Int. J. Cancer: **81,** 871–876 (1999)
Published 1999 Wiley-Liss, Inc.

Publication of the International Union Against Cancer
Publication de l'Union Internationale Contre le Cancer

RISK OF STOMACH CANCER IN RELATION TO CONSUMPTION OF CIGARETTES, ALCOHOL, TEA AND COFFEE IN WARSAW, POLAND

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To identify reasons for the high incidence rates of stomach cancer in Poland, we conducted a population-based case-control study in Warsaw. Cases were residents aged 21 to 79 years who were newly diagnosed with stomach cancer between March 1, 1994, and April 30, 1997. Controls were randomly selected from Warsaw residents registered at the nationwide Polish Electronic System of Residence Evidency, frequency-matched to cases by age and sex. Information on demographic characteristics; consumption of cigarettes, alcohol, tea and coffee; diet; medical history; family history of cancer; occupational history; and living conditions during adolescence was elicited by trained interviewers using a structured questionnaire. Included were 464 cases (90% of eligible) and 480 controls (87% of eligible). Among men, the risk of stomach cancer was significantly elevated among current smokers (OR = 1.7, 95% CI = 1.1–2.7) but not among former smokers. The excess risk was largely confined to long-term and heavy smokers, with significant 2-fold excess risk among men who smoked 40 or more pack-years. Among women, an 80% increase in risk was observed in both current and former smokers but dose-response trends were less consistent than among men. Alcohol consumption was not clearly related to risk, and no association was found for drinking regular coffee or herbal tea or using milk/cream in coffee or tea. A significant reduction in risk was linked to daily tea drinking among women, but not among men. Our findings confirm an association with cigarette smoking, which is estimated to account for approximately 20% of stomach cancers diagnosed among Warsaw residents during the study period. *Int. J. Cancer* 81:871–876, 1999.
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The incidence and mortality rates of stomach cancer in Poland are among the highest in Europe (Zatonski *et al.,* 1996; Parkin *et al.,* 1997). While reasons underlying the high rates are unclear, lifestyle factors may play a role. Moderate excess risks have been associated with cigarette smoking in numerous cohort and population-based case-control studies (Kneller *et al.,* 1991; Inoue *et al.,* 1994; McLaughlin *et al.,* 1995; Ji *et al.,* 1996; Nomura, 1996; Zhang *et al.,* 1996; Gammon *et al.,* 1997) but not in other studies, especially in Europe (Buiatti *et al.,* 1989; Boeing *et al.,* 1991; Agudo *et al.,* 1992; Jedrychowski *et al.,* 1993; Engeland *et al.,* 1996). The role of alcohol drinking remains uncertain, with most studies reporting no association (Kneller *et al.,* 1991; Nomura, 1996; Zhang *et al.,* 1996; Gammon *et al.,* 1997), though some have reported a positive association (Falcao *et al.,* 1994; Jedrychowski *et al.,* 1993; Ji *et al.,* 1996). *Per capita* alcohol consumption is high in Poland, and a hospital-based case-control study in the southern part of the country found significant dose-response trends with frequency and amount of vodka consumption, by far the most popular alcoholic drink in the country (Jedrychowski *et al.,* 1993). On the other hand, tea drinking has been associated with reduced risk of stomach cancer in several studies in Asia, North America and Europe (Hansson *et al.,* 1993; Blot *et al.,* 1996; Ji *et al.,* 1996; Zheng *et al.,* 1996). The high consumption of cigarettes, vodka and tea in Poland provided an opportunity to further clarify the roles of these factors and to assess dose-response relationships. Herein, we examine risks associated with consumption of these products in a population-based case-control study of stomach cancer conducted in Warsaw, Poland.

METHODS

The study was conducted in the city of Warsaw, the capital of Poland, with a population of 1.6 million persons in 1993 (Wronkowski *et al.,* 1993). Residents aged 21 to 79 years who were newly diagnosed with stomach cancer (ICD-O 151 or ICD-O-2 C16) between March 1, 1994, and April 30, 1996, were identified by collaborating physicians in each of the 22 hospitals serving the study area. A total of 72 clinics and endoscopic departments within these hospitals and 8 private endoscopic units were covered. In addition, the Cancer Registry files were reviewed regularly to ensure completeness of case ascertainment. Diagnostic information was abstracted in a standardized manner from hospital records and endoscopy, surgical and pathology reports by a collaborating physician or by the study physician, who visited the hospitals once a month. For this study, a special effort was made to obtain tissue slides or specimens. All pathological slides were reviewed for confirmation of the diagnosis and standardized re-classification using the Laurén (1965) and WHO (Watanabe *et al.,* 1990) criteria by 2 pathologists, one from Poland (ANG) and the other from the United States (FDG). The final decision on classification of borderline cases was made by a senior U.S. pathologist (LHS) specializing in gastro-intestinal tumor pathology.

