

A Systematic Review of Selected Interventions for Worksite Health Promotion

The Assessment of Health Risks with Feedback

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Background: Many health behaviors and physiologic indicators can be used to estimate one's likelihood of illness or premature death. Methods have been developed to assess this risk, most notably the use of a health-risk assessment or biometric screening tool. This report provides recommendations on the effectiveness of interventions that use an Assessment of Health Risks with Feedback (AHRF) when used alone or as part of a broader worksite health promotion program to improve the health of employees.

Evidence acquisition: The *Guide to Community Preventive Services*' methods for systematic reviews were used to evaluate the effectiveness of AHRF when used alone and when used in combination with other intervention components. Effectiveness was assessed on the basis of changes in health behaviors and physiologic estimates, but was also informed by changes in risk estimates, healthcare service use, and worker productivity.

Evidence synthesis: The review team identified strong evidence of effectiveness of AHRF when used with health education with or without other intervention components for five outcomes. There is sufficient evidence of effectiveness for four additional outcomes assessed. There is insufficient evidence to determine effectiveness for others such as changes in body composition and fruit and vegetable intake. The team also found insufficient evidence to determine the effectiveness of AHRF when implemented alone.

Conclusions: The results of these reviews indicate that AHRF is useful as a gateway intervention to a broader worksite health promotion program that includes health education lasting ≥ 1 hour or repeating multiple times during 1 year, and that may include an array of health promotion activities. These reviews form the basis of the recommendations by the Task Force on Community Preventive Services presented elsewhere in this supplement.

(Am J Prev Med 2010;38(2S):S237–S262) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

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0749-3797/00/\$17.00

doi: 10.1016/j.amepre.2009.10.030

Introduction

Over the past 25 years, the number of organizations and companies that offer a health promotion program for their employees at the worksite has increased, with 81% of worksites in 1990 and nearly 90% of all workplaces with at least 50 employees by 2000, offering some type of health promotion program for their employees.^{1,2} This is due, in part, to the fact that American adults are spending increasingly larger portions of their waking hours at work, and because poor employee health comes at a cost to employers. Furthermore, the top five health conditions (diseases of the heart, cancers, cerebrovascular disease, chronic lower respiratory disease, and unintentional injuries) are potentially responsive to health intervention. Several of the diseases associated with these conditions and almost 55% of all deaths are strongly affected by four modifiable behavioral factors³ that may be addressed in the worksite setting. These four factors—tobacco use, poor diet, physical inactivity, and alcohol use—are related to five of the 20 most costly physical health conditions for U.S. employers (including angina pectoris [chest pain], diabetes mellitus, acute myocardial infarction [heart attack], chronic obstructive pulmonary disease, and back pain).⁴ These factors give further reason for the widespread offering of health promotion programs at worksites.

One of the components of a worksite health promotion program most often offered is the health-risk assessment or biometric screening, with close to 50% of companies of more than 750 employees reporting having offered a health-risk assessment, according to a 2004 national survey of worksite health promotion.⁵ Assessments of health risks may be of interest to worksite health promotion planners because they are easy to administer (computerized versions are available), convey a lot of information quickly, allow for access to a large number of people, provide workforce-wide estimates, and allow the potential for follow-up.

Historically, the terms health-risk appraisal and health-risk assessment, which share the acronym HRA, have been used interchangeably to describe assessments of health risks. Although the assessment of health risks has been conducted in community settings for more than 2 decades, no consensus definition exists. HRA has been variously described as a tool or questionnaire, as a technique, and more recently, as a process with three or more steps.^{6–8} Most authors in the field agree, though, that there are basic elements of HRAs: the assessment of personal health habits and risk factors (which may be supplemented by biomedical measurements of physiologic health); a quantitative estimation or qualitative assessment of future risk of death and other adverse health

outcomes; and provision of feedback in the form of educational messages and counseling that describe ways in which changing one or more behavioral risk factors might alter the risk of disease or death.^{6–8}

This report provides evidence on the effectiveness of worksite interventions that use an Assessment of Health Risks with Feedback (AHRF) as the primary intervention component (when used alone) or as part of a broader worksite health promotion program (when health education and other health promotion components are offered as follow-up to the assessment) to improve the health of employees. It addresses three main research questions: Does AHRF, when used alone, lead to behavior change or change in health outcomes among employees? Does this type of assessment, when used with other worksite-based intervention components result in change? And finally, what types of behaviors or health outcomes are affected by these interventions?

Some of the earliest research in the use of HRAs for changing targeted health behaviors and conditions was conducted on a large scale at the community level in the U.S. with the Multiple Risk Factor Intervention Trial (MRFIT).^{9–11} This was soon followed by the European Collaborative Trial of Multifactorial Prevention of Coronary Heart Disease.^{12–15} Conducted in the late 1970s and early 1980s, this latter initiative focused on more than 60,000 working men across worksites in six countries in Europe. In the mid-1980s the CDC released an HRA for public use.⁸ A partnership between the CDC and the Carter Center developed around this tool, and the Carter Center later adopted it (it is now known as the Healthier People HRA). During this time, use of assessments of health risks in the workplace increased dramatically and studies were conducted to examine different aspects of the tools and process of assessments of health risks. In the mid-1990s a number of reviews were published on this topic, each offering the general conclusion that use of HRAs and other AHRFs, when used alone (not in the context of broader health education programs), had value as tools for assessing the health of populations and for increasing awareness of potential health risks. Problems with the quantity and quality of the available evidence, however, made it difficult to draw a conclusion about the impact of these interventions on health behaviors and risk factors.^{7,16}

Guide to Community Preventive Services

The systematic reviews in this report present the findings of the independent, nonfederal Task Force on Community Preventive Services (Task Force). The Task Force is developing the *Guide to Community Preventive Services* (*Community Guide*) with the support of the USDHHS in

collaboration with public and private partners. The CDC provides staff support to the Task Force for development of the *Community Guide*. The book, *The Guide to Community Preventive Services: What Works to Promote Health?*¹⁷ (also available at www.thecommunityguide.org/library/default.htm) presents the background and the methods used in developing the *Community Guide*.

Healthy People 2010 Goals and Objectives

There are well over 400 *Healthy People 2010*¹⁸ objectives, and most are relevant to the working population. *Healthy People 2010* includes among its top ten leading health indicators six variables addressed in most assessments of health risk: physical activity, overweight and obesity, tobacco use, substance use (typically limited to alcohol use), injury and violence (most often seatbelt use), and health-care service use (which would include a range of cancer screening services).¹⁹ The interventions reviewed here should be useful in reaching several *Healthy People 2010* objectives in these categories, which identify some of the significant preventable threats to health and focus the efforts of public health systems, legislators, policymakers, healthcare organizations, and employers for addressing those threats. *Healthy People 2010* also includes two worksite-specific objectives. Objectives 7-5 and 7-6 state that (1) at least three quarters of U.S. employers, in worksites with 50 or more employees, will offer a comprehensive employee health promotion program; and (2) at least 88% of U.S. employees will be participating in employer-sponsored health promotion activities.

Evidence Acquisition

Conceptual Approach

Using methods developed for the *Community Guide*,¹⁷ the review team conducted a set of systematic reviews to evaluate the evidence on effectiveness of AHRF when implemented alone and when used in combination with other intervention components (AHRF Plus) in worksite settings.

In brief, this process involved forming a systematic review development team composed of experts in worksite health promotion, public health, and systematic reviews; developing a conceptual approach to organizing, grouping, and selecting interventions; selecting interventions to evaluate; searching for and retrieving available research evidence on the effects of those interventions; assessing the quality of and abstracting information from each study that meets inclusion criteria; assessing the quality of and drawing conclusions about the body of evidence of effectiveness; and translating the evidence on intervention effectiveness into recommendations. Evidence was collected and summarized regarding the effectiveness of interventions for altering selected health-related outcomes and on positive or negative

effects of the intervention on other health and nonhealth outcomes. When an intervention has been shown to be effective, information is also included about the applicability of evidence (i.e., the extent to which available effectiveness data might generalize to diverse population segments and settings), the economic impact of the intervention, and barriers to implementation.

To be included in the reviews, a study had to: (1) be primary research published in a peer-reviewed journal, technical report, or government report; (2) be published in English between January 1980 and June 2005; (3) meet minimum research quality criteria for study design and execution;²⁰ (4) evaluate the effects of an AHRF when implemented in a population of workers in worksite settings; and (5) evaluate change in one or more outcomes of interest (see the Outcomes Evaluated section).

Assessment of Health Risks with Feedback

For this review the team used the term “Assessment of Health Risks with Feedback” to refer to a process that includes three elements: (1) the collection of information about at least two personal health behaviors or indicators; (2) translation of the information collected into one or more individual risk scores or categoric descriptions of risk status; and (3) feedback to the participants regarding their risk status, either overall or with respect to specific risk behaviors. Although AHRF can be offered as an independent intervention, it is often applied as a gateway intervention to a broader worksite health promotion program, which may be risk-specific or broad in scope, and which may be of limited duration and intensity or may occur over many months or years (with few or multiple contacts). When used as a gateway intervention, the assessment is typically conducted one or more times, and the feedback is offered to the participant along with information about the identified health risks, information about programs directed toward the prevention or treatment of the identified health risks, or referrals to programs or providers addressing the identified health risks.

The first element of AHRF, the collection of individual health information, is typically done by questionnaire, but occasionally data are gathered from medical records or through personal health interviews. Both the form and function of this data collection have changed in concert with technologic changes. Some of these changes include the use of computers for generation of health-risk scores, web-based data collection, and generation of individualized reports. Biometric screenings, an optional element of the basic AHRF intervention, are often used to obtain up-to-date and accurate measures of blood pressure, cholesterol, weight or BMI, and other physiologic indicators.

Data collected are used to inform the second element of AHRF, the translation of information into a risk score. The data may be converted into a variety of indicators:

1. A simple qualitative statement of general risk status (e.g., “you smoke and therefore are at increased risk for getting cancer”)
2. A quantitative evaluation (actual test results) of an individual’s health risks
3. An individual health risk estimate (summary scores, health age [estimated age of death due to certain diseases], or health risk category [usually based on a score or presence of a specified number of risk factors])

The generation and use of health risk estimates are often tailored to the needs of the intervention team, and so from a research perspective, the estimates are not necessarily comparable.

The third element of AHRF, feedback, can be provided verbally or in writing, and is defined broadly to include referrals; single-point, short-term counseling; and brief health education. It may include the use of pamphlets, videos, or other forms of small media. For the purposes of this review, if the feedback was provided in a single session lasting less than 1 hour and provided only once, it was considered part of the basic AHRF process, instead of as a supplementary health education intervention.

Assessment of Health Risks with Feedback Plus

If AHRF was implemented with additional health-related interventions provided by employers at the workplace, the team referred to these collectively as AHRF Plus. Additional interventions may include health education (to be included as a unique intervention component, the educational efforts must last for longer than 1 hour or occur in multiple sessions over time), enhanced access to physical activity, nutritious food alternatives, medical care, or policy interventions like smoking bans or restrictions. These interventions are described below.

Health education. Based on early definitions by Green, Kreuter et al.,^{21,22} the team defined health education as any combination of learning experiences intended to bring about behavioral changes in individuals, groups, or larger populations to facilitate voluntary actions conducive to health. The health education session(s) offered may provide information about one or more health factors.

