

Online Supplementary Material

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Supplemental Appendix. A Practice-Sponsored Web Site to Help Patients Pursue Healthy Behaviors

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Introduction

This online Supplemental Appendix documents the methods used to develop and test the My Healthy Living (MHL) Web site (<http://www.myhealthyliving.net>) and describes the detailed results of the evaluation. The rationale for the study and its implications for primary care are discussed in the companion print article.¹

In brief, the objective of the study was to determine whether primary care patients would be more successful in pursuing healthy behaviors—healthy diet, physical activity, smoking cessation, and reduced problem drinking—if they were encouraged by practices to visit a Web site that offered valuable national and local information to support behavior change. The Web site, sponsored by the practices, was intended to extend educational outreach beyond the clinical encounter and to collect information on health behaviors and patient expectations that is otherwise difficult for clinicians to obtain systematically. The study was funded by the Robert Wood Johnson Foundation Prescription for Health program.² The MHL Web site combined 4 features: (1) an intake assessment that collected a behavioral history and assessed stage of readiness to change; (2) an individually tailored resource library with links to Web pages from national organizations and agencies; (3) links to local resources, including Web services offered by the patients' practices; and (4) tailored health advice and printouts for clinicians.

Methods

Overview

For 9 months (January-September 2004), 6 primary care practices (4 intervention and 2 control) encouraged adults with unhealthy behaviors to visit the MHL Web site. Patients from control practices were directed to static information pages that lacked the resources described above. We did not design the study with sufficient statistical power to assess the effect on health behaviors, but we did include behavior change as a secondary measure. We also studied Web site use and acceptability. Data on health behaviors, readiness to change, and user satisfaction were obtained from e-mail questionnaires sent to patients 1 and 4 months after their first Web site visit. To protect privacy, we obtained e-mail addresses but no other identifiable information. The protocol was approved by the Institutional Review Board of Virginia Commonwealth University.

Aims

Our study objective was to test the effectiveness and feasibility of using a practice-sponsored Web site to help primary care clinicians promote healthy behaviors among their patients. Our primary hypothesis was that patients from the 4 practices who accessed the intervention Web site would progress further in stage of readiness to change than would patients from the 2 control practices who accessed static information pages.

Focus and Sampling Frame

We focused on 4 target behaviors: unhealthy diet, physical inactivity, smoking, and problem drinking. The study participants were adult patients with access to a computer who visited the MHL Web site, agreed to complete follow-up questionnaires, and provided an e-mail address. We excluded children and adolescents (aged 0 to 18 years) because parents might be unable to give consent before children accessed the Web site.

Setting

The study was conducted at 6 family practices in the Northern Virginia suburbs of Washington, DC. The practices collectively see approximately 820 patients per day. The population is of moderate to high socioeconomic status, has high Internet literacy, and has healthier behaviors than Virginians generally. Participating practices were affiliated with the Virginia Ambulatory Care Outcomes Research Network (ACORN).³ As described elsewhere,⁴ the practices helped design the intervention, recruited physician and nurse champions, and promoted the implementation of MHL.

Description of Web Site

Portal: Patients making their first visit to the MHL Web site passed through a portal (a preliminary series of Web pages) before accessing the resource library. The portal included 9 questions (measures) about the 4 target behaviors: 3 questions about diet, 2 questions about physical activity, 1 question about tobacco use, and 3 questions about alcohol use (Supplemental Appendix Table 1). Patients were also asked to describe their readiness to change (based on the transtheoretical model)⁵ in relation to each of the 9 measures, and the level of assistance they desired from the doctor (based on the 5As model popularized in smoking cessation guidelines).⁶ The steps embodied in the 5As include *assess* (asking about behavior status and factors affecting change), *advise* (giving a clear, personal message of encouragement to change), *agree* (setting goals based on readiness to change), *assist* (using behavior change techniques, such as self-help and/or counseling, to acquire the skills, confidence, and environmental supports for change, supplemented by medical treatments when appropriate), and *arrange* (scheduling follow-up contacts, including referral for more intensive treatment).⁶

Intervention sites: The MHL Web site offered brief, individualized health behavior advice^{7,8} (see the Annex at the end of this Supplemental Appendix), based on portal responses and invited patients to print a summary report for their next doctor's visit. Patients were then directed to the MHL Web site home page, where they could navigate the resource library. Guided by a short list of thematic topic headings, users could "drill down" to access links to hundreds of relevant Web sites from national organizations and federal agencies that were carefully vetted for quality control (Supplemental Appendix Annex). The library also provided links to local resources, such as jogging paths, classes, Alcoholics Anonymous meetings, and other community services to support behavior change. The Web site home page was personally tailored, with resources that were

appropriate for patients' self-reported behaviors and readiness to change. The MHL Web site also linked patients to the Web site of their practice to make it convenient to obtain contact information and, at some practices, to make appointments with their clinician.

Control sites: Patients from control practices answered the same introductory portal questions but received no counseling message, printout options, or resource library. Rather, they were directed to static information pages on the 4 health behaviors, adapted with permission from an American Academy of Family Physicians Web site.⁹ The information consisted of 1 Web page per health behavior that provided general health promotion tips but did not include hyperlinks to additional resources.

The Supplemental Appendix Annex provides further details about the development, beta-testing, and mechanics of the MHL Web site. Practices, patients, computer programmers, graphics artists, behavioral scientists, national organizations, and community partners worked together to develop the MHL Web site, a collaboration described in the Supplemental Appendix Annex and summarized in a recent article.⁴ The Supplemental Appendix Annex also displays the portal questions, from which our outcomes data derive, and the methods by which they were developed.

Promotion of Web Site by Practices

Intervention and control practices aggressively promoted the Web site, using a combination of resources (eg, wall posters, telephone hold-line messages) and actions taken by physicians and nurses, as described in the Supplemental Appendix Annex and elsewhere.⁴

Follow-up Surveys

Data for the main test of effectiveness came from questionnaires that participants were invited by e-mail to complete 1 and 4 months after their first Web site visit. The instruments included the same questions about behaviors and stages of change that appeared in the portal (Supplemental Appendix Table 1). These responses provided the outcomes data for measuring the effect on readiness to change and on health behaviors. Additional questions gave patients the opportunity to evaluate the Web site, including open-ended questions about what they liked most and least about the MHL Web site. If patients did not respond to the questionnaire within 1 week, the e-mail message was resent weekly for 2 weeks to enhance response rates.

