did you have your last mammogram?') and cervical cancer screening ('When did you have your last Pap smear?'). Dietary fat consumption was assessed using an 18-item food frequency questionnaire derived from the Health Habits and History Questionnaire (HHHQ) (Block *et al.*, 1986) and from an abbreviated (13-item) version of the HHHQ which has been used as a brief screen for fat intake (Block *et al.*, 1989). Patients' baseline status on each of these behaviors is shown in Table I.

According to Prochaska and DiClemente's Transtheoretical Model or 'stages of change' theory (Prochaska and DiClemente, 1983), change in many health-related behaviors is best characterized as an ongoing process rather than as a distinct

Table I. Characteristics of sample at baseline, by study group

	Enhanced HRA (n = 427)	Typical HRA (n = 427)	Control (n = 463)
Mean age (years)	39.0	40.5	39.9
Ethnicity (% white)	88	86	85
Gender (% female)	68	66	62
Mean years of education	13.6	13.5	13.6
Percent present smokers (% contemplators)	22 (69)	24 (62)	22 (59)
Percent doing no aerobic exercise (% contemplators)	37 (100)	39 (100)	35 (100)
Percent with diet high in fat ^a (% contemplators)	26 (46)	24 (51)	30 (60)
Percent with seat belt use < 100% of time (% contemplators)	20 (68)	27 (63)	20 (64)
Percent no cholesterol test in last 5 years (% contemplators)	25 (30)	31 (29)	31 (27)
Percent no Pap test in the last year (% contemplators)	33 (76)	38 (67)	29 (63)
Percent no mammogram as recommended ^b (% contemplators)	20 (42)	28 (48)	22 (50)

^aExceeding upper quartile of grams of fat consumed by entire study population.

^bUsing American Cancer Society mammography screening guidelines (American Cancer Society, 1988).

event with a dichotomous outcome. The theory proposes that individuals move through a series of distinct and measurable stages, each one incrementally closer to the desired outcome. For each of the seven health-related behaviors in this study, we assessed stage of change by asking patients, 'Have you seriously thought about (changing this behavior, e.g. quitting smoking) in the next 6 months?' Patients answering 'no' were classified as—in stage terminology—'precontemplators'. Patients answering 'yes' were then asked, 'Are you planning to (change the behavior) in the next 30 days?'. Patients who were seriously thinking about changing in the next 6 months but *not* planning to do so in the next 30 days were classified as 'contemplators'; those both seriously thinking about changing *and* planning to change in the next 30 days are identified by Prochaska and DiClemente as being in the 'preparation' stage (Prochaska and DiClemente, 1992). Because the theory suggests that precontemplators are not likely to respond to behavior change interventions, only patients in contemplation or preparation stages

received tailored information for any given behavior. Table I shows, for each of the seven behaviors of interest in the study, the percentage of patients from each group who were in the contemplation and preparation stages.

Statistical methods

Statistical analyses compared rates of behavior change from baseline to follow-up between the enhanced HRA group and the typical HRA and control groups combined. The latter groups were combined because it was hypothesized *a priori* that neither condition alone would be sufficient to promote changes in behavior. For each behavior, analyses included only those patients who both had the problem (e.g. smoked cigarettes) *and* who wanted to change it (e.g. smoking cessation contemplators). This stratification was necessary in order to assure an equivalent comparison group, because patients in the enhanced HRA group only received feedback when these two conditions were met.

For all individual behavioral outcomes, multiple

logistic regression was used to compare the proportion of patients in each group which had changed the behavior at follow-up. Overall intervention effects were assessed using the same method to evaluate a composite variable measuring change in any behavior. Age, sex and ethnicity (white, non-white) were included as control variables in all regression models, and the number of behavior-specific perceived barriers cited by each patient was included as a control variable in all regression models except that assessing the composite behavior change variable.

