American Journal of Epidemiology
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Vol. 150, No. 2
Printed in U.S.A.

Nutrient Intake and Use of Beverages and the Risk of Kidney Stones among Male Smokers

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High intakes of calcium, potassium, and fluids have been shown to be associated with lowered risk of kidney stones. The authors studied the associations between diet and risk of kidney stones in a cohort of 27,001 Finnish male smokers aged 50–69 years who were initially free of kidney stones. All men participated in the Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study and completed a validated dietary questionnaire at baseline. After 5 years of follow-up (1985–1988), 329 men had been diagnosed with kidney stones. After data were controlled for possible confounders, the relative risk of kidney stones for men in the highest quartile of magnesium intake was 0.52 (95% confidence interval (CI) 0.32–0.85) as compared with men in the lowest quartile. Intake of fiber was directly associated with risk (relative risk (RR) = 2.06, 95% CI 1.39–3.03). Calcium intake was not associated with the risk of kidney stones. Beer consumption was inversely associated with risk of kidney stones; each bottle of beer consumed per day was estimated to reduce risk by 40% (RR = 0.60, 95% CI 0.47–0.76). In conclusion, the authors observed that magnesium intake and beer consumption were inversely associated and fiber intake was directly associated with risk of kidney stones. *Am J Epidemiol* 1999; 150:187–94.

beer; beverages; diet; dietary fiber; drinking; kidney calculi; magnesium; smoking

Urolithiasis is a common urinary tract disease in Western societies. It is a very painful medical condition that entails considerable costs. The traditional prescription for kidney stone patients has been a low calcium diet, based on the facts that calcium is the main constituent of kidney stones and that hypercalciuria is a well known risk factor for kidney stones. However, a high calcium intake has been found to be protective against kidney stones in two prospective cohort studies (1, 2).

Fluid intake has traditionally been central in both the treatment and the prevention of urolithiasis. A high water intake is beneficial, because it makes the urine more dilute. However, the role of different sources of fluids is largely unknown. There are both observational (3) and experimental (4) data suggesting that the incidence of kidney stones could be decreased by limiting soft drink consumption.

Only two cohort studies have investigated the association between type of beverage and risk of urolithiasis. In a study of US males (5), apple juice and grapefruit juice were directly associated with the risk of urolithiasis, whereas total fluid intake and consumption of coffee (both caffeinated and decaffeinated), tea, beer, and wine were inversely associated with the risk of urolithiasis. In a study of US women (6), there was also an inverse association between fluid intake and risk of kidney stones. As among men, coffee, wine, and tea were found to be protective, whereas beer consumption was not related to the risk of kidney stones. Consumption of grapefruit juice was found to increase the risk of kidney stones.

MATERIALS AND METHODS

The Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study

The Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study (hereafter called the ATBC Study) was a randomized, double-blind, placebo-controlled primary prevention trial undertaken to determine whether supplementation with α-tocopherol, β-carotene, or both would reduce the incidence of lung cancer in male smokers. The rationale, design, and methods of the study, as well as the characteristics of

Received for publication April 7, 1998, and accepted for publication November 20, 1998.

Abbreviations: ATBC, Alpha-Tocopherol, Beta-Carotene [Lung Cancer Prevention Study]; CI, confidence interval; RR, relative risk.

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the participants, have been previously described in detail (7).

Participants in the ATBC Study were male smokers recruited from the total male population aged 50–69 years in southwestern Finland (n = 290,406) in 1985–1988. To be eligible, the men had to smoke at least five cigarettes per day at study entry and provide written informed consent. The exclusion criteria included a history of cancer or other serious disease limiting long term participation; use of vitamin E, vitamin A, or β-carotene supplements in excess of predefined doses; and treatment with anticoagulant agents.

After these exclusions, 29,133 men were randomized into one of four dietary supplementation regimens: α-tocopherol alone (daily dose of 50 mg), β-carotene alone (20 mg), α-tocopherol and β-carotene, or placebo. Follow-up continued for 5–8 years (median, 6.1 years).

Diet was assessed at baseline using a self-administered, modified diet history method (8). This questionnaire was satisfactorily completed by 27,111 participants (93 percent). In addition, 110 men at baseline reported a history of kidney stones. Thus, 27,001 men were included in the present analyses.