Enhanced access. Enhanced access refers to nonfinancial or financial programs or policies (e.g., reduced out-of-pocket costs, walking trails, healthy foods in the cafeteria) that enable or facilitate access to programs, workshops, classes, and other resources in a clinical or nonclinical setting. In practice, the focus is typically toward one or more of three main health-oriented arenas: physical activity, nutrition, and medical care. Financial means of enhancing access often include efforts to reduce financial barriers to employees through reimbursement, voucher distribution, or increased (full or partial) third-party payment for offsite services or programs and are referred to in this paper as reduced out-of-pocket costs (ROPC).

Policies and environmental change. Policies are typically written, company-wide guidelines that affect all employees and cover topics like smoking bans, smoking restrictions, smoke-free buildings, or vending machine content rules. Policies that facilitated enhanced access were considered to fall within that category for the purposes of this review.

Incentives. Incentives are financial or material awards provided for three main reasons: to increase study participation, to increase program participation, or to motivate participants to reach a behavioral goal. Incentives vary in size and type and can be awarded in the form of a lottery or reduction in insurance premiums, among other forms. They may also be targeted toward either individuals or groups.

Analytic Framework

The analytic framework (Figure 1) was developed by the review team to guide the review process and the assessment of the evidence on the effectiveness of AHRF and AHRF Plus. The analytic framework considers the three elements of the AHRF process, as described above, as a package. The personalized information regarding risk of becoming chronically ill or dying prematurely provided by these interventions is intended to motivate employees to engage on their own in healthier behaviors (e.g., to quit smoking) or to participate in further health education or health promotion activities. A change in an individual’s motivation can result in his or her initiating efforts to change one or more health behaviors or to engage in the management (diagnosis, treatment) of a health condition. When AHRF is implemented alone, a worker may seek to improve health through outside means, such as by managing conditions with medication, changing health behaviors, or modifying healthcare service use. When AHRF is implemented with additional interventions (as depicted in the large circle in Figure 1, and described previously), workers may still use outside means to improve health on their own, but may also be directed toward or given access to programs, policies, or facilities provided by the employer. The ultimate goal is to improve health behaviors, which in turn would improve intermediate health-related outcomes including physiologic indicators (such as a change in blood pressure or cholesterol) and psychological indicators (such as measurements of stress or job satisfaction). Improvements in any of the above areas are expected to lead to reduced morbidity and mortality, and to improve productivity (which is typically measured as absenteeism in the AHRF evaluation literature).

Outcomes Evaluated

The outcomes of interest in this review fall into three broad categories: behavioral, physiologic, and other indicators of aggregated effects. Because AHRF and AHRF Plus target multiple behaviors and health conditions, assessing the overall effectiveness of these interventions requires indices

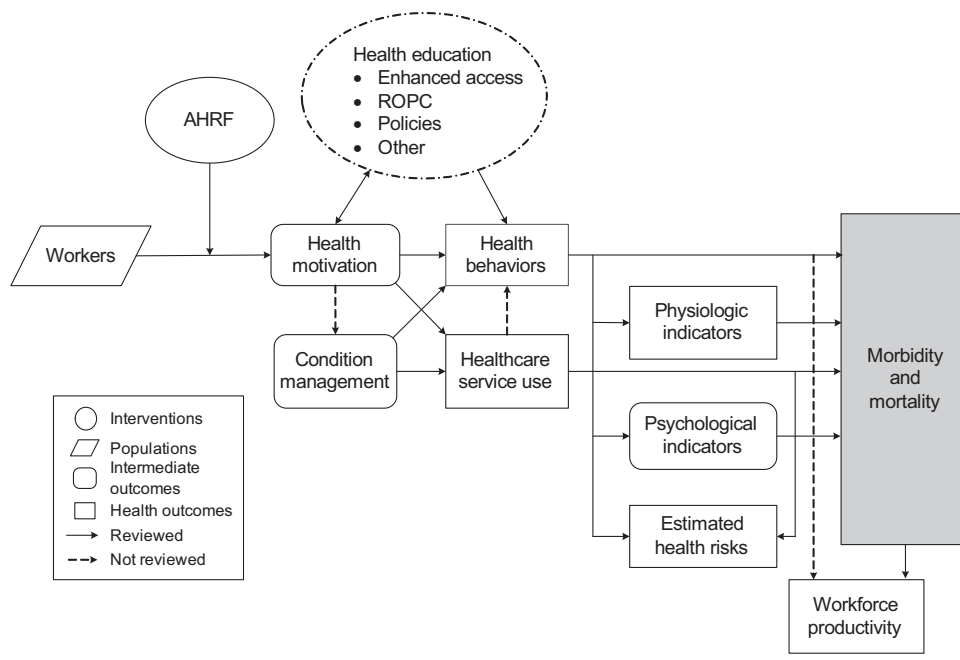


Figure 1. Analytic framework showing the hypothesized pathways through which AHRF (assessment of health risk with feedback) interventions would affect intermediate and health outcomes
ROPC, reduced out-of-pocket costs

that reflect the aggregated effects of changes across a range of risk behaviors and physiologic indices. In this review, three different categories of outcomes may provide useful information on such aggregated effects: summary health risk estimates, healthcare services use, and absenteeism. The first of these, summary health risk estimates, is typically obtained from the intervention assessment tool itself. Although summary health risk estimates measure change across a wide range of health behaviors and indicators, they reflect the specific set of questions or biometric data included in each assessment tool. As a result, these estimates may not be directly comparable to one another because assessment tools may evaluate different health conditions (e.g., cardiovascular risk change; cancer risk change) or be informed by different types of health indicators (e.g., behavioral only or physiologic only). Healthcare services used by individual workers (such as hospital days) and measurements of absenteeism also provide opportunities to assess such aggregated effects. Table 1 has a list of all included outcomes. Although many included studies reported additional outcomes (for example, several studies reported measurements of change in perceived stress), these were not systematically evaluated in this review.

Search for Evidence

The articles to be reviewed were obtained from systematic searches of multiple databases, reviews of bibliographic reference lists, and consultations with experts in the field. The following databases were searched: Medline, Employee Benefits, NTIS, Sports Information Resource Center, Cambridge

Scientific Abstracts, Business Week, ABI Inform, Health Promotion and Education, Cumulative Index to Nursing & Allied Health Literature, Office of Smoking and Health, AIDSLine, PsycInfo, and Sociological Abstracts. Details of the search strategy are available at www.thecommunityguide.org/worksite/.

Evaluating and Summarizing the Studies

Each study that met the inclusion criteria was evaluated for the suitability of the study design and study execution by at least two independent abstractors using the standardized *Community Guide* abstraction form.²³ Abstractors rated the suitability of each study design as “greatest,” “moderate,” or

“least,” depending on the degree to which the design protects against threats to internal validity. They rated the quality of execution of each study as “good,” “fair,” or “limited,” based on several predetermined factors that could potentially limit a study’s utility for assessing intervention effectiveness. Studies of “limited” quality of execution were excluded from the final assessment of intervention effectiveness. For the remaining qualifying studies, effect estimates were calculated for each study outcome, where possible. When it was not possible to calculate a summary effect estimate for a particular outcome due to heterogeneity or for other reasons, the team provided a qualitative summary of study findings.

Calculation of effect estimates for qualifying studies. The team calculated summary effect sizes when the included evidence provided a sufficient number of similar (if

Table 1. Categories of outcomes included in the reviews

Behavioral	Physiologic	Other
Alcohol use	Blood pressure	Healthcare service use
Diet	Body composition	Absenteeism
Physical activity	Cholesterol	Health risk estimate
Seatbelt use	Fitness	
Tobacco use		

not identical) outcome measurements. Summary effect size results provided in this report include the median estimate and the interquartile intervals (IQI) of change across the qualifying evidence. For bodies of evidence with fewer than seven measurements of change, the team did not generate an IQI and instead provided the median measurement of change and the simple range of values (minimum and maximum).

Where possible, effect estimates from qualifying studies were calculated using measures of absolute change, relative change, or both. Specifically, for categoric (dichotomous) data, the team presented estimates of absolute percentage point or relative percentage change in the proportion of people within the higher-risk category. For continuous data, the team presented mean differences or percentage changes when appropriate (i.e., when these effect estimates can be interpreted given the units of the original measurement scale). When CIs were not provided in the primary studies, the team calculated or estimated them if sufficient information was available.²⁴ When studies provided multiple measurements over time, the team used the “pre” measurement closest to the start of the intervention, and the most distal “post” measurement reported. The team included formulas used to generate absolute and relative change below.

Absolute change. Absolute changes were calculated using the following formula, where I_{post} is the posttest measure for the group receiving the intervention, I_{pre} is the pretest measure for the group receiving the intervention, C_{post} is the post-test measure for the comparison group, and C_{pre} is the pretest measure for the comparison group:

$$(I_{\text{post}} - I_{\text{pre}}) - (C_{\text{post}} - C_{\text{pre}})$$

When studies did not include a comparison group, the team calculated the net intervention effect using measurements from the intervention group:

$$I_{\text{post}} - I_{\text{pre}}$$

When studies had a comparison group but no baseline measurements, the team calculated the net intervention effect as:

$$I_{\text{post}} - C_{\text{post}}$$

Relative change. For continuous variables, the team calculated relative percentage changes in the outcomes of interest according to the following formulas:

$$\left(\left(\frac{I_{\text{post}}/I_{\text{pre}}}{C_{\text{post}}/C_{\text{pre}}} \right) - 1 \right) \times 100\%$$

The team calculated the relative intervention effect for studies without a comparison group as,

$$\left(\frac{I_{\text{post}} - I_{\text{pre}}}{I_{\text{pre}}} \right) \times 100\%$$

and studies without baseline measurements as,

$$\left(\frac{I_{\text{post}} - C_{\text{post}}}{C_{\text{post}}} \right) \times 100\%$$

For dichotomous variables, the team used

$$([RR_{\text{post}}/RR_{\text{pre}}] - 1) \times 100\%$$

where RR refers to the relative risk for the outcome in the intervention group versus the comparison group. For simple before-and-after studies or those with comparisons at post-test only, the relative percentage change was calculated based on the available comparison, using the formula

$$(RR - 1) \times 100\%$$

When possible, the team examined the evidence stratified according to (1) study design suitability: separating data obtained from studies with greatest suitability of design from data obtained from all other studies; (2) risk category: analyzing absolute or relative differences calculated in all participants and in a high-risk group alone; (3) follow-up time: distinguishing data obtained from studies with a follow-up time of less than 1 year from baseline using data obtained from studies with a follow-up time more than 1 year from baseline; and (4) sample size.

For most outcomes evaluated in this review, an overall assessment of the evidence on effectiveness was conducted in order to incorporate information from studies with unique measurements of the outcome. To the extent possible, this evaluation considered the overall direction and magnitude of effect for all of the measurements reported in the qualifying studies, the median effect size and IQI or range of values across the evidence or subsets of the evidence, differences in strata-specific effect sizes on stratification, and consideration of limitations in strength of the evidence both within individual studies and across the body of evidence.

Evidence Synthesis

In this section, the team separately presents the results of the team’s reviews of AHRF and AHRF Plus. The first review described here includes only those studies or study arms that examine the effectiveness of AHRF alone. The latter review of evidence includes all studies of AHRF Plus (i.e., AHRF with additional intervention components). The literature search for these reviews yielded over 4584 titles and abstracts for review, 334 of which were examined in detail. Of these, 86 studies presented in 108 papers evaluated interventions that met the definition of AHRF or AHRF Plus.