Results

Intervention recall

To confirm differences in the allocation of study conditions, several measures of patient recall were used. To assess patients' recall of the intervention in general, all study participants were asked at follow-up if they had received any health information in the mail from this study during the last 6 months. As expected, most patients in the enhanced HRA group (74.5%) and typical HRA group (70.6%) remembered receiving information, while only a small percentage of control subjects (13.3%) reported (mistakenly) receiving information ($n = 1105$, $\chi^2 = 392.8$, $P < 0.0001$). To assess patients' recall of receiving risk information specifically, patients were asked if they had received information about their risk of death from heart attack, stroke, cancer and motor vehicle crash. Again, most patients in the enhanced HRA (71.1%) and typical HRA (74.5%) groups remembered receiving risk information, while few control subjects (5.4%) said they did ($n = 1106$, $\chi^2 = 546.6$, $P < 0.0001$). In addition, patients in the enhanced HRA group were asked at follow-up if they remembered receiving information about specific behaviors for which they had been sent tailored feedback. Recall of tailored information varied by behavior, with patients most likely to remember receiving information about reducing dietary fat consumption (73.7%), followed by seat belt use (72.5%), cholesterol testing (71.4%), Pap testing

(68.1%), mammography (60.9%), quitting smoking (60.0%) and exercise (55.1%).

Behavioral effects

To assess overall effects of the intervention, we compared the proportion of patients in each group who reported at follow-up having made any behavior changes. Included in this analysis were all patients who both needed to change (i.e. were at risk) and wanted to change (i.e. contemplators) at least one behavior. About 60% of all participants met this criteria ($n = 674$, 59.6%). Patients receiving enhanced HRA feedback were 18% more likely to change at least one risk behavior than were patients receiving typical HRA feedback or no feedback (OR = 1.18, 95% CI = 1.00, 1.39; $P < 0.06$). As shown in Table II, over half (54%) of patients in the enhanced HRA group reported changing at least one behavior, compared with 45% of patients in the typical HRA group and 47% of controls.

To determine whether the intervention influenced certain behaviors but not others, we then analyzed each of the seven behaviors separately. As shown in Table II, statistically significant or near-significant intervention effects were found for cholesterol screening, reducing dietary fat consumption and engaging in regular aerobic exercise. Among patients who, at baseline, had not had a cholesterol test in the last 5 years and wanted to get one, 53% of those in the enhanced HRA group had done so by the time of the follow-up assessment, compared with 28% of patients in the typical HRA group and 40% of controls ($n = 106$; OR = 1.68, 95% CI = 1.06, 2.68; $P < 0.05$).

Among patients whose dietary fat consumption at baseline was high (exceeded the 75th percentile of grams of fat consumed in the study population as a whole) and who wanted to start eating less fat, 93% of those in the enhanced HRA group, 88% in the typical HRA group and 73% of controls were eating less fat at 6 month follow-up ($n = 155$; OR = 1.84, 95% CI = 0.95, 3.53; $P < 0.07$). Interestingly, when dietary change is considered in terms of percentage reduction in grams of fat rather than dichotomous change, the enhanced and typical