Baseline measurements

At baseline, the men provided information on general background characteristics and on their medical and smoking histories. The frequency of leisure time physical activity (at least slightly strenuous activity for a minimum of 30 minutes at a time) was categorized as less than once per week, once or twice per week, and three or more times per week. Height and weight were measured, and body mass index was calculated as weight in kilograms divided by height in meters squared.

Dietary assessment

The diet questionnaire included 276 food items and mixed dishes and a portion-size picture booklet of 122 photographs of foods, each with 3–5 different portion sizes. Each subject was asked to report the usual frequency of consumption and the usual portion size of foods consumed during the previous 12 months. The frequencies were reported as number of times per month, week, or day. At the first visit, the questionnaire and picture booklet were given to the subject to be completed at home. At the second baseline visit 2 weeks later, the questionnaire was returned, and a nurse checked and completed it, spending on average 30 minutes interviewing the participant about possible discrepancies.

The food consumption data were translated into daily nutrient intake values using the software at the National Public Health Institute (Helsinki, Finland) and the food composition database, which is mainly based on Finnish analyses of foods. Water intake was based on the water content of all foods and drinks (soups, milk, coffee, etc.) other than water per se, since drinking water was not included in the questionnaire.

The dietary method was validated in a pilot study carried out among 190 men prior to the ATBC Study (8). The men completed the questionnaire first and then kept 24 days of food records spread out over 6 months as the reference method. They filled in the questionnaire again at the end of the pilot study. The energy-adjusted correlations between the first and second dietary questionnaires and the food records were 0.80 and 0.81 for alcohol, 0.72 and 0.73 for fiber, 0.57 and 0.68 for potassium, 0.68 and 0.66 for calcium, and 0.57 and 0.67 for magnesium.

Follow-up and case ascertainment

The men had follow-up visits three times per year. At these visits, they reported whether they had contacted a physician since the previous visit, and the reason for this. Whenever a man reported a physician-diagnosed kidney stone for the first time, he was considered a case.

Statistical analysis

The participants contributed follow-up time from the date of randomization to the endpoint or their last follow-up visit. Men were grouped into quartiles of energy-adjusted intakes of nutrients, as calculated from the food consumption data. All nutrient intakes were log-transformed before energy adjustment, which was done by the regression residual method (9). Water and alcohol intakes were not energy-adjusted.

Proportional hazards models were used to estimate the relative risks of kidney stones (and 95 percent confidence intervals) associated with intakes of nutrients, with simultaneous adjustment for age and supplementation group first and then adjustment for marital status, vocational training, and magnesium, fiber, and alcohol intakes. Models for beverage use were first adjusted for age and supplementation group and then for marital status, vocational training, and magnesium and fiber intakes. These covariates were chosen in two steps. First, we fitted a model that included all variables considered to be related to formation of kidney stones (age, education, marital status, body mass index, leisure time physical activity, smoking, and intakes of water, alcohol, protein, animal protein, dietary fiber, calcium, magnesium, phosphorus, potassium, vitamin C, vitamin B_6, and vitamin D). Second, we eliminated all nonsignificant variables one by one (backward stepwise regression). Tests for linearity of trend were done by treating the energy-adjusted nutrient intakes as continuous variables in the proportional hazards model. All p values cited are two-tailed. The χ^2 test was used to test the significance of the distributions of data on background factors.

RESULTS

During the 128,170 years of follow-up, there were 329 cases of kidney stones. The background characteristics of cases and noncases are shown in table 1. Kidney stone cases had more vocational training than noncases (72 percent vs. 62 percent) and were more often married (88 percent vs. 81 percent). There were no other statistically significant differences in the background factors between cases and noncases.

Many of the nutrient intakes correlated highly with each other (table 2). The largest correlation coefficients were those for correlations between protein and phosphorus (r = 0.80), calcium and phosphorus (r = 0.77), magnesium and potassium (r = 0.74), potassium and vitamin B_6 (r = 0.68), phosphorus and potassium (r = 0.64), and magnesium and phosphorus (r = 0.64).

Water intake was inversely associated with the risk of kidney stones when data were adjusted for age and supplementation group: The relative risk in the highest quartile as compared with the lowest was 0.66 (95 percent confidence interval (CI) 0.48–0.91; p for trend = 0.02) (table 3). However, in the multivariate model, the inverse association disappeared.

