Does a Vegetarian Diet Reduce the Occurrence of Diabetes?

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Abstract: We propose the hypothesis that a vegetarian diet reduces the risk of developing diabetes. Findings that have generated this hypothesis are from a population of 25,698 adult White Seventh-day Adventists identified in 1960. During 21 years of follow-up, the risk of diabetes as an underlying cause of death in Adventists was approximately one-half the risk for all US Whites. Within the male Adventist population, vegetarians had a substantially lower risk than non-vegetarians of diabetes as an underlying or contributing cause of death. Within both the male and female Adventist populations, the prevalence of self-reported diabetes also was lower in vegetarians than in non-vegetarians. The associations observed between diabetes and meat consumption were apparently not due to confounding by over- or under-weight, other selected dietary factors, or physical activity. All of the associations between meat consumption and diabetes were stronger in males than in females. (*Am J Public Health* 1985; 75:507–512.)

Introduction

We studied a population of 25,698 adult White Seventh-day Adventists identified in 1960. Members of this conservative religious group are encouraged by the church to avoid the consumption of meat, fish, eggs, coffee, alcohol, and tobacco. Approximately 50 per cent of all Adventists consume a lacto-ovo-vegetarian diet—a diet that excludes meat and fish but includes dairy and egg products. During 21 years of follow-up, the rate of diabetes as an underlying cause of death in Adventists was only 45% of the rate for all US Whites (Table 1). This observation suggested to us that some characteristic(s) of the Adventist population, possibly the vegetarian diet advocated by the church, may explain the low risk of diabetes as an underlying cause of death. We report here the results of a preliminary investigation of this hypothesis.

Methods

Data described in this report are for 25,698 White male and female California Adventists who were 30 to 89 years old in 1960. Subjects in this study completed a self-administered questionnaire in 1960 in which they were asked how many days per week they ate meat and poultry and several other foods and beverages. Since red meat and poultry consumption were assessed by the same question, we could not determine whether these foods were related differently to diabetes. The question on meat consumption was answered by 24,673 subjects. The actual number of subjects included in the analyses described in Tables 2 to 6 was smaller than 24,673 because, to be included in these tables, subjects had to have legitimate responses to questions on meat consumption, weight, and height. Subjects also were asked on the questionnaire if they had "ever had diabetes." Information was also obtained on the history of other selected diseases, demographic factors, and other lifestyle characteristics. The self-reported values for height and weight were used to calculate per cent desirable weight using the midpoint of the ranges published in 1959 by the Metropolitan Life Insurance Company.[2] When calculating per cent desirable weight, we assumed that all subjects had a medium frame.

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It may be expected that at least 75 per cent of the diabetics in the age group that we studied have non-insulin-dependent diabetes (most of whom are probably maturity-onset).[3] Thus, the findings in this report are probably more applicable to non-insulin-dependent than to insulin-dependent diabetes.

A medically trained clerk reviewed all death certificates and identified those which mentioned diabetes mellitus as a contributing or underlying cause of death. The underlying cause of death was determined by the state nosologist. All deaths in the Adventist cohort during 1960 to 1980 were identified by computer-assisted record linkage to the California death certificate file.[4,5] The record-linkage procedure utilized a birthplace code (state or area of world), seven components of name, and three components of birth date to identify potential linkages. All potential linkages which did not match exactly on the aforementioned identifiers were manually resolved by clerks. This procedure missed deaths among subjects whose name or other identifiers (used in the linkage) were inaccurate on the California state death certificate file or in our records as well as deaths which occurred outside California.

To assess the quality of the linkage procedure, in 1981 we completed an intense person-by-person follow-up of 600 randomly selected questionnaire respondents (300 males, 300 females). Among the 600 individuals subjected to intensive follow-up, 571 were successfully traced through 1980. Of the 247 deaths identified by intense follow-up, 85 per cent were also identified by record linkage, 7 per cent occurred outside of California, and 8 per cent were California deaths missed by record linkage. The record linkage procedure correctly identified approximately the same proportion of deaths among vegetarians (86.1 per cent) and non-vegetarians (82.5 per cent).

