Acta Oncologica Vol. 35, No. 5, pp. 553–570, 1996

CANCER OF THE DIGESTIVE SYSTEM IN CIRCUMPOLAR INUIT

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Cancer of the oesophagus, stomach, small intestine, colon, rectum, liver, gallbladder, biliary tract and pancreas was studied in the Inuit populations of Alaska, Canada and Greenland. Indirect standardization to the populations in Canada, Connecticut (USA) and Denmark was used. High risk of oesophageal cancer was observed in both sexes with standardized incidence ratios (SIRs) of up to 7. An increased risk of colon and rectum cancer occurred among Alaskan Inuit compared with the Inuit populations in Canada and Greenland, which had lower rates. Liver and gallbladder cancer rates were high, with SIRs of 1.5 to 4.1, whereas there were no differences in pancreatic cancer in the populations compared. Dietary habits, alcohol and tobacco consumption are believed to play an important role in most of the observed cancer patterns, but for liver cancer hepatitis B virus infection is also believed to have a causal role.

Cancer of the digestive tract include those of the oesophagus, stomach, small intestine, colon, rectum, liver, gallbladder and biliary tract and pancreas. Cancer in these sites often shows large international differences, and the results of migrant studies in particular have led to hypotheses about the influence of different dietary habits and other lifestyle factors.

Among the Inuit, living conditions, dietary and other lifestyle factors vary substantially from those of most other populations (1–3). The current paper is part of a joint project analysing 20 years of cancer incidence data among the Circumpolar Inuit residing in Greenland, Canada and Alaska (4).

Material and Methods

Cancer incidence data from 1969–1988 from the Inuit populations of Alaska, Canada and Greenland were collected and compiled into a standard format for the purpose of this analysis. The definitions, methods and data sources have been fully described earlier (4). The accompanying site-specific tables state, by calendar period, country and sex, the total numbers, crude rates, age-standardized incidence rates (ASRs) to the world populations, cumulative rates up to and including the age of 64 (Cum 64) and standardized incidence ratios (SIRs) compared with populations in Connecticut (USA), Canada and Denmark. Age-specific rates are presented for the combined Circumpolar area for the 20-year study period as a whole. The basis of diagnosis is given over a 20-year period, by region. In the following the results for each site are dealt with separately followed by a brief discussion. The tabular data for cancer of the small intestine are only partly included and have not been commented on, as only 5 cases (all men) occurred in the 20-year period.

Received 13 December 1995.
Accepted 6 March 1996.
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Oesophagus (ICD9 150)

Results. A total of 113 cases of oesophageal cancer were diagnosed among Inuit during the 20-year period from 1969 to 1988, 63 in men and 50 in women (Table 1). In the Circumpolar area, 74% of the cases were histologically verified, varying from 100% in Alaska to 66% in Greenland (Table 2). Age-standardized incidence rates (ASRs) were high in both men and women compared to other registries around the world; 2–3 times higher among men

 ISSN 0284-186X

Table 1

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR world)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

150 Oesophagus			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	63	6.4	12.6	0.4	2.0	1.6–2.6	3.5	2.7–4.5	3.1	2.4–4.0
		Alaska	12	3.6	6.1	0.1	1.0	0.5–1.8	1.7	0.9–3.0	1.5	0.8–2.7
		Greenland	44	10.5	20.9	0.9	3.4	2.4–4.5	5.8	4.2–7.8	5.2	3.8–6.9
		Canada	7	3.0	8.0	0.1	1.2	0.5–2.4	2.0	0.8–4.1	1.8	0.7–3.7
	1969–73	Circumpolar	12	5.6	14.1	0.4	2.2	1.1–3.9	3.7	1.9–6.4	3.5	1.8–6.1
		Alaska	6	8.4	21.8	0.5	2.9	1.1–6.3	4.8	1.7–10.4	4.5	1.7–9.9
		Greenland	6	6.2	15.5	0.5	2.6	0.9–5.6	4.4	1.6–9.5	4.1	1.5–8.8
		Canada	6	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1974–78	Circumpolar	12	5.1	10.5	0.3	1.7	0.9–3.0	3.1	1.6–5.4	2.6	1.4–4.6
		Alaska	4	5.1	8.3	0.0	1.5	0.4–3.8	2.7	0.7–6.8	2.3	0.6–5.8
		Greenland	7	6.8	14.1	0.6	2.3	0.9–4.8	4.2	1.7–8.7	3.6	1.5–7.5
		Canada	1	1.8	3.0	0.3	0.7	0.0–4.1	1.3	0.0–7.4	1.1	0.0–6.4
	1979–83	Circumpolar	19	7.4	14.2	0.7	2.4	1.4–3.7	4.5	2.7–7.1	3.5	2.1–5.4
		Alaska	1	1.1	1.8	0.0	0.3	0.0–1.8	0.6	0.0–3.4	0.5	0.0–2.6
		Greenland	14	13.3	24.8	1.5	4.1	2.2–6.9	8.0	4.3–13.3	6.1	3.3–10.2
		Canada	4	6.3	20.9	0.0	2.6	0.7–6.6	5.1	1.4–12.9	3.9	1.0–9.9
	1984–88	Circumpolar	20	7.1	12.4	0.4	1.9	1.2–3.0	3.0	1.8–4.7	2.9	1.8–4.5
		Alaska	1	1.0	1.6	0.1	0.3	0.0–1.4	0.4	0.0–2.2	0.4	0.0–2.1
		Greenland	17	15.1	25.9	0.7	3.9	2.3–6.2	6.2	3.6–9.9	6.0	3.5–9.6
		Canada	2	2.9	7.1	0.0	1.0	0.1–3.4	1.5	0.2–5.5	1.5	0.2–5.3
Females	1969–88	Circumpolar	50	5.2	9.1	0.4	5.4	4.0–7.1	7.0	5.2–9.2	6.7	5.0–8.8
		Alaska	10	3.1	5.5	0.3	3.1	1.5–5.8	3.9	1.9–7.3	3.8	1.8–7.0
		Greenland	32	7.9	11.8	0.5	7.2	4.9–10.1	9.3	6.4–13.2	8.9	6.1–12.5
		Canada	8	3.6	9.1	0.3	5.0	2.1–9.8	6.6	2.8–13.0	6.3	2.7–12.5
	1969–73	Circumpolar	10	4.7	8.9	0.3	7.4	3.5–13.5	7.2	3.5–13.3	6.9	3.3–12.8
		Alaska	1	1.4	4.3	0.0	2.0	0.0–12.2	2.2	0.0–11.3	2.1	0.0–11.6
		Greenland	8	8.2	14.9	0.7	11.8	5.1–23.2	12.1	5.2–23.8	11.1	4.8–21.8
		Canada	1	2.3	6.8	0.0	4.5	0.1–24.9	4.5	0.1–24.9	4.2	0.1–23.4
	1974–78	Circumpolar	11	4.8	8.9	0.5	4.8	2.4–8.5	6.9	3.5–12.4	6.2	3.1–11.1
		Alaska	3	3.9	6.9	0.6	3.9	0.8–11.5	5.4	1.1–15.9	5.0	1.0–14.5
		Greenland	7	7.0	11.2	0.4	6.1	2.4–12.5	9.1	3.6–18.7	8.1	3.2–16.7
		Canada	1	1.9	5.4	0.7	2.5	0.0–14.2	3.8	0.0–21.2	3.3	0.0–18.6
	1979–83	Circumpolar	12	4.9	7.8	0.0	4.8	2.5–8.4	6.5	3.4–11.4	6.1	3.1–10.6
		Alaska	2	2.4	3.9	0.0	2.3	0.3–8.5	3.2	0.4–11.5	2.9	0.3–10.6
		Greenland	9	8.8	11.3	0.0	7.4	3.4–14.1	10.0	4.5–18.9	9.3	4.2–17.6
		Canada	1	1.6	3.7	0.0	2.4	0.0–13.2	3.3	0.0–18.3	3.1	0.0–17.2
	1984–88	Circumpolar	17	6.2	10.1	0.6	5.5	3.2–8.8	7.1	4.1–11.4	7.4	4.3–11.8
		Alaska	4	4.1	6.9	0.4	3.6	1.0–9.3	4.6	1.2–11.9	4.7	1.3–12.1
		Greenland	8	7.4	10.6	0.9	5.6	2.4–11.1	7.3	3.1–14.4	7.6	3.3–15.0
		Canada	5	7.4	17.4	0.5	8.8	2.8–20.5	11.7	3.8–27.3	12.4	4.0–28.8

than in the national comparison populations and about 5–7 times higher in women. ASRs in women are among the highest on record in the world. The overall sex ratio (M : F) was 1.4.

For the Circumpolar region as a whole virtually no variation in age-standardized incidence rates during the study period was reported (Figs. 1, 2). For the 20 years combined, incidence was higher in Greenland than in Canada and Alaska for both sexes.

Discussion. Age-standardized incidence rates of oesophageal cancer are below 10 per 100 000 in most countries (5), with hot spots of high incidence in southern Africa and in a belt across Asia from the Caspian region of Iran to the northern provinces of China (6). High incidence rates among the Inuit populations of Greenland, Alaska and Canada have previously been described (7–10). The fact that equally high incidence rates of oesophageal cancer were observed among men and women differs from observations among white populations in North America and northern Europe, where the incidence in men is 2–4 times higher than in women.

