

Adherence to the AICR Cancer Prevention Recommendations and Subsequent Morbidity and Mortality in the Iowa Women's Health Study Cohort

James R. Cerhan,¹ John D. Potter,² Julie M.E. Gilmore,³ Carol A. Janney,¹ Larry H. Kushi,⁴ DeAnn Lazovich,⁵ Kristin E. Anderson,⁵ Thomas A. Sellers,¹ and Aaron R. Folsom⁵

¹Department of Health Sciences Research, Mayo Clinic College of Medicine, Rochester, Minnesota; ²Division of Cancer Prevention, Fred Hutchinson Cancer Research Center, Seattle, Washington; ³Department of Epidemiology, College of Public Health, University of Iowa, Iowa City, Iowa; ⁴Department of Research, Kaiser Permanente, Oakland, California; and ⁵Division of Epidemiology, University of Minnesota School of Public Health, Minneapolis, Minnesota

Abstract

In 1997, the American Institute for Cancer Research (AICR) published 14 recommendations related to diet for individuals to reduce cancer incidence on a global basis; smoking was also discouraged. We operationalized these into nine recommendations that are particularly relevant to western populations in a cohort of 29,564 women ages 55 to 69 years at baseline in 1986 who had no history of cancer or heart disease. The cohort was followed through 1998 for cancer incidence ($n = 4,379$), cancer mortality ($n = 1,434$), cardiovascular disease (CVD) mortality ($n = 1,124$), and total mortality ($n = 3,398$). The median number (range) of recommendations followed was 4 (0-8), and 33% of the cohort had ever smoked. Women who followed no or one recommendation compared with six to nine recommendations were at an increased risk of cancer incidence [relative risk (RR) 1.35, 95% confidence interval (CI) 1.15-1.58] and cancer mortality (RR 1.43, 95% CI 1.11-1.85), but there was no association with CVD mortality (RR 1.06, 95% CI 0.78-1.43). We calculated the population attributable risk (PAR) to estimate the proportion

of cancer incidence, cancer mortality, and CVD mortality that theoretically would have been avoidable if the entire cohort had never smoked, had followed six to nine recommendations, or had done both. The PARs for smoking were 11% (95% CI 10-13) for cancer incidence, 21% (95% CI 17-24) for cancer mortality, and 20% (95% CI 16-23) for CVD mortality. The PARs for not following six to nine recommendations were 22% (95% CI 12-30) for cancer incidence, 11% (95% CI -5 to 24) for cancer mortality, and 4% (95% CI -20 to 19) for CVD mortality. When smoking and the operationalized AICR recommendations were combined together, the PARs were 31% (95% CI 19-37) for cancer incidence, 30% (95% CI 15-40) for cancer mortality, and 22% (95% CI 4-36) for CVD mortality. These data suggest that the adherence to the AICR recommendations, independently and in conjunction with not smoking, is likely to have a substantial public health impact on reducing cancer incidence and, to a lesser degree, cancer mortality at the population level. (Cancer Epidemiol Biomarkers Prev 2004;13(7):1114-20)

Introduction

In the United States, an estimated one in three women will develop cancer during her lifetime, and in 2003, an estimated 658,800 women will be newly diagnosed with a cancer, excluding nonmelanoma skin cancers (1). Cancer was the second leading cause of death in U.S. women in 2000 and was the leading cause of death for women ages 40 to 79 years (1).

In 1997, the American Institute for Cancer Research (AICR) issued 14 recommendations regarding diet and factors related to diet (Table 1), which were designed to reduce cancer incidence and mortality on a global basis (2).

The recommendations not only outlined public health goals but also provided advice to individuals for the prevention of cancer. The recommendations were noted to be generally consistent with other dietary recommendations at that time, and the recommendations were designed to be implemented as a whole; that is, no individual recommendation was to be promoted or followed out of context. Smoking was not part of the recommendations per se, but the panel recommended not using tobacco because this could overwhelm any potential protective effect of the dietary recommendations.

In the present study, we operationalized the AICR recommendations into nine recommendations relevant to western populations and available in our study cohort and assessed the effect of following these operationalized recommendations on cancer incidence and mortality in a prospective cohort study of postmenopausal women. In addition, using the population attributable risk (PAR), we estimated the proportion of morbidity and mortality that might have been prevented (or deferred) if all women in the cohort had followed six or more of the operationalized recommendations.