Controls were randomly selected among Warsaw residents from a computerized registry of all legal residents in Poland, the Polish Electronic System of Residence Evidency (PESEL), and frequency-matched to cases by sex and age in 5-year groups. The system is updated monthly, and completeness of registration is estimated to be nearly 100%.

After written consent was obtained, controls and cases or next of kin of deceased cases were interviewed by trained interviewers to

Grant sponsor: U.S. National Cancer Institute; Contract numbers: N02-CP-40501; N01-CP-05626; N02-CP-71103.

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Received 26 October 1998; Revised 8 January 1999

elicit information on demographic background, usual diet prior to 1990, childhood living conditions, family history of cancer, history of selected medical conditions and medication use, lifetime occupational history and consumption (prior to 2 years before) of cigarettes, alcohol and other beverages. Among ever-users of cigarettes or alcohol, information was collected on age started and stopped, total years and amount of use and type of cigarettes (filtered, non-filtered) and alcohol (beer, wine, liquor). An ever-smoker was defined as a smoker of at least one cigarette per day for 6 months or longer. An ever-drinker was defined as a drinker of at least one serving of beer, wine or liquor per month for 6 months or longer. Those who stopped smoking or drinking alcohol within the prior 2 years were considered current smokers or drinkers. For other beverages, usual frequency of consumption before 1990 (prior to economic reform) was obtained for coffee, herbal tea and regular tea, and questions were asked regarding whether milk or cream was used in coffee or tea.

For analysis, pack-years of cigarettes smoked were computed by multiplying the number of packs of cigarettes smoked per day by the total years of smoking. Similarly, ''drink-years'' of alcohol used were computed for each type of alcohol and total alcohol by multiplying drinks per week and years of drinking. Stomach cancer risk was estimated by odds ratios (ORs) and 95% confidence intervals (CIs) using unconditional multiple logistic regression models (Breslow and Day, 1980). All ORs were adjusted for age, education, years lived on a farm and family history of cancer, the latter 3 factors being related to risk of stomach cancer in this study. For alcohol and other beverages, ORs were also adjusted for pack-years of cigarette smoking. Further adjustment for other potential confounding variables, including dietary intake (fresh fruits and vegetables, preserved vegetables, sausages and calories), history of gastro-esophageal reflux, use of ulcer medications, having a toilet in the apartment or house at ages 14 to 18 (as a measure of living conditions in early life), population size of birth place and seropositivity for *Helicobacter pylori*, did not affect the risks appreciably. Since the prevalence of smoking and alcohol use varied greatly between men and women, risks were estimated for each sex separately. Initial analyses on smoking status and drinking status for alcohol and other beverages, as well as pack-years of smoking and drink-years of alcohol, showed that risks were essentially unaltered after excluding interviews provided by next of kin. Risks also were unaltered after excluding 34 (7.3%) cases diagnosed by surgery and/or endoscopy but without microscopic confirmation. The analyses presented below therefore were based on all subjects in the study.

RESULTS

Of the 515 eligible cases identified, 34 (6.6%) refused and 17 (3.3%) were untraceable or unavailable for other reasons. Inter-

TABLE I – DEMOGRAPHIC AND OTHER CHARACTERISTICS OF STOMACH CANCER PATIENTS AND POPULATION CONTROLS IN WARSAW, POLAND, 1994–1997