The high risk of oesophageal cancer among Inuit remains unexplained. Major risk factors for this disease are cigarette smoking and alcohol consumption. The fact that

Table 2

Cancer in Circumpolar Inuit 1969–1988. Total number of cases and verification of diagnosis (% of total by site (ICD 9) and region

		Total No.	DCO[1] %	HV[2] %	OTH[3] %
150 Oesophagus	Circumpolar	113	6	74	19
	Alaska	22	0	100	0
	Greenland	76	5	66	29
	Canada	15	20	80	0
151 Stomach	Circumpolar	152	6	84	11
	Alaska	73	0	96	4
	Greenland	50	14	66	20
	Canada	29	7	83	10
152 Small intestine	Circumpolar	5	0	100	0
	Alaska	2	0	100	0
	Greenland	1	0	100	0
	Canada	. 2	0	100	0
153 Colon	Circumpolar	286	4	86	10
	Alaska	167	0	96	4
	Greenland	82	7	70	23
	Canada	37	14	76	11
154 Rectum	Circumpolar	104	4	88	8
	Alaska	48	0	94	6
	Greenland	35	6	80	14
	Canada	21	10	90	0
155 Liver	Circumpolar	69	3	93	4
	Alaska	43	0	95	5
	Greenland	22	5	91	5
	Canada	4	25	75	0
156 Gallbladder	Circumpolar	65	2	95	3
	Alaska	40	0	100	0
	Greenland	17	0	88	12
	Canada	8	13	88	0
157 Pancreas	Circumpolar	94	6	61	33
	Alaska	36	0	72	28
	Greenland	46	11	48	41
	Canada	12	8	75	17

[1] DCO = Death certificate only
[2] HV = Histologically verified
[3] OTH = Other

both exposures are prevalent and a growing problem among all Inuit population groups for both sexes (1–3) may explain the similar incidence rate for Inuit men and women. In other parts of the world, heavy exposure to tobacco and alcohol generally predominates in males. Some traditional Inuit fish dishes contain high amounts of N-nitrosodimethylamine (NDMA) (11), an alleged carcinogen for the oesophagus, which also may explain part of the similarity of incidence in both sexes. Low consumption of fresh fruit and vegetables by Inuit may also lead to an increased incidence since these foods have consistently been shown to give protection against oesophageal cancer.

Stomach (ICD9 151)

Results. With 107 cases diagnosed among men and 45 cases among women (Table 3), stomach cancer accounted for 4.7% of all cancers during the period (2.6% of female cancers and 7.0% of male cancers). Overall, 84% of cases were histologically verified, varying from 96% in Alaska to 66% in Greenland (Table 2).

By international standards the incidence rates were low to intermediate. The age-specific incidence rates (Tables 4, 5) and the sex ratio exhibited the same pattern as found in all other populations world-wide. Incidence rates increased rapidly with age (Tables 4, 5), particularly after age 60. Male:female ratio for the entire period and for all ages was 2.6, but varied by age group with generally higher ratios in age groups over 50.

Incidence rates tended to increase among the Canadian Inuit during the study period, possible as a result of improved cancer registration. However, no significant time trend was observed in either men or women in the Circumpolar region (Figs. 3, 4). For the 20 years combined, the incidence of stomach cancer among Inuit men was significantly increased in relation to all three comparison populations, with SIRs varying between 1.4 and 2.0. Women experienced an increased risk at a lower level (1.1–1.7)

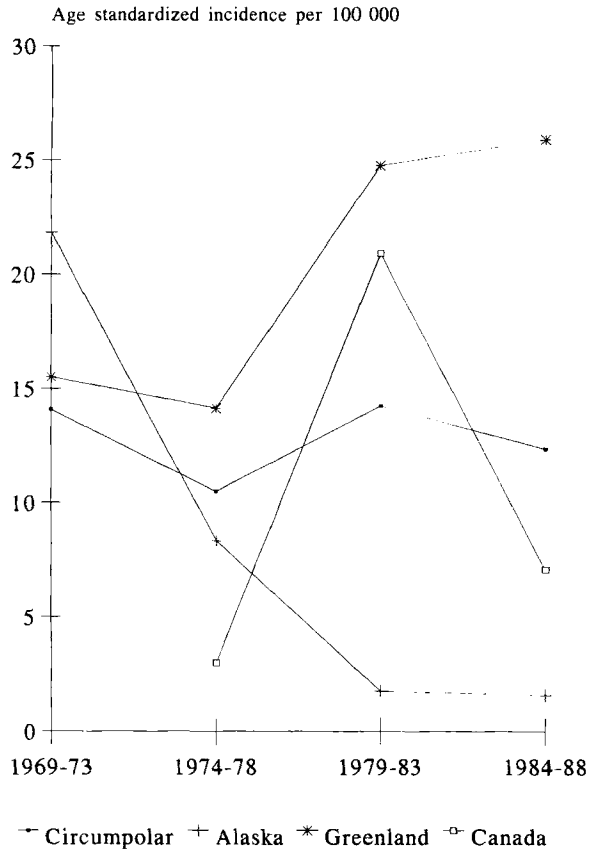

Fig. 1. Trends in cancer incidence among Inuit: ICD9 150 Oesophagus, Men.

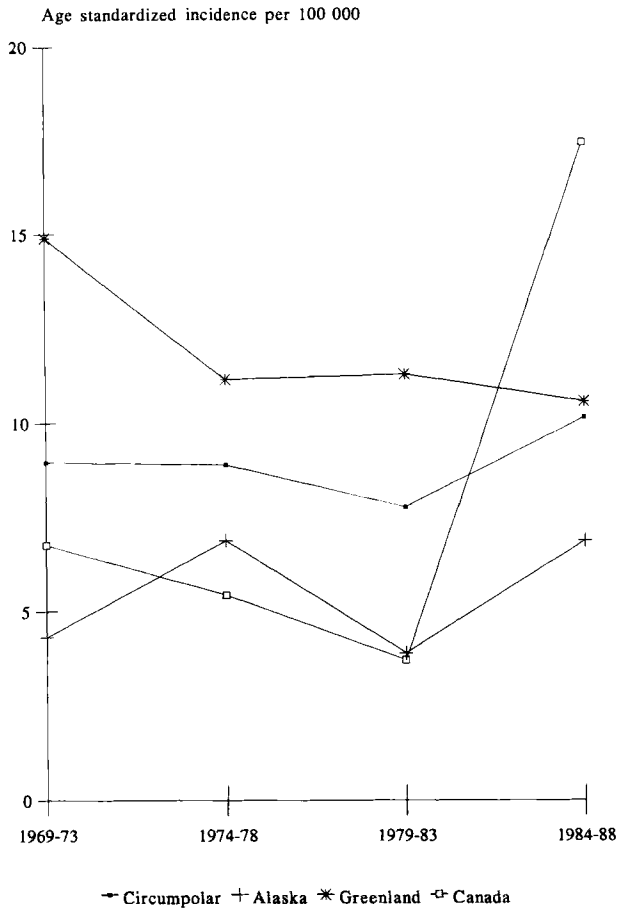

Fig. 2. Trends in cancer incidence among Inuit: ICD9 150 Oesophagus, Women.

only significant compared to the Connecticut population (Table 3).

Discussion. Stomach cancer is estimated to be the second most common cancer in the world after lung cancer, with the highest incidence rates recorded in Japan, Costa Rica and parts of China. Iceland and the eastern European countries exhibit intermediate rates, whereas lower rates are recorded in the western European countries (5). The most remarkable feature of the epidemiology of stomach cancer is the virtually universal decline in its incidence over the past 40 years, although there is variation in time as to onset of the decline among different countries. The generally stable, and perhaps increasing, trend among the Inuit contrasts sharply with the world-wide trends.

Increased risk of stomach cancer appears to be associated with starch foods and smoked, salted, and fried food. Fruit and vegetables have been identified as major protective factors, possibly by inhibiting the endogenous formations of N-nitroso compounds (12–17). Daily consumption of fresh fruit and vegetables, now available the year-round to most people, has been associated with a 50% risk reduction of stomach cancer (18). Food factors associated with increased risk are relatively uncommon in the traditional Inuit diet in Greenland, possibly explaining their reduced risk in comparison with other Inuit populations. However, smoked and salted foods are part of the diet in Alaska and the persistent lack of access to fresh vegetables and fruit in most Inuit societies even today, may explain why the otherwise universal decline in the incidence of stomach cancer does not seem to have reached the Circumpolar Inuit (1–3).

Colon (ICD9 153)

Results. A total of 286 cases of colon cancer were diagnosed during 1969–1988 (Table 6) of which 86% were histologically verified, varying from 96% in Alaska to 70% in Greenland (Table 2). In the Circumpolar region for the 20 years combined incidence rates of colon cancer were high compared with other registries around the world. Incidence rates were significantly high among Inuit women, where the SIRs for colon cancer were 1.4 and 1.2 respectively, compared with populations in Denmark and Canada (Table 6). A female predominance was seen and the overall sex ratio was 0.8.

The pattern of high incidence among the Circumpolar Inuit was due almost exclusively to high rates among Alaskan Inuit, and the female predominance derived from

Table 3

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR world)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