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Requests for reprints: James R. Cerhan, Department of Health Sciences Research, Mayo Clinic College of Medicine, 200 First Street SW, Rochester, MN 55905. Phone: 507-538-0499; Fax: 507-266-2478. E-mail: cerhan.james@mayo.edu

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Materials and Methods

Study Cohort. Detailed descriptions of the Iowa Women's Health Study (IWHS) have been published previously (3-5). The IWHS was reviewed and approved by the institutional review boards of the University of Iowa and University of Minnesota. In January 1986, 41,836 Iowa women ages 55 to 69 years returned a 16-page mailed questionnaire and form the cohort under study. We have followed this cohort for cancer incidence by annual computer linkage of participant identifiers to the Iowa Cancer Registry, which is part of the National Cancer Institute's Surveillance, Epidemiology, and End Results Program (6). Date and cause of death were determined by annual computer linkage of participant identifiers to a database of Iowa death certificates. Decedents (along with date and cause of death) were also identified through mailed follow-up surveys in 1987, 1989, 1992, and 1997 and, for survey nonrespondents, through linkage to the National Death Index.

Eight of the 14 AICR recommendations, plus smoking history, were operationalized as detailed in Table 1. The first recommendation was not operationalized due to its nonspecific nature and because it was encompassed by other recommendations (i.e., nos. 4, 5, and 7). Because the "body weight" guideline had two distinct and clinically relevant components ("avoid being underweight or

overweight" and "limit weight gain during adulthood to <11 pounds"), we operationalized both using historical weight data self-reported on the 1986 baseline questionnaire. Physical activity was determined using a previously published physical activity index (7). We did not have data on occupational physical activity.

Adherence to the dietary recommendations (nos. 4 to 9) was determined from a semiquantitative food frequency questionnaire developed by Willett et al. (8). Usual intakes of specified portions for 127 food items were ascertained, and nutrient intakes and total energy were estimated using a nutrient database (8). The diet questionnaire is reasonably valid and reliable in this population for a variety of nutrients including total fat (9). For the recommendation regarding consuming a diet rich in starches and nonstarch polysaccharides (no. 5), we summed items providing complex carbohydrates, excluding highly refined sources of carbohydrates. In our cohort, only 3% of the women reported consuming the recommendation of ≥ 600 g/d, so we defined adherence a priori as ≥ 400 g/d (approximately the 20th percentile). Daily sodium consumption from foods was determined from the food frequency questionnaire. In addition, respondents were asked if they added salt to their food. If dietary sodium consumption was $< 2,400$ mg/d and the respondent reported no additional salt use, they were categorized as adherent.

Table 1. AICR recommendations, operationalization in this study, and percentage of cohort following the recommendation (n = 30,518)

Recommendation	Description
1. Food supply and eating	Choose predominately plant-based diets rich in a variety of vegetables and fruits, pulses, and minimally processed starchy staple foods
2. Body weight	Avoid being underweight or overweight Limit weight gain during adulthood to <5 kg (11 pounds)
3. Physical activity	If occupational physical activity is low, exercise moderately daily and exercise vigorously at least 1 hour per week
4. Vegetables and fruits	Eat 400-800 g (15-30 ounces) or five or more portions a day of a variety of vegetables and fruits, all year-round (excluding pulses and starchy vegetables)
5. Other plant foods	Eat 600-800 g (20-30 ounces) or seven or more portions a day of a variety of cereals, pulses, roots, tubers, and plantains; prefer minimally processed foods; limit refined sugar
6. Alcoholic drinks	Alcohol consumption is not recommended; if consumed at all, limit alcoholic drinks to less than one drink a day for women
7. Meat	If eaten at all, limit red meat intake to <80 g (3 ounces) daily
8. Total fats and oils	Limit intake of fatty foods, particularly those of animal origin; choose moderate amounts of appropriate vegetable oils
9. Salt and salting	Limit consumption of salted foods and use of cooking and table salt; use herbs and spices to season foods
10. Storage	Do not eat food that, as a result of long storage at ambient temperatures, is liable to contamination by mycotoxins
11. Preservation	Use refrigeration and other appropriate methods to preserve perishable food as purchased and at home
12. Additives and residues	When levels of additives, contaminants, and other residues are properly regulated, their presence in food and drink is not known to be harmful
13. Preparation	Do not eat charred food. Avoid burning of meat juices. Consume the following only occasionally: meat and fish grilled (broiled) in direct flame, cured and smoked meats
14. Dietary supplements	For those who follow dietary recommendations supplements are probably unnecessary, and possibly unhelpful for reducing cancer risk
Tobacco	Do not smoke or chew tobacco