A higher intake of alcohol was strongly associated with a reduced risk of kidney stones (table 3). In the multivariate model adjusting for age, supplementation group, marital status, vocational training, and magnesium and fiber intakes, the relative risk of kidney stones was 0.51 (95 percent CI 0.36–0.72; p for trend = 0.0001) for the highest quartile of alcohol intake compared with the lowest quartile. However, after data were controlled for beer consumption, the association with the risk of kidney stones was attenuated: The relative risk in the highest quartile compared with the lowest was 0.74 (95 percent CI 0.49–1.12; p for trend = 0.34).

Magnesium intake was also inversely associated with the risk of kidney stones. After multivariate adjustment, the relative risk of kidney stones for men in the highest quartile as compared with the lowest was 0.52 (95 percent CI 0.32–0.85; p for trend = 0.0001). Further adjustment for potassium intake had no effect on the relative risk (RR = 0.51, 95 percent CI 0.32–0.84; p for trend = 0.0001).

A high intake of potassium was also associated with a lower incidence of kidney stones in the multivariate model (adjusted for age, supplementation group, vocational training, marital status, and fiber and alcohol intakes) before adjustment for magnesium intake (highest quartile vs. lowest: RR = 0.56, 95 percent CI 0.41–0.77; p for trend = 0.004), but after adjustment for magnesium intake, the association diminished and became nonsignificant (RR = 0.79, 95 percent CI 0.52–1.19; p for trend = 0.34).

In contrast, intake of dietary fiber was directly associated with the risk of kidney stones. Adjusting for background factors, the relative risk of kidney stones for men in the highest quartile as compared with the lowest was 2.06 (95 percent CI 1.39–3.03; p for trend = 0.001). The risk of kidney stones was significantly

TABLE 1. Characteristics (%) of the study population, Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study, 1985–1993

Characteristic	No kidney stones (n = 26,672)	Kidney stone cases (n = 329)	p value*
Age (years)			
<55	35.6	40.1	
55–59	32.2	31.7	
60–64	22.1	18.1	
>64	10.1	10.1	0.35
Basic education			
Elementary school or less	78.3	78.4	
High school or less	15.7	16.8	
Graduate examination	6.0	4.7	0.70
Vocational training			
No training	33.6	23.5	
Vocational training	62.0	71.9	
University degree	4.4	4.7	0.001
Marital status			
Not married	19.0	11.6	
Married	81.0	88.4	0.006
Body mass index†			
<20	3.2	1.5	
20–25	35.5	38.4	
26–30	46.1	48.0	
31–35	13.2	11.0	
>35	2.0	1.2	0.22
Frequency of leisure-time physical activity (no. of times/week)			
≥3	19.6	19.3	
1–2	28.7	30.1	
<1	51.7	50.7	0.90
No. of cigarettes smoked per day			
<15	22.6	27.5	
15–29	60.4	60.3	
>29	17.1	12.2	0.09

* χ^2 test for difference between cases and other participants.
† Weight (kg)/height (m)^2.

TABLE 2. Pearson correlation coefficients for daily nutrient intakes,* Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study, 1985–1993

Variable	Water	Alcohol	Protein	Fiber	Calcium	Magnesium	Phosphorus	Potassium	Vitamin C	Vitamin B_6	Vitamin D
Water	1.00	0.27	0.10	−0.08	0.19	0.35	0.23	0.36	0.11	0.13	0.01
Alcohol		1.00	−0.31	−0.32	−0.21	−0.14	−0.24	−0.27	−0.16	−0.13	0.03
Protein			1.00	0.12	0.59	0.34	0.80	0.54	0.25	0.53	0.31
Fiber				1.00	−0.11	0.63	0.29	0.37	0.32	0.41	0.01
Calcium					1.00	0.22	0.77	0.42	0.09	0.01	−0.06
Magnesium						1.00	0.64	0.74	0.20	0.44	0.02
Phosphorus							1.00	0.64	0.13	0.37	0.09
Potassium								1.00	0.47	0.68	0.11
Vitamin C									1.00	0.50	0.16
Vitamin B_6										1.00	0.37
Vitamin D											1.00

* Intakes of all nutrients except water and alcohol were energy-adjusted.

lower in the highest quartile of animal protein intake, but the trend was not statistically significant. Intakes of protein, calcium, phosphorus, vitamin C, vitamin B_6, and vitamin D were not associated with the risk of kidney stones (table 3).