Part 1: Review of Evidence for the Assessment of Health Risks with Feedback (AHRF)

Effectiveness. The search identified 37 studies, represented in 51 published articles, that evaluate the effectiveness of AHRF.^{25–74} Five studies with limited quality of execution^{27,30,46,53,66} were not included in the body of evi-

Table 2. Number of qualifying studies by study characteristics for AHRF (alone)

Study design suitability	Number of studies	References
● Least (before-and-after)	23	27,29,32,34,35,37,41,46,49–51,55,57–59,62–64,68,70,71,74,75
● Moderate (time series)	1	36
● Greatest		
○ prospective cohort	1	69
○ group randomized trial	3	33,60,61
○ individual randomized trial	3	34,39,44
○ other study design with concurrent comparison group	1	42
Type of questionnaire or assessment		
● Questionnaire type		
○ Named HRA	12	32,33,39,42,49,50,63–65,69,74,75
○ Named questionnaire	8	27,29,37,58,60,61,68,71
○ Other HRA	4	36,40,46,62
○ Other questionnaire	8	34,35,44,51,55,57,59,70
● Biometric data collected	26	27,29,33–35,39,40,42,44,46,50,51,55,57,59–62,64,66,68–70,73–75
Type of feedback		
● Individual	22	27,29,33,35,39,40,42,44,49–51,55,57–60,63,64,68,70,74,75
● Group	4	37,62,66,69
● Mailed	3	36,46,73
● Not reported	3	32,34,61
Method of feedback		
● Computerized	8	32,36,37,42,57,64,66,69
● Verbal	17	27,29,33–35,37,40,44,49–51,58,60,61,70,74,75
● Written	7	39,55,59,62,63,68,73
● Not reported	1	46
Size of company		
● Small	2	74,75
● Medium	6	29,35,42,46,60,61
● Large	24	27,32–34,36,37,39,40,44,49–51,55,57–59,62–64,66,68–71

AHRF, Assessment of Health Risks with Feedback

dence. The team provides a brief description of key details of the 32 qualifying studies in Table 2 and provide further information at the website: www.thecommunityguide.org/worksite/.

Information in Table 2 includes the number of studies and a list of references for the studies by study design, type of assessment used in the AHRF intervention, type and method of feedback used, and the size of the company in which the intervention took place. Study design refers to the research design used to evaluate the effective-

ness of the intervention and includes three categories of study suitability: least (before-and-after studies), moderate (time series or retrospective cohort studies), and greatest (prospective cohort studies, group and individual randomized trials, and other study designs with concurrent comparison groups) studies. For the AHRF review, most qualifying studies used a before-and-after (least suitable) study design.

The type of health risk-assessment tool varied from study to study and included questionnaires called

HRAs that are referred to by an industry name (for example, the Healthier People HRA); other HRAs that are not referred to by an industry name; questionnaires not called HRAs, but which met review criteria and were named by the study authors (for example, the Behavior Risk Factor Survey); and other questionnaires (only described in content and not referred to as HRAs or by any other name). Also included in the assessment category are the number of studies and references for studies that included a biometric screening in the AHRF process.

Type and method of feedback refer to how information gathered from the assessment is provided back to employees. Most studies evaluated programs in which feedback was given by an occupational health practitioner or other staff member (verbally), some evaluated programs that provided immediate computer feedback upon completion of the assessment, and a few evaluated programs in which the feedback was mailed to employees.

Companies with fewer than 50 employees are considered small. Medium companies are those with 50 to 499 employees, and large companies are those with 500 or more employees. The overwhelming majority of these studies were conducted in large companies.

Of the 32 qualifying studies, 17 provided data on baseline sample size (median=431 workers, IQI=195–1836),^{28,31–34,36,38,39,42,45,48,49,68,69,73–75} 12 provided enough information to generate participation rates at baseline (57.8%, IQI=42.6–66.3),^{7,33,34,36,39,42,45,48,59,60,69,75} and 13 provided enough information to generate retention rates (79.0% of those who participated at baseline, IQI = 582.0%–83.25%).^{7,28,32–34,36,38,39,42,45,48,60,75}

Health behaviors. The specific health behaviors of interest include alcohol use, diet and nutrition, physical activity, seat belt use, and tobacco use. These outcomes were measured in a variety of ways that can be categorized as reflecting quantity or frequency of actions (e.g., consumption or activity) or proportion of employees engaging in high-risk behaviors or with high-risk profiles. The results sections for these reviews are organized around these basic categories for each health behavior.

Alcohol. Ten study arms from nine studies assessed intervention effects on various measures of alcohol use, including overall alcohol consumption,^{33,35,59,60} proportion of subjects with high-risk alcohol consumption patterns,^{59,60} and other measures related to alcohol consumption.^{43,48,61,63,68} Nine^{33,36,43,48,59–61,63,68} of these ten study arms found results that favored the intervention. Three of the four studies^{33,35,59,60} that assessed alcohol consumption reported decreases, with two studies^{59,60} reporting large reductions compared to untreated comparison groups (mean reductions of 2.9 and 3.7

drinks per week; significance tests were not performed). These same two studies, conducted in Australia, reported small reductions in the proportion of “regular excessive drinkers” (–0.1 and –3.4 percentage points), but increases in the proportion of binge drinkers (2.5 and 0.3) relative to comparison groups. These studies, conducted among police and postal workers, reported high levels of baseline and follow-up drinking, with as many as 28% of men reporting excessive drinking at follow-up. Three studies^{43,48,63} reported favorable changes in drinking patterns, with one⁴³ reporting a significant increase in the percentage of at-risk drinkers who reduced their alcohol consumption when compared to an untreated group of employees. Although most of these studies found results that suggested beneficial effects for AHRF, several of these estimated effects were based on outcome measures that may not reflect true reductions in harmful alcohol consumption or are too small to have a substantial effect on downstream health outcomes.

Dietary behaviors. Twelve study arms from 11 studies^{26,28,34–36,43,48,49,58,67,72} included dietary behaviors as outcomes. Seven studies^{26,35,36,43,58,67,72} reported on mean intake of dietary fat or percentage energy from fat, and three^{26,67,72} reported unit intake of fruits, vegetables, or a combination of fruits and vegetables. With the exception of one study²⁶ that reported no change in intake of fruits and vegetables, effect estimates from all studies were small (e.g., an increase of 0.14 fruits and vegetables per day) and in the favorable direction. Six study arms from five studies^{28,34,43,48,49} used self-reports of improved diet as an outcome measure. All found favorable intervention effects; however, only one⁴³ of these studies included a comparison group. This study reported a non-significant, 5.5–percentage point change in the proportion of employees with high-risk dietary behaviors who increased their intake of fruits and vegetables, and an 11.2–percentage point change ($p<.001$) change in the percentage of employees who decreased their fat intake when compared to an untreated comparison group. Although this body of evidence was generally positive, the magnitudes for these effect estimates were small.

Physical activity. Fourteen studies^{26,31,34–36,38,40,42,48,54,56,57,61,68} included physical activity outcomes. For the four studies^{35,36,38,57} that assessed time spent engaged in physical activity per week, there was a median 11.1% increase in this outcome (range: 1.7%–88.5%). Eight study arms from seven studies^{26,31,34,43,48,54,61} reported the proportion of individuals who were considered physically active according to study-defined thresholds that were often less stringent than current physical activity recommendations (e.g., exercising more than once per week, a nonsedentary lifestyle). All of these study arms

showed favorable intervention effects, but the differences in thresholds used were too great for a median effect estimate to be meaningful. Two studies reported on other measures of physical activity. One⁵⁶ reported the number of weekday hours dedicated to physical activity outside of work, reporting a significant decrease, and another⁶⁸ used a Likert scale to assess frequency of participation in moderate physical activity (reporting a near zero increase in frequency of activity). One study⁴⁰ reported an increase in aerobic capacity (which the team considered a proxy for physical activity). Although the reported findings are generally in favor of the intervention, only three^{38,43,68} of these 13 studies included comparison groups. The effect estimates for these three studies were small and, because of measurement differences, cannot be adequately compared to before-and-after study designs. Because of potential biases in the reported effect estimates and questions about whether the thresholds for physical activity used in these studies would have meaningful health effects, it is difficult to determine the effects of AHRF on the proportion of employees meeting recommended levels of physical activity.

Seatbelt use. Eight studies^{31,32,35,36,38,48,49,68} included seatbelt use as outcomes. One study³² that assessed observed seatbelt use reported a 16.2–percentage point increase in seatbelt use among intervention participants relative to an untreated comparison group. However, this study was conducted in a state without a mandatory seatbelt law in a sample with very low baseline rates of seatbelt use (15.1%). The remaining studies used various self-report measures of seatbelt use, and all showed intervention effects in the favorable direction. Four of these studies^{32,35,36,38} provided categorical data on the proportion of people who reported irregular or no seatbelt use (with somewhat different measures for each study). In these studies, the proportion of nonusers decreased by a median of 33.8% (range: –45.5% to –18.8%) following AHRF. However, only one of these studies³² included a concurrent comparison group, and it produced the smallest effect estimate. As with other behavioral outcomes presented thus far, results are generally in favor of the intervention; however, concerns regarding generalizability and potential biases dictate that they be interpreted cautiously.

Tobacco use. Twenty-one studies^{26,31,33–36,39,43,48,49,54,56,58,60–63,65,67,68,76} included tobacco use as the outcome. Eleven studies with twelve study arms^{31,34,39,43,48,56,58,61,65,67,76} either measured cessation or provided sufficient information to calculate cessation rates among participants who were tobacco users at baseline. The median quit rate achieved by participating tobacco users was 8.1% (IQI=0.8%–16.2%) over a median follow-up interval

of 12 months. Only one of these studies⁴³ included a concurrent comparison group, and it found only a small improvement in cessation rates for the AHRF group relative to untreated controls (0.3 percentage points, $p>.05$).

Fourteen studies with 15 study arms^{26,31,33,35,36,43,54,56,58,60,61,63,67,76} provided measurements of change in the prevalence of self-reported tobacco use among study participants. The median change was an absolute reduction of 2.8 percentage points (IQI=–4.0 percentage points, –1.5 percentage points) in self-reported tobacco-use prevalence with a median period of observation of 18 months. The median relative change was a decrease of 13% (IQI=–17.6% to –7.3%). Only two of these studies^{43,60} included untreated concurrent comparison groups, and in both studies the observed differences were small and not statistically significant (absolute changes of 0.1 and –1.5 percentage points, and relative changes of 0.3% and –4.9%). Although the results from studies providing measurements of before-and-after change demonstrated a reduction in tobacco use among workers, results from the two studies^{43,60} with concurrent untreated controls did not demonstrate a significant increase in tobacco-use cessation or reductions in tobacco-use prevalence.