Recommendations pertaining to food storage (no. 10) and preservation (no. 11) were not operationalized, as they were considered to be less relevant to most western populations. The recommendations on additives and residues (no. 12) and meat preparation (no. 13) were not included because they were not assessed on the baseline survey. Use of dietary supplements (no. 14) was not included because the recommendation was deemed to be neutral on whether these should be used or avoided.

Data on cigarette smoking history were obtained at baseline and included age started, age stopped, and usual number of cigarettes smoked per day.

Data Analysis. We excluded women who were not postmenopausal ($n = 569$), women who reported a history of cancer other than skin cancer or prior cancer chemotherapy ($n = 3,881$), women who self-reported a history of heart disease or heart attack ($n = 5,116$), and women who left ≥ 30 items blank on the dietary questionnaire or had implausibly high or low total energy intake (<600 or $>5,000$ kcal/d; $n = 3,096$); these exclusions were not mutually exclusive. After implementing the exclusions, a total of 30,518 women were available for analysis, 29,838 with complete data on all recommendations. To obtain the "number of recommendations followed," we summed across the nine operationalized recommendations for each woman (Table 1). This variable was modeled as a categorical variable (0 to 1, 2, 3, 4, 5, or 6 to 9), and categories were selected a priori

to cover the entire distribution of scores and to ensure a sufficient sample size in each category.

We estimated the relative risks (RRs) of cancer incidence (excluding nonmelanoma skin cancer), cancer mortality (*International Classification of Diseases, Ninth Edition* codes 140 to 239), cardiovascular mortality (*International Classification of Diseases, Ninth Edition* codes 390 to 459), and all-cause mortality according to the summary score of recommendations followed using Cox proportional hazards regression models using each woman's age as her own time scale for the baseline risk (10). The proportional hazards assumptions underlying the models were examined, and if violated, this was specifically noted.

We also computed the PAR to estimate the proportion of cancer incidence or cause-specific mortality that might have been avoided or deferred if all women in the IWHS had been in the low-risk categories (i.e., never smoked or followed six to nine recommendations) using the assumption that there was a causal association between these factors and each end point. The variance and 95% confidence interval (95% CI) of the PARs were estimated with a *Splus* macro (11).

Results

The majority of women did not comply with six of the operationalized recommendations, while a majority was

Table 1. AICR recommendations, operationalization in this study, and percentage of cohort following the recommendation ($n = 30,518$) (Cont'd)

Operationalization	Categories	<i>n</i>	(%)
1. Not included			
2. Body mass index (kg/m ²) at baseline (1986)	≤ 25.0	12,360	(40.5)
	> 25.0	18,158	(59.5)
Weight gain since age 18	Gained < 11 pounds	6,977	(22.9)
	Gained ≥ 11 pounds	23,416	(76.7)
	Missing values	125	(0.4)
3. Usual recreational physical activity at baseline (1986)	Active	8,556	(28.0)
	Not active	21,801	(71.4)
	Missing values	161	(0.5)
4. Daily vegetable and fruit consumption, excluding pulses and starchy vegetables	< 5 servings per day	27,157	(89.0)
	≥ 5 servings per day	3,361	(11.0)
5. Daily intake of complex carbohydrates > 400 g (~ 80 th percentile)	< 400 g	25,133	(82.4)
	≥ 400 g	5,385	(17.6)
6. Daily alcohol intake (one drink $\cong 14$ g of alcohol)	< 14 g	28,030	(91.8)
	≥ 14 g	2,488	(8.2)
7. Daily red meat intake (beef, lamb, pork, and products from these meats)	< 80 g	15,497	(50.8)
	≥ 80 g	15,021	(49.2)
8. Daily consumption of fat as percentage total calories	$\leq 30\%$	7,101	(23.3)
	$> 30\%$	23,417	(76.7)
9. Daily sodium consumption from diet questionnaire plus use of table salt	$< 2,400$ mg	20,290	(66.5)
	$\geq 2,400$ mg	10,228	(33.5)
10. Not included			
11. Not included			
12. Not included			
13. Not included			
14. Not included			
Ever vs. never smoked cigarettes	Never smoked	19,966	(65.4)
	Ever smoked	10,144	(33.2)
	Missing values	408	(1.3)