Nonrandom Design

The grant supporting this study was inadequate to conduct a randomized controlled trial, the optimal design for evaluating the effectiveness of the intervention. For pragmatic reasons we pursued a pre-post design but sought to address temporal and other confounding variables by including control practices and comparing outcomes contemporaneously. The 2 practices assigned to the control group were selected nonrandomly by the investigators, who chose practices that seemed willing to postpone access to the intervention Web site until after the study. Patients decided for themselves whether to access the Web site; this self-selection made the distribution of patients to intervention and control arms both nonrandom and unpredictable.

Statistical Plan

Power analysis: Our study was powered to detect forward progress among patients in the preaction stages (precontemplation, contemplation, or preparation) in addressing the 2 most prevalent behaviors (unhealthy diet and physical inactivity). We predicted 93% power to detect a 10% positive stage shift in these behaviors among intervention patients and a 5% shift among patients in the control practices if 1,300 patients with these behaviors (900 intervention and 400 control) enrolled in the study (1-sided test of proportions, .05 significance level). Assuming that 50% of Web site visitors would consent to the study, we concluded that 2,720 patients from the intervention and control practices must visit the MHL Web site.

Data analysis: We used descriptive statistics to characterize the attributes of Web site visitors and to report responses to the questionnaires. To assess whether the intervention advanced patients' stage of readiness to change, we used Fisher's exact test¹⁰ to compare intervention and control patients on 3 parameters: (1) the proportion of patients in the preaction stages who advanced to action or maintenance stages; (2) the proportion of patients whose stage moved toward maintenance; and (3) the aggregate stage of change across the health behaviors. (The Supplemental Appendix Annex has the definitions of these parameters.) The intervention's effect on health behaviors was measured by examining net change (the difference between improved and

worsened behaviors) compared with net change in control patients. We compared intervention and control McNemar statistics¹⁰ to assess statistical significance, excluding from the denominator patients who reported no change in behaviors. Health behaviors were considered improved if patients moved toward goals (eg, increasing from 1 to 3 servings of fruits-vegetables per day), regardless of whether they achieved recommended targets (eg, 5 servings per day). Data were analyzed using SAS (version 9.1, Copyright 2002-2003, SAS Institute Inc, Cary, NC).

Results

Web Site Usage

We estimate that 25,488 unique adult patients attended the study practices during the project. During this period, the Web site recorded 1,285 "hits," 1,091 (85%) from first-time visitors. Of these, 932 (85%) indicated that they were patients of the 6 study practices, and 273 (29%) of these patients gave consent to participate. Fully 256 (94%) completed the portal questions, and 126 (49%) of these patients responded to the 1-month follow-up e-mail questionnaire; 80 (31%) responded to the 4-month follow-up questionnaire. The rate at which patients visited the MHL Web site did not decay substantially with time (Supplemental Appendix Figure 1), even though intensive efforts by the practices to promote the Web site subsided in month 5. Nonetheless, our follow-up sample of 126 patients was far fewer than the 1,300 subjects required under our power analysis.

Description of Users

The 273 study participants included 177 (65%) patients from the 4 intervention practices and 96 (35%) from the 2 control practices. Most MHL Web site visitors (79% and 71%, respectively) were younger than 50 years and female (Supplemental Appendix Figure 2). Female users were younger than male users ($P = .008$). Study participants and nonparticipants did not differ significantly by age, but we did observe marginally significant differences ($P = .07$) in their practice affiliation. No other data on nonparticipants were collected to enable further comparisons.

Baseline health behaviors: The health behaviors reported by the MHL Web site visitors (Supplemental Appendix Figure 3) were comparable to rates reported in national surveys,¹¹⁻¹⁴ although our Web site visitors were less likely to report consuming 5 or more servings of fruits and vegetables per day (13% vs 26%)¹⁵ or engaging in light-moderate physical activity 5 or more days per week (14% vs 33%).¹⁶ Of the 256 respondents, 254 (99%) reported poor dietary habits (inadequate fruit-vegetable intake or failure to restrict dietary fats) and 182 (71%) did not achieve recommended weekly levels of light-moderate or vigorous physical activity. One of 5 (20%) respondents reported problem drinking (too many drinks per week or binge drinking). Health behaviors of patients from intervention and control practices did not differ significantly.

Stage of readiness to change: At their first Web site visit, most respondents (80% to 92%) indicated they were in a preaction stage with regard to physical activity and healthy eating (other than dietary fat intake, for which 44% were in a preaction stage and 43% were in maintenance) (Supplemental Appendix Table 2). When asked about engagement in light-moderate physical activity, almost one half of respondents (47%) reported being in the preparation stage. With regard to tobacco and alcohol use, most (83% to 89%) respondents classified themselves in the maintenance stage, reflecting the local population's low prevalence of smokers and problem drinkers. Readiness to change did not differ significantly between intervention and control groups.

Desired assistance: Although not actively engaged in behavior change, the respondents did indicate a strong desire for receiving the 5As (to be asked whether they engage in the behavior or to receive advice or assistance) from their doctors. Fully 55% and 53% of respondents, respectively, wanted such help on diet or physical inactivity; 50% of smokers wanted the doctor's assistance. Only 10% of respondents wanted to be asked about alcohol use, and only 24% of problem drinkers wanted advice.

Outcomes

Advancement in stage of readiness to change: The 1-month follow-up questionnaire responses ($n = 126$) showed there were sizable subgroups of patients, from both intervention and control practices, who advanced beyond preaction to action or maintenance stages (Supplemental Appendix Table 3). Stage advancement in patients from intervention and control practices was most common for avoiding high-fat foods (48% and 24%, respectively), becoming physically

active (24% and 17%, respectively), and eating fruits and vegetables (11% and 10%, respectively). Stage advancement in patients at 4-months ($n = 80$) favored the same behaviors: dietary fat reduction (50% and 44%, respectively), physical activity (27% and 31%, respectively), and fruit-vegetable intake (18% and 14%, respectively). Fewer than 5% of patients reported stage advancement for eating grains. There were too few smokers and problem drinkers for meaningful analysis.

Analysis of our 3 parameters of stage advancement yielded inconsistent results in assessing the primary outcome of the study: whether the magnitude of advancement differed between intervention and control groups. No significant differences were noted with 2 of the 3 parameters: the percentage of patients whose stage moved toward maintenance or the aggregate stage of change across health behaviors. When measured in terms of advancement beyond preaction stages, patients from the intervention practices appeared to have significantly greater readiness than patients from the control practices to address light-moderate activity ($P = .02$) and dietary fat intake ($P = .06$) as of the 1-month survey, but no significant differences persisted at 4 months (Supplemental Appendix Table 3).