	Total	Men				Women			
		Cases		Controls		Cases		Controls	
	(n = 302)	%	(n = 314)	%	(n = 162)	%	(n = 166)	%
Age (years)									
<50	32	10.6	34	10.8	23	14.2	24	14.5
50–59	49	16.2	50	15.9	24	14.8	30	18.1
60–69	125	41.4	134	42.7	52	32.1	51	30.7
70+	96	31.8	96	30.6	63	38.9	61	36.7
Education									
≤High school	125	41.4	111	35.4	81	50.0	72	43.4
Some college	104	34.4	97	30.9	65	40.1	68	41.0
≥College graduate	73	24.2	106	33.8	16	9.9	26	15.7
Years lived on farm									
Never	163	54.0	149	47.5	106	65.4	72	43.4
1–9	31	10.3	33	10.5	13	8.0	16	9.6
10–14	23	7.6	31	9.9	14	8.6	20	12.0
15–19	48	15.9	65	20.7	13	8.0	32	19.3
≥20	37	12.3	32	10.2	15	9.3	26	15.7
Unknown	0	0.0	4	1.3	1	0.6	0	0.0
Family history of cancer									
No family history	171	56.6	214	68.2	90	55.6	104	62.7
Stomach cancer	42	13.9	11	3.5	17	10.5	8	4.8
Other cancer	69	22.8	82	26.1	48	29.6	53	31.9
Unknown	20	6.6	7	2.2	7	4.3	1	0.6
ABO Blood group									
A	113	37.4	115	36.6	73	45.1	51	30.7
B	49	16.2	53	16.9	21	13.0	30	18.1
AB	30	9.9	27	8.6	19	11.7	16	9.6
O	94	31.1	106	33.8	41	25.3	63	38.0
Unknown	16	5.3	13	4.1	8	4.9	6	3.6
Respondent status									
Personal	208	68.9	314	100.0	116	71.6	166	100.0
Next-of-kin	94	31.1	0	0.0	46	28.4	0	0.0
Site of tumor origin									
Cardia only	46	15.2	N/A[1]		15	9.3	N/A	
Cardia/distal	40	13.2	N/A		12	7.4	N/A	
Distal only	201	66.6	N/A		133	82.1	N/A	
Unknown	15	5.0	N/A		2	1.2	N/A	
Laurén classification									
Intestinal	209	74.6	N/A		101	67.3	N/A	
Diffuse	35	12.5	N/A		31	20.7	N/A	
Indeterminate	31	11.1	N/A		13	8.7	N/A	
Unclassified	5	1.8	N/A		5	3.3	N/A	

[1]Not applicable.

views were obtained in person for 324 (62.9%) cases and with next of kin of 140 (27.2%) cases who died or were too ill to participate. About 40% of interviews with cases were conducted in hospitals, sometimes prior to surgery and final diagnostic confirmation. In addition, a 30-ml blood sample was collected by a trained phlebotomist from 326 (63.3%) cases who consented. Interviews with next of kin of cases were conducted at the subjects' homes.

Of the 586 potential controls identified, 37 (6.3%) had moved. Of the 549 remaining subjects, 480 (87.4%) agreed to be interviewed and 433 (78.9%) agreed to donate a 30-ml blood sample. The predominant reason for non-interview was subject refusal (10.9%). Nearly all interviews and blood collection with control subjects were conducted in their homes.

Thus, a total of 464 stomach cancer patients (302 men and 162 women) and 480 controls (314 men and 166 women) were included in the study. Cases and controls were similar in distribution by gender and age (Table I). Controls tended to have higher education and to have lived on a farm longer than cases, while cases were more likely to report family history of stomach cancer than controls. The ABO blood group distribution was similar for male cases and controls, but female cases were more likely to have blood type A than female controls. Among cases, 15% of cancers among men and 9% among women originated from the gastric cardia. The majority of tumors were of the intestinal pathological type, comprising 75% among men and 67% among women.

A higher proportion of stomach cancer cases (79% men and 52% women) than controls (75% men and 35% women) smoked (Table II). Among men, risk was significantly elevated among current smokers (OR = 1.7, 95% CI = 1.1–2.7) but not among former smokers. However, risk was elevated among male former smokers of long duration and pack-years (data not shown). Overall, the excess risk was limited to smokers of more than 10 cigarettes per day (Table II). Risk also tended to increase with duration and with pack-years, with an OR of approximately 2 among smokers of 40 years or more and among those who smoked 40 or more pack-years. Risk tended to decline with years since quitting and with age started smoking, but there was little difference in risk by type of cigarettes smoked, *i.e.*, filtered *vs.* non-filtered. Among women, excess risks (OR = 1.8) of borderline significance were observed in both current and former smokers. However, dose-response trends were less consistent than among men.