in compliance for three (Table 1). The lowest compliance was for intake of vegetables and fruits, with only 11% consuming five or more servings per day. The highest compliance was for consumption of <14 g/d of alcohol (92%), which reflects the relatively low use of alcohol in this group of Iowa women. In addition, a majority (65%) of the women had never smoked cigarettes. When the recommendations were summed, the median number followed was 4; not a single woman followed all nine recommendations and 68 women did not follow a single recommendation. Each of the individual recommendations, with the exception of daily alcohol intake and smoking history, was strongly and positively associated with the total number of recommendations followed (Table 2).

After 13 years of follow-up, 4,379 women developed at least one new primary cancer, while 3,398 women died [1,434 due to cancer and 1,124 due to cardiovascular disease (CVD)]. Women who followed less than six recommendations were at increased risk of cancer incidence compared with women who followed six to nine recommendations (Table 3). However, there was no dose response for number of recommendations followed, and while the RRs were weak (~1.3), they were highly statistically significant. In contrast, for cancer and total mortality, only the lowest category (i.e., followed no to one recommendation) had significantly elevated risk of each end point, while there was no association for CVD mortality. Results were similar when analyses were stratified by smoking status (Table 3). In secondary analysis, we further excluded long-term quitters (>8 years) from the ever-smoker group, and the associations reported in Table 3 slightly strengthened (data not shown).

If women in this cohort had never smoked, we estimate that 11% of the cancer incidence, 21% of the cancer mortality, 20% of the CVD disease mortality, and 22% of the total mortality could have been delayed or prevented (Table 4). Irrespective of smoking status, if all women had followed six to nine versus less than six recommendations, 22% of cancer incidence and 11% of cancer mortality could have been delayed or prevented but only 4% of CVD mortality and 9% of the total mortality. These PARs were slightly stronger among never-smokers than among ever-smokers. If women had

never smoked cigarettes and had followed six to nine recommendations, 31% of the cancer incidence, 30% of the cancer mortality, 22% of the CVD mortality, and 29% of the total mortality could have been delayed or prevented.

While we focused on evaluating the recommendations as a group, in a secondary analysis, we evaluated the dietary recommendations alone. There was no association for the number of dietary recommendations followed (4+ versus 0 to 1) with cancer incidence (RR 0.93, 95% CI 0.78-1.10), cancer mortality (RR 0.99, 95% CI 0.74-1.33), coronary heart disease mortality (RR 0.95, 95% CI 0.67-1.35), or total mortality (RR 0.98, 95% CI 0.81-1.19).

Discussion

In this cohort of older Midwestern women, compliance with the operationalized AICR recommendations was associated with a lower risk of cancer incidence, cancer mortality, and total mortality, although there was no dose-response relation. In contrast, there was little association with CVD mortality. The PARs for following six to nine versus less than six recommendations were strongest for cancer incidence (22%), lower for cancer mortality (11%), and weakest for CVD mortality (4%). The PARs were slightly stronger among never-smokers relative to ever-smokers. Our estimates are somewhat lower than the AICR panel's estimate that cancer incidence throughout the world could be reduced by 30% to 40% if all the cancer prevention recommendations were followed (2). Nonetheless, given the certainty for measurement error, the lack of operationalization of the all of the recommendations, and the low adherence to several recommendations (e.g., fruit and vegetable intake and intake of starch and nonstarch polysaccharides), our estimates would be expected to be conservative. In addition, the impact of the recommendations will vary across populations according to the prevalence of exposure to these various factors. Of note in the IWHS, the prevalence of smoking and alcohol use was fairly low compared with the general U.S. population. Finally, there was a lack of an association for the diet-only recommendations (i.e., excluding the body mass index, weight

Table 2. Percentage distribution of compliance with individual dietary recommendations and smoking by total number of recommendations followed