Change in health behaviors: Supplemental Appendix Table 4 displays the proportion of survey respondents who reported improved, worsened, or unchanged behaviors at 1 and 4 months. Patients from both the intervention and control practices reported improvements, but net behavior change (Supplemental Appendix Figure 4) did not differ significantly between groups. A larger proportion of intervention practice patients reported progress with light-moderate activity at 1 month and eating grain products at 4 months, but these differences were of borderline significance ($P = .10$ and $.08$, respectively).

A notable finding, albeit lacking in statistical significance, was the consistently greater net behavior change reported at 1 month by intervention practice patients than by control practice patients (Supplemental Appendix Figure 4). This trend recurred across multiple behaviors: diet (intake of fruits and vegetables, grains, dietary fat), physical activity (light-moderate and vigorous), and smoking. The favorable trend observed at 1 month was no longer apparent at 4 months.

Moreover, differences in the magnitude of behavior change were modest. At the 1-month follow-up, for example, changes in light-moderate activity in the intervention and control practice groups differed by 0.92 days per week (SE = 0.29). Differences in the magnitude of change in other behaviors were trivial (fruit and vegetable intake: 0.05 servings [SE = 0.18]; grain intake: -0.05 servings [SE = 0.22]; vigorous activity: 0.37 days per week [SE = 0.22]; alcohol intake: -0.17 drinks per day [SE = 0.13]).

Representativeness of follow-up sample: Patients who responded to the follow-up questionnaires differed from nonrespondents. Respondents were significantly older ($P \leq .001$)—34% of 1-month respondents (vs 15% of nonrespondents) were aged 50 years and older. Respondents were also less likely than nonrespondents to be current smokers or problem drinkers ($P \leq .05$). Finally, 4-month respondents reported marginally healthier habits in fruit and vegetable intake ($P = .08$) and in days per week and daily quantity of alcohol consumption ($P = .07$ and $P = .06$, respectively).

Web Site Feasibility and Acceptability

Promotion: Visitors to the MHL Web site were most likely (33%) to have heard about it from their physician. Other cited sources included wall posters (17%), telephone hold-line messages (12%), tear-off sheets and Web site prescriptions (12%), and nurses (3%).

User evaluation: Answers to fixed-response questions about the performance and value of MHL are provided in Supplemental Appendix Table 5. Responses did not differ significantly between patients from intervention and control practices.

Respondents from intervention practices made 20 entries to an open-ended question about what they liked best about the MHL Web site. They most frequently discussed the Web site's quantity of information (9), encouragement and awareness about healthy behaviors (2), understandability and clarity (2), practical assistance (2), and ease of use (1). For example:

"It brings to my attention the goals I should be working on for healthy living"

"It is like having a Dr or Nurse to talk to at all times."

"The opportunity for someone in the area to respond to our needs"

Respondents from intervention practices made 21 open-ended entries about what they liked least about the MHL Web site. They most frequently noted that the Web site resources lacked adequate detail (3), interactivity with health personnel (3), and guidance for patients with specific disease conditions (2). For example:

"I am looking for more detailed information. What is [the] exact diet for lowering cholesterol? What is [the] exact diet for diabetes?"

"I wished it had sent me follow up e-mails...reminders"

"Not being able to have someone respond to questions"

Respondents from control practices, whose Web site provided only limited information, were more likely to complain of inadequate detail (eg, "I was looking for specific advice on diet to help reduce weight and lower cholesterol"; "not enough information or links to surrounding areas for help on diet and exercise"). Some users valued the simplicity of the control practice site ("easy to use") and its reinforcement of basic lifestyle concepts ("simple and easy information and tips"; "it is a good reminder of the things that we have heard over the years and need to be reminded about as we age").

Discussion

Low Rate of Visits to the Web Site

The low number of patients who visited MHL compromised the statistical power of the study. It is unclear whether the low visit rate (an estimated 4% of adult patients) was specific to our study—reflecting limitations in our promotional efforts or in the MHL Web site itself—or reflects a reluctance to embrace practice-sponsored Web sites that patients anywhere might exhibit. Presumably, the MHL Web site would have been visited less in a region with lower computer literacy. A 2000 survey by one study practice found that 87% of patients had Internet access,¹⁷ whereas the national rate in 2002 was 59%.¹⁸

Technical factors may have influenced visit rate. The Web site operated off a server at Virginia Commonwealth University, which functioned uneventfully throughout the study. However, to give practices added value in making referrals to the MHL Web site, patients were encouraged to access MHL via links posted on their practice Web site. Intermittently for approximately 2 months, some practices experienced server failures and delays in restoring MHL links as Web sites were updated, potentially dampening patient enrollment.

The low visit rate must also be placed in a larger context. The MHL Web site was not meant to be instrumental among people who need in-person counseling, motivation, or long-term interaction to change behaviors; rather, it was meant to help among the subset who are "information-dependent": self-motivated patients for whom the pivotal obstacle is access to information or contact details about available programs. Interactive technologies have proved effective in promoting behavior change.¹⁹ Those who gravitate to such technology are almost certainly distinct.¹⁸ In our study, for example, the Web site visitors were younger and included a higher percentage of women than in the primary care population.²⁰

The crude visit rate measure of 4% therefore may understate the proportion of the target audience (ie, the subset of information-dependent patients for whom the Web site was intended) who visited the MHL Web site. Moreover, from a public health perspective, the involvement of even 4% of patients could have meaningful consequences at the population level if exposure improves health behaviors.

Effectiveness

Our study's low power leaves important questions unresolved. Does referring patients to a Web site facilitate behavior change? A positive effect would be consistent with previous research.²¹ What is the incremental benefit of the intervention practice Web site, and its rich library of resources, compared with the simple static Web site offered to control practice patients? How real is the trend in health behaviors that we observed at 1 month, in which the proportion of intervention practice patients reporting progress consistently exceeded that of control practice patients across multiple behaviors? Did the trend dissipate by 4 months, as our data suggest, or did it persist undetected because of a type II error or response bias? Were the outcomes that did achieve significance (eg, dietary fat intake) chance occurrences or true effects?

Factors other than low power might have diluted the effect of our intervention. For example, our survey data might have revealed greater effectiveness had respondents included a more

representative proportion of young adults, the population most apt to use Web sites.^{22,23} Further, our observation period may have been too short. Exposure to interventions must often be sustained to affect behavior.²⁴ Prochaska et al observed a "delayed action effect," in which outcomes improve with time well after the intervention delivers its information.^{25,26} Patients referred to the MHL Web site might not return to the site to make use of its resources until their stage of readiness progressed, a delayed outcome that might require a longer observation period to detect.