Table II. Behavior change at 6 month follow-up, by study group

Behavior change	Enhanced HRA (%)	Typical HRA (%)	Control	Odds ratio	95% CI	P value
Any behavior (<i>n</i> = 674)	54 (<i>n</i> = 199)	45 (<i>n</i> = 227)	47 (<i>n</i> = 248)	1.18	1.00, 1.39	0.054
Getting a cholesterol test (<i>n</i> = 106)	53 (<i>n</i> = 30)	28 (<i>n</i> = 36)	40 (<i>n</i> = 40)	1.68	1.06, 2.68	0.029
Reducing dietary fat consumed (<i>n</i> = 155)	93 (<i>n</i> = 41)	88 (<i>n</i> = 42)	78 (<i>n</i> = 72)	1.84	0.95, 3.53	0.069
Aerobic exercise three times weekly (<i>n</i> = 206)	25 (<i>n</i> = 67)	14 (<i>n</i> = 70)	15 (<i>n</i> = 69)	1.34	0.94, 1.97	0.106
Getting a Pap smear (<i>n</i> = 126)	63 (<i>n</i> = 48)	52 (<i>n</i> = 46)	66 (<i>n</i> = 32)	1.17	0.80, 1.73	0.418
Regular seat belt use (<i>n</i> = 184)	24 (<i>n</i> = 55)	23 (<i>n</i> = 70)	24 (<i>n</i> = 59)	1.06	0.72, 1.58	0.759
Getting a mammogram (<i>n</i> = 88)	54 (<i>n</i> = 24)	58 (<i>n</i> = 33)	55 (<i>n</i> = 31)	1.01	0.62, 1.65	0.961
Quitting smoking (<i>n</i> = 180)	12 (<i>n</i> = 59)	13 (<i>n</i> = 61)	17 (<i>n</i> = 60)	0.87	0.54, 1.40	0.550

HRA groups are nearly identical (−39 and −38%, respectively) and both are significantly greater than that found in the control group (−27%).

Among patients in the enhanced HRA group who reported engaging in no aerobic exercise at baseline but who wanted to start exercising regularly, 25% of patients in the enhanced HRA group, 14% in the typical HRA group and 14% of controls reported doing aerobic exercise three or more times per week at follow-up (*n* = 206; OR = 1.34, 95% CI = 0.94, 1.97; *P* = 0.10). No group differences were observed for smoking cessation, increased seat belt use, mammography or Pap smears.

Discussion

This study provides some evidence for a modest, but positive overall effect of adding individually-tailored behavior change information to typical health risk appraisal feedback. The enhanced HRA feedback appeared to promote changes in cholesterol screening, dietary fat consumption and aerobic exercise, though it had no effect on smoking cessation, seat belt use, mammography and Pap smears. While hardly a ringing endorsement of HRA, these results do suggest that if HRA feedback

is fortified with theory-based, individualized behavior change information, it may be a useful tool in promoting health-related behavior change in medical care settings. The study provides no evidence for the effectiveness of typical HRA feedback in the absence of tailored messages.

The fact that tailored messages were effective for some behaviors but not others is puzzling. It is possible that these differential effects were due to varying quality of the tailored messages from one behavior to the next, although we think this is unlikely. If message quality varied, we would expect to see predictable patterns in patients' recall of receiving the information and in their evaluation of the usefulness of the messages in changing each behavior. No such differences were observed (data not shown). Instead, we think these differences may be related to the number of behaviors considered in the study. Previous tailoring studies have focused on a single behavior. In this study, some patients received tailored feedback on four or more behaviors. Intervention effects may have been enhanced by prioritizing among patients' various needs—based on epidemiologic risk, motivational or changeability criteria—and focusing on one or two behaviors only.

It could be argued that our typical HRA condition

was not typical at all because it did not include a health professional interpreting the feedback as is recommended by most HRAs in order to achieve optimal results. However, given the research evidence that health care providers' advice is a strong predictor of patients' behavior change (Kottke *et al.*, 1988; Hollis *et al.*, 1993, 1994; Rimer, 1996), but that use of HRA is not, to say that HRA works best with provider counseling is a bit like saying an automobile runs best when there is fuel in its tank.

Further, it is not at all clear that such counseling routinely accompanies the use of HRA. Therefore, one goal of this study was to modify the form and content of typical HRA feedback to make it easily interpretable without a professional translator. Follow-up assessments of interpretability suggest we were successful in meeting this goal. Among those patients who remembered receiving the HRA information, nearly 98% said the information was 'very easy to understand' (60.4%) or 'fairly easy to understand' (37.4%) and only 2% of patients rated the feedback as 'fairly difficult to understand' or 'very difficult to understand'. It should also be noted that by making the typical HRA feedback more easily interpretable, we provided a much stiffer test for the enhanced HRA. That is, if the effectiveness of enhanced HRA feedback had been evaluated relative to unmodified, confusing HRA feedback, it might have compared even more favorably.