Specific Recommendation	Total Number of Recommendations Followed*					
	0-1 (n = 1,935)	2 (n = 5,770)	3 (n = 8,004)	4 (n = 6,768)	5 (n = 4,445)	6-9 (n = 2,916)
Body mass index ≤ 25.0 kg/m ²	3	12	28	52	70	87
Gained 5 kg (11 pounds) since age 18	1	3	11	26	46	69
Engaged in daily moderate and weekly vigorous physical activity	2	9	19	32	47	72
Vegetable and fruit consumption ≥ 5 servings per day	1	4	8	11	16	32
Complex carbohydrate intake ≥ 400 g/d	2	15	16	17	20	33
Alcohol intake <14 g/d	73	91	93	94	93	97
Red meat intake <80 g/d	2	11	49	64	81	92
Daily consumption of fat $\leq 30\%$ of total calories	1	2	7	29	47	76
Consumption of sodium <2,400 mg/d	8	54	69	76	81	81
Never-smoker	61	69	68	66	63	65

*Excludes 680 women with missing data on one or more of the recommendations.

Table 3. Association of AICR cancer prevention recommendations followed with cancer incidence, cancer mortality, cardiovascular mortality, and total mortality among never-smokers and ever-smokers, IWHS, 1986-1998

Smoking Status and Number of Recommendations Followed	Mortality									
	Cancer Incidence			Mortality						
	Person-Years	Cases	RR (95% CI)	Person-Years	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)
All women										
6-9	33,421	326	1.00 (reference)	36,290	120	1.00 (reference)	103	1.00 (reference)	294	1.00 (reference)
5	50,387	648	1.29 (1.13-1.47)	55,017	218	1.15 (0.92-1.44)	130	0.79 (0.61-1.02)	476	1.02 (0.88-1.18)
4	76,577	987	1.30 (1.14-1.47)	83,554	326	1.15 (0.93-1.42)	250	1.01 (0.80-1.27)	781	1.12 (0.98-1.28)
3	91,082	1,200	1.35 (1.19-1.52)	98,889	364	1.12 (0.91-1.37)	313	1.13 (0.90-1.41)	891	1.12 (0.98-1.28)
2	66,213	830	1.28 (1.13-1.46)	71,546	250	1.09 (0.87-1.35)	228	1.18 (0.93-1.49)	614	1.11 (0.96-1.27)
0-1	22,032	297	1.35 (1.15-1.58)	23,872	117	1.43 (1.11-1.85)	71	1.06 (0.78-1.43)	247	1.27 (1.07-1.50)
Never-smokers										
6-9	22,118	189	1.00 (reference)	23,797	64	1.00 (reference)	57	1.00 (reference)	158	1.00 (reference)
5	32,488	371	1.35 (1.13-1.60)	35,227	105	1.12 (0.82-1.53)	60	0.73 (0.51-1.05)	222	0.97 (0.79-1.19)
4	51,613	587	1.33 (1.13-1.57)	55,791	179	1.20 (0.90-1.59)	144	1.08 (0.80-1.47)	415	1.12 (0.94-1.35)
3	62,540	752	1.43 (1.22-1.67)	67,543	202	1.15 (0.87-1.52)	173	1.13 (0.84-1.52)	485	1.13 (0.95-1.35)
2	46,356	529	1.37 (1.16-1.61)	49,832	138	1.08 (0.80-1.45)	127	1.16 (0.85-1.58)	328	1.06 (0.88-1.29)
0-1	13,761	153	1.35 (1.09-1.67)	14,739	54	1.49 (1.03-2.14)	31	1.01 (0.65-1.56)	113	1.30 (1.02-1.66)
Ever-smokers										
6-9	11,302	137	1.00 (reference)	12,494	56	1.00 (reference)	46	1.00 (reference)	136	1.00 (reference)
5	17,899	277	1.21 (0.99-1.49)	19,790	113	1.18 (0.86-1.64)	70	0.85 (0.58-1.24)	254	1.08 (0.87-1.33)
4	24,964	400	1.25 (1.03-1.52)	27,763	147	1.10 (0.80-1.50)	106	0.92 (0.65-1.31)	366	1.12 (0.92-1.37)
3	28,542	448	1.24 (1.02-1.50)	31,346	162	1.08 (0.80-1.47)	140	1.12 (0.80-1.56)	406	1.11 (0.91-1.35)
2	19,857	301	1.17 (0.95-1.43)	21,713	112	1.09 (0.79-1.51)	101	1.20 (0.85-1.71)	286	1.16 (0.94-1.43)
0-1	8,271	144	1.32 (1.05-1.68)	9,132	63	1.38 (0.96-1.99)	40	1.10 (0.72-1.68)	134	1.24 (0.98-1.58)