Patients and practices might also need time to acclimate to a new process for patient education. For generations, patients have expected physicians to answer questions during appointments or by distributing handouts. Although the public has embraced computers in other aspects of daily life,²⁷ patients remain unaccustomed to being directed to Web sites by clinicians. Nine months, the duration of our study, might have been too little time to adapt to the notion of a Web site "prescription," which might come more naturally to the next generation of patients, today's young people.

One could argue that an intervention which affects behaviors should first demonstrate an effect on readiness to change, which ours did not. Our study was originally designed with stage advancement as the primary outcome in the belief that the project would be too brief to detect movement on behaviors.²⁸ Systematic reviews published after our study began, however, question the validity of the transtheoretical model and of stages of readiness in predicting behavior change.²⁹⁻³¹ The failure of our intervention to produce a clear effect on stage advancement might bear little on its effectiveness in changing behavior.

The substantial stage advancement and improved behaviors that we observed in the control practice patients, which may have diluted the observed effect of the intervention, could have several explanations. The improvements could represent a secular trend³² (albeit inconsistent with national data showing a stable prevalence of unhealthy behaviors for the past decade),³³ the self-selection of patients who chose to visit a Web site and enroll in a study, or a Hawthorne effect. Finally, the outcomes could reflect "contamination of controls" if the static Web site itself facilitated behavior change or if control practices differed from intervention practices on relevant cofactors (eg, intensity or quality of counseling and support services, attributes of patients motivated to visit the Web site). Physicians at control practices, who were aware that they were directing patients to a static Web site, may have compensated by providing more extensive in-office counseling. Finally, as noted by some users, the simpler design of the control practice Web site may have enhanced its effectiveness in supporting behavior change.

Enhancing Web Site Use and Utility

The study confirmed the feasibility with which practices could offer the Web site resource to patients, and responses to our satisfaction questions reflected its appeal to users. Clinician encouragement to use MHL was, by itself, insufficient to draw many patients to this resource, however. Visit rates might be enhanced by more proactive promotion (eg, instructing patients to visit the site before appointments, making the Web site available in waiting rooms, and e-mailing patient reminders to visit the Web site). Many MHL users were young women; tailoring Web site content to match the demographic attributes of the user (eg, age, sex, educational status) might enhance salience.

An improved Web site design might also enhance utility to patients, but we lack data to provide an empirical basis for modifying features. We do not know, for example, which features of the MHL Web site were most difficult or most helpful. Nor do we know how the usability and effectiveness of MHL compare to other health information Web sites. Finally, we lack data on the extent to which MHL users visited other health Web sites or used those sites to obtain information on similar topics.

In our study, satisfaction with the MHL Web site did not differ significantly between intervention and control practice patients, suggesting that the patients may have found little added value to the intervention practice Web site. A meaningful advance in meeting patient needs may require Web sites to offer interactive features that go beyond the functions of MHL to provide customized personal support. For example, interactive sites already available from private vendors can provide tailored advice, help individuals track progress toward behavioral goals, provide normative benchmarks on how similar individuals fare, and offer modified tools as needs and

stages of change evolve over time. Formal usability testing, which was unaffordable under our small grant, would best determine which features users find most beneficial.

Limitations

Our study has limitations aside from low power and the self-selection of Web site visitors and survey respondents. Its nonrandom, pre-post design is subject to confounding. Outcomes data relied on self-report,³⁴ and the questions were drawn from validated instruments but were not validated in combination. We asked only 1 to 3 questions about each behavior; longer instruments would better characterize diet and other health habits. Finally, generalizability might have been limited by the high socioeconomic status and Internet literacy of the patient population and by other differences between study sites and ordinary primary care practices.

Supplemental Appendix Annex

Design and Development of the Web Site

The MHL Web site was developed in July-December 2003 with input from 5 sources:

1. Practice input: The clinicians and staff who would later participate in the study were first engaged to help write the grant. Once the study was funded, we used existing office management infrastructures and a September 2003 site visit at each practice to solicit input on the basic MHL concept, practice needs, perceived Web site value, study feasibility, and Web site promotional strategies. A secondary goal of this consultation was to promote "buy-in" (see below). More than 90 physicians and 180 staff from the study sites gave input.
2. Community input: Local partners in Fairfax County, Va, assisted with identification of relevant community resources to post on the MHL Web site. These included a local hospital system (INOVA Health System), cancer center (VCU Massey Cancer Center), county agency responsible for recreation and physical fitness centers (Fairfax County Park Authority), alcohol treatment center (Community Alcohol Treatment Services), and an oversight agency (Fairfax-Falls Church Community Services Board, Alcohol and Drug Services).
3. Expert input: We engaged behavioral scientists from the United States and Canada to help design the questions that patients encountered on entering the Web site and a framework to link resources with reported stage of change. A Web site programmer and database designer built the Web site architecture. Finally, we engaged graphic artists to make the Web pages attractive.
4. User input: In November 2003 we beta-tested the MHL Web site with 8 mock users and several physicians to identify problematic features of the Web site and the wording of questions and to obtain additional feedback on readability, understandability, and ease of use.
5. National organization input: We sought advice from 10 federal agencies, specialty societies, and voluntary health organizations: the Agency for Healthcare Research and Quality, American Academy of Family Physicians, American Cancer Society, American College of Physicians, American College of Preventive Medicine (primary partner), American Diabetes Association, American Heart Association, Centers for Disease Control and Prevention, and National Institutes of Health. In telephone conferences and follow-up surveys, we asked these partners for input on study design, their organization's best resources to post on the MHL Web site, and their assistance in raising national awareness about the project.

Vetting of Resources Posted on the Web Site

Resources posted on the MHL Web site consisted of existing Web pages available from prominent federal health agencies, professional associations, and disease-related groups. Many sites were identified in collaboration with Research Association of Practices, a research network that was simultaneously developing a Web site for its Prescription for Health study.³⁵ To ensure quality control, the investigators chose resources selectively, promoting sites with evidence-based content and eschewing commercially-sponsored Web sites or those that charged subscription fees. Other selection criteria included user-friendliness (eg, font size, ease of navigation) and the degree to which content addressed behaviors and stages of change that other resources did not cover.