Rates of behavior change reported in the control group were striking. Among control subjects who needed and wanted to change the following behaviors, 17% quit smoking, 78% reduced their dietary fat consumption, 24% began wearing seat belts regularly, 55% got a mammogram and 66% got a Pap smear. It is possible that these rates of change indeed reflect the preventive activity of patients in these practices in the absence of any intervention. However, control subjects may also have benefited from participation in the study in ways not anticipated in the study design. Completion of the detailed baseline questionnaire may have stimulated or renewed patients' interests in

changing some of the behaviors being assessed. Further, by providing some kind of personalized health information to roughly two-thirds of participating patients from each practice, it is possible that physicians in these practices became more conscientious about providing all their patients with appropriate preventive counseling. Any such control group effects would attenuate the magnitude of real intervention effects. Similarly, any biases in patients' self reports should lead to non-differential misclassification across study groups due to randomization and thus would also bias effects toward the null.

The Health Belief Model provided a useful framework for identifying important characteristics of an enhanced HRA and for conceptualizing the behavior change process. These findings provide some evidence that—as Becker and Janz speculated—the failure of HRA to affect individual behavior change may be due to its exclusion of important psychosocial factors in its assessment and feedback components. Because the addition of tailored information to HRA is consistent with theories of behavior change and because findings from this study were consistent with theoretical predictions, it seems reasonable to conclude that these additions would be important for HRA.

While these findings add to the growing body of evidence for the effectiveness of individually-tailored print messages, less is known about the actual mechanisms which make tailoring effective. We know that tailored messages are more likely to be read and remembered (Campbell *et al.*, 1994; Skinner *et al.*, 1994), but do not know which, if any, components of these messages are most potent. For example, tailoring may work simply because personalization (putting the patient's name on the feedback) increases attentiveness to print information. Alternatively, tailoring effects may be attributable to the increased relevancy of particular messages (e.g. overcoming barriers). Both explanations may be correct. To maximize the efficiency of future tailored print interventions, studies are needed to identify specific determinants of effective tailoring.

Acknowledgements

The authors would like to acknowledge the efforts of Drs Karl Bauman, Russell Harris, Victor Schoenbach and James Sorenson who reviewed earlier drafts of this manuscript. This research was supported in part by grants from the Lineberger Comprehensive Cancer Center and the Hearst Foundation.