151 Stomach			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	107	10.8	19.6	1.2	2.0	1.6–2.4	1.4	1.2–1.7	1.5	1.3–1.9
		Alaska	58	17.3	28.2	1.5	2.7	2.1–3.5	2.0	1.5–2.6	2.1	1.6–2.8
		Greenland	29	6.9	11.8	0.8	1.3	0.9–1.8	0.9	0.6–1.3	1.0	0.7–1.4
		Canada	20	8.6	17.8	1.5	1.9	1.2–3.0	1.4	0.9–2.2	1.5	0.9–2.3
	1969–73	Circumpolar	19	8.8	20.0	1.0	1.6	0.9–2.5	1.1	0.6–1.7	1.3	0.8–2.0
		Alaska	8	11.3	25.9	0.9	1.7	0.7–3.4	1.2	0.5–2.3	1.4	0.6–2.8
		Greenland	10	10.3	21.3	1.4	1.9	0.9–3.6	1.3	0.6–2.4	1.6	0.8–2.9
		Canada	1	2.1	3.6	0.4	0.4	0.0–2.4	0.3	0.0–1.7	0.4	0.0–2.0
	1974–78	Circumpolar	18	7.6	14.3	0.8	1.4	0.8–2.2	1.0	0.6–1.5	1.1	0.6–1.7
		Alaska	13	16.4	27.8	1.7	2.6	1.4–4.5	1.8	1.0–3.1	2.0	1.1–3.4
		Greenland	4	3.9	6.9	0.4	0.7	0.2–1.9	0.5	0.1–1.3	0.6	0.2–1.4
		Canada	1	1.8	2.4	0.2	0.4	0.0–2.3	0.3	0.0–1.6	0.3	0.0–1.7
	1979–83	Circumpolar	36	14.1	23.5	1.5	2.5	1.7–3.4	1.8	1.3–2.6	1.9	1.4–2.7
		Alaska	17	19.5	29.8	1.6	2.9	1.7–4.7	2.2	1.3–3.5	2.3	1.3–3.7
		Greenland	10	9.5	13.3	1.0	1.7	0.8–3.0	1.2	0.6–2.3	1.3	0.6–2.4
		Canada	9	14.2	30.4	2.2	3.4	1.5–6.4	2.6	1.2–4.9	2.6	1.2–5.0
	1984–88	Circumpolar	34	12.1	20.2	1.3	2.3	1.6–3.2	1.9	1.3–2.6	1.8	1.2–2.5
		Alaska	20	20.2	29.3	1.5	3.4	2.1–5.2	2.7	1.7–4.2	2.6	1.6–4.1
		Greenland	5	4.5	7.6	0.5	0.8	0.3–1.9	0.7	0.2–1.6	0.6	0.2–1.5
		Canada	9	13.1	26.1	2.6	3.1	1.4–5.9	2.5	1.2–4.8	2.4	1.1–4.6
Females	1969–88	Circumpolar	45	4.7	7.6	0.3	1.7	1.3–2.3	1.1	0.8–1.4	1.3	0.9–1.7
		Alaska	15	4.6	7.0	0.2	1.7	0.9–2.7	1.0	0.6–1.7	1.2	0.7–2.0
		Greenland	21	5.2	7.6	0.4	1.7	1.0–2.5	1.0	0.6–1.6	1.2	0.8–1.9
		Canada	9	4.0	8.7	0.4	2.0	0.9–3.8	1.2	0.6–2.4	1.5	0.7–2.8
	1969–73	Circumpolar	7	3.3	6.8	0.2	1.2	0.5–2.5	0.7	0.3–1.3	0.9	0.4–1.9
		Alaska	3	4.3	11.5	0.1	1.6	0.3–4.6	0.8	0.2–2.3	1.2	0.2–3.4
		Greenland	3	3.1	6.1	0.2	1.0	0.2–3.1	0.6	0.1–1.7	0.8	0.2–2.3
		Canada	1	2.3	5.7	0.0	1.1	0.0–5.8	0.6	0.0–3.2	0.8	0.0–4.3
	1974–78	Circumpolar	7	3.1	5.2	0.4	1.1	0.4–2.3	0.6	0.3–1.3	0.8	0.3–1.7
		Alaska	2	2.6	4.3	0.4	0.9	0.1–3.3	0.5	0.1–1.9	0.7	0.1–2.5
		Greenland	3	3.0	4.6	0.5	1.0	0.2–2.8	0.6	0.1–1.6	0.7	0.1–2.1
		Canada	2	3.8	9.8	0.4	1.8	0.2–6.7	1.1	0.1–3.9	1.4	0.2–5.0
	1979–83	Circumpolar	9	3.7	5.5	0.1	1.4	0.6–2.6	0.9	0.4–1.7	1.0	0.4–1.8
		Alaska	2	2.4	3.9	0.0	0.9	0.1–3.2	0.6	0.1–2.1	0.6	0.1–2.3
		Greenland	6	5.9	7.5	0.3	1.9	0.7–4.0	1.2	0.4–2.6	1.3	0.5–2.9
		Canada	1	1.6	3.7	0.0	0.9	0.0–5.2	0.6	0.0–3.3	0.6	0.0–3.6
	1984–88	Circumpolar	22	8.1	11.9	0.6	2.9	1.8–4.4	2.1	1.3–3.2	2.2	1.4–3.3
		Alaska	8	8.2	10.7	0.4	2.9	1.3–5.7	2.1	0.9–4.1	2.2	0.9–4.3
		Greenland	9	8.3	12.0	0.5	2.6	1.2–5.0	1.9	0.9–3.6	2.0	0.9–3.8
		Canada	5	7.4	14.6	1.0	3.7	1.2–8.6	2.6	0.9–6.2	2.8	0.9–6.5

this population only. Incidence rates of colon cancer in Alaskan Inuit women were among the highest in the world and generally 2–3 times higher than those in Greenlandic and Canadian Inuit women. The female predominance in Alaskan Inuit was particularly strong in the peri- and postmenopausal age groups (Table 5). Trends over time in male and female colon cancer showed a consistent increase in Circumpolar men, whereas the trend among women deviated, with a marked increase among Alaskan Inuit women and a decrease in the other two population groups (Figs. 5, 6).

Discussion. Considerable international variations are found in the incidence of colon cancer, with high incidence areas in North America and the lowest incidence in India (5). Incidence of colon and rectal cancer in Alaskan Inuit has been shown previously to be comparable to that of the US (19), whereas the Greenlandic Inuit have lower rates than those seen in Denmark (10, 20).

Epidemiological studies have identified diet as the most important exogenous factor in the etiology of cancer of the colon, with two food groups or nutrients influencing the risk in opposing directions. Protective factors include fresh

Table 4

Cancer in Circumpolar Inuit 1969–1988. Total number of cases and average annual incidence per 100 000 by site (ICD 9), region and 5-year age group. Males

			Age group															
		No.	00–04	05–09	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75+
150 Oesophagus	Circumpolar	63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	7.7	6.3	30.6	39.2	103.7	131.6	150.7
	Alaska	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	16.1	45.2	58.1	122.9
	Greenland	44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.4	11.5	7.0	72.4	75.0	202.4	149.8	217.7
	Canada	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.7	0.0	0.0	35.0	240.0	74.7
151 Stomach	Circumpolar	107	0.0	0.0	0.0	0.0	0.0	2.6	3.2	5.7	15.5	20.5	43.8	53.6	89.5	97.2	142.6	150.7
	Alaska	58	0.0	0.0	0.0	0.0	0.0	3.7	9.5	11.8	21.2	22.6	58.5	50.3	112.4	150.6	232.2	270.3
	Greenland	29	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	18.7	23.0	20.9	45.2	50.0	50.6	74.9	62.2
	Canada	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	12.1	68.3	77.9	137.3	69.9	120.0	0.0
153 Colon	Circumpolar	123	0.0	0.0	0.0	0.9	1.1	1.3	1.6	3.8	13.3	15.4	31.3	42.1	67.1	162.0	197.4	336.3
	Alaska	70	0.0	0.0	0.0	0.0	0.0	3.7	0.0	5.9	28.3	7.5	68.3	30.2	80.3	225.9	319.3	540.5
	Greenland	33	0.0	0.0	0.0	2.0	0.0	0.0	0.0	4.2	9.4	17.2	20.9	45.2	62.5	118.0	99.9	62.2
	Canada	20	0.0	0.0	0.0	0.0	4.6	0.0	7.2	0.0	0.0	24.2	0.0	58.4	54.9	104.9	180.0	373.4
154 Rectum	Circumpolar	58	0.0	0.0	0.0	0.9	0.0	1.3	0.0	0.0	4.4	18.0	15.7	34.4	61.5	38.9	32.9	150.7
	Alaska	28	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	7.1	15.1	29.3	30.2	96.3	75.3	58.1	122.9
	Greenland	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	23.0	7.0	36.2	62.5	0.0	25.0	217.7
	Canada	7	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	12.1	13.7	38.9	0.0	35.0	0.0	74.7
155 Liver	Circumpolar	53	2.3	0.8	2.3	2.6	5.3	0.0	0.0	0.0	4.4	18.0	12.5	30.6	28.0	38.9	32.9	34.8
	Alaska	37	0.0	2.2	7.0	7.6	16.5	0.0	0.0	0.0	14.2	30.2	29.3	50.3	64.2	30.1	58.1	73.7
	Greenland	15	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.2	7.0	27.1	12.5	50.6	25.0	0.0
	Canada	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.0	0.0	0.0
156 Gallbladder	Circumpolar	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.6	12.5	7.7	28.0	25.9	21.9	46.4
	Alaska	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.8	10.1	64.2	30.1	29.0	98.3
	Greenland	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	13.9	9.0	12.5	16.9	25.0	0.0
	Canada	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	13.7	0.0	0.0	35.0	0.0	0.0
157 Pancreas	Circumpolar	49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	6.6	10.3	6.3	34.4	44.8	84.2	43.9	46.4
	Alaska	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	7.1	22.6	0.0	20.1	64.2	90.4	58.1	49.1
	Greenland	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.7	0.0	13.9	54.3	37.5	101.2	49.9	62.2
	Canada	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	12.1	0.0	19.5	27.5	35.0	0.0	0.0

Table 5

Cancer in Circumpolar Inuit 1969–1988. Total number of cases and average annual incidence per 100 000 by site (ICD 9), region and 5-year age group. Females