Implementation of the Web Site

Only 12 months were available for participant enrollment and Web site assessment. We undertook 3 steps at the practices to ensure swift and sustained promotion of the MHL Web site.

Cementing Practice Participation

We conducted 2 site visits at each practice not only to obtain input but also to foster physician and staff acceptance of MHL through an instilled sense of ownership. At each site we identified 3 champions (a physician, nurse, and office manager) to promote the project and troubleshoot study problems. We also e-mailed bimonthly newsletters to keep the clinicians engaged.

Promotional Materials

Guided by the advice we received from practices, we developed strategies to optimize patient awareness of the MHL Web site. Colorful posters about the Web site, designed by a graphics artist, were displayed in lobbies and examination rooms of each of the 6 practices. Pads with tear-off sheets attached to the posters enabled patients to bring the details home. We mentioned MHL in telephone on-hold messages, handouts distributed at wellness visits, and directions for obtaining laboratory test results. We placed a distinctive icon on each of the practices' Web sites to facilitate access to the MHL Web site.

During site visits conducted 1 month before the Web site was launched (December 2003), we encouraged nurses and physicians to personally recommend the MHL Web site, either proactively or in response to patients' inquiries about behavior change. Clinicians received preprinted "prescription pads" that described the Web site and provided the Web site address (URL). During the intervention period, when the low rate of visits to the Web site became apparent, we engaged physician and nurse champions at each practice and e-mailed physicians directly to enlist their assistance in directing more patients to the site. They intensified promotional efforts at the practices, giving clinicians and staff further encouragement to promote the Web site, and devising additional avenues for promoting patient awareness. For example, office managers ordered special stamps to mention the Web site in standard patient mailings.

In-Service Training

Approximately 1 month before the MHL Web site was launched, we conducted a training session at each practice to provide a hands-on demonstration and review the promotional materials.

Web Site Portal

Supplemental Appendix Table 1 lists the questions that MHL users answered on their first Web site visit before they could access the resource library. (Similar survey questions appeared on the 1-month and 4-month follow-up questionnaires.) The wording and structure of the questions and response options were derived from the literature (with preference given to examining behaviors targeted in *Healthy People 2010* and using validated questions from national surveys) and modified further based on comments received from content experts and beta-testing by patients.

Based on the responses, MHL generated a personalized message that included positive reinforcement for healthy behaviors and suggestions for behavioral change to meet current recommendations. A sample message follows:

"It's good that you eat 1 or more servings of fruits or vegetables per day, eat 1 or more servings of grain products per day and do physical activities for at least 20 or 30 minutes. It's also good that you don't smoke and do not have more than 14 drinks per week. This is good for your health.

You said that you are not consistently avoiding high fat foods and having 5 or more drinks on the same occasion. According to current guidelines, it would be better for your health if you ate 5 or more servings of fruits or vegetables per day, ate 6 or more servings of grain products per day and consistently avoided high fat foods. It would also be better for your health if you stopped having 5 or more drinks on the same occasion."

Return Visits

Patients who at their first visit completed the question module and provided an e-mail address received an immediate e-mail thank you message. For patients at intervention practices, the e-mail included a special link (URL query string) that they could open to return to their customized home page and reexamine the resources identified on their first visit. Patients who returned to the

Web site via the conventional URL had access to these resources, but the homepage resources were not customized. Return visitors were free to navigate the MHL Web site in their customary manner and were not required to answer questions.

Data Analysis

Measuring Stage Advancement

Our main test of effectiveness was to compare intervention and control practice patients on 3 variables: (1) the proportion of patients in the preaction stages who advanced in stage of change for any of the behaviors (1-sided analyses); (2) the proportion of patients whose stage moved toward maintenance; and (3) magnitude of change in the median global health score for all 4 behaviors (1-sided analysis). The denominator for smoking and alcohol excluded patients who indicated that they have never engaged in the unhealthful behavior. The global health behavior score devised for the last hypothesis assigned 0 points for precontemplation, 1 for contemplation, and so on, summed across the behaviors for a total score.

Measuring Web Site Usage

We originally planned to use Web-tracking software to evaluate MHL usage. Although we were able to measure the number of visits to the welcome page and some details about Web site visitors (eg, age, sex, practice affiliation), we were unable to document which MHL resources patients used. Our programmers were faced with the challenge of designing Web pages with customized resources based on the user's behaviors and stage of change. They created heuristics that formed an artificial Web page for each individual user, based on their survey responses, making it impossible for conventional Web-tracking software to identify specific Web pages that patients selected.

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Supplemental Appendix Table 1. Web Site Portal Questions Answered by Patients on First Visit

Background Information

1. Is this your first visit to My Healthy Living? (*Yes; /No*)
2. Please select the name of your doctor's office (*Broadlands Family Practice; Fairfax Family Practice; Herndon Family Medicine; Prince William Family Medicine; Town Center Family Medicine; Vienna Family Medicine; A primary care doctor in Northern Virginia not listed; A primary care doctor not listed; I do not have a primary care doctor*)
3. What is your age? (*Less than 18 years; 18-35 Years; 36-49 Years; 50-65 years; More than 65 years*)
4. How did you hear about this web site? (*Doctor; Nurse; Wall poster; Printed matter I took home; Message while I was waiting on hold; Other*)
5. Do you want to participate in the study to learn more about health behaviors and improve the Web site? If you will help us to study this Web site, please check YES below. If NO, we understand. (*Yes, include me in the Web site study; No, I prefer not to help with the study. [Take me directly to the home page]*)
6. What is your sex? (*Male/Female*)

Health Behavior Survey

1. In a typical day, how many servings of fruits or vegetables do you eat? (*None; 1 Serving; 2 Servings; 3 Servings; 4 Servings; 5 Servings or More; I would rather not answer this question*)
2. In a typical day, how many servings of grain products (including whole grains) do you eat? (*None; 1 Serving; 2 Servings; 3 Servings; 4 Servings; 5 Servings; 6 Servings or more; I would rather not answer this question*)
3. Do you usually avoid eating high fat foods? (*Yes; No; I would rather not answer this question*)
4. In a typical week, how many days do you do LIGHT OR MODERATE activities for AT LEAST 30 MINUTES that cause ONLY LIGHT sweating or a SLIGHT TO MODERATE increase in breathing or heart rate? (*None; 1 Day; 2 Days; 3 Days; 4 Days; 5 Days; 6 Days; 7 Days; I would rather not answer this question*)
5. In a typical week, how many days do you do VIGOROUS activities for AT LEAST 20 MINUTES that cause HEAVY sweating or LARGE increases in breathing or heart rate? (*None; 1 Day; 2 Days; 3 Days; 4 Days; 5 Days; 6 Days; 7 Days; I would rather not answer this question*)
6. Do you now smoke cigarettes? (*Yes, every day; Yes, some days; No, but smoked in the past; No, never smoked; I would rather not answer this question*)
7. On average, how many days a week do you drink alcohol? (*None; 1 Day; 2 Days; 3 Days; 4 Days; 5 Days; 6 Days; 7 Days; I would rather not answer this question*)
8. On a typical day when you drink, how many drinks do you have? (*None; 1 Drink; 2 Drinks; 3 Drinks; 4 Drinks; 5 Drinks; 6 Drinks; 7 Drinks or more; I would rather not answer this question*)
9. In the last month have you had 5 or more drinks on the same occasion? (*Yes; No; I would rather not answer this question*)