Current drinking of beer, wine or liquor was inversely related to stomach cancer risk among men but not women (Table III). The only elevated ORs were for those who reported stopping drinking within the prior 5 years. In both current and former drinkers, there was no evidence of dose-response trends with drinks per week, age started drinking or drink-years (Table IV). Risks were similar for those who reported drinking vodka *vs.* other hard liquors (data not shown).

No association was observed between stomach cancer risk and ever drinking of regular coffee or herbal tea or use of milk/cream in coffee and tea (Table V). Daily tea drinking, however, was associated with a significant risk reduction among women but not men. Further analyses by frequency of consumption did not yield a consistent dose-response relationship with any beverage.

TABLE II – ODDS RATIOS (OR) AND 95% CONFIDENCE INTERVALS (CI) FOR STOMACH CANCER IN RELATION TO CIGARETTE SMOKING BY GENDER IN WARSAW, POLAND, 1994–1997

Cigarette smoking	Men				Women			
	Cases	Controls	OR[1]	95% CI	Cases	Controls	OR[1]	95% CI
Non-smoker	61	77	1.0	—	77	108	1.0	—
Smoking status								
Ever smoked	228	236	1.2	0.8–1.8	82	58	1.8	1.1–3.0
Former smoker	98	136	0.9	0.6–1.4	33	20	1.8	0.9–3.7
Current smoker	130	100	1.7	1.1–2.7	49	38	1.8	1.0–3.3
Number smoked per day								
≤10	31	58	0.7	0.4–1.2	32	27	1.3	0.7–2.5
11–20	143	127	1.5	1.0–2.3	43	27	2.5	1.3–4.8
≥21	63	49	1.5	0.9–2.6	6	4	1.8	0.5–7.6
Years of smoking								
<20	22	45	0.6	0.3–1.1	21	13	2.3	1.0–5.4
20–29	41	53	1.0	0.6–1.8	24	18	1.8	0.8–3.8
30–39	56	61	1.1	0.7–1.9	20	15	1.6	0.7–3.7
40–49[2]	84	56	2.0	1.2–3.4	16	11	1.8	0.7–4.4
≥50	32	21	2.0	1.0–3.9				
Age started smoking (years)								
<18	76	76	1.3	0.8–2.1	10	7	2.1	0.7–6.3
18–19	71	52	1.7	1.0–2.8	27	11	3.5	1.5–8.0
20–24	71	76	1.1	0.7–1.9	18	20	1.1	0.5–2.4
≥25	14	32	0.6	0.3–1.3	27	20	1.7	0.8–3.4
Years since stopped smoking								
<10	28	39	1.0	0.5–1.8	8	7	1.3	0.4–4.0
10–19	32	43	0.9	0.5–1.7	11	8	1.5	0.5–4.3
20–29[3]	16	24	0.8	0.4–1.6	13	5	3.0	1.0–9.2
≥30	15	27	0.7	0.4–1.5				
Pack-years of smoking								
<10	21	33	0.8	0.4–1.5	21	14	1.8	0.8–4.2
10–<20	18	29	0.9	0.5–1.9	22	15	1.8	0.8–3.8
20–<30	41	50	1.0	0.6–1.8	16	14	1.4	0.6–3.3
30–<40[4]	40	50	1.0	0.6–1.8	22	15	2.3	1.0–5.2
40–<50	50	31	2.1	1.2–3.8				
≥50	67	41	1.9	1.1–3.3				
Type of cigarettes smoked								
Filtered	122	121	1.2	0.8–1.9	64	50	1.7	1.0–3.0
Non-filtered	45	70	0.8	0.5–1.3	8	5	1.9	0.5–6.6
Both	61	43	1.9	1.1–3.2	9	1	12.2	1.4–107.2

[1]Adjusted for age, education, years lived on a farm and family history of cancer.–[2]Category for women is ≥40 years of smoking.–[3]Category for women is ≥20 years since stopped smoking.–[4]Category for women is ≥30 pack-years of smoking.