			Age group															
		No.	00–04	05–09	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75+
150 Oesophagus	Circumpolar	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	12.7	11.7	48.0	58.2	86.8	120.6
	Alaska	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6	11.3	32.7	18.4	96.6	40.9
	Greenland	32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.0	20.3	16.5	52.9	92.3	88.7	160.1
	Canada	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.5	40.7	61.5	207.8
151 Stomach	Circumpolar	45	0.0	0.0	0.0	0.9	0.0	1.3	0.0	5.9	9.2	16.1	12.7	0.0	21.3	45.2	77.2	56.3
	Alaska	15	0.0	0.0	0.0	2.5	0.0	3.8	0.0	5.9	7.0	16.4	9.6	0.0	0.0	36.8	96.6	61.3
	Greenland	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	4.9	23.0	13.6	0.0	31.7	52.7	53.2	53.4
	Canada	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	23.2	0.0	16.1	0.0	31.5	40.7	123.0	51.9
153 Colon	Circumpolar	163	0.0	0.0	0.0	0.9	2.1	1.3	1.6	2.0	16.2	32.1	25.5	70.2	112.1	187.4	192.9	337.6
	Alaska	97	0.0	0.0	0.0	0.0	3.2	0.0	0.0	5.9	14.1	57.2	66.9	101.9	228.9	276.2	386.5	592.4
	Greenland	49	0.0	0.0	0.0	0.0	2.4	0.0	3.9	0.0	14.7	17.3	6.8	41.1	63.5	131.8	142.0	195.7
	Canada	17	0.0	0.0	0.0	3.8	0.0	6.4	0.0	0.0	23.2	25.8	0.0	86.0	31.5	162.7	0.0	103.9
154 Rectum	Circumpolar	46	0.0	0.0	0.8	0.0	0.0	2.7	3.3	0.0	0.0	13.4	9.5	15.6	37.4	38.8	38.6	96.5
	Alaska	20	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	8.2	19.1	11.3	32.7	36.8	128.8	143.0
	Greenland	12	0.0	0.0	0.0	0.0	0.0	3.1	3.9	0.0	0.0	5.8	0.0	8.2	42.3	39.6	0.0	17.8
	Canada	14	0.0	0.0	3.3	0.0	0.0	6.4	0.0	0.0	0.0	38.7	16.1	43.0	31.5	40.7	0.0	207.8
155 Liver	Circumpolar	16	0.0	0.8	0.0	2.6	1.1	0.0	0.0	0.0	0.0	0.0	9.5	3.9	10.7	6.5	9.6	24.1
	Alaska	6	0.0	0.0	0.0	7.5	3.2	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	0.0	3.2	0.0
	Greenland	7	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.6	0.0	10.6	13.2	0.0	35.6
	Canada	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.1	0.0	31.5	0.0	0.0	51.9
156 Gallbladder	Circumpolar	42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	5.4	6.4	27.3	32.0	51.7	38.6	96.5
and extrahepatic	Alaska	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	8.2	9.6	22.6	65.4	92.1	64.4	224.7
bile ducts	Greenland	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	32.9	21.2	26.4	17.7	0.0
	Canada	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.9	0.0	21.5	0.0	40.7	61.5	51.9
157 Pancreas	Circumpolar	45	0.0	0.0	0.0	0.9	0.0	0.0	1.6	0.0	6.9	10.7	19.1	50.7	10.7	32.3	28.9	56.3
	Alaska	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	56.6	16.4	36.8	32.2	81.7
	Greenland	23	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	14.7	17.3	27.1	41.1	0.0	39.6	17.7	53.4
	Canada	7	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	12.9	0.0	64.5	31.5	0.0	61.5	0.0

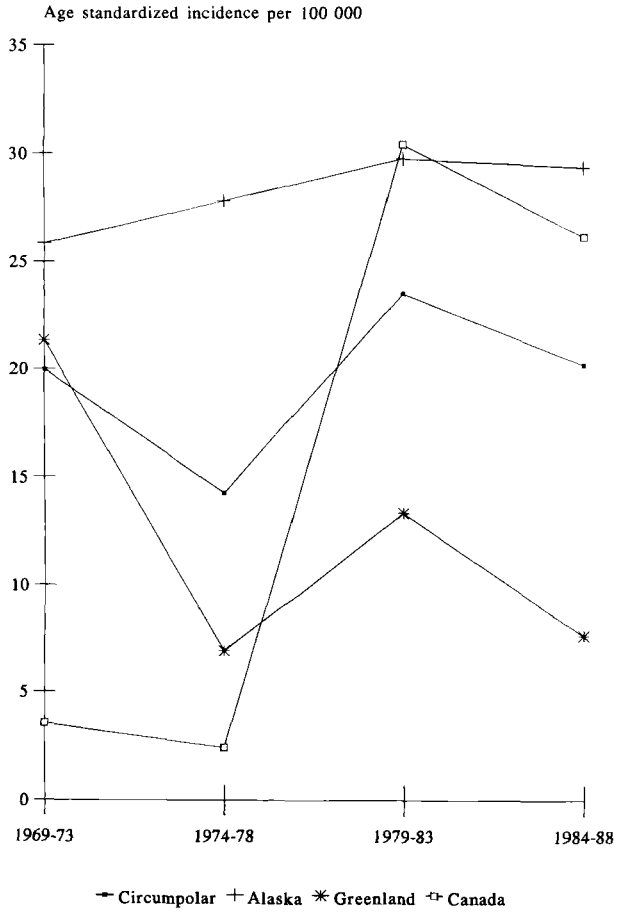

Fig. 3. Trends in cancer incidence among Inuit: ICD9 151 Stomach, Men.

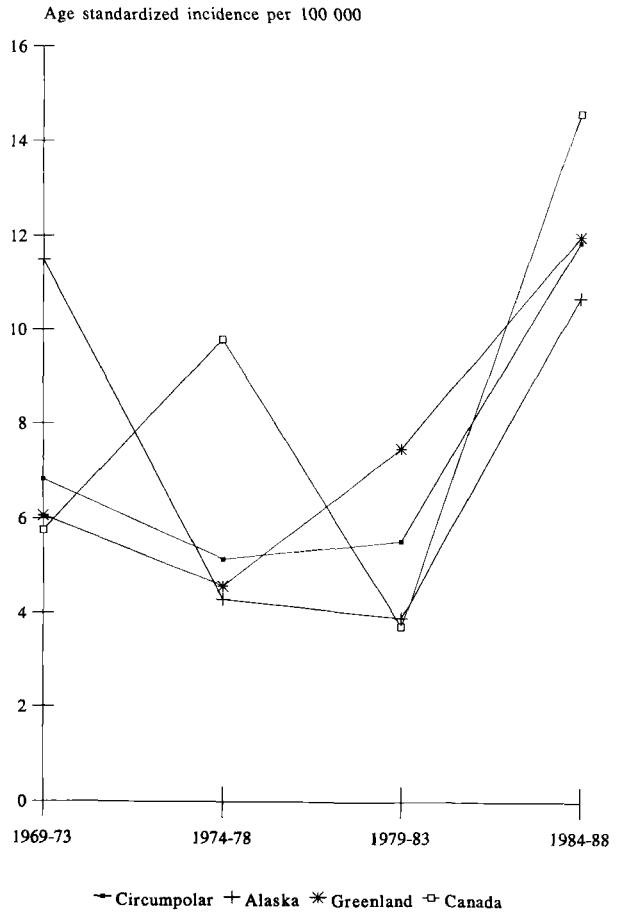

Fig. 4. Trends in cancer incidence among Inuit: ICD9 151 Stomach, Women.

fruit and vegetables and fibre-rich food (cereals); factors that may increase the risk are total and saturated fats, animal and total proteins, and total calories (21, 22).

The high risk of colon cancer among Alaskan Inuit compared with their counterparts in Greenland and Canada remains unexplained. Caution is necessary when attempting to interpret such findings. In addition to possible differences in diet, access to health care, availability of specialized diagnostic procedures, methods used to record and classify cancers, including definitions used for multiple primaries must all be considered.

The Inuit diet, as earlier described (1–3), would tend to increase the risk of colon cancer, particularly in Alaska, where the Inuit incorporated dietary habits from the South earlier than other Circumpolar populations. However, the proportion of poly- and mono-unsaturated fats consumed is relativley high, which may constitute a protective factor (22) that varies within the Circumpolar region, particularly for populations retaining a more traditional diet.

Rectum (ICD9-154)

Results. From 1969 to 1988 a total of 104 cancers of the rectum and rectosigmoid junction were reported among the three Inuit populations, 58 among men and 46 among women (Table 7). Based on age-standardized rates, a small male predominance was seen as in most parts of the world (5), with a male:female ratio of 1.2. For colon cancer, the age-standardized incidence rates were highest among Alaskan Inuit men, and male rates in Alaska were by and large similar to those in the three comparison populations of Connecticut, Denmark and Canada (SIR 0.8–0.9). In contrast, the SIRs for Greenlandic Inuit men ranged between 0.6 and 0.7, and Canadian Inuit men between 0.4 and 0.5 with an upper confidence boundary of less than 1.0, the risk was thus significantly lower than in the comparison populations. Among women, only the risk among Greenlandic Inuit was significantly low, with an SIR of 0.4 and an upper confidence limit of 0.8.

Incidence rates among Canadian Inuit men were half those of Alaska, whereas Greenlandic Inuit men took an intermediate position (Table 7). This constrasts with the observations among women, where Canadian Inuit took the lead with an ASR of 12.3 per 100 000 over the Alaska-Inuit ASR of 10.0, while the Greenlandic ASR of 4.4 was just over one-third of the Canadian rate.