Stage of Change

1. For healthy behaviors ...
How long have you been [doing healthy behavior] ...? (*Less than 6 months; 6 Months or more; I would rather not answer this question*)
2. For unhealthy behaviors ...
Do you think you will [start healthy behavior] ...? (*No, and I don't intend to in the next 6 months; Yes, and I intend to in the next 6 months; Yes, and I intend to in the next 30 days; I would rather not answer this question*)

Continued

Supplemental Appendix Table 1, continued

Desired Assistance

How would you like your doctor to help you with each of the following health behaviors (*Ask: Ask me about my health risks and things in my life that make behavior change harder or easier; Advise: Give me clear, specific, personal advice, including information about the harms and benefits for me; Agree: Work with me to make the treatment plans that I want; Assist: Help me reach my goals by getting skills, confidence, and other help. Includes medical treatment when appropriate; Arrange: Schedule follow-up contacts (appointments or telephone calls) to continue helping and to adjust the plan as needed. Includes referral to other community services when appropriate; Nothing: I don't think I need my doctor's help)*

Supplemental Appendix Table 2. Stages of Readiness to Change at Baseline

Health Behavior	Stages of Readiness to Change at Baseline									
	Precontemplation		Contemplation		Preparation		Action		Maintenance	
	Interv n (%)	Control n (%)	Interv n (%)	Control n (%)	Interv n (%)	Control n (%)	Interv n (%)	Control n (%)	Interv n (%)	Control n (%)
Fruits and vegetable intake	32 (19)	20 (23)	49 (30)	22 (25)	63 (38)	36 (41)	3 (2)	1 (1)	18 (11)	10 (11)
Total	52 (20)		71 (28)		99 (39)		4 (2)		28 (11)	
Whole grain intake	67 (41)	39 (44)	34 (21)	18 (20)	45 (28)	28 (32)	1 (1)	0 (0)	15 (9)	3 (3)
Total	106 (42)		52 (21)		73 (29)		1 (0)		18 (7)	
Avoiding dietary fat intake	19 (12)	16 (18)	15 (9)	10 (11)	32 (20)	16 (18)	17 (11)	14 (16)	75 (47)	31 (36)
Total	35 (14)		25 (10)		48 (20)		31 (13)		106 (43)	
Light-moderate physical activity	18 (11)	17 (19)	39 (25)	21 (24)	80 (50)	36 (41)	5 (3)	4 (5)	17 (11)	10 (11)
Total	35 (14)		60 (24)		116 (47)		9 (4)		27 (11)	
Vigorous physical activity	31 (19)	16 (18)	46 (29)	28 (32)	53 (33)	25 (28)	12 (8)	5 (6)	18 (11)	14 (16)
Total	47 (19)		74 (30)		78 (31)		17 (7)		32 (13)	
Smoking cessation	2 (1)	3 (3)	8 (5)	8 (9)	6 (4)	5 (6)	2 (1)	2 (2)	144 (89)	68 (79)
Total	5 (2)		16 (6)		11 (4)		4 (2)		212 (85)	
Limiting alcohol use	5 (3)	2 (2)	1 (1)	1 (1)	5 (3)	1 (1)	6 (4)	6 (7)	139 (89)	71 (88)
Total	7 (3)		2 (1)		6 (3)		12 (5)		210 (89)	
Reducing binge drinking	9 (6)	6 (7)	2 (1)	3 (3)	11 (7)	4 (5)	1 (1)	4 (5)	132 (85)	69 (80)
Total	15 (6)		5 (2)		15 (6)		5 (2)		201 (83)	

Interv = intervention

Supplemental Appendix Table 3. Patients' Self-Reported Advancement From Preaction to Action or Maintenance Stages

Behavior Change	Intervention			Control			P Value*
	Preaction Stage at First Visit	Patients (n) Advancing to Action or Maintenance Stage	Percent Moved	Pre-action Stage at First Visit	Patients (n) Advancing to Action or Maintenance Stage	Percent Moved	
1-Month Survey							
Diet: fruits and vegetables	61	7	11	40	4	10	.54
Diet: whole grains	63	2	3	47	3	6	.90
Diet: dietary fat intake	33	16	48	21	5	24	.06
Exercise: light/moderate	57	12	21	40	2	5	.02
Exercise: vigorous	58	6	10	36	6	17	.89
Smoking cessation	5	0	0	4	0	0	NA
Alcohol restriction (drink/wk)	4	0	0	2	0	0	NA
Alcohol restriction (reduced binge drinking)	6	0	0	6	2	33	1.00
4-Month Survey							
Diet: fruits and vegetables	34	6	18	22	3	14	.50
Diet: whole grains	36	0	0	26	1	4	1.00
Diet: dietary fat intake	16	8	50	16	7	44	.50
Exercise: light/moderate	36	5	14	25	4	16	.73
Exercise: vigorous	34	7	21	21	6	29	.84
Smoking cessation	4	1	25	1	0	0	.80
Alcohol restriction (drink/wk)	1	0	0	0	0	0	NA
Alcohol restriction (reduced binge drinking)	5	2	40	0	0	0	NA
Note: Based on self-designated stage on follow-up surveys. Preaction = precontemplation (no plans to change in the next 6 months), contemplation (plans to change in the next 6 months), and preparation (plans to change in the next month). Action = healthy behavior for less than 6 months; Maintenance = healthy behavior for 6 months or more.							
* One-sided Fisher's exact test ¹⁰ comparing proportional advancement among intervention and control populations.							