TABLE III – ODDS RATIOS (OR) AND 95% CONFIDENCE INTERVALS (CI) FOR STOMACH CANCER IN RELATION TO ALCOHOL DRINKING STATUS BY GENDER IN WARSAW, POLAND, 1994–1997

Type of alcohol	Men				Women			
	Cases	Controls	OR[1]	95% CI	Cases	Controls	OR[1]	95% CI
Non-drinker	61	43	1.0	—	109	110	1.0	—
Beer								
Current drinker	83	108	0.5	0.3–0.9	9	7	1.4	0.5–4.4
Former drinker	55	54	0.7	0.4–1.2	7	4	1.9	0.5–7.6
Stopped <5 years	18	7	2.2	0.8–5.9	4	0	∞	—
Stopped 5–9 years	12	11	0.8	0.3–2.2	2	2	1.6	0.2–13.2
Stopped ≥10 years	23	36	0.4	0.2–0.9	1	2	0.5	0.0–7.3
Wine								
Current drinker	58	91	0.5	0.3–0.8	20	21	1.2	0.6–2.6
Former drinker	34	46	0.5	0.3–0.9	10	18	0.7	0.3–1.6
Stopped <5 years	10	7	1.3	0.4–3.7	3	3	1.1	0.2–6.7
Stopped 5–9 years	10	17	0.3	0.1–0.9	1	5	0.2	0.0–2.2
Stopped ≥10 years	11	22	0.4	0.2–0.9	6	10	0.7	0.2–2.2
Liquor								
Current drinker	136	186	0.4	0.3–0.7	27	24	1.4	0.7–2.9
Former drinker	67	58	0.8	0.4–1.3	10	7	1.3	0.4–4.0
Stopped <5 years	35	9	3.2	1.3–7.5	9	1	11.3	1.2–102.9
Stopped 5–9 years	15	21	0.4	0.2–1.0	0	2	—	—
Stopped ≥10 years	13	28	0.3	0.1–0.7	1	4	0.2	0.0–2.3
Any alcohol								
Current drinker	161	212	0.5	0.3–0.7	35	36	1.1	0.6–2.1
Former drinker	63	57	0.8	0.4–1.4	16	20	0.8	0.4–1.8
Stopped 2–4 years	31	11	2.2	1.0–5.1	12	2	8.0	1.6–41.4
Stopped 5–9 years	12	18	0.4	0.2–1.1	1	7	0.2	0.0–1.4
Stopped ≥10 years	16	28	0.4	0.2–0.9	3	11	0.3	0.1–1.1

[1]Adjusted for age, education, years lived on a farm, cigarette smoking and family history of cancer.

TABLE IV – ODDS RATIOS (OR) AND 95% CONFIDENCE INTERVALS (CI) FOR STOMACH CANCER IN RELATION TO PATTERNS OF TOTAL ALCOHOL DRINKING BY DRINKING STATUS

Drinking patterns	Current drinkers				Former drinkers			
	Cases	Controls	OR[1]	95% CI	Cases	Controls	OR[1]	95% CI
Non-drinker	170	153	1.0	—	170	153	1.0	—
Drinks per week								
<1	41	52	0.7	0.4–1.2	21	32	0.6	0.3–1.1
1–<3	42	76	0.5	0.3–0.9	19	13	1.2	0.5–2.6
3–<7	32	66	0.4	0.2–0.7	20	13	1.0	0.4–2.3
≥7	79	54	1.2	0.7–2.0	16	16	0.5	0.2–1.3
Age started (years)								
<20	81	113	0.5	0.3–0.8	26	21	0.8	0.4–1.6
20–24	66	91	0.5	0.3–0.9	28	34	0.5	0.3–0.9
≥25	44	44	1.0	0.6–1.7	23	22	1.0	0.5–2.1
Drink-years[2]								
<10	72	112	0.6	0.4–0.9	41	41	0.8	0.5–1.4
10–19	29	53	0.5	0.3–0.9	10	14	0.5	0.2–1.2
20–29	20	29	0.6	0.3–1.3	8	6	0.5	0.1–1.7
30–39	12	15	0.5	0.2–1.3	5	3	0.9	0.2–4.7
40–79	32	20	1.3	0.6–2.6	6	5	0.7	0.2–2.9
≥80	27	19	1.0	0.5–2.0	3	5	0.2	0.0–0.9

[1]Adjusted for age, sex, education, years lived on a farm, cigarette smoking and family history of cancer.–[2]Number of drinks per week times number of drinking years.

Risks of stomach cancer associated with smoking status, pack-years of smoking, alcohol drinking status and drinking of coffee or tea were not substantially modified by ABO blood group or infection with *H. pylori*, variables that are related to stomach cancer risk (data not shown). There was also no appreciable difference in risk for subtype of tumors defined by anatomic site (cardia only, distal only and cardia/distal) or Laurén classification (intestinal, diffuse and indeterminate).