The distribution of beverages consumed is shown in table 4. The majority of men drank coffee daily. Most of the alcohol consumed was in the form of either spirits or beer, with wine drinking being much less common. Fruit juice consumption was uncommon.

Consumption of beer was associated with a decreased risk of kidney stones. In the multivariate model, for each bottle of beer consumed per day, the risk of kidney stones was reduced by 40 percent (RR = 0.60, 95 percent CI 0.47–0.76) (table 5). After further adjustment for total alcohol intake, the relative risk was 0.66 (95 percent CI 0.49–0.88) for each bottle of beer consumed per day. Other beverages did not have significant associations with the risk of kidney stones in any of the models (model including alcohol not shown).

DISCUSSION

In this large cohort of older men, we observed a significant inverse association between magnesium intake and the risk of kidney stones, whereas fiber intake was directly associated with risk. Intakes of calcium and water were not associated with the risk of kidney stones. Both alcohol consumption and beer consumption were associated with a lower risk of kidney stones, but when both factors were included in the multivariate model simultaneously, only beer consumption retained its significance.

The protective effect of magnesium is biologically plausible, because magnesium binds to intestinal oxalate, lowers the urinary saturation of calcium oxalate, and increases urinary citrate level in animal studies (10). In humans, magnesium has also been shown to decrease urinary oxalate level and the incidence of kidney stone recurrence (11, 12). In addition, it has been found that kidney stone patients have lower urinary magnesium levels than controls (13). However, there have been intervention studies in which magnesium did not have any beneficial effects (14, 15). Furthermore, previous cohort studies have not found magnesium to be protective (4, 5).

Two previous cohort studies (1, 2) have found an inverse association between calcium intake and risk of kidney stones. We found no association with calcium. This could have been due to a much higher calcium intake in our study (mean intake = 1,340 mg/day). In the previous studies (1, 2), most participants' calcium intake was less than 1,000 mg/day. It is possible that with very high intake levels (1,000 mg/day), there is enough calcium to bind oxalic acid. Increasing calcium intake from this level does not seem to add to the protection.

The role of dietary fiber in kidney stone formation is controversial. Fiber is known to bind calcium (16). Therefore, with high fiber intake there is less calcium available in the intestine. This could have two kinds of consequences. On one hand, decreased calcium absorption reduces urinary calcium excretion and therefore inhibits kidney stone formation. On the other hand, since there is less calcium in the intestine for binding oxalic acid, absorption of oxalic acid increases, resulting in kidney stone formation. In intervention studies (17–20), fiber treatment decreased calcium excretion and increased oxalic acid excretion. In addition, foods with a high fiber content usually also contain high amounts of oxalic acid; for example, the oxalic acid content of wheat bran is 240 mg/100 g (20).

In a recent intervention study (21), 99 patients with calcium oxalate kidney stones were assigned either to an intervention group with a diet high in fiber, low in animal protein, and high in fluid or to a control group whose subjects were instructed only on fluid intake

TABLE 3. Relative risk of kidney stones by quartile of daily nutrient intake, Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study, 1985–1993