Throughout this report, vegetarians are defined as those individuals whose combined use of meat or poultry is less than one day per week. These vegetarians rarely eat fish, but regularly consume milk, cheese, and eggs. Non-vegetarians were divided into three categories according to their frequency of meat use.

Person-years were used to derive the relative risks for death certificate data in Tables 1–3. Subjects began contributing person-years at the beginning of the study in 1960. Subjects stopped contributing person-years at the earliest of the following dates: 1) the year of their death from any cause; 2) the year of their 89th birthday; or 3) the end of follow-up (i.e., December 31, 1980).

Relative risks and their 95% confidence limits were calculated for the various meat consumption groups using

TABLE 1—Standardized Mortality Ratios (SMR) for Diabetes as an Underlying Cause of Death among Seventh-day Adventists, 1960–1980

Sex and Age	Deaths: Observed[a] (O)	Deaths: Expected[b] (E)	SMR (O/E)	95% Confidence Limits
Males	40	84.5	0.47	0.34,0.64
Females	87	194.7	0.45	0.36,0.55
Total	127	279.2	0.45	0.38,0.54
30–49	4	5.5	0.72	0.20,1.86
50–69	24	70.0	0.34	0.22,0.51
70–89	99	203.7	0.49	0.39,0.59

[a]Since the record linkage procedure that was used to identify deaths in this study identified approximately 85% of all deaths, the observed deaths in this table were derived by multiplying the number of record linkage deaths by 100/85.

[b]The number of expected deaths represent the sum of the products obtained by multiplying the person-years of observation for Adventists in each sex-age (5 year) group by the age- and sex-specific mortality rates for diabetes as an underlying cause of death for the U.S. white population (during each of the four corresponding time periods; 1960–64, 1965–69, 1970–74, 1975–80).[1] Data in this Table are based on 25,698 persons who were known for age and sex.

the methods described by Rothman and Boice.[6] These relative risks were adjusted for age and per cent desirable weight. The adjusted relative risks used in this report were similar to the Mantel-Haenszel estimate of the odds ratio.[6,7] For the adjustment, attained age was stratified into five categories (i.e., 30–49, 50–59, 60–69, 70–79, and 80–89), and per cent desirable weight was stratified into four categories (i.e., 70–89, 90–109, 110–129, and 130+ per cent desirable weight). The two youngest age decades (i.e., 30–39, 40–49) were combined to maximize the small number of disease events in that age range. A trend statistic was used to test for linear trends in risk across exposure categories.[8] All p-values reported are two-tailed.

Risk estimates that were adjusted by age and per cent desirable weight also were obtained by comparing ratios of observed to expected deaths. For each age and weight strata, expected deaths were obtained by distributing the total observed deaths in direct proportion to the person-years experienced by the respective meat consumption groups. For each meat consumption group, the observed and expected deaths were then summed over all age-weight strata. A similar procedure was used to obtain ratios of observed to expected prevalent cases (i.e., counts of individual were used rather than person-years). Since risk estimates derived by these methods were comparable to those obtained by the Mantel-Haenszel technique, only the Mantel-Haenszel relative risks are presented in this report.

Multivariate analyses were also done using the logistic regression model[9] which allowed us to make the multivariate results for prevalence and mortality comparable. For the mortality data, the following variables were included simultaneously in the logistic regression: frequency of use of meat, eggs, milk, fruit, sweet desserts, candy, and soft drinks, and per cent desirable weight, and age in 1960. Since physical activity (at home or work) was not available for females, it was included in the model for the males only. For prevalence data, the regression model did not include fruit, sweet desserts, candy, and soft drinks because these foods are almost always excluded from the diet recommended to diabetics. Thus, the possibility that they predict diabetes cannot be assessed with 1960 prevalence data. Exclusion of these foods resulted in a slightly more conservative estimate of the strength of the association between meat consumption and diabetes prevalence.