Physiologic outcomes

Blood pressure. Fifteen studies^{26,31,33,35,38,40,42,54,56,58,61,63,69,73,74} included measures of blood pressure as an outcome. Nine studies^{26,33,35,38,42,54,56,58,69} (seven^{26,33,35,54,56,58,69} using a before-and-after study design) measured absolute change in diastolic blood pressure, with a median decrease of 0.40 mm Hg (IQI=–1.9 to +0.2 mm Hg). Eight studies^{26,33,35,38,54,56,58,69} (seven using a before-and-after study design) measured the change in systolic blood pressure with a median decrease of 0.8 mm Hg (IQI=–2.9 to 1.6 mm Hg). Three studies (four study arms) reported changes in the proportion of employees with high-risk blood pressure readings or those taking blood pressure medication, with one study arm⁶³ reporting a significant decrease of 4.0 percentage points, and the other three^{31,56,63} reporting nonsignificant changes of 2.5 percentage points, 0.05 percentage points, and –1.0 percentage points. Four studies^{40,61,73,74} reported other measures of blood pressure (such as the mean change in blood pressure or the proportion of employees who experienced an increase or decrease in blood pressure); all studies used a before-and-after study design; and one reported a significant decrease in blood pressure. Overall, results for blood pressure were not consistently in favor of the intervention, and median changes in blood pressure readings were close to zero.

Body composition. Seventeen studies^{26,31,33–36,38,39,43,45,49,54,56,61,63,73,74} included measures of body composition as an outcome. The majority of these studies (14)

used before-and-after study designs. Ten study arms from nine studies^{26,36,40,42,44,54,56,73,74} measured change in BMI; the median effect of the eight study arms presenting outcome data^{26,36,40,42,45,54,56} was an increase of 0.1 point of BMI (IQI=0.0–0.4 BMI points). Five studies^{26,33,38,56,61} reported a median gain of 1.0 pounds (range: –2.9 to 2.8 pounds). Three of four studies^{31,35,49,63} reporting on other measures related to body composition (such as pounds over ideal weight and prevalence of overweight employees) found results that were small and in favor of the intervention. Overall, most studies showed little to no change in body weight or BMI.

Cholesterol. Sixteen studies^{26,31,33,35,38,40,42,45,54,56,58,61,63,69,73,74} 13 employing before-and-after study designs, included measures of cholesterol as an outcome. Fifteen study arms from 14 studies^{26,33,35,38,40,42,45,54,56,58,61,69,73,74} measured change in total cholesterol. Two of these studies, with three study arms,^{40,74} did not provide specific effect estimates, but reported no significant change in total cholesterol. The remaining 12 study arms^{26,33,35,38,42,45,54,56,58,61,69,73} reported a median decrease of 3.3 mg/dL (IQI=–8.4 to 0.7 mg/dL). Three studies representing four study arms^{31,56,63} presented additional findings for total cholesterol. One study⁶³ reported a 12.0–percentage point decrease in the proportion of employees with a cholesterol reading above 210 mg/dL for each of two study arms, a second,⁵⁶ reported a 0.45–percentage point decrease in proportion of employees with a self-reported high-risk indicator (total cholesterol>239 mg/dL, LDL<40 mg/dL, or taking medications for cholesterol); the third study³¹ reported a 3.3–percentage point increase in the proportion of employees with a reading greater than 6.5 mmol or 259 mg/dL (based on self-report data) ($p<.05$). Overall, most of the studies found changes in favor of the intervention, with a moderate decrease in total cholesterol.

Other outcomes

Risk status. Eleven studies,^{31,35,36,38,39,41,42,50,54,58,61} eight employing before-and-after study designs, evaluated changes in indicators of health risks. Six studies^{35,36,41,42,54,56} reported changes in health-risk scores that were based on the presence or absence of select physiologic and behavioral indicators such as high blood pressure or tobacco use. Three of these used an algorithm based on the Framingham index,^{35,36,39} one weighted three risk factors on a four-point scale and summed the weights,⁵⁸ and the other two created a sum based on present risk factors.^{41,54} The median relative decrease in these health risk scores was 3.8% (range: –18.4% to 3.0%). Four studies found favorable results of moderate magnitude for various other measures, including appraised age,^{38,61} a measure of healthy lifestyles,⁵⁰ and the propor-

tion of employees with a positive change in the number of risk factors reported.³¹ In general, the above findings represent moderate changes in favor of the intervention in these health-risk estimates.

Healthcare service use. Six study arms from five studies^{36,49,61,63,70} measured changes in the use of healthcare services. The goal of AHRF would be to increase use of necessary medical services (such as preventive care visits) and decrease the use of unnecessary medical services (hard to determine) or services suggestive of notable acute or chronic health events (such as hospital days). Three studies, all using before-and-after designs,^{49,61,72} assessed changes in the proportion of employees reporting use of necessary or preventive care services among participants who had not recently followed recommended guidelines (all baseline rates were zero). One⁴⁹ found increases in the proportion of employees reporting having a rectal exam or Pap of 23 percentage points and 40 percentage points, respectively; one⁶¹ found increases in breast self-exam or breast palpitation by physician of 42.3 percentage points and 21.5 percentage points, respectively; and one⁷² found a 35.0–percentage point increase in employees who complied with recommendations regarding cancer screenings. Two studies reported findings related to other medical service use, including self-reported change in hospital days per year, with no change reported in one study³⁶ and a negligible increase of 0.05 days (1.7% relative increase) in another.⁶³ Doctors visits per year decreased, but it is not clear if these visits were for treatment or preventive care (–1.6 visits, 23.5% relative decrease).⁶³ The preventive care results are promising, but the findings on other medical care service use are difficult to interpret in this context.

Absenteeism. Six study arms from five before-and-after studies^{36,50,54,58,63} included absenteeism as outcomes. Absenteeism was generally reported as days off due to illness,^{36,54,58,63} with a median reduction of 0.3 days (range: –1.2 to +2.7 days); additionally, one study⁵⁰ reported a decrease in the total number of days off from work (for leisure or sickness) of 4.8 days. These results are not consistently in favor of the intervention, and the median effect estimate is small.

Conclusion

Although many of the results presented in this review of AHRF are in favor of the intervention, most effect estimates were small or modest in size and came from simple before-and-after studies that were susceptible to several potential sources of bias. In the absence of measurements from a concurrent comparison population, it is difficult to address the effects of aging or of secular trends on the

outcomes of interest. These effects may bias outcomes either toward or away from the null. For example, it may be reasonable to expect increases in body mass or cholesterol as participants age, leading effect estimates from before-and-after studies to underestimate true intervention effects on these outcomes. In contrast, for outcomes such as smoking or seatbelt use, secular trends may inflate effect estimates. Use of health risk–assessment or health risk–appraisal tools for many outcomes is another potential problem in these studies to the extent that many of the behavioral outcomes were assessed based on self-report. It is quite possible that demand characteristics of the AHRF process may have led to favorable self-reports at posttest, even in the absence of behavior changes.

Because of small to moderate effect estimates, inconsistent findings for some outcomes, and the large number of potential threats to validity in this body of evidence, it is difficult to draw conclusions regarding the effectiveness of this intervention for the wide range of outcomes presented here. At the end of this article the team offers recommendations for future evaluation of AHRF as an intervention approach that may address many of the challenges present in the literature at the time of this review.

Part 2: Review of Evidence for the Assessment of Health Risks with Feedback When Combined with Additional Interventions (AHRF Plus)

Effectiveness. The search identified 59 studies^{15,26,27,32–34,39,45,50,54,57,58,63,65,67,72,75–117} evaluating the effectiveness of the assessment of health risks with feedback when combined with additional interventions. Thirty-one additional articles^{12,13,15,29,37,40,44,51,52,55,64,70,72,87,118–134} provided information on an already included study. Of the 59 studies, eight^{27,83,84,93,95,96,98,100} were not included because they did not meet *Community Guide* criteria for quality of execution.²⁰ Among the 51 remaining studies, one⁶⁵ was rated as good in quality of execution, and the other 50 were rated as fair in quality of execution. Details of the 51 qualifying studies, including intervention components, brief sample characteristics, outcome measures, and study effect size are available in summary evidence tables at the website: www.thecommunityguide.org/worksites/.

As with Table 2 for the AHRF review, Table 3 includes information on the number of studies and a list of references for the studies by study design, type of assessment used in the AHRF intervention, type and method of feedback used, and the size of company where the intervention took place. The studies included in this review used a variety of study designs, including group RCTs, retro-

spective and prospective cohort designs, and before-and-after study designs. As with the AHRF review, the type of assessment varied from study to study, but most included a biometric screen in the AHRF process. Again, most studies evaluated interventions where the feedback was presented in an individual forum and verbally and most evaluated programs in which feedback was given by an occupational health practitioner or other staff member (verbally), and the majority of these studies were conducted in large companies.

Intervention characteristics. All studies included in this review assessed the effectiveness of unique combinations of interventions of which AHRF was a component, in which AHRF was used in different ways, and which had varying degrees of program intensity and duration. Categorizing studies by duration or intensity was not possible because a broad range of program components were offered and many studies did not provide an adequate intervention description. Most interventions examined (60 of 63 study arms) included health education lasting more than 1 hour or occurring at more than one time during the course of the intervention. About half (29) offered health education in group settings, ten offered one-on-one health education, and 18 offered both group and individual health education; the type of health education was not described for three study arms. Health education was the only additional intervention component offered in 17 intervention settings, although in some cases more than one topic was offered. Enhanced access to physical activity was offered in 17 intervention settings, nutrition in six, and medical care in three. Twenty-one programs offered some form of incentive or competition for participating or for meeting a program goal. Fifteen programs offered some combination of health education and at least two other elements from other intervention categories.

Sample characteristics. The 51 studies in this review provided different levels of information about the included sample populations and interventions. Among the 42 studies reporting gender, the median percentage of women was 42.2 (IQR=21.9%–60.0%). Sixteen studies reported the proportion of white employees (median: 86.8%, IQR=63.5%–91.3%), ten reported the proportion of African Americans (median: 11.5%, IQR=4.5%–33.0%) and seven reported the proportion of Hispanics (median: 5.1%, IQR=3.0%–9.0%). One study was conducted in Japan and did not report race,¹⁰⁸ and one study,¹⁵ conducted by the WHO, included approximately 50,000 men who lived in one of five European countries at the time of the study. Median age of employees included in 27 studies that reported a mean age was 42.3 years.