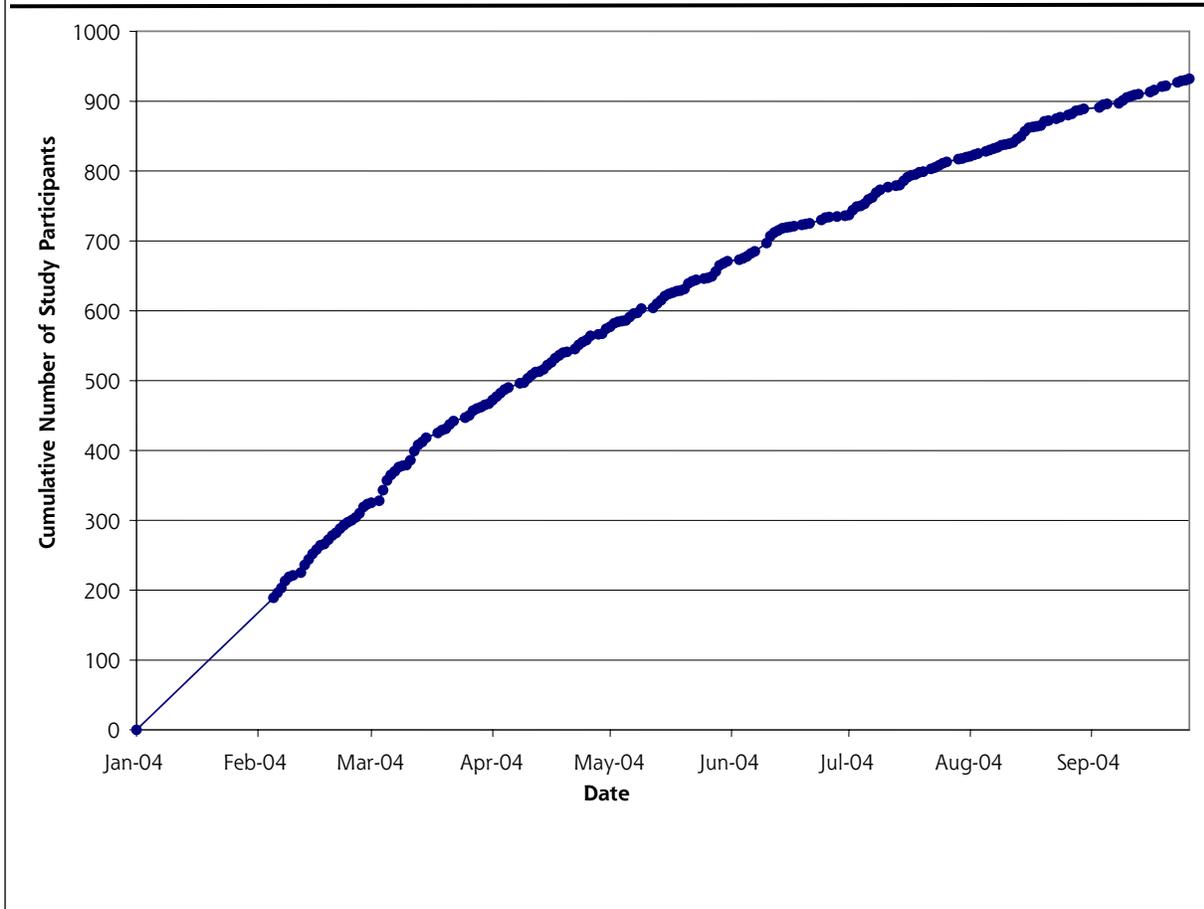
Supplemental Appendix Table 4. Self-Reported Health Behaviors								
Behavior	Intervention				Control			
	n*	Behavior Worsened[†] %	No Change %	Behavior Improved %	n*	Behavior Worsened[†] %	No Change %	Behavior Improved %
1-Month Survey								
Diet: fruits and vegetables	74	11	38	51	51	14	41	45
Diet: whole grains	74	22	47	31	50	28	36	36
Diet: dietary fat intake	73	7	70	23	49	6	84	10
Exercise: light/moderate	74	11	46	43	51	22	47	31
Exercise: vigorous	74	16	53	31	51	22	57	22
Smoking cessation	74	1	96	3	50	6	90	4
Alcohol restriction (d/wk)	72	19	65	15	49	16	73	10
Alcohol restriction (drink/d)	74	18	65	18	48	8	71	21
Alcohol restriction (reduced binge drinking)	74	3	97	0	50	4	92	4
4-Month Survey								
Diet: fruits and vegetables	47	17	47	36	30	23	37	40
Diet: whole grains	48	29	31	40	30	43	40	17
Diet: dietary fat intake	45	7	73	20	29	3	69	28
Exercise: light/moderate	48	17	38	46	30	27	27	47
Exercise: vigorous	48	17	52	31	30	17	50	33
Smoking cessation	47	4	89	6	30	7	90	3
Alcohol restriction (d/wk)	48	21	69	10	29	21	69	10
Alcohol restriction (drink/d)	48	13	71	17	29	10	76	14
Alcohol restriction (reduced binge drinking)	48	6	90	4	30	7	93	0
Note: See Figure 1 in the main article for statistical significance of differences in net improvement in intervention and control practice patient groups.								
* Sample size varies due to missing values.								
† Based on behaviors reported on follow-up questionnaire responses.								

Supplemental Appendix Table 5. User Comments on Web Site

Comments	Intervention %	Control %	Total %
Visited Web site 2-5 times	52	69	60
Would use Web site again	49	59	53
Not sure	45	33	41
Would advise a friend or relative to use the Web site	45	47	46
Not sure	51	49	50
Web site helped in changing behaviors			
A lot	9	8	9
A little	55	47	52
None	35	45	39
Web site helped a little or a lot with medical care	27	37	30
Advice about maintaining the Web site			
Keep the Web site as is	73	79	75
Keep only if its problems are fixed	19	16	19
Do not bother keeping it	8	5	7