Nutrient and quartile	Median intake	Age-adjusted RR†,‡	95% CI†	Multivariate RR§	95% CI
Water* (g)					
1	2,000	1.00		1.00	
2	2,400	0.86	0.64–1.16	0.98	0.72–1.32
3	2,700	0.90	0.67–1.20	1.12	0.82–1.52
4	3,100	0.66	0.48–0.91	0.95	0.67–1.35
p for trend		0.02		0.97	
Alcohol (g)					
1	0.4	1.00		1.00	
2	6.3	0.94	0.72–1.25	0.92	0.70–1.22
3	17.4	0.77	0.57–1.03	0.76	0.56–1.02
4	39.3	0.49	0.35–0.69	0.51	0.36–0.72
p for trend		0.0001		0.0001	
Protein (g)					
1	84	1.00		1.00	
2	97	0.97	0.72–1.31	0.96	0.71–1.30
3	105	0.97	0.72–1.31	0.96	0.71–1.31
4	116	0.75	0.55–1.04	0.78	0.55–1.10
p for trend		0.11		0.19	
Animal protein					
1	53	1.00		1.00	
2	66	0.80	0.60–1.08	0.85	0.63–1.13
3	76	0.86	0.65–1.15	0.94	0.70–1.26
4	90	0.59	0.43–0.81	0.69	0.49–0.97
p for trend		0.011		0.15	
Dietary fiber (g)					
1	16	1.00		1.00	
2	22	1.19	0.86–1.64	1.27	0.91–1.77
3	27	0.99	0.71–1.39	1.19	0.82–1.72
4	34	1.54	1.13–2.09	2.06	1.39–3.03
p for trend		0.03		0.001	
Calcium (mg)					
1	860	1.00		1.00	
2	1,240	0.99	0.74–1.32	1.04	0.78–1.39
3	1,490	0.81	0.60–1.10	0.88	0.64–1.21
4	1,790	0.80	0.59–1.10	0.94	0.67–11.31
p for trend		0.08		0.49	
Magnesium (mg)					
1	382	1.00		1.00	
2	451	0.70	0.52–0.94	0.65	0.46–0.91
3	497	0.72	0.53–0.97	0.60	0.40–0.89
4	563	0.75	0.56–1.01	0.52	0.32–0.85
p for trend		0.08		0.0001	
Phosphorus (g)					
1	1.7	1.00		1.00	
2	2.0	0.89	0.66–1.19	0.96	0.71–1.30
3	2.2	0.78	0.57–1.05	0.87	0.62–1.23
4	2.4	0.80	0.59–1.08	0.91	0.62–1.33
p for trend		0.09		0.52	

Table continues

TABLE 3. Continued

Nutrient and quartile	Median intake	Age-adjusted RR†,‡	95% CI†	Multivariate RR§	95% CI
Potassium (g)					
1	3.8	1.00		1.00	
2	4.6	0.73	0.54–0.99	0.76	0.55–1.05
3	5.1	0.78	0.58–1.05	0.85	0.60–1.22
4	5.7	0.75	0.55–1.01	0.79	0.52–1.19
p for trend		0.09		0.34	
Vitamin C (mg)					
1	52	1.00		1.00	
2	77	0.98	0.73–1.42	0.98	0.70–1.36
3	100	1.07	0.85–1.60	1.07	0.77–1.47
4	141	1.12	0.97–1.80	1.12	0.80–1.55
p for trend		0.04		0.42	
Vitamin B_6 (mg)					
1	2.0	1.00		1.00	
2	2.3	0.91	0.68–1.23	0.89	0.65–1.21
3	2.6	0.80	0.59–1.09	0.77	0.56–1.07
4	3.0	0.90	0.66–1.21	0.83	0.60–1.16
p for trend		0.36		0.21	
Vitamin D (μg)					
1	2.6	1.00		1.00	
2	4.1	0.89	0.66–1.20	0.89	0.66–1.20
3	5.7	0.80	0.59–1.09	0.81	0.59–1.10
4	8.6	0.93	0.69–1.26	0.95	0.70–1.28
p for trend		0.51		0.60	

* Drinking water is not considered here.
† RR, relative risk; CI, confidence interval.
‡ Adjusted for age and supplementation group.
§ Adjusted for age, supplementation group, vocational training, marital status, and intakes of magnesium, fiber, and alcohol.

and adequate calcium intake. After 4.5 years of follow-up, the relative risk of recurrent kidney stones was 5.6 (95 percent CI 1.2–26.1) in the intervention group in comparison with the control group. Therefore, the high-fiber, low-animal-protein diet was more harmful than beneficial. This result is in accordance with the findings of our study.

Potassium was not found to be protective here, as it was in previous studies (1, 2). However, the possibility of collinearity should be kept in mind, because of the

TABLE 4. Distribution of data on beverage consumption (ml/day), Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study, 1985–1993

Beverage	Percentile				
	10th	25th	50th	75th	90th
Low-fat milk	64	127	244	484	959
High-fat milk	0	0	0	340	680
Sour milk	0	7	75	227	427
Fruit juices	0	0	0	17	81
Berry juices†	0	0	0	73	200
Soft drinks	0	1	41	141	330
Coffee	220	420	550	770	1,100
Tea	0	0	0	63	220
Beer	0	0	55	196	500
Wine	0	0	0	0	25
Spirits	0	1	17	50	71

* Juices made of berries by steaming, diluted with water before drinking; also includes other diluted juices.