Table 3. Number of qualifying studies by study characteristics for AHRF Plus (AHRF when combined with additional interventions)

Study characteristics	Number of studies	References
Study design		
● Least suitability (before-and-after)	22	76,78,79,81,82,85–87,92,94,99,101,102,104,105,108,111–114,116,117
● Moderate suitability		
○ Time series	4	77,80,106,118
○ Retrospective cohort	5	89,91,103,107,110
● Greatest suitability		
○ Prospective cohort	1	90
○ Group randomized trial	12	16,27,33,40,58,59,64,66,68,71,109,115
○ Individual randomized trial	4	34,35,55,88
○ Other study design with concurrent comparison group	3	46,51,97
Type of questionnaire or assessment		
● Named HRA	16	33,66,79,89,91,94,102–104,106,107,112,114,116–118
● Questionnaire	10	34,51,55,59,68,80,99,105,109,111
● Named questionnaire	5	27,58,73,78,92
● Other health risk appraisal	13	16,35,40,46,76,81,82,88,90,97,110,113,136
● Health risk assessment	4	77,85,86,101
● Biometric screen	43	27,33–35,40,46,51,55,58,59,64,66,68,71,76–82,85–92,94,97,99,101–103,105,106,110,112–116
● Not reported	2	64,115
Type of feedback		
● One-on-one	35	16,27,33,34,40,51,55,58,59,64,68,76–78,80–82,85,89,92,94,102,105–114,116–118
● Group	2	66,99
● Mailed	9	46,71,86–88,90,91,101,103
● Not described	5	79,81,97,113,115
Method of feedback		
● Computerized	12	64,66,79,81,87,104,106,110,112,116–118
● Verbal	20	16,27,33–35,40,55,58,76,80,82,92,94,99,102,107–109,111,113
● Written	12	59,68,73,77,78,85,86,89,101,103,105,114
● Not described	7	46,51,88,90,91,97,115
Size of company		
● Small	1	116
● Medium	7	35,46,78,79,82,87,88
● Large	43	16,27,33,34,40,51,55,58,59,64,66,68,73,76,77,80,81,85,86,89–92,94,97,99,101–115,117,118

AHRF, Assessment of Health Risks with Feedback

Participation rates for the studies included in AHRF Plus were very similar to that of AHRF. Of the 62 qualifying study arms, 37 provided enough information to generate participation rates at baseline, with a median rate of 57.3% (IQR=44.2%–75.0%).^{15,26,33,34,39,45,50,54,57,58,65,75–77,79,82,86,90,92,97,101–106,108,109,111–113,116,135}

Sample sizes were larger. Data for baseline sample size were available for 59 of 63 study arms (median=1099 workers, IQR=346–3141),^{15,32,57,75–79,81,82,85,86,88,90–92,94,97,101–117,135,136} and the median retention rate of 57.7% was lower (41 study arms, IQR=35.8–78.4%).^{26,33,34,39,45,50,54,57,58,64,65,70,75–79,79,80,80,82,86,88,90,92,94,97,99,101–103,105,106,109,111–113,115,115,135}

Health behaviors. The search identified 40 studies in the overall set of qualifying studies with a health behavior outcome. Twenty-six of these studies provided effect measures for more than one behavioral outcome. Nine studies included outcomes for alcohol,^{33,58,81,90,94,97,101,104,116} 14 included outcomes for dietary behaviors,^{26,34,67,72,75,80,85,90,91,104,109,111,115,126} 18 included outcomes for physical activity,^{26,34,57,65,76,80,81,85,90,91,94,101,103,104,106,108,115,116} 30 included outcomes for tobacco use,^{15,26,33,34,39,54,58,63,65,67,78,80–82,87,89–91,94,97,101,103,104,106,108,109,111,116,117,135} and 10 included outcomes for seat belt use.^{32,81,91,97,99,101,103,106,114,116} As with the review of AHRF alone, the results sections for each of these outcomes are categorized by action (e.g., consumption or activity) and proportion of employees engaging in high-risk behaviors or with high-risk profiles.

Alcohol. Nine studies evaluated intervention effects on alcohol consumption. Four studies assessed quantity of alcohol consumed, among either the general employee population or a subset deemed to be high-risk drinkers. One study,⁸¹ reported a decrease of almost 10 in the mean number of drinks per week among those reporting drinking 15 or more drinks per week ($p<.001$) and a second⁵⁸ reported a nonsignificant mean reduction of 1 drink per week. One study³³ reported a nonsignificant increase in the mean number of drinks per week (0.02, 95%CI not available). An additional study⁹⁴ reported a significant decrease in ounces of alcohol consumed daily (–0.11 ounces, representing a relative percentage decrease of 20%, $p<.001$). Five of these studies,^{90,97,101,104,116} assessing the proportion of employees defined as high-risk drinkers, found a median absolute reduction of 2.0 percentage points (range: –3.0 to 0.2 percentage points) and a relative reduction of 27.3% (range: –41.7% to 20.0%).

Four of the nine studies^{33,58,90,97} assessing alcohol-related outcomes compared the AHRF plus intervention group to a group of employees receiving a lesser intervention (either AHRF or health education). As expected, these studies tended to show smaller estimated effects

than those studies with untreated comparison groups or with no comparison group. Overall, these studies show moderate relative decreases in alcohol consumption and in the proportion of excessive drinkers, although studies with treated comparison groups reported smaller overall effects than those with no comparison group.

Diet. Fourteen studies^{26,34,67,69,70,80,85,90,91,103,104,109,111,115} included dietary behaviors as outcomes. Of these, eight study arms from six studies^{26,67,70,80,109,111} provided results for self-reported consumption of fruits and vegetables. The median change for the six qualifying studies (including four studies with comparison groups that participated in AHRF) was an increase of 0.09 servings of fruits and vegetables per day (IQR=–0.07 to +0.17 servings). Thirteen study arms from 11 studies^{26,67,70,75,85,90,91,103,104,109,115} provided results from self-reports of a variety of indicators of dietary fat intake (e.g., percentage of energy obtained from fat, proportion of study sample with high level of fat intake). Results were transformed to indicate relative change in the proportion of employees with high-risk fat intake. The majority of results favored the intervention, with a median relative decrease of 5.4% (IQR=–21.9% to –1.8%). Among them were results from five studies representing six study arms with treated comparison groups,^{26,67,72,90,109} which tended to produce smaller effect estimates (decrease of 3.8%, IQR=–18.1% to 1.7%). The evidence included in these studies indicates that this type of intervention is not effective in substantially increasing the average daily intake of fruits and vegetables, but is effective in decreasing the intake of fat.

Physical activity. Eighteen studies^{26,34,57,65,76,80,81,85,90,91,94,101,103,104,106,108,115,116} included physical activity outcomes; all based on self-report data. Twenty-one study arms from 16 studies reported on the proportion of employees considered physically active using study-defined criteria, which varied in intensity (e.g., >45 minutes of activity per week; 3 times per week for more than 20 minutes each time). Results from all but one of 16 study arms from 12 studies^{26,65,76,81,90,91,101,103,104,106,108,116} indicated increases in the proportion of people being physically active, with a median relative increase of 15.3% (IQR=8.3%–37.2%). Among the four study arms that included a comparison group (all receiving AHRF), the relative increase was 24.6% (range: 5.4%–47.9%).

Three of five additional studies reported findings in favor of the intervention. One⁸⁰ reported a 26% increase in the percentage of participants exercising three times per week for 20 minutes or more, one⁸⁵ reported a 37.0% decrease in the percentage of employees at elevated risk because of physical inactivity, and one¹⁰⁶ that found a

mean increase of 17.4 minutes walked per week. Two before-and-after studies^{57,115} reported no change in the percentage of employees reporting being physically active, and another before-and-after study⁹⁴ reported a nonsignificant decrease in the number of kilocalories burned per week. In summary, all but three studies, all of which used a before-and-after design,^{57,94,115} showed a positive change in physical activity. Overall, the evidence indicates that AHRF with additional components is effective in increasing physical activity.

Seatbelt use. Ten studies^{32,81,91,97,99,101,103,106,114,116} included seatbelt use among reported outcomes. Some studies reported directly observed seatbelt use; others reported results based on self-report. All but one⁹⁷ of the findings were in favor of the intervention. All results were translated to the same metric: relative change in the proportion of employees who were either observed not wearing seatbelts or who reported that they did not consistently wear seatbelts. Results for all study arms are in favor of the intervention, with a median relative decrease of 27.6% (IQI = −56.4% to −7.4%). The five study arms drawn from studies with comparison groups^{32,97,114} had a median relative decrease of 11.1% (range: −24.6% to 0.3%). It is important to note, however, that the greatest absolute changes in effect size occurred in studies of interventions that were initiated before most states enacted seatbelt laws (the majority of which went into effect between 1984 and 1991). Findings were consistently favorable across studies that assessed both self-reported and observed seatbelt use, and across studies with and without comparison groups. The preponderance of the evidence indicates that AHRF Plus is effective in increasing seatbelt use.

Tobacco use. Thirty studies^{15,26,33,34,39,54,58,63,65,67,78,80–82,87,89,90,91,94,97,101,103,104,106,108,109,111,116,117,135} provided measurements of change in tobacco use. Twenty-four studies with a total of 30 study arms^{26,34,39,54,58,65,67,78,80–82,87,89–91,94,101,103,104,106,108,109,111,117} evaluated tobacco-use cessation among participating workers who were tobacco users at baseline. The median study sample was 128 tobacco users (range: 10–1798) per intervention arm at baseline. The median quit rate for participants exposed to the interventions was 17.8% (IQI = 11.1%–22.6%), with a median follow-up duration of 21 months (range: 6 weeks to 6 years). Eleven studies with 15 study arms^{26,34,39,54,58,65,67,87,89,109,111} provided comparisons of cessation rates between participants exposed to the full intervention and participants exposed to a “lesser” intervention (typically AHRF alone). In this subset, the median incremental effect on tobacco-use cessation was 3.8 percentage points (IQI = 1.5–11.0 percentage points), a relative increase of 49.0% (IQI: 15.0% to 169.0%).

Twenty-three studies with a total of 27 study arms^{15,26,33,54,58,63,67,81,87,89–91,94,97,101,103,104,106,108,111,116,117,135} provided measurements of change in the prevalence of tobacco use among participating workers. The median change in self-reported tobacco use was an absolute reduction of 2.3 percentage points (IQI = −5.0 to −1.1 percentage points), and a relative reduction of 13.3% (IQI = −24.0% to −3.3%). The median study sample included 500 participating workers (range: 26–24,615), and the median duration of observation was 2 years (range: 1–6 years). Ten studies with 14 study arms^{15,26,33,54,58,63,67,87,97,111} evaluated change compared to a treated control group, which was typically provided with AHRF alone. These studies generally reported small, but consistent, incremental reductions in tobacco-use prevalence (median absolute change: −1.5 percentage points [IQI = −3.2 to −0.8 percentage points]; median relative change: −3.4% [IQI = −12.7% to −1.7%]).

These findings suggest that AHRF Plus is effective in reducing tobacco use among participating workers and that the additional intervention components in AHRF Plus tend to produce incremental benefits compared to AHRF alone. Estimated effect magnitudes were larger for cessation than for prevalence; this may be partially accounted for by the fact that all participants in the cessation studies were smokers at baseline.

Physiologic outcomes

Blood pressure. Thirty-one studies^{15,26,33,40,54,58,64,65,76–82,85,87–92,94,102,103,105,106,112,113,115,116} provided measurements of change in blood pressure. Based on the 12 studies that reported mean blood pressure for their study samples at baseline,^{26,54,58,77–79,81,88,94,102,106,115} it appears that many participating employees were in the high-normal range (median baseline: 78.7 mm Hg and 121.6 mm Hg, for diastolic and systolic readings, respectively). Twenty-two study arms from 17 studies^{26,33,54,58,65,76–80,88,89,94,102,105,106,115} measured change in diastolic blood pressure, with a median decrease of 1.8 mm Hg (IQI = −4.4 to −0.3 mm Hg). For six study arms from five studies with treated comparison groups^{33,54,58,65,89} (all of which received AHRF) the incremental effects of the additional components was a median decrease of 1.5 mm Hg (range: −5.3 to 0.9 mm Hg). Twenty-four study arms from 19 studies^{15,26,33,54,58,65,76–82,88,89,94,102,106,115} reported a median decrease of 2.6 mm Hg (IQI = −4.8 to −0.3 mm Hg) in systolic blood pressure. Median change among the six study arms from five studies with a comparison group^{33,54,58,65,89} that received the AHRF intervention was −2.5 mm Hg (range: −7.6 to 0.0 mm Hg).

In addition to studies reporting mean blood pressure, 12 studies representing 16 study arms^{39,63,76,85,87,89,}

90,92,103,106,113,116 found that AHRF Plus was associated with a 4.5–percentage point decrease (IQI = -8.7 to -0.4 percentage points) in the prevalence of employees with a high-risk blood pressure reading. One study, representing two study arms,³⁹ reported nonsignificant changes in mean blood pressure. Another¹¹² reported nonsignificant changes in blood pressure, but did not report the metric or the magnitude of change. Overall, the findings are consistent and in favor of the intervention.