The age-specific incidence pattern of rectal cancer

Table 6

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR World)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

153 Colon			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	123	12.5	23.8	0.9	0.7	0.6–0.8	1.2	1.0–1.4	1.0	0.8–1.1
		Alaska	70	20.8	34.6	1.1	1.0	0.8–1.3	1.7	1.3–2.1	1.4	1.1–1.8
		Greenland	33	7.9	14.2	0.8	0.5	0.3–0.6	0.8	0.5–1.1	0.6	0.4–0.9
		Canada	20	8.6	21.0	0.7	0.6	0.4–0.9	1.0	0.6–1.6	0.8	0.5–1.3
	1969–73	Circumpolar	19	8.8	19.4	0.9	0.6	0.4–1.0	1.1	0.7–1.8	1.0	0.6–1.5
		Alaska	9	12.7	26.4	1.1	0.8	0.4–1.5	1.4	0.6–2.7	1.2	0.5–2.3
		Greenland	8	8.2	16.9	1.2	0.6	0.3–1.2	1.1	0.5–2.2	0.9	0.4–1.8
		Canada	2	4.3	7.9	0.2	0.4	0.0–1.3	0.6	0.1–2.2	0.5	0.1–1.9
	1974–78	Circumpolar	25	10.6	20.2	0.9	0.6	0.4–0.9	1.0	0.7–1.5	0.9	0.6–1.3
		Alaska	14	17.7	29.6	1.2	0.9	0.5–1.5	1.5	0.8–2.5	1.3	0.7–2.2
		Greenland	7	6.8	13.0	0.7	0.4	0.2–0.9	0.7	0.3–1.4	0.6	0.2–1.2
		Canada	4	7.3	17.3	0.7	0.5	0.1–1.4	0.9	0.2–2.3	0.8	0.2–1.9
	1979–83	Circumpolar	35	13.7	24.9	0.9	0.7	0.5–1.0	1.2	0.8–1.7	1.0	0.7–1.4
		Alaska	22	25.3	40.1	1.1	1.1	0.7–1.7	1.9	1.2–2.9	1.6	1.0–2.3
		Greenland	7	6.6	10.9	0.7	0.4	0.1–0.7	0.6	0.2–1.2	0.5	0.2–1.0
		Canada	6	9.5	18.3	1.1	0.7	0.3–1.5	1.2	0.4–2.5	0.9	0.3–2.0
	1984–88	Circumpolar	44	15.7	27.8	0.9	0.7	0.5–1.0	1.2	0.9–1.7	1.0	0.7–1.3
		Alaska	25	25.2	37.9	1.2	1.1	0.7–1.6	1.8	1.1–2.6	1.4	0.9–2.1
		Greenland	11	9.8	16.9	0.7	0.5	0.2–0.8	0.8	0.4–1.4	0.6	0.3–1.1
		Canada	8	11.6	30.6	0.8	0.7	0.3–1.4	1.2	0.5–2.3	0.9	0.4–1.8
Females	1969–88	Circumpolar	163	17.0	28.3	1.3	1.1	0.9–1.2	1.4	1.2–1.6	1.2	1.0–1.4
		Alaska	97	29.6	49.3	2.4	1.8	1.5–2.2	2.4	1.9–2.9	2.1	1.7–2.6
		Greenland	49	12.1	17.6	0.7	0.7	0.5–0.9	0.9	0.6–1.2	0.8	0.6–1.0
		Canada	17	7.6	15.4	0.9	0.7	0.4–1.1	0.8	0.5–1.4	0.7	0.4–1.2
	1969–73	Circumpolar	32	15.1	29.4	1.4	1.1	0.8–1.6	1.6	1.1–2.3	1.4	0.9–1.9
		Alaska	12	17.2	33.6	1.6	1.3	0.7–2.3	1.8	0.9–3.1	1.5	0.8–2.7
		Greenland	15	15.4	26.9	1.3	1.1	0.6–1.7	1.5	0.8–2.5	1.3	0.7–2.1
		Canada	5	11.3	26.1	1.5	1.1	0.3–2.5	1.5	0.5–3.5	1.3	0.4–2.9
	1974–78	Circumpolar	34	14.8	26.3	0.9	1.0	0.7–1.4	1.3	0.9–1.8	1.1	0.8–1.6
		Alaska	18	23.4	44.6	0.5	1.6	0.9–2.5	2.0	1.2–3.2	1.8	1.1–2.8
		Greenland	13	13.0	19.8	1.3	0.8	0.4–1.3	1.0	0.5–1.7	0.9	0.5–1.5
		Canada	3	5.7	12.0	0.7	0.5	0.1–1.5	0.7	0.1–2.0	0.6	0.1–1.7
	1979–83	Circumpolar	40	16.2	26.4	1.2	1.0	0.7–1.3	1.3	0.9–1.7	1.1	0.8–1.5
		Alaska	26	31.1	50.5	2.7	1.9	1.2–2.7	2.4	1.6–3.5	2.1	1.4–3.1
		Greenland	9	8.8	12.0	0.2	0.5	0.2–0.9	0.6	0.3–1.1	0.5	0.2–1.0
		Canada	5	8.2	16.7	1.0	0.8	0.2–1.8	0.9	0.3–2.2	0.8	0.3–1.9
	1984–88	Circumpolar	57	20.9	30.4	1.6	1.1	0.9–1.5	1.5	1.1–1.9	1.3	1.0–1.7
		Alaska	41	42.2	61.0	4.0	2.2	1.6–3.0	2.9	2.1–4.0	2.6	1.9–3.5
		Greenland	12	11.1	13.9	0.4	0.5	0.3–0.9	0.7	0.4–1.2	0.6	0.3–1.1
		Canada	4	5.9	10.1	0.6	0.4	0.1–1.1	0.6	0.2–1.5	0.5	0.1–1.3

among both Inuit men and women is similar to that seen in Denmark, with practically no cases below age 40 years and a steep increase in incidence with increasing age, as for any other carcinoma (Tables 4, 5). The rates, however, were somewhat lower than those observed in the comparison populations, reflecting the overall lower incidence described above.

A decreasing trend over time was seen for rectal cancer among Inuit men (Fig. 7), with a small upturn in the most recent time period. Among women, ASRs were stable at around 8 per 100 000 (Fig. 8). Incidence rates of rectal cancer should always be interpreted by giving consideration to possible misclassification of cancers of the rectosigmoid junction in the past, when pathological and endoscopy diagnostic methods were less frequently used.

High validity for diagnosis of rectal cancer was found with an average of 88% histologically verified during the entire study period, and 4% recorded from death certificates only (Table 2). These figures match those reported from Denmark, Canada and Connecticut. No particular improvement in histologic verification over time was found that could explain the observed trends.

Discussion. Considerable international variation in incidence of rectal cancer exists from ASRs of 22.7 per

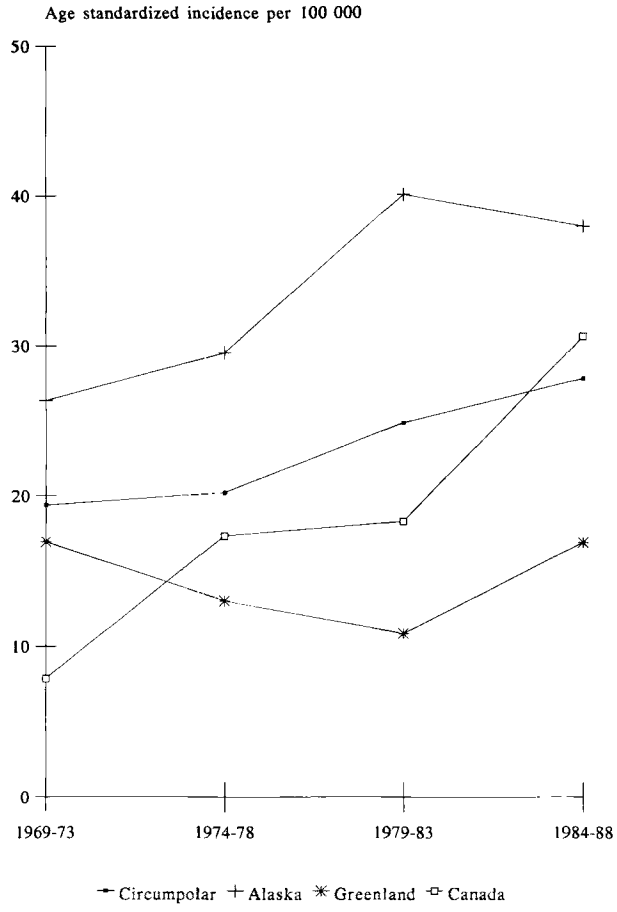

Fig. 5. Trends in cancer incidence among Inuit: ICD9 153 Colon, Men.

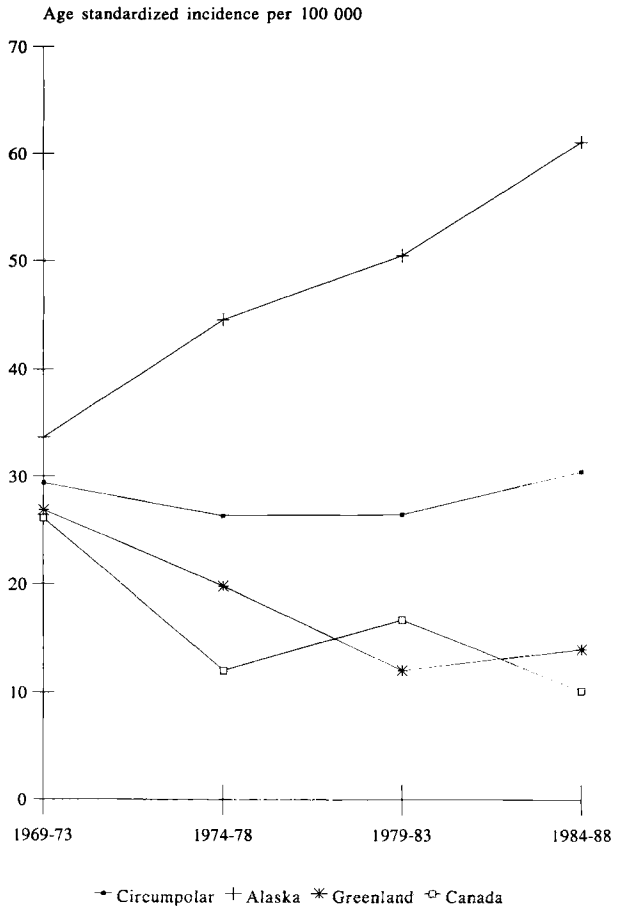

Fig. 6. Trends in cancer incidence among Inuit: ICD9 153 Colon, Women.

100 000 among male Israeli Jews (US or European born) to less than five in Africa, India and Asia (5). Among females, Israeli Jews (US or European born) top the list at 15.9, while Indians, Arabs and Asians have the lowest rates. Male and female Inuit populations, when combined, experience ASRs similar to those observed in Japan and in parts of Europe (UK, Spain, Hungary), close to average ASRs world-wide. However, ASRs among female Inuit in Alaska and Canada are among the highest in the world.

The large international variation and the close correlation to colon cancer (23) have led to the suggestion that colon and rectal cancers share risk factors (24), of which diet is the most important (21, 25). These factors include: a positive correlation with consumption of meat and animal fat, which may be mediated by exposure to faecal bile acids excreted as a response to fat intake (23); alcohol—particularly beer consumption described earlier by Breslow & Enström (26) and confirmed by many studies, most recently by Newcomb et al. (27); medical conditions such as familial polyposis; and inflammatory bowel disease.