All exposure variables included in the logistic regression were partitioned into several binary terms (coded as zero or one) to accommodate their possible non-linear relation to risk. Two binary terms were used for milk (1–2 glasses/day, 3+ glasses/day), soft drinks (daily, occasional but less than daily), sweet desserts and candy (1–2 days/wk, 3+ days/wk), fruit (5–6 days/wk, <5 days/wk), and physical activity ("heavy", "moderate"). Three binary terms were used for meat and eggs (1–2 days/wk, 3–5 days/wk, 6+ days/wk). Four binary terms were used for per cent desirable weight (110–119, 120–129, 130–139, 140+) and age in 1960 (30–49, 50–59, 60–69, 70–79). The reference categories were <1 glass/day for milk, "none" for soft drinks, <1 day/wk for sweet desserts and candy, "daily" for fruit, "none" or "slight" for exercise, <1 day/wk for meat and eggs, 70–109 for per cent desirable weight, and 80–89 for age. Subjects in the reference group were characterized in the logistic model by a code of zero for each relevant binary term (e.g., subjects who did not consume soft drinks had a code of zero for the two soft drink terms.) There were slightly fewer deaths in the logistic regression analyses than in the previ-

TABLE 2—Meat Consumption and the Relative Risk of any Mention of Diabetes on the Death Certificate (1960–1980)[a]

Meat Consumption	Relative Risk Adjusted for Age and Per Cent Desirable Weight (95% CL)[b]: Male	Relative Risk Adjusted for Age and Per Cent Desirable Weight (95% CL)[b]: Female	Deaths: Males	Deaths: Females	Person-Years[c]: Males	Person-Years[c]: Females
<1 day/wk (vegetarian)	1.0	1.0	38	96	79835	134008
1+ day/wk (non-vegetarian)	1.8(1.2,2.8)	1.1(0.8,1.5)	55	89	67983	127511
<1 day/wk	1.0	1.0	38	96	79835	134008
1–2 days/wk	1.4(0.8,2.4)	1.2(0.9,1.7)	20	45	30317	49111
3–5 days/wk	1.4(0.8,2.6)	1.2(0.8,1.8)	16	33	25024	51168
6+ days/wk	3.8(2.2,6.4)	0.7(0.4,1.3)	19	11	12642	27232
	Trend p < 0.001	Trend p = 0.90				

[a]Subjects with a history of diabetes at the beginning of the study in 1960 were eliminated from these analyses.

[b]The reference category for each risk estimate is the group of vegetarians—those consuming meat less than one day per week. CL denotes confidence limits.

[c]The number of subjects in each meat consumption group can be derived from the data in Table 4.

TABLE 3—Relative Risk of any Mention of Diabetes on the Death Certificate (1960–1980) for Non-Vegetarians Compared to Vegetarians among Subjects in Different Categories of Per Cent Desirable Weight[a]

Per Cent Desirable Weight	Age-Adjusted Relative Risk for Non-vegetarians Compared to Vegetarians (95% CL)[b]		Deaths (non-veg/veg)[c]		Person-Years (non-veg/veg)[d]	
	Male	Female	Male	Female	Male	Female
70–89	e	e	0/1	0/2	2208/5849	7028/12068
90–109	1.4(0.5,4.0)	1.5(0.8,2.9)	6/10	15/20	25058/36438	57975/64691
110–129	2.1(1.2,3.6)	1.3(0.8,2.2)	30/18	29/31	32844/32581	41135/41840
130+	1.7(0.7,3.8)	0.9(0.6,1.4)	19/9	45/43	7873/4967	21373/15409

[a,b]See Table 2 for explanations.
[c]Non-Veg denotes the non-vegetarians and Veg denotes the vegetarians.
[d]The number of subjects in each meat consumption group can be derived from the data in Table 5.
[e]Relative risk could not be calculated because of insufficient data.

ously described stratified analyses because logistic analyses required that all subjects have legitimate values for all variables in the model. Furthermore, the Walker-Duncan type of logistic analyses that we used required there to be one or more deaths in each exposure category. Therefore, we had to combine the 70 to 89 and the 90 to 109 per cent desirable weight cateogries.