NOTE: Models are adjusted for age. In addition, pack-years are adjusted for in the ever-smoker models.

gain, and physical activity recommendations), suggesting that the weight control and physical activity recommendations may be particularly important.

We evaluated the association of the number of recommendations followed with total cancer incidence and total cancer mortality and did not evaluate the associations with specific cancer sites. This approach is consistent with the AICR's principle that, while cancer is more than one disease entity with often unique (but overlapping) risk factors, devising a series of recommendations for different cancers would not be helpful and that "common factors have allowed a coherent set of recommendations to be presented" (2). One notable finding was that the recommendations were more strongly associated with cancer incidence than cancer mortality perhaps due to the importance of other factors in determining cancer survival (and therefore mortality).

The AICR panel noted that recommendations aimed at the prevention of cancer would be incomplete without discouraging the use of tobacco and that the detrimental effects of tobacco use on cancer may overshadow any protective effect that might be conferred by following the recommendations. Our data offer some support to this concept, as the PARs for following the AICR recommendations were slightly stronger among never-smokers, although the differences were small. This may be in part due to the relatively low prevalence and intensity of smoking in this cohort or that these risk factors are independent.

Although the AICR recommendations were developed to prevent cancer, the panel noted that the recommendations were not in conflict with recommendations

designed to prevent other diseases and should "contribute overall to improvement of child and general adult health, prevention of deficiency diseases, and therefore increased resistance to infectious diseases and the prevention of other chronic diseases" (2). In this cohort, following more AICR recommendations was associated with lower total mortality but was unrelated to CVD mortality. Although we did not ascertain nonfatal CVD events, this does not seem to be an explanation for finding no association, given previously published risk factor associations for CVD mortality in this cohort (7, 12-14). Comprehensive recommendations would need to take into account additional factors to prevent CVD, possibly including use of nonhydrogenated fats and $\omega - 3$ fatty acids (15), as well as control of other CVD risk factors including hypertension and diabetes.

Strengths of this study include the prospective design, simultaneous evaluation of multiple end points, virtually complete follow-up of the cohort, use of a Surveillance, Epidemiology, and End Results cancer registry to ascertain incident cancers, and use of a validated diet questionnaire. Another strength is that the independent variable evaluated here (i.e., number of recommendations followed) was developed on the basis of external criteria and therefore ensures some protection from overly optimistic results from models derived from previously identified risk factors in the study population.

There are also limitations. We were unable to operationalize all of the recommendations, although we have operationalized most of the recommendations clearly relevant to western populations, with the exception of preparation of meats (i.e., charring) and

regulation of pesticide residues, for which we did not have baseline data on either factor. The operationalization for the recommendation on sodium intake was also incomplete, as we could not directly assess total sodium intake due to a lack of data on the amount of salt specifically added during cooking or at the table. Thus, our assessment of this recommendation would misclassify women as not adherent who had low sodium intake from foods and added only a small or moderate amount at the table; the extent or effect of this misclassification is unknown. For the recommendation to eat a diet rich in starches and nonstarch polysaccharides, we had to lower the adherence threshold because only 3% of the cohort complied at the recommended level. We assessed dietary intake at a single point in time (the 1986 study baseline), and this may not be representative of the women's lifetime intake or intake during the critical window for cancer prevention. In particular, because this is an older cohort, the impact of these risk factors may be different for younger women. Nevertheless, even at this older age, our data suggest a potentially important role for prevention. Furthermore, we cannot address whether changes in diet would lead to lower cancer incidence, a hypothesis most validly tested in a clinical trial. Finally, our results may be confounded by other healthy lifestyle factors that were not evaluated.