References

- American Cancer Society (1988) *Summary of Current Guidelines for the Cancer-related Checkup: Recommendations*. American Cancer Society, New York.
- Amler, R., Moriarty, D. and Hutchins, E. (eds) (1989) *Healthier People. The Carter Center of Emory University Health Risk Appraisal Program. Guides and Documentation*. The Carter Center, Decatur, GA.
- Becker, M. H. (ed.) (1974) The health belief model and personal health behavior. *Health Education Monographs*, 2, 324-473.
- Becker, M. H. and Janz, N. K. (1987) On the effectiveness and utility of health hazard/health risk appraisal in clinical and nonclinical settings. *Health Services Research*, 22, 537-551.
- Beery, W. L., Schoenbach, V. J., Wagner, E. H., Graham, R., Karon, J. and Pezzullo, S. (1986) *Health Risk Appraisal: Methods and Programs with Annotated Bibliography*. USDHHS publ. no. (PHS) 86-3396. National Center for Health Services Research and Health Care Technology, Washington, DC.
- Block, G., Hartman, A., Dresser, C., Carroll, M., Gannon, J. and Gardner, L. (1986) A data-based approach to diet questionnaire design and testing. *American Journal of Epidemiology*, 124, 453-469.
- Block, G., Clifford, C., Naughton, M., Henderson, M. and McAdams, M. (1989) A brief dietary screen for high fat intake. *Journal of Nutritional Education*, 21, 199-207.
- Campbell, M. K., DeVellis, B. M., Strecher, V. J., Ammerman, A. S., DeVellis, R. F. and Sandler, R. S. (1993) The impact of message tailoring on dietary behavior change for disease prevention in primary care settings. *American Journal of Public Health*, 84, 783-787.
- DeFries, G. H. and Fielding, J. E. (1990) Health risk appraisal in the 1990s: opportunities, challenges, and expectations. *Annual Review of Public Health*, 11, 401-418.
- Fielding, J. E. (1989) Frequency of health risk assessment activities at US worksites. *American Journal of Preventive Medicine*, 5, 73-81.
- Fishbein, M. and Ajzen, I. (1975) *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Addison-Wesley, Reading, MA.
- Foxman, B. and Edington, D. W. (1987) The accuracy of health risk appraisal in predicting mortality. *American Journal of Public Health*, 77, 971-974.
- Gazmararian, J. A., Foxman, B., Tze-Ching Yen, L., Morgenstern, H. and Edington, D. W. (1991) Comparing the predictive accuracy of health risk appraisal: the Centers for Disease Control versus Carter Center program. *American Journal of Public Health*, 81, 1296-1301.
- Hollis, J. F., Lichtenstein, E., Vogt, T. M., Stevens, V. J. and Biglan, A. (1993) Nurse assisted counseling for smokers in primary care. *Annals of Internal Medicine*, 118, 521-525.
- Kotke, T. E., Battista, R. N., DeFries, G. H. and Brekke, M. L. (1988) Attributes of successful smoking cessation interventions in medical practice. A meta-analysis of 39 controlled trials. *Journal of the American Medical Association*, 259, 2882-2889.
- Marlatt, G. A. and Gordon, J. R. (1980) Determinants of relapse: implications for the maintenance of behavior change. In: Davidson, P. and Davidson, S. (eds), *Behavioral Medicine: Changing Health Lifestyles*. Brunner/Mazel, New York, pp. 410-452.
- Prochaska, J. O. and DiClemente, C. C. (1983) Stages and processes of self-change for smoking: toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51, 390-395.
- Prochaska, J. O. and DiClemente, C. C. (1992) In search of how people change: applications to addictive behaviors. *American Psychologist*, 47, 1102-1114.
- Rimer, B. K. (1994) Mammography use in the US: trends and the impact of interventions. *Annals of Behavioral Medicine*, 16, 317-326.
- Schoenbach, V. J. (1987) Appraising health risk appraisal (editorial). *American Journal of Public Health*, 77, 409-411.
- Schoenbach, V. J., Wagner, E. H. and Beery, W. L. (1987) Health risk appraisal: review of evidence for effectiveness. *Health Services Research*, 22, 553-580.
- Skinner, C. S., Strecher, V. J. and Hoppers, H. (1994) Physician recommendations for mammography: do tailored messages make a difference? *American Journal of Public Health*, 84, 43-49.
- Smith, K. W., McKinlay, S. M. and McKinlay, J. B. (1991) The validity of health risk appraisals for coronary heart disease: results from a randomized field trial. *American Journal of Public Health*, 81, 466-470.
- Strecher, V. J., Becker, M. H., Kirscht, J. P., Eraker, S. A. and Graham-Tomasi, R. P. (1985) Psychological aspects of changes in cigarette smoking behavior. *Patient Education and Counseling*, 7, 249-262.
- Strecher, V. J., Kreuter, M. W., Den Boer, D. J., Kobrin, S. C., Hopper, H. J. and Skinner, C. S. (1994) The effects of computer-tailored smoking cessation messages in family practice settings. *Journal of Family Practice*, 39, 262-270.
- Wagner, E. H., Beery, W. L., Schoenbach, V. J. and Graham, R. M. (1982) An assessment of health hazard/health risk appraisal. *American Journal of Public Health*, 72, 347-352.
- Weinstein, N. D. (1988) The precaution adoption process. *Health Psychology*, 7, 355-386.

Received on October 15, 1993; accepted on July 14, 1995