Body composition. Twenty-seven studies^{15,26,29,33,34,39,44,54,63,76–82,87,89–91,94,101–103,105,106,116} provided measurements of change in body composition. Eight study arms from six studies^{26,39,44,54,78,89} measured change in BMI; the median absolute decrease was 0.5 point BMI (IQI = -1.1 to -0.3 points BMI), and the median relative decrease was 1.6% (IQI = -3.5 to -1.1 %).

Seventeen study arms from 12 studies^{15,26,29,33,76,78–80,82,90,102,105} measured changes in body weight, with a median decrease of 0.56 pounds (IQI = -5.10 to 1.50 pounds). Seven study arms from five studies^{29,39,77,102,106} reported a 2.2–percentage point median reduction in mean percentage body fat (IQI = -4.5 to -0.5 percentage points). Six study arms from five studies^{63,87,91,103,116} reported outcomes related to high-risk body composition status (e.g., percentage that were obese, percentage that were 10% or more over ideal weight). These studies found a small median relative decrease of 2.2% (range = -14.8 % to 5.9%) in the proportion of employees in these high-risk groups. Four additional studies found inconsistent results on various indicators of change in body composition. Overall, most studies in this body of evidence showed little to no change in body weight and percentage body fat, but a moderate decrease in BMI. Other study outcomes were hard to compare and were not consistently in favor of the intervention. These inconsistent results across effect measures are difficult to account for, and make it difficult to clearly determine the effects of the intervention on body composition.

Cholesterol. Thirty-six study arms from 27 studies^{15,26,29,33,39,45,54,58,63,75,77,78,80,81,89–92,94,101–106,113,115} reported cholesterol outcomes. All outcomes were transformed to mg/dL. Among the 14 studies that reported mean total cholesterol readings at baseline,^{26,45,54,75,77–79,81,94,102,105,106,113,115} the median was 206.5 mg/dL (IQI = 198.9–221.8 mg/dL), suggesting that participating employees were generally at the high end of the normal range for this health outcome. Mean change in total cholesterol was reported in 19 of these studies for 23 study arms. The median change in total cholesterol was -4.8 mg/dL (IQI = -10.4 to 0.0 mg/dL) for all studies,^{7,15,29,33,45,54,58,75,77,78,80,81,89,94,102,105,106,113,115} and -0.77 mg/dL (IQI = -3.9 to 4.0 mg/dL) for the seven

study arms that compared AHRF Plus to a comparison condition (five of the comparison groups participated in AHRF, and two participated in a screening with no feedback).^{15,26,33,45,58} For ten study arms from eight studies,^{29,45,54,58,78,89,94,102} the median increase in high-density lipoprotein (HDL) was 0.94 mg/dL (IQI = -0.88 to 2.25 mg/dL). Twelve study arms from 11 studies^{63,75,90–92,101,103,104,106,113,115} reported percentage of employees with high-risk cholesterol readings. The median change for this indicator was a reduction of 6.6 percentage points (IQI = -14.8 to -2.4 percentage points). All of the studies showed a moderate intervention effect on total cholesterol levels.

Fitness. Nine study arms from six studies^{29,33,39,77,82,102} reported on various fitness indicators (e.g., mean aerobic capacity, mean time for a treadmill test). Eight of nine effect estimates were in favor of the intervention, although effect magnitudes tended to be small, and the impact of the changes on overall health cannot be determined from information provided in the studies.

Other outcomes

Risk status. As noted above, risk status can be assessed as an estimate of either the actual risk of morbidity or mortality, or as an index based on reported or measured risk factors. For AHRF Plus, 21 study arms from 16 studies^{50,54,58,63,76,81,85,86,91,94,101,104–106,112,113} reported a range of different health risks and indicators measured and presented in different ways. A general description of the measures used to determine risk status is included in Table 4. Nine studies assessed the effect of AHRF Plus on the proportion of employees whose summary health risk scores indicate that they are at high risk for chronic diseases, such as cardiovascular disease,^{63,94,112} cancer,^{63,94,112} diabetes,^{63,91} or any chronic disease.^{81,86,101,104,106} The magnitude of the effect estimates varied by risk status category. Median relative changes in the proportion of employees in the high-risk group were: -25.4 % for cardiovascular disease (range: -19.6 % to 63.0%), -30.3 % for cancer (range: -53.9 % to 0%), -7.7 % for diabetes (range: -21.3 % to 6.07%), and -13.9 % for general risk (range: -24.9 % to 20.9%). Figure 2 has a graphic summary of these results.

Several studies reported other findings related to risk status such as absolute change in total risk score,^{54,58,63,85,105,106} risk of developing cardiovascular disease,⁵⁰ and coronary risk rating.¹¹³ One⁸⁵ reported an 83% decrease in risk scores among company senior executives (from a score of 12 to 2). Another¹⁰⁵ reported an 11.7% decrease (from 2.47 to 2.18) in a risk score based on weight, blood pressure, and cholesterol risk status. The one study¹⁰⁶ reporting an increase in risk factor score

Table 4. Health risk estimates reported in included studies

Study	Type	Focus	Measure	Variables
Bertera (1993) ⁸¹	% high-risk	General	Percentage	3 or more risk factors
Donnelly (1996) ⁸⁵	Health risk factor	General	Score	Lifestyle and medical risk factors
Edington (2002) ⁸⁶	% not low-risk	General	Percentage	3 or more risk factors
Goetzel (2002) ⁹¹	% high-risk of diabetes	Diabetes	Percentage	—
Heirich (1993) ⁷⁶	% population risks reduced	CVD	%	BP, height, weight, smoking history, exercise
Holt (1995) ⁹⁴	Relative risk	Heart attack Stroke Cancer	RR	SBP, DBP, cholesterol, HDL, exercise, alcohol use, type A behavior, smoking behavior
Maes (1998) ⁵¹	Relative risk	CVD	RR	Age, serum cholesterol, SBP, smoking
Musich (2003) ¹⁰¹	Risk status transition	General	Percentage	—
Nilsson (2001) ⁵⁵	Changes in risk factor score	General	Score	Range 0–20, M=7
Pelletier (2004) ¹⁰⁴	Number of risks (0–9)	CVD	Percentage	Diet, BMI, cholesterol, physical inactivity, stress, preventive visits, emotional fulfillment, BP, diabetes or blood glucose, tobacco use, alcohol use
Pilon (1990) ¹⁰⁵	CVD risk factor score	CVD	Score	Calculated CVD risk factor value
Poole (2001) ¹⁰⁶	Changes in risk factor score % with 3 or more risk factors	General	Percentage score	Total risk score
Puska (1988) ⁵⁹	Cardiovascular risk	General	Score	Smoking, serum cholesterol, blood pressure
Shi (1992) ⁶⁴	Susceptibility overall	Heart attack Cancer Diabetes	% % % Score	Smoking, alcohol abuse, exercise, unsafe driving, dietary habits, uncontrolled hypertension
Stevens (1996) ¹¹²	Risk status	Heart attack	Percentage	Risk behaviors, cholesterol, BP
Walton (1999) ¹¹⁴	Coronary risk rating	CVD	Percentage	Based on comprehensive health risk assessment, undefined

CVD, cardiovascular disease

(based on four physiologic and three behavioral factors), attributed the 6.6% increase to seasonal variations in assessments (baseline was conducted in spring and follow-up was conducted in the winter, 4 years later). Three studies included a comparison group^{54,58,63} and reported relative decreases in scores, based on physiologic and behavioral risk factors, ranging from 14.1% to 2.9%. Another study,⁷⁶ which included four sites, found that the site that received the most intensive intervention showed the greatest level of risk reduction and relapse prevention. Although the studies reviewed used various risk indicators, the majority of effect estimates were in favor of the intervention and of moderate size.

Healthcare service use. Seven study arms from six studies^{63,72,88,91,104,110} included measures of healthcare service use. One study¹⁰⁴ reported a 12.2–percentage point decrease in the proportion of employees who

were not following preventive care guidelines, and another⁷² reported increases in the proportion of people who had a digital rectal screening for colon cancer following recommendations made during the intervention. A third⁶³ reported a decrease of just over 0.5 doctor visits attributable to the intervention in the two study arms included in this review. Fielding⁸⁸ reported an increase in new users of blood pressure medication in favor of the intervention.

Two studies^{63,110} reported a decrease in hospital bed days in favor of the intervention group. One of these studies¹¹⁰ also reported that the intervention group had a decrease in the number of annual lifestyle-related hospital admissions relative to the comparison group (adjusted for age and gender). Finally, Goetzel⁹¹ assessed emergency department visits, outpatient visits, and inpatient hospital days over several years. He found that the num-

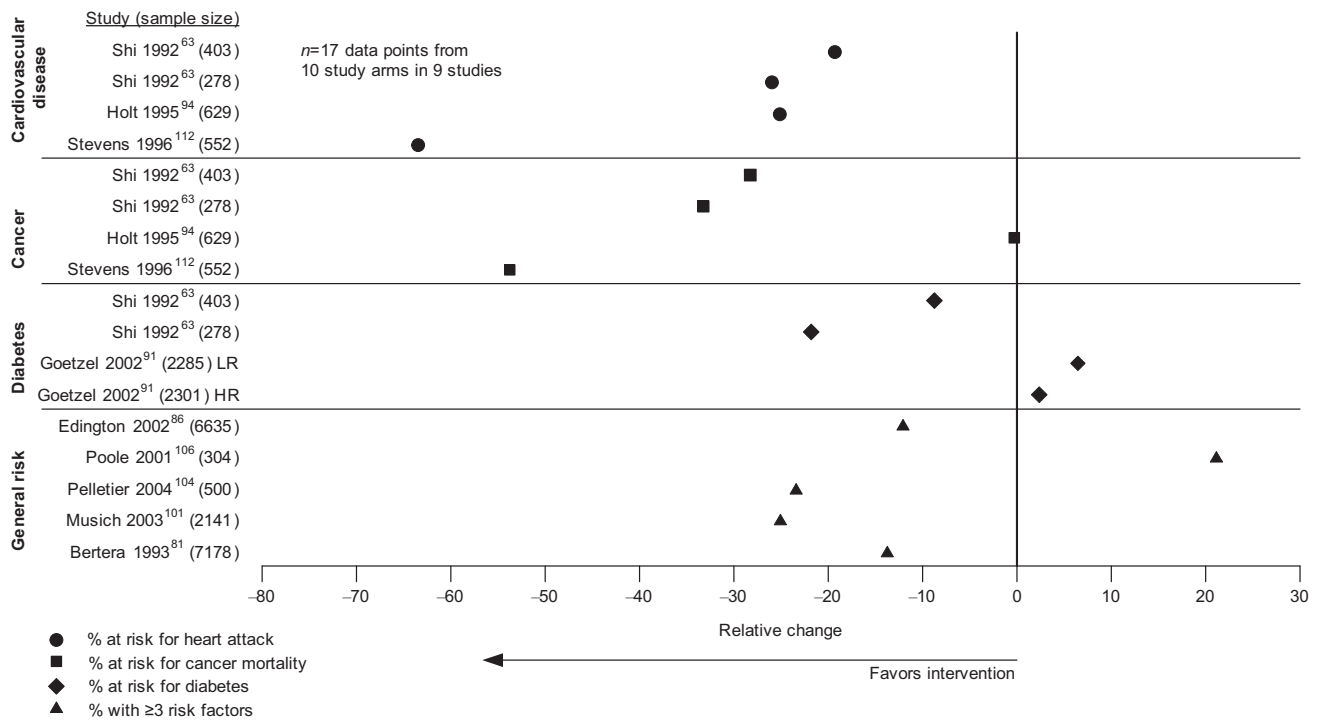


Figure 2. Scatterplot indicating relative percentage change in four health outcomes attributable to AHRF Plus interventions. Studies with multiple study arms are repeated.