TABLE 5. Relative risk of kidney stones according to consumption of various beverages (per portion per day), Alpha-Tocopherol, Beta-Carotene Lung Cancer Prevention Study, 1985–1993

Beverage and portion size	Age-adjusted RR*,†	95% CI*	Multivariate RR‡	95% CI
Low-fat milk—glass (170 ml)	1.00	0.94–1.07	1.00	0.94–1.07
High-fat milk—glass (170 ml)	0.97	0.91–1.03	1.00	0.94–1.08
Sour milk—glass (170 ml)	0.94	0.85–1.04	0.96	0.87–1.07
Fruit juices—glass (170 ml)	1.24	0.97–1.58	1.21	0.94–1.55
Berry juices—glass (170 ml)	1.04	0.92–1.18	1.01	0.89–1.15
Soft drinks—bottle (330 ml)	1.10	0.94–1.28	1.18	0.98–1.42
Coffee—cup (110 ml)	0.96	0.93–1.00	0.97	0.93–1.02
Tea—cup (170 ml)	1.10	1.00–1.21	1.05	0.95–1.17
Beer—bottle (330 ml)	0.57	0.46–0.72	0.60	0.47–0.76
Wine—glass (120 ml)	1.07	0.82–1.39	1.12	0.87–1.45
Spirits—serving (40 ml)	0.88	0.77–0.99	0.93	0.82–1.06

* RR, relative risk; CI, confidence interval.
† Adjusted for age and supplementation group.
‡ Adjusted for age, supplementation group, other beverages, vocational training, marital status, and intakes of magnesium and fiber.

high correlation between magnesium intake and potassium intake ($r = 0.74$). Collinearity is also possible regarding phosphorus, vitamin B_6, fiber, and calcium, because of their high correlations. Therefore, definitive conclusions about these substances and the risk of kidney stones cannot be made.

The fact that beer was the only alcoholic beverage associated with risk needs further consideration. Beer has been found to be protective in previous studies among men (3, 5), whereas among women no such effect has been seen (6). The protective effect of beer could be mediated through water or alcohol. Alcohol suppresses the excretion of vasopressin, resulting in increased urine flow and more dilute urine. On the other hand, some studies have suggested that alcohol consumption could increase the excretion of calcium (22, 23). Higher water intake also increases urinary output and makes urine more dilute. In addition, beer could contain some other protective substances found in hops. Active components in hop extract, xanthohumol and humulone, have been shown to strongly inhibit bone resorption (24). These compounds could therefore slow the release of calcium from bone and reduce calcium excretion.

In contrast to the studies by Curhan et al. (1, 6), in this study we did not find high water intake to be protective. However, our study participants were not asked about water drinking. Therefore, total water intake was somewhat underestimated; this may have attenuated our results. On the other hand, since we included the water content of all beverages as well as all cooked foods and total water intake was as high as 2,500 ml, underestimation is not likely to have been substantial. Moreover, the consumption of water rather than milk or berry juices is not very common in this age group in Finland.

The consumption of beverages in this cohort was quite different from that in the typical US diet. Consumption of fruit juices, tea, and wine was very low; therefore, an association of these items with the risk of kidney stones may not have been seen in this cohort. The consumption of spirits in this study was high, because many Finnish men consume spirits on weekends.

Selection bias cannot be ruled out as having an effect on our results, since the exclusion of previous kidney stone cases was probably not complete (only 110 men reported a history of kidney stones). Therefore, some of the men denoted as cases may have had their first kidney stone before the baseline assessment. If so, they may have reported a higher beverage intake and a lower calcium intake, since these measures are recommended to kidney stone patients. This would have attenuated the possible increased risks of low liquid intake and high calcium intake toward unity.

Our results are generalizable to male smokers over 50 years of age. However, we have no reason to believe that the associations we observed would be different among nonsmokers, since smoking has not been found to be related to kidney stones. It is probable that these findings also apply to women and to younger men, since there are no major physiologic differences between these groups regarding kidney stones.

In conclusion, the findings of this study and of previous studies do not support the concept of calcium restriction in the treatment of kidney stones. The role of magnesium and fiber in the etiology of kidney stones should be studied further. Since beer seemed to be protective against kidney stones, the physiologic effects of other substances besides ethanol, especially those of hops, should also be examined.

ACKNOWLEDGMENTS

This study was supported by National Cancer Institute contract NO1-CN-45165.

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