Results

Per cent desirable weight had a positive association with self-reported diabetes prevalence and any mention of diabetes on the death certificate. For these analyses, the 90 to 109 per cent desirable weight category acted as the reference group and necessarily had a relative risk (or prevalence ratio) equal to 1.0. The age- and sex-adjusted diabetes prevalence ratios (and their 95 per cent confidence limits) were 0.6 (0.2, 1.4) for the 70–89 per cent desirable weight category, 1.2 (0.9, 1.5) for the 110–129 category, and 2.0 (1.6, 2.6) for the 130+ category. Among subjects without a self-reported history of diabetes at the beginning of the study, the age- and sex-adjusted relative risks for any mention of diabetes on the death certificate were 0.3 (0.04, 2.1) for the 70–89 per cent desirable weight category, 3.1 (1.8, 5.3) for the 110–129 cateogry, and 7.1 (5.3, 9.5) for the 130+ category. Risk of any mention of diabetes on the death certificate is a reflection of the probability of death from any cause in the total population enrolled at the beginning of the study, and the probability that diabetes is mentioned on the death certificate.

Overweight (130+ per cent desirable weight) also was related to vegetarian/non-vegetarian status. Compared to vegetarians, the age-adjusted prevalence ratio of overweight in non-vegetarians was 1.9 (1.6, 2.1) among males and 1.6 (1.4, 1.7) among females. Because of the observed relation between overweight and diabetes and the clear excess of overweight people in the non-vegetarians compared to vegetarians, we adjusted all associations between meat consumption and diabetes by per cent desirable weight. We also examined associations between meat consumption and diabetes within categories of per cent desirable weight.

Table 2 presents data on the relation between the vegetarian diet and any mention of diabetes on the death certificate after adjusting for age and per cent desirable weight. These and all other death certificate analyses (except Table 1) were done on subjects who did not report a history of diabetes at the beginning of the study. Among males, there was a moderately strong positive association between meat consumption and any mention of diabetes on the death certificate. Among females, there was essentially no association between meat consumption and diabetes on the death certificate. The relative risks were slightly larger when they were adjusted for age alone. Compared with vegetarians, the relative risk of diabetes on the death certificate, adjusted only for age, was 2.2 (1.5, 3.4) for male non-vegetarians and 1.4 (1.0, 1.9) for female non-vegetarians.

TABLE 4—Meat Consumption and the Prevalence Ratio of Self-Reported Diabetes in 1960

Meat Consumption	Prevalence Ratio Adjusted for Age and Per Cent Desirable Weight (95% CL)[a]		Number of Self-Reported Diabetics		Number at Risk	
	Male	Female	Male	Female	Male	Female
<1 days/wk (vegetarian)	1.0	1.0	61	136	4504	7489
1+ days/wk (non-vegetarian)	1.8(1.3,2.5)	1.4(1.2,1.8)	82	155	3791	6848
<1 days/wk	1.0	1.0	61	136	4504	7489
1–2 days/wk	1.3(1.0,1.8)	1.1(0.9,1.2)	32	53	1699	2680
3–5 days/wk	1.5(1.0,2.3)	1.1(0.9,1.2)	25	49	1378	2694
6+ days/wk	2.4(1.7,3.4)	2.1(1.6,2.7)	25	53	714	1474
	Trend $p < 0.001$	Trend $p < 0.001$				

[a]The reference category for each risk estimate is the group of vegetarians—those consuming meat less than one day per week. CL denotes confidence limits.

TABLE 5—Prevalence Ratio of Self-Reported Diabetes in 1960 for Non-Vegetarians Compared to Vegetarians in Different Categories of Per Cent Desirable Weight

Per Cent Desirable Weight	Age-Adjusted Prevalence Ratio for Non-vegetarians Compared to Vegetarians (95% CL)[a]		Number of Self-Reported Diabetics (Non-Veg/Veg)[b]		Number at Risk (Non-Veg/Veg)	
	Males	Females	Males	Females	Males	Females
70–89	3.8(1.0,13.9)	3.1(1.3,7.6)	5/3	9/7	142/365	398/746
90–109	1.7(1.1,2.8)	1.5(1.0,2.2)	28/29	45/47	1382/2070	3023/3515
110–129	2.1(1.3,3.6)	1.2(0.8,1.8)	42/24	43/49	1831/1795	2211/2336
130+	1.0(0.5,1.9)	1.5(1.0,2.3)	7/5	58/33	436/274	1216/892

[a]See Table 4 for explanation.