DISCUSSION

In this population-based case-control study of stomach cancer conducted among residents in Warsaw, Poland, we found cigarette smoking but not alcohol drinking to be a significant risk factor. The excess risk was moderate, with a 2-fold elevated risk largely confined to long-term and heavy smokers among men and no consistent dose-response trend among women. The relatively high prevalence of cigarette smoking in Poland may have contributed to the high rates of stomach cancer. If the association is proven to be causal, we estimate that about 20% of the stomach cancers occurring in Warsaw during the study period could be attributable to smoking.

An increased risk of stomach cancer among cigarette smokers has been observed in numerous case-control and cohort studies (Kneller *et al.,* 1991; Inoue *et al.,* 1994; McLaughlin *et al.,* 1995; Ji *et al.,* 1996; Nomura, 1996; Zhang *et al.,* 1996; Gammon *et al.,* 1997), though some, especially in Europe, have reported no association (Buiatti *et al.,* 1989; Boeing *et al.,* 1991; Agudo *et al.,* 1992; Jedrychowski *et al.,* 1993; Engeland *et al.,* 1996). A lack of association most often was found in hospital-based case-control

TABLE V – ODDS RATIOS (OR) AND 95% CONFIDENCE INTERVALS (CI) FOR STOMACH CANCER IN RELATION TO BEVERAGE CONSUMPTION BY GENDER IN WARSAW, POLAND, 1994–1997

Type of beverage	Men				Women			
	Cases	Controls	OR[1]	95% CI	Cases	Controls	OR[1]	95% CI
Regular coffee								
No	52	65	1.0	—	27	39	1.0	—
Yes	205	243	1.1	0.7–1.7	112	123	1.1	0.6–2.1
<1/week	57	67	1.1	0.7–1.9	14	27	0.7	0.3–1.8
1–<7/week	52	91	0.8	0.4–1.3	35	28	1.8	0.8–3.8
≥7/week	95	85	1.4	0.8–2.4	63	68	1.0	0.5–2.0
Not ascertained	45	6	8.4	3.2–22.0	23	4	6.5	1.9–22.6
Regular tea								
No/<7/week	13	17	1.0	—	12	4	1.0	—
Yes	245	291	1.0	0.5–2.2	127	158	0.2	0.1–0.7
7–<14/week	32	57	0.7	0.3–1.6	16	33	0.1	0.0–0.5
14–<21/week	96	125	1.0	0.4–2.2	49	63	0.2	0.1–0.7
≥21/week	117	109	1.2	0.6–2.8	62	62	0.2	0.1–0.8
Not ascertained	44	6	7.6	2.4–24.4	23	4	1.2	0.2–6.4
Herbal tea								
No	200	221	1.0	—	84	86	1.0	—
Yes	54	84	0.8	0.5–1.2	53	76	0.8	0.5–1.4
<1/week	29	50	0.8	0.4–1.3	22	26	0.9	0.4–1.8
≥1/week	23	32	0.8	0.5–1.5	28	49	0.8	0.4–1.4
Not ascertained	48	9	5.6	2.6–12.0	25	4	5.8	1.8–18.6
Milk/cream in coffee/tea								
No	188	200	1.0	—	80	95	1.0	—
Yes	69	108	0.7	0.5–1.1	59	67	1.0	0.6–1.8
Not ascertained	45	6	7.0	2.8–17.4	23	4	6.1	1.9–19.8

[1]Adjusted for age, education, years lived on a farm, cigarette smoking and family history of cancer.

studies in which the controls might have a relatively high prevalence of smoking-related illnesses (Boeing *et al.,* 1991; Agudo *et al.,* 1992; Jedrychowski *et al.,* 1993). Among studies that reported a positive association, most found the excess risk to be moderate, with ORs ranging approximately from 1.3 to 2.5 overall and increasing among heavy and long-term smokers. Tobacco smoke contains a variety of carcinogenic agents, including *N*-nitroso compounds and nitrogen oxides that may promote endogenous formation of *N*-nitroso compounds (Tricker, 1997), which have been linked to gastric carcinogenesis (Mirvish, 1995). Further indicative of a potential causal role of tobacco are data from a study of pre-cancerous lesions in a high-risk area of China, where smoking was found to nearly double the risk of transition to gastric dysplasia (Kneller *et al.,* 1992).