AHRF, Assessment of Health Risks with Feedback; HR, high-risk; LR, low-risk

ber of such visits increased in the early years of exposure to AHRF Plus, and subsequently decreased well below initial usage rates. In contrast, inpatient days showed a steady decline in use over the entire study period. In sum, the six studies reporting healthcare service use are in favor of the intervention.

Absenteeism. Ten studies, representing 11 study arms,^{54,63,81,90,101,104,107,108,116,117} included absenteeism among reported outcomes. Absenteeism was defined and reported differently for all studies (e.g., self-reported injuries, mean days absent due to illness). Seven qualifying studies^{54,58,63,81,90,116,117} reported mean changes in days absent per year, typically due to illness, showing an overall decrease of about 1 day in favor of the intervention from a baseline median of 5.6 days.

Musich¹⁰¹ reported a 2.3–percentage point decrease in the proportion of employees absent due to illness for 6 days or more during the previous year. Shimizu¹⁰⁸ reported that the number of employees (N=1029) with at least one absence due to sickness during the previous year decreased from 93 at baseline to 67 at follow-up. Overall, all of the studies indicated moderate reductions in absenteeism among employees.

Morbidity and mortality. The WHO study,¹⁵ conducted among more than 40,000 working men in five

countries in Europe provided morbidity and mortality data. This study found that the intervention was associated with a 10.2% reduction in all coronary heart disease events ($p=.07$) and a 5.3% reduction in all deaths ($p=0.40$) when compared to an untreated control group. This study represents the ultimate goal of this multiple approach/multiple outcome intervention—to address a range of health indicators with the goal of reducing the likelihood of serious illness and death. Studies also reported a decrease in self-reported injuries during work, an indicator of worker safety and productivity (two study arms: -1.2 and -0.2 injuries)⁶³ and short-term disability days (-4.5 days).¹⁰⁷

Conclusion

In summary, this review synthesized evidence across a variety of outcomes relevant to overall health and wellness, including a range of health behaviors, physiologic measurements, and summary indicators linked to changes in health status. Although most of the 51 qualifying studies reported different sets of outcome measurements, the review considered data on effectiveness for each outcome across the body of evidence. The strength of evidence for the effectiveness of AHRF Plus varied across these outcomes. According to the *Community*

Guide rules of evidence,²⁰ there was strong or sufficient evidence for meaningful effects on the following outcomes: tobacco use, alcohol use, seatbelt nonuse, dietary fat intake, blood pressure cholesterol, summary health risk estimates, worker absenteeism, and healthcare service use. There was insufficient evidence to determine effectiveness for intake of fruits and vegetables, body composition, and physical fitness, due to a combination of small and inconsistent effect estimates.

Applicability

The team assessed applicability through stratification of results for four outcomes that had adequate data (smoking behaviors, diastolic and systolic blood pressure, and total cholesterol) for key stratification variables that had sufficient variability (year of publication, sample size, and duration of follow-up from baseline). Duration of follow-up from baseline is confounded by length of intervention such that most studies with longer study periods examined interventions that were offered for longer periods of time. No specific trends emerged for year of publication or duration of follow-up. However, studies with larger follow-up sample sizes tended to report smaller effect sizes, as has been observed in other systematic reviews.¹³⁷ This could represent a publication bias or could be related to participation rates. Among the 31 studies^{15,26,33,39,45,50,54,57,58,65,76,77,79,82,86,90,92,97,101–106,108,109,111–113,116,135} with adequate data to generate participation rates, overall participation rates were lower among larger companies, suggesting that studies with smaller sample sizes may have greater effects estimates because more of the study sample actually received the intended intervention. Risk status of participants at baseline could also play a role in the magnitude of change experienced. Smaller companies, which are likely to have fewer resources, may choose to focus those resources on those workers at greatest risk of illness or injury. However, when using total cholesterol as an example, only a small (-0.08) correlation existed between baseline cholesterol readings and the total number of study participants at baseline.

In addition to examining these stratification variables, results for high-risk subgroups were analyzed for all outcomes with data from at least five studies. High risk was defined differently in each study (e.g., a risk score based on responses to the HRA or a baseline reading on an outcome measure of interest). Some studies evaluated the effectiveness of AHRF Plus for high-risk participants. Others described the effectiveness for all participants and the high-risk participant subset. In some cases, the high-risk subset was offered additional intervention components. In 12 study arms from eight studies^{26,54,76,78,80,88,89,105} that provided results specifically

for high-risk participants, diastolic blood pressure decreased by 4.3 mm Hg (range: -5.6 to -2.5 mm Hg) for those high-risk participants. This compares to a decrease of 1.8 mm Hg (IQI = -4.4 , -0.3 mm Hg) for study arms that included samples of lower-risk participants or of the general population of employees (which would include people with a full range of risk statuses). For systolic blood pressure, 13 study arms from 9 studies^{15,26,54,76,78,80,81,88,89} found a decrease of 6.3 mm Hg (range: -9.4 to -3.4 mm Hg) for high-risk participants, compared to -2.6 mm Hg (IQI = -4.6 to -0.3 mm Hg) for the complete sample. For total cholesterol, 13 study arms from 11 studies^{7,15,45,54,75,77,78,80,81,89,105} found a decrease of 11.4 mg/dL (range: -24.7 to -1.9 mg/dL) for high-risk participants, compared to -5.0 mg/dL (IQI = -10.4 to 0.0 mg/dL) for the complete sample. For weight and BMI, results did not substantially differ by risk status: median reductions of 0.9 pounds ($n=8$ study arms)^{15,26,45,76,105} and 0.5 kg/m² ($n=6$ study arms)^{26,45,54,78,138} respectively, for high-risk participants, compared to -0.56 pounds (95% CI = -5.1 to -1.5 pounds) and -0.5 kg/m² (95% CI = -0.3 to 1.1 kg/m²) for the complete sample. With the exception of the findings for weight and BMI, these effect estimates are large and suggest that AHRF Plus is effective for high-risk employees.

The interventions evaluated in this review were conducted in a variety of worksites including manufacturing plants, healthcare facilities, health insurance companies, government offices, field settings, banks, schools, and in an ambulance service workforce. Most studies were conducted in companies or worksites with more than 500 employees and in urban or suburban settings. Six studies were conducted in medium-sized companies (50–499 employees) and one in a small company (<50 employees). Forty studies were conducted in the U.S., two in a group of European countries, two each in Australia and Finland, and one study was conducted in each of the following countries: Canada, Japan, the Netherlands, Sweden, and Switzerland. Whites and African Americans were well represented among studies reporting information on race. Adequate information regarding other ethnic groups is not available and data were not available to determine if the intervention had differential effects for different racial or ethnic groups. Because so many lifestyle and genetic characteristics associated with outcomes included here are correlated with racial and ethnic group membership, concluding on applicability for different racial or ethnic groups should be done with caution. The average age of participants was 40 years, and a range of educational levels and job positions was represented.

Stratifying according to variables specific to the intervention such as the presence of or intensity of particular forms of health education or enhanced access was not

conducted. Although most studies included health education, no study reported intervention details at a level necessary for fair categorization. In addition, while many interventions included very similar components, there were not enough studies of any one approach or combination of approaches to create distinct categories for analysis.

Other Positive or Negative Effects

The interventions reviewed here include multiple components with various potential benefits, challenges, and barriers to implementation that may apply to some intervention components and not to others. The assessment element of AHRF has many potential benefits. It may help employees understand the relationship between their behaviors and health,⁶ increase referrals to medical professionals for employees at high risk for morbidity or mortality, or for whom biometric screening suggests symptoms of specific health conditions; and may lead to the creation of need-specific worksite health promotion programs based on aggregated results of the assessments.¹³⁹ Shoenbach et al.¹⁶ suggests that this intervention allows for organization of health concepts and information around a coherent theme, can facilitate discussion of emotional or embarrassing issues, provides a “teachable” moment, and can serve as a reminder to physicians. However, he also cautions “assessment must deal with appropriate risk characteristics and produce appropriate recommendations for change.” These studies did not assess the potential for increased employee satisfaction that may result from having worksite health promotion programs available, but that, along with a more positive image for the employer among current or potential employees, is a potential benefit of the AHRF Plus intervention.

Studies were assessed for mention of adverse effects. Although no study provided data on adverse effects, a number of possible effects were suggested by authors. These include: information received in the feedback portion of AHRF may cause anxiety for the recipient; false positives are likely, particularly with the biometric screenings; some employees may experience the “white coat” syndrome when their blood pressure is being checked; and others may not follow directives for fasting prior to cholesterol checks, leading to overestimates of risk status. Finally, breach of confidentiality is of substantial concern in worksite settings and if it occurs, may have some potential for influencing decision making not just about which programs to offer, but about which benefits to provide.

Less than a third of the interventions described in the studies included in this review included named assessment tools that have been examined for reliability and

validity in independent studies. Many of the other studies used assessment tools tailored for the specific intervention or used questionnaires that met criteria for this review but would normally not be considered a health risk-assessment tool. As a result, research regarding the reliability and validity of the various assessments and feedback used in the studies included in this review and for HRAs more broadly is generally unavailable. (See Edington et al. for a more detailed discussion of the reliability and validity of HRAs.¹⁴⁰)

Barriers to Intervention Implementation

Employers may be reluctant to implement interventions involving AHRF due to employee concerns over breach of confidentiality of health records to other employees or to health insurance providers. The Society for Preventive Medicine attempted to address this concern by creating the Ethics Guidelines for the Development and Use of HRAs. However, more recent trends by large employers providing incentives for completion of HRA tools or requiring that employees meet specific health standards (for example, they must fall within a particular BMI range), may exacerbate this fear.

Other potential barriers relate to levels of employee participation. Those who think or know that they have important health risks may be least likely to participate.¹²⁸ Some have argued that interventions such as this attract the worried well, those who typically seek out medical information on a regular basis,⁴³ even though workers who are less healthy might benefit more from these programs. Even if there is broad participation in AHRF, there may be low participation in intervention components offered in addition to AHRF. In such cases, some employers may be inclined to reduce the scope of or cancel these components. Some employers have tried incentives to increase employee participation, although the success of such incentives has not been investigated systematically.

Economic Efficiency

A search for evidence on the economic efficiency of AHRF Plus was conducted to supplement the search for studies evaluating intervention effectiveness. The intervention definition and characteristics defined for the effectiveness review were adopted as primary inclusion and exclusion criteria. Studies meeting the intervention definition were then evaluated based on established *Community Guide* standards to determine eligibility for economic review.¹⁴¹ Broadly speaking, these require that studies be published in English, be implemented in a country with a high-income economy as defined by the

World Bank,^a and have used an economic evaluation method. The Panel on Cost Effectiveness on Health and Medicine¹⁴² recommends using the societal perspective to account for all costs and benefits of a program. However, for this review, the economics review team used the employers' perspective in accounting for costs and benefits of the intervention.