[b]Non-Veg denotes the non-vegetarians and Veg denotes the vegetarians.

Table 3 shows that the elevated relative risk of diabetes on the death certificate for non-vegetarians compared with vegetarians persists among subgroups defined by per cent desirable weight. These findings suggest that per cent desirable weight does not materially modify the relation between vegetarian/non-vegetarian status and diabetes on the death certificate.

Table 4 presents data on meat consumption and self-reported diabetes prevalence after adjusting for age and per cent desirable weight. There was a moderately strong positive association between meat consumption and diabetes prevalence in both men and women. The prevalence ratios were slightly larger when they were adjusted for age alone. Compared with vegetarians, the prevalence ratio for diabetes, adjusted only for age, was 1.9 (1.4, 2.6) for male non-vegetarians and 1.6 (1.3, 2.0) for female non-vegetarians.

Diabetes prevalence ratios for non-vegetarians compared with vegetarians are presented in Table 5 for subgroups defined by per cent desirable weight. Although the relation between the non-vegetarian diet and diabetes prevalence appears strongest among the underweight group, this finding was based on a relatively small number of diabetic cases. Overall, per cent desirable weight did not appear to modify substantially the relation between vegetarian/non-vegetarian status and diabetes prevalence.

Table 6 presents data from logistic regression analyses that related meat and other factors to any mention of diabetes on the death certificate as well as self-reported diabetes prevalence. In these analyses, several dietary and non-dietary variables were included simultaneously in the logistic model. The findings from the logistic regression analyses were similar to the results previously described: the association between meat consumption and diabetes on the death certificate was moderately strong in men and essentially absent in women. Positive associations between meat consumption and self-reported diabetes prevalence were observed among both males and females.

Discussion

These data support the hypothesis that a vegetarian diet reduces the risk of developing diabetes. The crude measures of diabetes occurrence, from death certificates and reports of diabetes on self-administered questionnaires, must be interpreted cautiously, because many death certificates do not mention diabetes when in fact diagnosed or undiagnosed diabetes was present at the time of death. Furthermore, for every known diabetic, there may be one to five undiagnosed diabetics—depending on the characteristics of the population and the diagnostic criteria.[3]

In this study, meat consumption was positively associated with self-reported diabetes prevalence in both males and females. Meat consumption also was positively associated with mention of diabetes on the death certificate in males, but not in females. In the same Adventist population, meat consumption also was positively associated with ischemic heart disease mortality.[10,11] Similar to our findings on diabetes, ischemic heart disease mortality had a stronger relation to meat consumption among males than females. Thus, it is possible that a relation between meat consumption and diabetes or blood glucose might partially explain the associations between meat and ischemic heart disease observed in Adventists. On the other hand, the relation between meat consumption and mention of diabetes on the death certificate might be an artifact of the association between meat consumption and ischemic heart disease mortality. That is, diabetes may be more likely to be reported on a death

TABLE 6—The Association of Meat Consumption with Diabetes Based on Logistic Regression Analyses[a]

Outcome	Meat Consumption	Multivariate-Adjusted Relative Risk (95% CL)[b]	
		Male	Female
Self-Reported Diabetes Prevalence (1960)	<1 day/wk (vegetarian)	1.0	1.0
	1+ days/wk (non-vegetarian)	1.7(1.2,2.4)	1.4(1.1,1.8)
	<1 day/wk	1.0	1.0
	1–2 days/wk	1.4(0.9,2.3)	1.1(0.8,1.6)
	3–5 days/wk	1.5(0.9,2.5)	1.2(0.9,1.8)
	6+ days/wk	2.7(1.6,4.6)	2.3(1.6,3.3)
Diabetes on the Death Certificate (1960–1980)	<1 day/wk (vegetarian)	1.0	1.0
	1+ days/wk (non-vegetarian)	1.9(1.2,3.1)	1.1(0.8,1.6)
	1 day/wk	1.0	1.0
	1–2 days/wk	1.6(0.9,2.9)	1.3(0.9,2.0)
	3–5 days/wk	1.6(0.8,3.0)	1.2(0.7,1.8)
	6+ days/wk	3.6(1.9,7.1)	0.6(0.3,1.2)

[a]The number of diabetes events and the population at risk are slightly smaller than previous tables because subjects had to have legitimate responses to all the variables included in the regression model. Like Tables 2 and 3, the death certificate analyses in this table were limited to those subjects who did not report a history of diabetes at the beginning of the study in 1960.