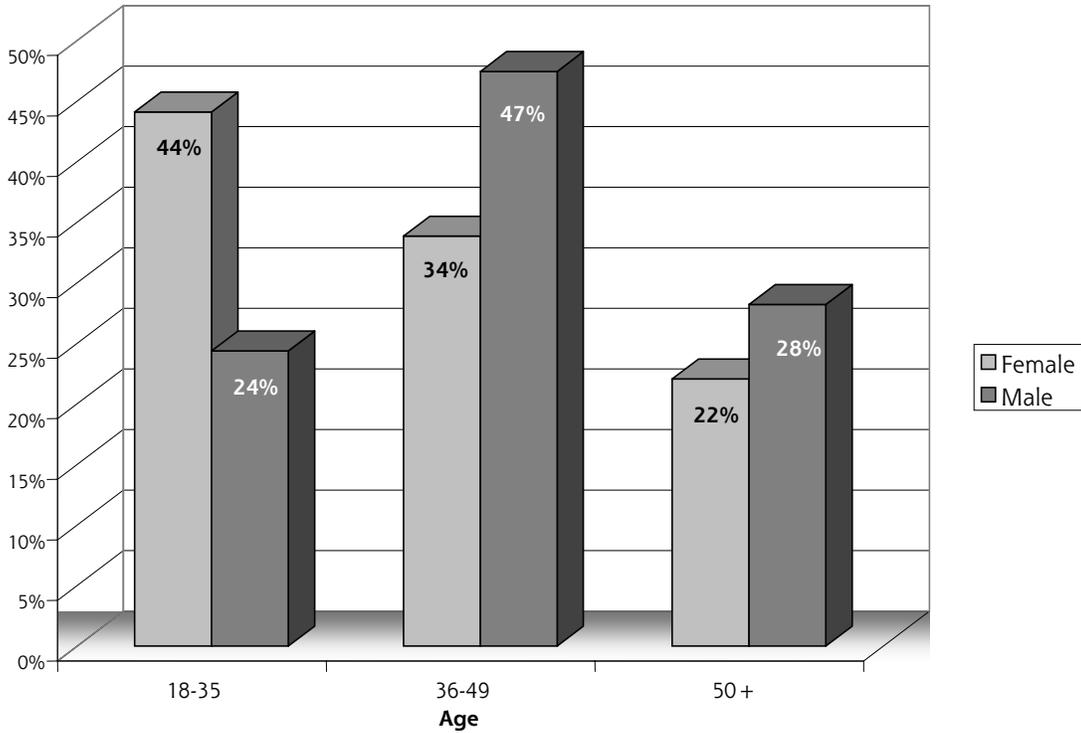
*Differences in the proportions reported by control and intervention practice patients were not statistically significant.

Supplemental Appendix Figure 1. First-time visits to Web site by study subjects, months 1- 9.



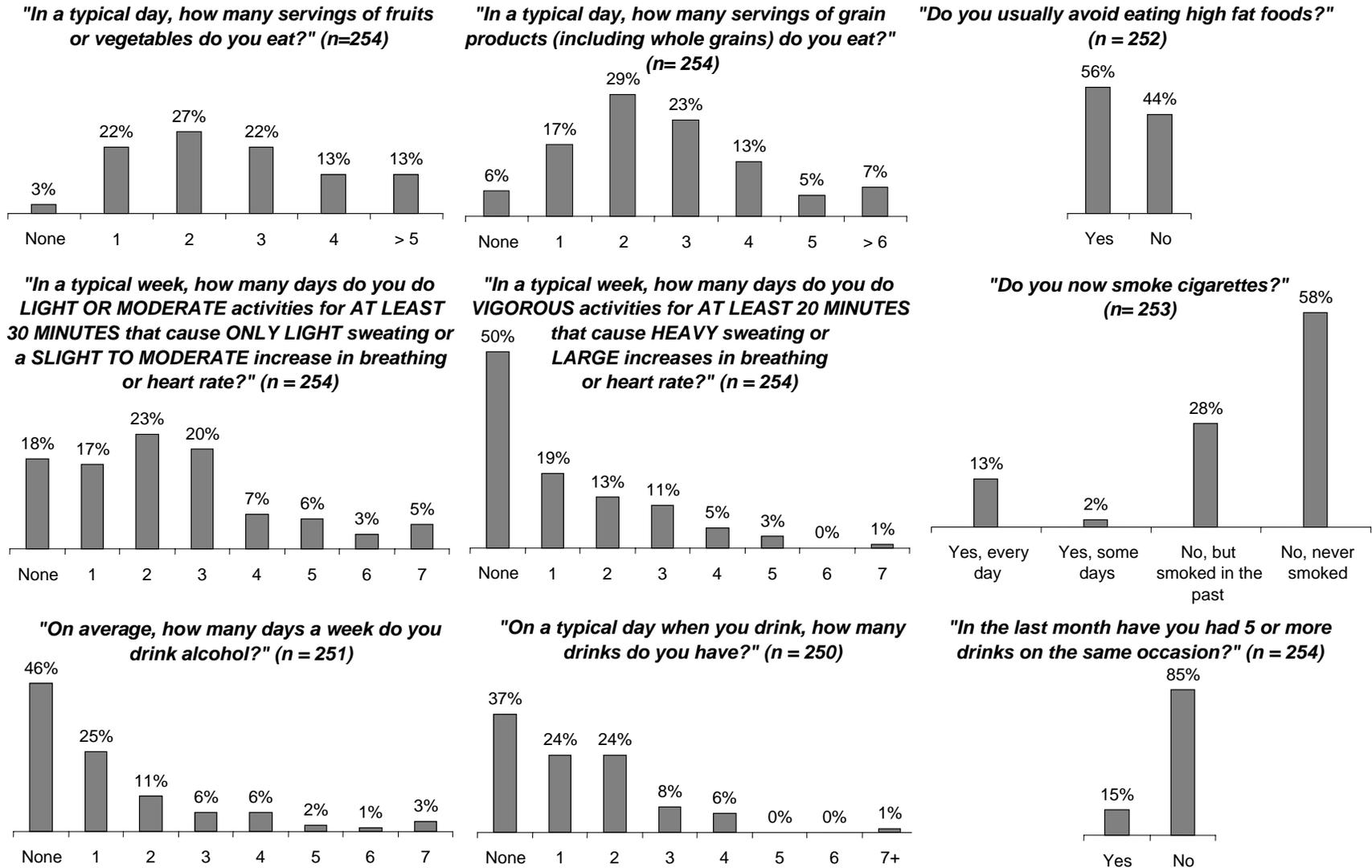
The Web site was launched on January 5, 2004. Active efforts to promote the Web site ceased in June 2004, but the visit rate persisted thereafter. The y-axis measures visits by patients from the 6 study practices; visits by individuals who did not designate these practices as their primary source of care are not counted. (The curve is normalized in January, after which we began recording the time stamp date when each user visited the Web site). Reprinted with permission from Krist et al.⁴

Supplemental Appendix Figure 2. Web site visitors, by age and sex.



Percentages refer to the proportion of the sex within the specified age-group.

Supplemental Appendix Figure 3. Health behaviors reported by Web site visitors at first visit.



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