Dietary differences likely exist among Inuit groups. If colon and rectal cancers are taken together, ASRs were highest in Alaska and second highest in Canada with similar ASRs in Greenland. The diet of Alaskan Inuit may differ from the other Inuit populations by including a higher percentage of animal fat—either as a consequence of a faster influx of dietary changes from the South or because of hunting of land-based animals. Hunting is less prevalent in Greenland, where traditional food items such as fish, fish roe, fish liver, meat and blubber from whale and seal, arctic birds and mutton are important food constituents (10). While differences in alcohol consumption may occur among the areas, alcohol consumption is generally high, and the increase in alcohol consumption in Greenland (1) does not correlate with a decreasing trend in incidence of rectal cancer and the slight increase in colon cancer. A recent study of Greenlandic migrants to Denmark revealed that the risk of rectal cancer increased dramatically (28). Differences in incidence rates and trends between colon and rectal cancer should be interpreted cautiously since misclassification between the two sites undoubtedly occurs. The differences in rates and trends between sexes in Canada are most likely due to misclassification combined with chance variation from small numbers, since ASRs for colorectal cancers combined are relatively stable. Future studies should be aimed

Table 7

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR world)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

154 Rectum			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	58	5.9	11.0	0.7	0.6	0.5–0.8	0.7	0.5–0.9	0.7	0.5–0.9
		Alaska	28	8.3	14.0	0.9	0.8	0.5–1.1	0.9	0.6–1.2	0.9	0.6–1.3
		Greenland	23	5.5	10.8	0.7	0.6	0.4–0.9	0.7	0.4–1.0	0.7	0.4–1.0
		Canada	7	3.0	6.0	0.4	0.4	0.2–0.8	0.4	0.2–0.9	0.5	0.2–0.9
	1969–73	Circumpolar	16	7.4	16.3	1.1	0.9	0.5–1.5	1.0	0.6–1.6	1.2	0.7–1.9
		Alaska	8	11.3	21.4	1.5	1.2	0.5–2.3	1.3	0.6–2.6	1.5	0.7–3.0
		Greenland	5	5.1	10.5	0.9	0.7	0.2–1.5	0.7	0.2–1.7	0.8	0.3–2.0
		Canada	3	6.4	14.4	0.8	0.9	0.2–2.6	1.0	0.2–2.8	1.1	0.2–3.3
	1974–78	Circumpolar	13	5.5	10.7	0.6	0.6	0.3–1.0	0.7	0.3–1.1	0.7	0.4–1.3
		Alaska	8	10.1	17.8	1.1	1.0	0.4–1.9	1.0	0.4–2.0	1.2	0.5–2.3
		Greenland	3	2.9	6.1	0.4	0.3	0.1–1.0	0.4	0.1–1.0	0.4	0.1–1.2
		Canada	2	3.6	6.8	0.2	0.5	0.1–1.8	0.5	0.1–1.9	0.6	0.1–2.1
	1979–83	Circumpolar	10	3.9	7.5	0.6	0.4	0.2–0.8	0.4	0.2–0.8	0.4	0.2–0.8
		Alaska	2	2.3	4.7	0.6	0.2	0.0–0.7	0.2	0.0–0.8	0.2	0.0–0.8
		Greenland	6	5.7	11.4	0.6	0.6	0.2–1.3	0.6	0.2–1.4	0.6	0.2–1.4
		Canada	2	3.2	5.6	0.6	0.4	0.0–1.6	0.5	0.1–1.8	0.5	0.1–1.7
	1984–88	Circumpolar	19	6.8	11.5	0.6	0.7	0.4–1.1	0.8	0.5–1.2	0.7	0.4–1.1
		Alaska	10	10.1	15.7	0.6	1.0	0.5–1.7	1.0	0.5–1.9	1.0	0.5–1.8
		Greenland	9	8.0	13.2	0.8	0.8	0.4–1.5	0.9	0.4–1.7	0.8	0.4–1.5
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
Females	1969–88	Circumpolar	46	4.8	7.7	0.4	0.7	0.5–1.0	0.8	0.6–1.1	0.8	0.6–1.1
		Alaska	20	6.1	10.0	0.4	0.9	0.6–1.4	1.0	0.6–1.6	1.0	0.6–1.6
		Greenland	12	3.0	4.4	0.3	0.4	0.2–0.7	0.4	0.2–0.8	0.4	0.2–0.8
		Canada	14	6.2	12.3	0.7	1.3	0.7–2.2	1.4	0.8–2.4	1.4	0.8–2.4
	1969–73	Circumpolar	8	3.8	7.7	0.3	0.7	0.3–1.3	0.7	0.3–1.4	0.8	0.3–1.6
		Alaska	4	5.7	10.4	1.0	1.0	0.3–2.7	1.1	0.3–2.7	1.2	0.3–3.2
		Greenland	2	2.1	3.7	0.0	0.3	0.0–1.2	0.3	0.0–1.3	0.4	0.0–1.4
		Canada	2	4.5	12.4	0.0	1.0	0.1–3.7	1.1	0.1–3.8	1.2	0.1–4.3
	1974–78	Circumpolar	10	4.4	7.3	0.4	0.7	0.3–1.2	0.8	0.4–1.4	0.8	0.4–1.5
		Alaska	4	5.2	10.0	0.2	0.8	0.2–2.0	0.9	0.2–2.3	1.0	0.3–2.5
		Greenland	4	4.0	6.3	0.3	0.5	0.1–1.4	0.6	0.2–1.6	0.7	0.2–1.7
		Canada	2	3.8	5.1	0.6	0.8	0.1–2.9	0.9	0.1–3.2	0.9	0.1–3.4
	1979–83	Circumpolar	13	5.3	8.5	0.7	0.8	0.4–1.3	0.8	0.4–1.4	0.8	0.4–1.4
		Alaska	4	4.8	7.7	0.1	0.7	0.2–1.8	0.8	0.2–1.9	0.7	0.2–1.9
		Greenland	5	4.9	7.3	0.8	0.6	0.2–1.4	0.7	0.2–1.5	0.7	0.2–1.5
		Canada	4	6.6	14.2	1.2	1.4	0.4–3.7	1.5	0.4–4.0	1.5	0.4–3.9
	1984–88	Circumpolar	15	5.5	7.5	0.3	0.8	0.5–1.3	0.9	0.5–1.5	0.8	0.5–1.3
		Alaska	8	8.2	10.6	0.3	1.2	0.5–2.3	1.3	0.6–2.6	1.2	0.5–2.4
		Greenland	1	0.9	1.0	0.1	0.1	0.0–0.7	0.1	0.0–0.7	0.1	0.0–0.7
		Canada	6	8.9	14.5	0.7	1.8	0.7–3.9	2.0	0.7–4.3	1.8	0.6–3.9

at elucidating dietary habits in the three populations as they relate to colo-rectal cancer.

Liver (ICD9-155)

Results. A total of 53 primary liver cancers among men were recorded in the Circumpolar regions, the majority among Alaskan Inuit (37 cases), followed by Greenland (n = 15), and only one among Canadian Inuit (Table 8). The combined ASR of 8 per 100 000 comprises the high Alaska ASR of 15.1, the Greenland ASR of 5.7, and the Canada ASR of 1.0. The 16 cases occurring among women were more evenly distributed among the three Inuit populations, as ASRs of 2.3, varying from 2.0 to 3.1, were observed. Liver cancer was almost 4 times as frequent in Inuit men than in women. The lifetime probability of liver cancer based on the cumulative rate to age 64 was as high as 0.5% in men and 0.1% in women.

Among Inuit men, the risk of liver cancer was 3–4 times higher than in Connecticut, Denmark and Canada (Table 8). Only a slight decrease in the overall SIRs was seen over time because a clearly decreasing incidence trend since 1969–73 in Alaska (Fig. 9), the area of highest incidence, was matched by a clearly increasing trend among Green-

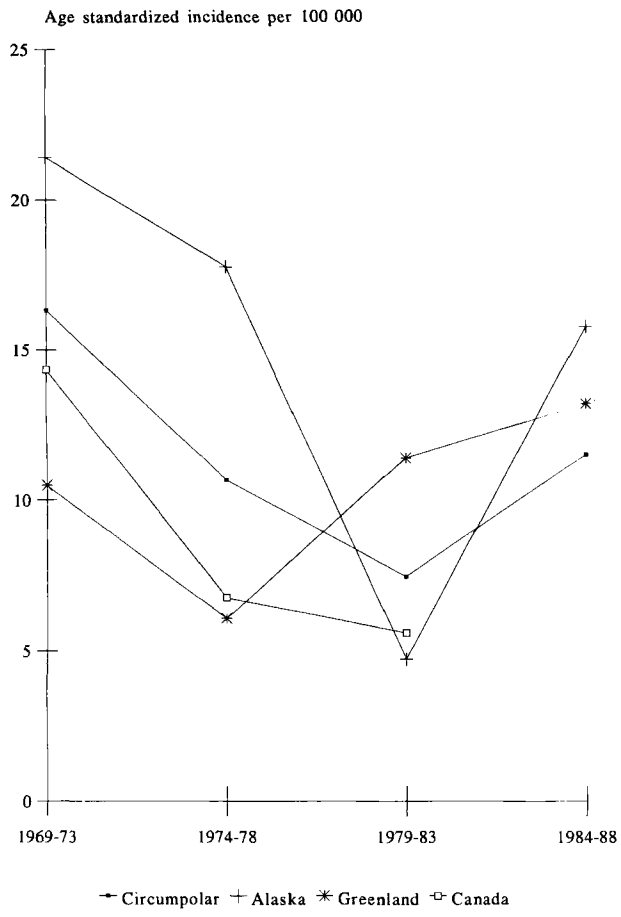

Fig. 7. Trends in cancer incidence among Inuit: ICD9 154 Rectum, Men.