[b]For prevalence data, the regression model included age, per cent desirable weight, physical activity (for males only), and frequency of use of meat, eggs, and milk. For death certificate data, the regression model included these same variables plus frequency of use of fruit, sweet desserts, candy, and soft drinks. A complete description of the terms included in the models and the rationale for the inclusion of less terms in the model for prevalence data can be found in the methods section. The "relative risk" estimates for the prevalence data should be interpreted as prevalence ratios. The reference category for each relative risk is the group of vegetarians. CL denotes confidence limits.

certificate if a diabetic dies as a result of an atherosclerotic disease than if a diabetic dies as a result of a non-atherosclerotic disease.

The lower frequency, among male vegetarians, of death certificates with any mention of diabetes also may be influenced by the lower overall mortality rate in the vegetarians. If vegetarians survived longer than non-vegetarians, this alone could cause the vegetarians to have a lower frequency of deaths during the follow-up period, and, as a result, a lower frequency of death certificates with mention of diabetes. However, among males without a history of diabetes at the beginning of the study, the age-adjusted relative risk of death from all causes combined was only 1.3 (1.2, 1.4) in non-vegetarians compared to vegetarians. Among the same males, the age-adjusted relative risk of diabetes on the death certificate was 2.2 (1.5, 3.4) in non-vegetarians compared with vegetarians. Thus, the slight excess risk of total mortality in non-vegetarians could only explain a small proportion of the excess frequency in non-vegetarians of death certificates with mention of diabetes. These data on total mortality also strengthen the evidence from the prevalence data which favor our hypothesis. Given the apparent longer life expectancy of vegetarians, prevalent diabetic cases should accumulate at a higher rate in vegetarians than non-vegetarians. Despite this possible accumulation of cases among vegetarians, the prevalence of diabetes was lower in vegetarians than non-vegetarians. This finding suggests that the rate of development of new diabetic cases is lower in vegetarians than in non-vegetarians.

The death certificate findings in this study also may have been influenced by changes in meat consumption habits during the 21-year follow-up period. The consistency of meat consumption habits over the 21-year follow-up period was tested in 7,012 subjects who were age 30 to 74 in 1960. In a different study, these subjects completed another questionnaire in 1976.[12] These preliminary data suggest that meat consumption generally declined during the follow-up period, while the vegetarian habit remained relatively stable. Approximately 88 per cent of the vegetarians in 1960 reported using that diet in 1976. Subjects with a high meat consumption in 1960 were most likely to continue to report meat use in 1976. Approximately 83 per cent of the group that ate meat 6+ days per week in 1960 also reported meat use (at least one day or more per week) in 1976, while the percentages were 72 per cent for the 3–5 days per week group and 49 per cent for the 1–2 days per week group. However, the probable decline in meat consumption throughout the follow-up period is not an explanation of our findings because it should increase the difficulty of detecting associations between meat consumption and disease that may actually exist in the Adventist population.

Findings on diabetes prevalence also may have been influenced by changes in meat consumption habits that occurred after diabetes was diagnosed. In 1960, when diabetes prevalence was assessed, the dietary treatment for diabetes may have increased the intake of protein and fat as a natural consequence of decreasing the intake of carbohydrates. However, since Adventists avoid the consumption of meat for health and spiritual reasons, it is difficult to envision a significant proportion of Adventist vegetarians switching to a non-vegetarian diet after a diagnosis of diabetes was made. Furthermore, in males, the moderately-strong positive association between meat consumption and diabetes on the death certificate was observed among subjects who did not report a history of diabetes at the beginning of the study. Thus, their reported dietary habits were not influenced by the knowledge that they had diabetes.