In 1981, Doll and Peto (16) estimated that diet (excluding alcohol) accounted for about 35% of all cancer deaths in the United States (range 10-70%), with a further contribution of 3% due to alcohol (range 2-4%). Other prominent reports have also suggested about one third of cancer mortality could be avoided through dietary means (16-18). In the Breast Cancer Detection Demonstration Project cohort, adherence to the Recommended Food Score, a summary of foods recommended by the U.S. Departments of Agriculture and Health and Human

Services, was inversely associated (highest versus lowest quartile) with total mortality (RR 0.69, 95% CI 0.61-0.78) as well as cancer mortality (RR 0.64, 95% CI 0.49-0.74), coronary heart disease mortality (RR 0.67, 95% CI 0.47-0.95), and stroke mortality (RR 0.58, 95% CI 0.35-0.96) after multivariate adjustment (19). However, the Recommended Food Score only weakly predicted CVD (incidence or mortality) and did not predict cancer (incidence or mortality) in the Nurses' Health Study cohort (20). In the latter study, the Healthy Eating Index, which was created by the U.S. Department of Agriculture and based on the food pyramid and the 1995 Dietary Guidelines for Americans (21), was only weakly and inversely associated with CVD risk and was not associated with cancer risk in the Nurses' Health Study (22). In a follow-up to the latter study, a modified Healthy Eating Index, which included expanded information on dietary choices and fat quality, was inversely associated (highest versus lowest quartile) with CVD (RR 0.72, 95% CI 0.60-0.86) but not cancer (RR 0.97, 95% CI 0.88-1.06; ref. 20). In a Swedish cohort, women who had the highest adherence to a Recommended Food Score had a lower risk of cancer mortality (RR 0.76, 95% CI 0.60-0.96), coronary heart disease mortality (RR 0.47, 95% CI 0.33-0.68), and stroke mortality (RR 0.40, 95% CI 0.22-0.73; ref. 23).

Unlike this analysis, the previous studies evaluated dietary factors exclusively in their guidelines. In the IWHS cohort, adherence to the 2000 Dietary Guidelines for Americans, which also included nondiet recommendations on weight status and level of physical activity, was inversely associated with total cancer incidence (RR for highest versus lowest quintile of the adherence score 0.85, 95% CI 0.77-0.93; ref. 24). Of note, when the nondiet factors were excluded from the guidelines, the association for total cancer incidence attenuated (RR 0.92, 95% CI 0.83-1.02). The lack of an association after the

Table 4. Percentage of cancer incidence or cause-specific and total mortality that might have been prevented (delayed) in the IWHS according to various scenarios

Scenario	Mortality			
	Cancer Incidence	Cancer	Cardiovascular	Total
	PAR (95% CI)	PAR (95% CI)	PAR (95% CI)	PAR (95% CI)
Smoking: PARs if all women had never smoked*	11 (10-13)	21 (17-24)	20 (16-23)	22 (20-24)
AICR recommendations: PARs if all women had followed 6-9 recommendations†	22 (12-30)	11 (-5 to 24)	4 (-20 to 19)	9 (-5 to 16)
AICR recommendations: PARs if never-smokers had followed 6-9 recommendations‡	25 (7-33)	13 (-10 to 32)	5 (-17 to 33)	8 (-7 to 20)
AICR recommendations: PARs if ever-smokers had followed 6-9 recommendations‡	17 (2-27)	11 (-17 to 28)	3 (-30 to 27)	10 (-5 to 23)
Smoking and AICR recommendations: PARs if all women had never smoked and followed 6-9 recommendations‡	31 (19-37)	30 (15-40)	22 (4-36)	29 (20-36)

*PARs adjusted for age and AICR cancer prevention recommendations.

†PARs adjusted for age and pack-years of smoking.

‡PARs adjusted for age.

exclusion of the nondiet recommendations in this analysis suggests that weight control and physical activity recommendations may be particularly important, although the likely greater measurement error for assessing diet in combination with low adherence for several of the dietary recommendations may also play a role.

In summary, the AICR recommendations that were operationalized here were found to be associated with cancer incidence (but weaker with cancer mortality) and may have a substantial population impact. The lack of an association with cardiovascular mortality suggests that additional recommendations will need to be integrated. Nevertheless, these data support public policy initiatives to improve diet and diet-related interventions (i.e., weight control and physical activity) to reduce the burden of cancer and other chronic diseases in the population.

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