Evidence Synthesis

The literature search yielded 1465 abstracts; of these, 127 were considered for full review. Nine studies,^{64,77,125,127,143–147} containing economic evaluations of direct and indirect costs, qualified for inclusion based on abstraction and quality scoring of study design and execution. One study¹²⁵ was considered very good in study design, and another study⁶⁴ good according to the quality criteria described in the *Community Guide* economic abstraction form.¹⁴¹ The remaining seven studies were rated satisfactory. Eight studies^{64,77,125,127,143,144,146,147} reported return on investment (ROI) ratios, and one study¹⁴⁵ reported a cost-effectiveness ratio. All program costs and economic benefit data from the qualifying studies were adjusted to 2005 U.S. dollar values by using inflation factors from the Consumer Price Index, available at <http://www.bls.gov/cpi/>. Methods used in assessing economic evaluations are described elsewhere.¹⁴¹

Economic summary measures are indicators used to gauge an intervention's economic efficiency and on which to base conclusions, after taking into account the costs and benefits of the intervention. The follow-up periods for evaluating costs and benefits of intervention in these studies ranged from 1 to 6 years. Costs are usually program costs incurred by the intervention sponsor and benefits include both direct and indirect economic gains due to the intervention. For this review, direct economic benefits were based on the medical costs averted per participant or employee, and usually were measured using healthcare claims paid by the employer. Studies did not include copayments or any other out-of-pocket expenses paid by the employee in their analyses. Indirect benefits were measured through productivity losses averted per employee or participant. Productivity losses

were defined as time missed from work due to a preventable illness or disability. The two common economic summary measures include cost-benefit analysis (CBA), which is based on the monetized value of both costs and benefits, and cost-effectiveness analysis (CEA), in which costs are measured per unit of outcome expressed in a physical unit. The latter approach is taken when the dollar value of all benefits is difficult to estimate.

Not all economic costs and benefits were explicitly reported in every CBA study. In such situations, the team calculated missing information by using a standard ROI equation. For example, if a study reported only program costs and the ROI yielded by the intervention, then benefits were calculated by multiplying the program costs by the reported ROI. This way, dollar values for all program costs, benefits, and economic summary measures could be provided for every study in this review.

Program Costs

Program costs ranged across studies from \$65 to \$285 per participant per year. Two studies^{144,146} were based on a single-group before-and-after study design that involved all employees at the particular workplaces. Costs were \$40 and \$234 per employee per year for these two studies. Most studies did not report detailed costs for implementation of the intervention being evaluated. Even when a study provided such details, it was not always clear how such numbers were derived. Three studies^{145–147} enumerated program costs, with the majority of expenses going toward providing health education classes and implementing the health-risk assessment.

Benefits

Economic benefits from the intervention ranged from \$93 to \$695 per participant per year. For the two studies that involved all employees at the particular workplaces,^{144,146} benefits were \$160 and \$272 per employee per year. Economic benefits were derived from direct medical costs averted, indirect productivity losses averted, or both. Most studies included in this review, however, considered only disability days averted as indirect benefits, although one study did measure both types of productivity losses (disability days and days missed due to illness) along with direct medical benefits. Aldana et al.⁷⁷ (1993) included in their benefit estimate the amount of decrease in healthcare costs for both program participants and nonparticipants because they assumed that the slight reduction in healthcare costs for the nonparticipants during the treatment period resulted from the social interaction between the two groups.

^aThose nations with high-income economies, as defined by the World Bank, are Andorra, Antigua and Barbuda, Aruba, Australia, Austria, The Bahamas, Bahrain, Barbados, Belgium, Bermuda, Brunei Darussalam, Canada, Cayman Islands, Channel Islands, Cyprus, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, French Polynesia, Germany, Greece, Greenland, Guam, Hong Kong (China), Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Republic of Korea, Kuwait, Liechtenstein, Luxembourg, Macao (China), Malta, Monaco, Netherlands, Netherlands Antilles, New Caledonia, New Zealand, Norway, Portugal, Puerto Rico, Qatar, San Marino, Saudi Arabia, Singapore, Slovenia, Spain, Sweden, Switzerland, Trinidad and Tobago, United Arab Emirates, United Kingdom, U.S., and Virgin Islands (U.S.).

Economic Summary Measures

All but one study in this economic review included a CBA and reported economic summary measures in terms of a ROI ratio, also known as a Benefit-to-Cost ratio, which is defined as averted medical costs, productivity losses due to the program, or both, divided by program intervention costs. ROI ratios, for the eight CBA studies that reported them, ranged from 1.4:1 to 4.6:1 (median 3.2:1),^{64,77,125,127,143,144,146,147} meaning that an annual gain of \$1.40 to \$4.60 for every dollar invested into the program would be realized.

The remaining study included a CEA and reported a cost-effectiveness ratio (CER).¹⁴⁵ However, the CEA did not include an economic summary measure with a final health outcome (e.g., the cost per life-year saved or cost per quality-adjusted life-year). Instead, this study used a cost-effectiveness ratio in terms of an intermediate health outcome, cost per 1% additional reduction or prevention in cardiovascular disease (CVD) risks, as an indicator of economic efficiency. This study evaluated three variations of an intervention involving AHRF in three manufacturing plants—one with health education, one with health education and follow-up counseling, and one with health education, follow-up counseling, and plant organizational strategies to create health communication networks, peer support groups, specific-interest health promotion groups, and plantwide health activities. A fourth plant that provided only wellness screening and existing services was used as a control site. For high-risk participants, the CERs compared to the control varied from \$14 to \$73 per 1% reduction in CVD risks over a 3-year period; for moderate-risk participants the range varied from \$11 to \$73. Lacking any benchmark values in terms of risk reduction for other diseases, it is difficult to interpret the economic efficiency of these particular estimates.

The systematic review of economic evaluation found evidence of positive economic impact based on eight studies that reported ROI ratios. Direct comparison of study results is difficult, lacking complete enumeration of all costs and benefits, and because of the wide variation among the studies regarding intervention components, length of follow-up period, and health risks for employees. Additional research is needed before firm conclusions about the economic effects of AHRF plus interventions can be reached.

Limitations

The interventions examined in this set of reviews, the range of outcomes of interest, and the setting of interest (worksites) presented many methodologic challenges for the primary study authors and in turn, for the review process. The first intervention considered, AHRF, was

often used as a comparison condition in the studies included in these two reviews. As a consequence, few studies of the effectiveness of AHRF included untreated comparison groups, and many of the effect estimates for AHRF Plus reflected incremental benefits over AHRF alone. HRAs, which are a crucial component of AHRF, often served as a primary measurement tool for evaluating intervention effectiveness. Because of this intimate link between the intervention and the outcome measurement, participants in these studies were almost always: (1) self-selected based on participation in the AHRF program and (2) had to be available as a worker for assessment periods (leading to a biased inclusion of long-term employees). Furthermore, many of the studies had high attrition rates (possibly due to employee turnover, work demands, or lack of motivation to complete the study). For example, in the AHRF review, the median proportion of employees who participated in the first assessment of health risks was 57.5%; of those, the median retention rate at follow-up was 79.0%.

The propensity for those who are aware of and concerned with their health condition and risks to participate in public health interventions would suggest that the majority of participants are either the “worried well” or those who were motivated to change their behavior. Higher-risk participants may therefore be underrepresented in many studies. Most of the included studies did not report differences in AHRF participants and nonparticipants. However, among the nine studies that did include information about participants and nonparticipants, two reported no differences,^{63,77} and the remaining seven reported similar patterns: participants were more likely to be female,^{31,89,90,94} older,^{45,107} and college educated.^{45,90,94} It is not clear if these differences had any impact on the effectiveness of the intervention.

Another limitation relates to the reporting of outcomes. In more than a few studies, authors reported assessing multiple outcomes, but presented results on only some of them. In one extreme case, authors reported only one outcome of several that were assessed. In many other cases, authors merely reported that the findings for a particular outcome were “not statistically significant,” and did not report any data. The extent to which this apparent selective reporting of results or of publication bias more broadly may have biased the findings of these reviews is unclear.

Conclusion

The results of these reviews indicate that the assessment of health risk with feedback has utility as a gateway intervention to a broader worksite health promotion program that includes health education lasting at least 1 hour or being repeated multiple times during 1 year and that may

include an array of health promotion activities. The specific magnitude of effect an employer might expect from implementing different types of health promotion programs will vary and may be influenced by type and duration of intervention component offered, participation rates, participant characteristics (e.g., evidence suggests that higher-risk participants will experience greater health gains), and other contextual factors. In addition, results of this review suggest that this intervention may be more effective for some outcomes (e.g., smoking behavior or cholesterol) than for others (e.g., change in body composition).

Research Issues

This review of the use of assessments of health risks with feedback in worksite settings addressed important questions that earlier reviews were unable to address, such as:

1. Does AHRF, when used alone, lead to behavior change or change in health outcomes among employees?
2. Does this type of assessment, when used with other worksite-based intervention components result in change?
3. And finally, what types of behaviors or health outcomes are affected by these interventions?

The structure of this review, however, leaves two additional questions about worksite health promotion programs unanswered:

1. Are worksite health promotion programs with a health education component effective in the absence of AHRF?
2. Does AHRF add value to worksite health promotion programs with regards to behavior change and improvement in health outcomes?

The field will also likely be interested in addressing questions related to implementation of the intervention: what components are necessary and for whom are they most effective? How many times must AHRF occur and for how long must employees be exposed to additional intervention components? What qualifications of staff or health educators are needed? How long do the effects last? With regards to the assessment: Are there key assessment questions or aspects of the assessment (like biometric screening) that provide information resulting in a more effective intervention? Does the format of the questionnaire or the feedback make a difference? Is employee participation in creation of the program important, and what role does organizational support play in participation rates and overall effectiveness?

Furthermore, additional descriptive information about participant and nonparticipant attributes would help address important questions regarding the general

belief that risk assessments attract the worried well; would provide implementers with information they could use to target intervention offerings (particularly as they related to high-risk behaviors or profiles); and would provide evaluators with needed information to stratify results to determine for whom the intervention is most effective. Consistent and more detailed reporting on intervention details, in manuscripts or through links to program websites, would clearly pave the way for evaluators and systematic reviewers to address many of the questions posed in the above paragraphs.

Finally, questions regarding economic efficiency will be of interest to most in the field and should be addressed more systematically. A first step would be to clearly delineate the aspects of program costs and benefits that should be assessed in program evaluation. How many employees need to be reached for a positive ROI? What should the GRP (gross rating product) be for the ROI? Is there a “break even point” or a certain amount of time for which costs will outweigh benefits before there are actual savings from program implementation? Although the questions above stem from this review of AHRF, many of them pertain to the broader field of worksite health promotion and can be used to inform future evaluation of these programs.

The authors would like to thank Geoff Alexander, Elizabeth Felter, Jeff Harris, Peggy Hannon, and Shirley Musich for their assistance during the conceptual stages of this review. They are also very appreciative of the methodologic and editorial support of Randy Elder, Tony Pearson-Clarke, Theresa Sipe, and other members of the *Guide to Community Preventive Services*.

Points of view are those of the Task Force on Community Preventive Services and do not necessarily reflect those of the CDC.

No financial disclosures were reported by the authors of this paper.

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