Over- or under-weight, other selected dietary factors, and physical activity do not appear to explain the relation between meat consumption and diabetes as indicated by the results of our multivariate analyses in Table 6. Furthermore, results from stratified analyses in Tables 2 to 5 also suggest that over- and under-weight do not explain the relation between meat consumption and diabetes. Since weight was determined only at the beginning of the study, however, we could not control for weight change over the 21-year follow-up period. It is conceivable that the meat eaters may have gained more weight than the vegetarians during the 21 years. However, weight gain during follow-up would not explain our findings on meat and diabetes prevalence since weight, meat, and diabetes prevalence were all measured simultaneously at the beginning of the study.

We do not have the data necessary to rule out the possibility that genetic or familial factors explain our findings on meat consumption and diabetes. However, it is difficult to envision that subjects with a family history of diabetes would choose a high meat diet more often than subjects without a family history. Nevertheless, other unknown dietary or non-dietary factors that are correlated with meat consumption in Adventists may explain our findings.

The positive associations observed in this study between the non-vegetarian diet and diabetes may be due to the meat or saturated fats eaten by the non-vegetarians. Meat consumption tends to parallel saturated fat consumption in Adventists.[13,14] West has observed that diabetes is very common in beef-eating populations.[3] Furthermore, meat consumption has shown positive associations with blood glucose in two studies.[15,16] In a study conducted by West in 11 countries, animal fat consumption in individuals was positively associated with diabetes prevalence.[17] Serum cholesterol in individuals also had a positive association with blood glucose in the same study. The relation between serum cholesterol and blood glucose was stronger and more consistent in the males than in the females—much like the stronger associations between meat and diabetes observed among the males in our study. Serum cholesterol has been shown to be positively associated with meat consumption in Seventh-day Adventists.[13]

The possibility that meat or saturated fat intake is related to diabetes is strengthened by the existence of several plausible pathophysiological mechanisms: 1) Saturated fat consumption may increase insulin secretion, and possibly lead to insulin insensitivity[18]; 2) Saturated fat intake may alter fecal microbial enzyme activity and steroid production which might increase the synthesis of estrogens which could impair insulin sensitivity[19]; and 3) N-nitroso compounds in meat may act as diabetogenic agents since N-nitroso compounds, such as streptozotocin (a nitrosamide), can induce diabetes in laboratory animals.[20]

It is also possible that some component of the non-vegetarian diet, other than meat, may relate to the risk of developing diabetes. Non-vegetarians are known to have a lower consumption than vegetarians of foods high in dietary fiber and complex carbohydrates (e.g., beans, legumes, whole grain bread, and fruit).[21] Compared with the high-fiber and high-complex-carbohydrate diet (typical for vegetarians), the low-fiber and low-complex-carbohydrate diet (typical for non-vegetarians) may unfavorably affect glucose tolerance,[22] insulin requirements in diabetics,[22,23] and risk of diabetes mortality.[24]

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Applications Available for ANF Nursing Research Grants

Applications for the 1985 American Nurses' Foundation (ANF) Competitive Extramural Grants Program are available as of March 1. The program supports nursing research directed by a registered nurse and is designed primarily for beginning nurse researchers. Consideration will also be given to experienced nurse researchers entering a new area of investigation. Since the program began in 1955, ANF has awarded grants totaling more than $1 million to over 200 nurse researchers. In 1985 the foundation expects to fund approximately 30 grants for a maximum amount of $2,500 each.

The program is supported by corporate contributions made to ANF and by individual contributions made to the foundation by the over 3,000 members of the ANF Century Club. To date, the foundation has recieved commitments from seven organizations. The American Organization of Nurse Executives, The Max and Victoria Dreyfus Foundation, Inc., and the Burroughs Wellcome Fund have each made contributions to sponsor one 1985 grant each and *Nursing '85* has contributed funds for two grants in their name. In addition, Allstate Foundation, C. V. Mosby, Inc., and Deluxe Check Printers, Inc., are co-sponsoring a grant to be named on behalf of the 1985 Distinguished Contribution to Nursing Science Award recipient.

The application deadline is July 1, 1985. Awards, to be announced October 1, 1985, are for one year. Application kits are available from the ANF Center for Research, 2420 Pershing Road, Kansas City, MO 64108, 816/474-5720.