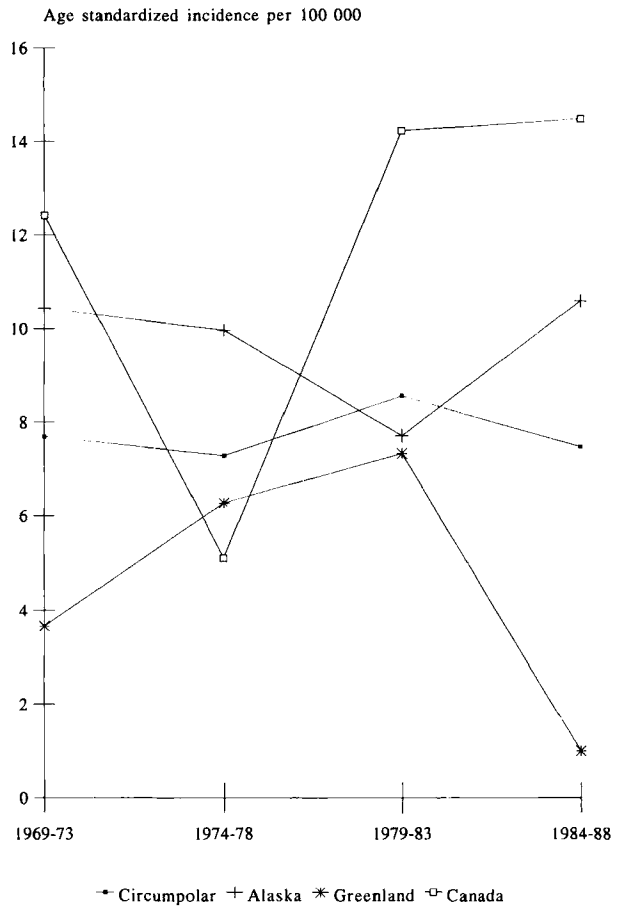

Fig. 8. Trends in cancer incidence among Inuit: ICD9 154 Rectum, Women.

land Inuit since 1974–1978. Moreover, the decrease in primary liver cancer in Alaska was compensated by a similar increase in gallbladder and biliary tract cancer (see below), suggesting that some misclassification may have occurred. In Inuit women, SIRs ranged between 1.5 and 2.6 and decreased from a range of 4 to 7 in the early period (1969–1973) to between 1 and 2 in 1984–1988. These trends are also apparent for the age-standardized incidence rates (Fig. 10).

Age-specific incidence rates (Tables 4, 5) show an unusual pattern, where rates for children and young adults under age 25, predominantly in Alaska, are 5–10 times the combined world experience (5). This cluster in young Inuit has been described earlier (29, 30). Otherwise, the age-specific incidence follows the normal pattern of carcinomas with an increasing incidence by age.

The validity of diagnosis may be questioned, in particular concerning liver, a frequent site of metastatic cancer. However, the histologic verification is as high as 93% (Table 2), and only 3% (2 cases) was based on death certificates only (among women in Canada and Greenland). Furthermore, based on the data from Greenland and Alaska (10, 29), the morphological types clearly belong to the liver.

Discussion. World-wide, cancer of the liver is among the most prevalent form of cancer, in many African and Asian countries (31) exceeded only by lung and cervical cancer. Compared to Connecticut, Denmark and Canada, SIRs among Inuit were high. Inuit men have the 25th highest incidence in the world (Alaskan 14th), and Inuit women the 40th (5). The causes of liver cancer of relevance to the Inuit populations are infection with hepatitis B virus (HBV) (32), and alcohol consumption or other exposures leading to cirrhosis (33). Alcohol consumption among the Inuit is a recognized and growing problem, and in Greenland a consumption twice that of the Danish and three to four times that of the other Nordic countries was reproted (1, 10).

A viral etiology has been strongly implicated (29, 34) by a high prevalence of HBV infection, resulting in initiation of an HBV immunization programme in Alaska in 1983 (35). Although very successfully reducing the incidence of HBV infection from 215 to 14 per 100 000, this programme is unlikely to have had any impact on the observed decrease in liver cancer incidence seen in Alaska in our data. The low liver cancer incidence in Greenland is surprising, considering the reported high prevalence of surface antigen

Table 8

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR world)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

155 Liver			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	53	5.4	8.0	0.5	4.0	3.0–5.2	3.1	2.3–4.0	4.1	3.0–5.3
		Alaska	37	11.0	15.1	1.1	7.2	5.1–9.9	5.5	3.9–7.6	7.4	5.2–10.2
		Greenland	15	3.6	5.7	0.4	2.7	1.5–4.5	2.1	1.2–3.4	2.8	1.5–4.5
		Canada	1	0.4	1.0	0.0	0.4	0.0–2.2	0.3	0.0–1.7	0.4	0.0–2.1
	1969–73	Circumpolar	11	5.1	7.7	0.6	5.5	2.7–9.8	4.3	2.1–7.7	5.6	2.8–9.9
		Alaska	9	12.7	18.1	1.7	12.1	5.5–22.9	9.6	4.4–18.1	12.2	5.6–23.1
		Greenland	2	2.1	3.2	0.0	2.3	0.3–8.1	1.8	0.2–6.4	2.3	0.3–8.4
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1974–78	Circumpolar	11	4.7	7.2	0.5	4.6	2.3–8.2	2.8	1.4–5.0	4.1	2.0–7.3
		Alaska	8	10.1	14.0	1.1	8.7	3.8–17.2	5.3	2.3–10.5	7.9	3.4–15.5
		Greenland	2	2.0	2.7	0.2	2.0	0.2–7.1	1.2	0.1–4.4	1.8	0.2–6.4
		Canada	1	1.8	4.3	0.0	2.2	0.0–12.2	1.3	0.0–7.4	1.9	0.0–10.5
	1979–83	Circumpolar	14	5.5	8.6	0.7	4.0	2.2–6.7	2.9	1.6–4.9	4.1	2.2–6.9
		Alaska	10	11.5	16.5	1.4	7.2	3.4–13.2	5.2	2.5–9.6	7.6	3.6–13.9
		Greenland	4	3.8	6.6	0.6	2.7	0.7–7.0	2.0	0.5–5.1	2.8	0.8–7.1
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1984–88	Circumpolar	17	6.1	8.4	0.4	3.2	1.9–5.1	2.9	1.7–4.6	3.4	2.0–5.5
		Alaska	10	10.1	12.2	0.4	4.8	2.3–8.8	4.2	2.0–7.8	5.2	2.5–9.6
		Greenland	7	6.2	9.5	0.5	3.3	1.3–6.7	2.9	1.2–6.0	3.5	1.4–7.1
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
Females	1969–88	Circumpolar	16	1.7	2.3	0.1	2.6	1.5–4.2	1.5	0.8–2.4	2.3	1.3–3.7
		Alaska	6	1.8	2.0	0.1	2.8	1.0–6.0	1.6	0.6–3.5	2.5	0.9–5.4
		Greenland	7	1.7	2.4	0.1	2.4	1.0–5.0	1.4	0.6–2.8	2.1	0.9–4.4
		Canada	3	1.3	3.1	0.2	2.6	0.5–7.5	1.5	0.3–4.5	2.3	0.5–6.9
	1969–73	Circumpolar	6	2.8	5.1	0.4	6.7	2.4–14.6	3.8	1.4–8.4	4.9	1.8–10.7
		Alaska	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
		Greenland	4	4.1	6.6	0.4	9.1	2.5–23.4	5.1	1.4–13.1	6.7	1.8–17.1
		Canada	2	4.5	13.7	0.9	12.6	1.4–45.4	7.4	0.8–26.8	9.2	1.0–33.2
	1974–78	Circumpolar	4	1.7	2.5	0.3	2.9	0.8–7.3	1.6	0.4–4.0	2.5	0.7–6.4
		Alaska	2	2.6	2.9	0.3	4.2	0.5–15.2	2.3	0.3–8.2	3.7	0.4–13.5
		Greenland	1	1.0	1.6	0.2	1.5	0.0–8.4	0.8	0.0–4.6	1.3	0.0–7.2
		Canada	1	1.9	3.9	0.4	3.9	0.1–21.7	2.2	0.0–12.3	3.5	0.0–19.4
	1979–83	Circumpolar	2	0.8	0.6	0.0	1.1	0.1–3.9	0.6	0.1–2.3	1.1	0.1–4.0
		Alaska	2	2.4	1.7	0.1	3.1	0.3–11.2	1.8	0.2–6.6	3.2	0.4–11.6
		Greenland	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1984–88	Circumpolar	4	1.5	2.0	0.0	1.9	0.5–5.0	1.2	0.3–2.9	1.7	0.5–4.4
		Alaska	2	2.1	2.6	0.0	2.7	0.3–9.6	1.6	0.2–5.7	2.4	0.3–8.5
		Greenland	2	1.9	2.5	0.0	2.2	0.3–8.0	1.3	0.1–4.6	1.9	0.2–6.9
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–

to HBV among Greenlanders (36). The findings may be due, in part, to underreporting of this cancer, either as an unknown primary, or because cases were missed due to poor survival rates for this cancer. However, differences in age at infection may play an important role, and the observation of liver cancer among young Inuit—particularly in Alaska—is intriguing.

Gallbladder and biliary tract (ICD9-156)

Results. The incidence of cancer of the gallbladder and biliary tract among Inuit showed a female preponderance, with, as elsewhere in the world (5), a male-female ratio of around 0.6 (Table 9). The 23 cases among men and 42 cases among women gave rise to ASRs of 4.5 per 100 000 among men and 7.4 among women, which place the Inuit as sixth and fifth highest in the world for men and women respectively. American Indians from New Mexico have the world's highest rates, twice those for Inuit. Among men, ASRs for Asian populations, Korean in Los Angeles and Japanese are somewhat higher than those for Inuit, as are ASRs for women in Poland and Colombia. Age-specific incidence rates did not deviate from those expected, and only one case was observed below the age range 40–44 (Tables 4, 5).