Our observation of a higher excess risk among male current smokers than former smokers also was consistent with previous findings (Kneller *et al.,* 1991; McLaughlin *et al.,* 1995; Ji *et al.,* 1996; Gammon *et al.,* 1997). Contrary to a few studies that found little reduction in risk among former smokers who quit for less than 20 years (Ji *et al.,* 1996; Gammon *et al.,* 1997), risk declined consistently with increasing years of smoking cessation in our study. Misclassification of years of smoking cessation and chance variation may partly explain the discrepant findings. Further assessment of the effect of smoking cessation on risk is warranted, particularly given the excess risk among female former smokers and the important public health implications of smoking cessation.

An association with alcohol consumption has not been consistently demonstrated in previous epidemiological studies of stomach cancer (Kneller *et al.,* 1991; Boeing *et al.,* 1991; Agudo *et al.,* 1992; Jedrychowski *et al.,* 1993; Falcao *et al.,* 1994; Ji *et al.,* 1996; Nomura, 1996; Zhang *et al.,* 1996; Gammon *et al.,* 1997). In our study, no increased risk was found among alcohol drinkers. Indeed, among men, current drinking was inversely related to risk, but no similar pattern was seen among women. The elevated OR we found among recent quitters suggests that, despite our efforts to ascertain only exposures more than 2 years prior to diagnosis, recall and reporting of drinking practices among cases likely were influenced by their recent illness-related changes in behavior; *i.e.,* cases may have stopped drinking alcohol due to stomach discomfort immediately prior to cancer diagnosis. The artifactual nature of this association was further supported by a lack of dose-response trends with increasing amount and duration of alcohol drinking among current drinkers as well as among former drinkers who quit for more than 5 years. It appears that overall, our data were most consistent with no association between alcohol drinking and stomach cancer risk.

A reduced risk of stomach cancer has been reported among drinkers of green and black tea in several epidemiological studies (Hansson *et al.,* 1993; Yu *et al.,* 1995; Ji *et al.,* 1996; Zheng *et al.,* 1996; Blot *et al.,* 1996) but not in others (LaVecchia *et al.,* 1992; Agudo *et al.,* 1992; Goldbohm *et al.,* 1996). In laboratory studies, the cancer-inhibiting effects of polyphenols and other compounds in tea and tea extracts have been well documented (Yang and Wang, 1993). We found a reduced risk with daily tea drinking but only among women and not among men. However, our ability to assess dose-response relations was limited by the uniformly high consumption of tea among Polish residents and by the lack of a detailed questionnaire on tea consumption. Data on the association between risk of stomach cancer and consumption of coffee and herbal tea are limited. Our findings are consistent with previous studies that found no association with coffee intake (Agudo *et al.,* 1992; Inoue *et al.,* 1994).

Differences in the strength of associations with smoking and alcohol drinking by gastric subsite have been shown in a few studies (Zhang *et al.,* 1996; Gammon *et al.,* 1997). We found generally similar risks for cardia and non-cardia gastric cancers, but the number of patients with cancers from the cardia in our study was too small for detailed analysis. Consistent with limited data on risk by the Laurén classification (Jedrychowski *et al.,* 1993), our study also found no substantial difference in risk for tumors of intestinal and diffuse histological types. However, the number of patients with diffuse-type tumors in our study was small.

In conclusion, cigarette smoking was a moderate risk factor for stomach cancer in our study and might have contributed to 20% of the stomach cancer cases occurring in Warsaw during the study period. We found no association with drinking of alcohol and other beverages, except for a reduced risk among female daily tea drinkers. The findings add to the growing consensus that cigarette smoking is a risk factor for stomach cancer and that efforts aimed at

smoking cessation may eventually help to reduce the burden of stomach cancer, still one of the world's most common malignancies.

ACKNOWLEDGEMENTS

The authors thank Drs. P. Sztabinski and F. Sztabinski at The Survey Center of the Polish Academy of Science for their assistance in training and coordination of interviewers; Ms. M. Mazur and Ms. M. Korzycka for coordinating the study; and numerous physicians, pathologists and nurses from all hospitals in Warsaw for their support and cooperation. We also thank Ms. L. Lannom and Ms. N. Odaka at Westat, Inc., for organizational and technical support.

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