SIRs for both men and women were significantly in-

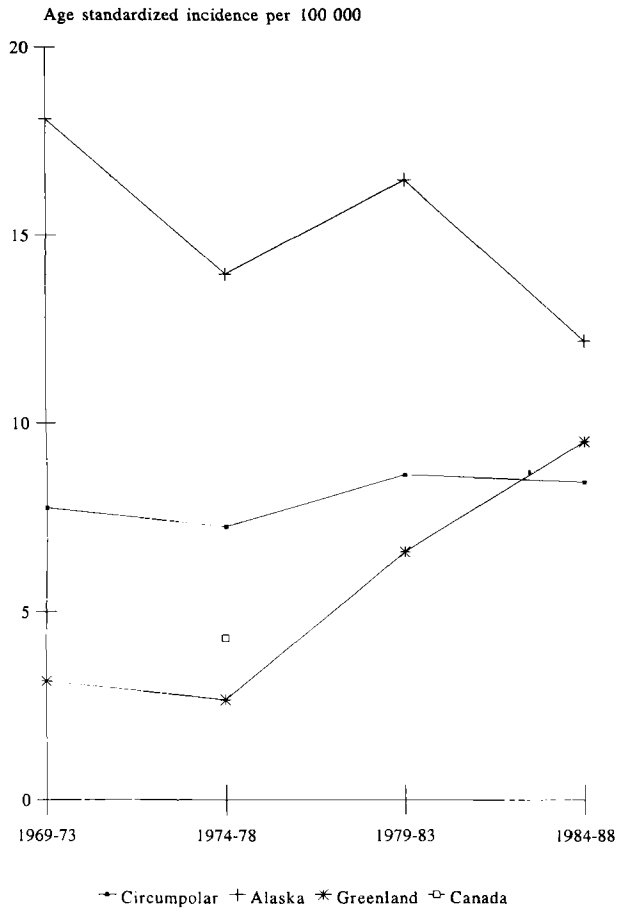

Fig. 9. Trends in cancer incidence among Inuit: ICD9 155 Liver, Men.

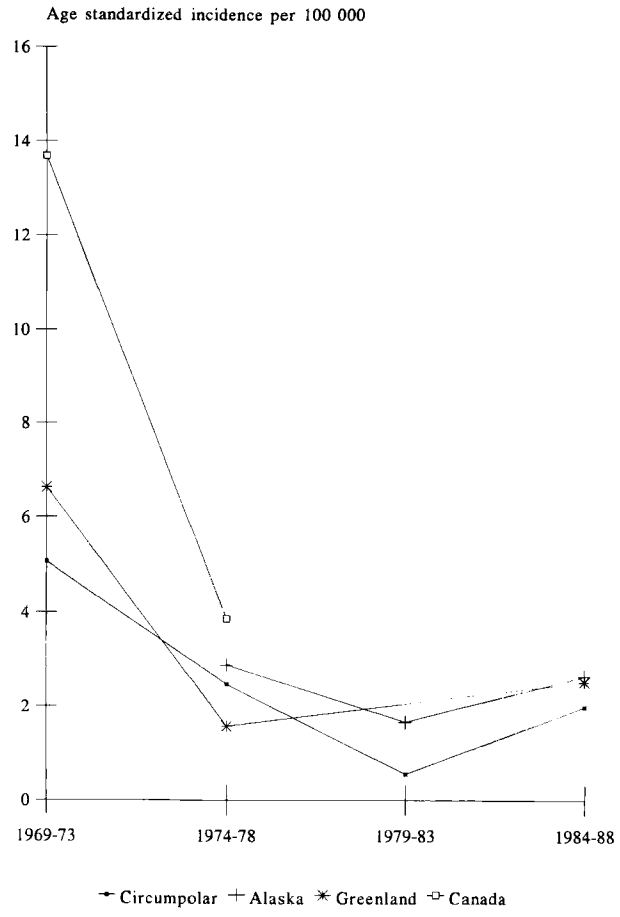

Fig. 10. Trends in cancer incidence Inuit: ICD9 155 Liver, Women.

creased two-to-four fold in comparison to the populations of Connecticut, Denmark and Canada (Table 9). The increase, however, was based entirely on the cases from Alaska which, as for cancer of the liver, accounted for more than half of the total number of Circumpolar cancers of the gallbladder and biliary tract.

Time trends (Fig. 11, 12) differed among men and women. Although ASRs were based on few cases, the two largest contributors, Alaska and Greenland, agreed on the general trend of a decrease among women and an increase among men. Liver and biliary tract cancers were both on the decrease among women, whereas the opposite trend was found in men with a decrease for liver and an increase for gallbladder and biliary tract cancer. Although this observation could result from cross-classification of cancer between sites, both Boss et al. (37) and Prener et al. (10) showed a remarkable sex differential in subsites, with gallbladder appearing as virtually the only site in biliary tract cancer among Inuit women. In the Greenland series (10), half of the biliary tract cancers among men were found in the Ampulla of Vater contrary to women where only one case ($< 10\%$) was found in this location. Among the Circumpolar Inuit, 95% of cases were histologically verified (Table 2), with no variation occurring among Inuit populations or over time.

Discussion. High incidence rates of biliary tract cancer reported among New Mexican Indians and Alaskan Natives (37) were found in Alaska to coincide with a high incidence of non-malignant gallbladder disease identified among cholelcystectomized patients. Earlier reports from Canada (7) and Greenland (10) did not show the same high rates, and the differences among the Inuit populations still remain. Boss et al. speculated (37) on whether a genetic component from intermarriage between Inuit and Indians in Alaska could account for the differences, but this explanation was discarded by the authors due to limited intermarriage between the ethnic groups.

Gallbladder cancer and gall-stones share epidemiologic characteristics (38). Obesity, dietary fat, low fibre diet, cholesterol and carbohydrates have been mentioned as possible causes, but no firm evidence of a link exists. A high fat, low fibre diet mediated by bile acid metabolism is believed to play a role in colo-rectal cancers (see above), cancers where the Alaskan Inuit have the highest incidence. Thus, differences in diet among the Inuit groups may offer an explanation.

Table 9

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR world)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

156 Gall bladder			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	23	2.3	4.5	0.3	2.4	1.5–3.5	2.2	1.4–3.3	2.5	1.6–3.7
		Alaska	13	3.9	6.9	0.4	3.3	1.8–5.7	3.2	1.7–5.4	3.5	1.9–6.1
		Greenland	7	1.7	2.8	0.2	1.7	0.7–3.6	1.6	0.7–3.3	1.8	0.7–3.8
		Canada	3	1.3	2.5	0.1	1.7	0.3–4.8	1.5	0.3–4.5	1.7	0.3–5.1
	1969–73	Circumpolar	4	1.9	4.4	0.1	1.9	0.5–4.9	1.9	0.5–4.8	2.6	0.7–6.7
		Alaska	2	2.8	5.3	0.0	2.5	0.3–9.0	2.4	0.3–8.8	3.4	0.4–12.3
		Greenland	2	2.1	4.2	0.2	2.2	0.2–8.0	2.2	0.2–7.9	3.0	0.3–11.0
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1974–78	Circumpolar	2	0.8	1.9	0.0	1.0	0.1–3.4	0.8	0.1–2.8	1.0	0.1–3.6
		Alaska	1	1.3	2.3	0.0	1.2	0.0–6.7	1.0	0.0–5.4	1.3	0.0–7.0
		Greenland	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
		Canada	1	1.8	4.3	0.0	2.5	0.0–14.2	2.1	0.0–11.5	2.6	0.0–14.7
	1979–83	Circumpolar	6	2.3	4.1	0.2	2.0	0.7–4.4	2.2	0.8–4.9	2.2	0.8–4.8
		Alaska	4	4.6	7.7	0.5	3.3	0.9–8.3	3.7	1.0–9.5	3.7	1.0–9.4
		Greenland	1	0.9	1.1	0.1	0.8	0.0–4.5	0.9	0.0–5.0	0.9	0.0–4.9
		Canada	1	1.6	2.4	0.2	1.9	0.0–10.5	2.1	0.0–11.5	2.0	0.0–11.4
	1984–88	Circumpolar	11	3.9	7.0	0.6	4.3	2.1–7.7	3.7	1.9–6.7	3.7	1.8–6.6
		Alaska	6	6.1	10.3	0.9	5.7	2.1–12.5	5.1	1.8–11.0	5.0	1.8–10.9
		Greenland	4	3.6	5.7	0.4	3.9	1.0–9.9	3.4	0.9–8.6	3.3	0.9–8.5
		Canada	1	1.5	2.1	0.2	2.0	0.0–11.3	1.8	0.0–9.8	1.8	0.0–9.7
Females	1969–88	Circumpolar	42	4.4	7.4	0.4	3.6	2.6–4.8	2.2	1.6–3.0	3.2	2.3–4.3
		Alaska	27	8.2	13.4	0.6	6.6	4.4–9.6	4.2	2.7–6.0	5.9	3.9–8.6
		Greenland	10	2.5	3.6	0.3	1.8	0.8–3.2	1.1	0.5–2.0	1.6	0.8–2.9
		Canada	5	2.2	5.1	0.2	2.6	0.8–6.0	1.6	0.5–3.7	2.3	0.7–5.3
	1969–73	Circumpolar	10	4.7	9.3	0.6	3.8	1.8–6.9	2.5	1.2–4.6	3.9	1.8–7.1
		Alaska	7	10.0	18.7	1.5	8.0	3.2–16.6	5.2	2.1–10.8	8.3	3.3–17.0
		Greenland	3	3.1	5.2	0.4	2.2	0.4–6.5	1.5	0.3–4.4	2.3	0.5–6.7
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1974–78	Circumpolar	11	4.8	8.7	0.4	4.2	2.1–7.5	2.3	1.2–4.2	3.9	2.0–7.1
		Alaska	7	9.1	16.9	0.6	7.8	3.1–16.0	4.4	1.8–9.0	7.4	3.0–15.2
		Greenland	3	3.0	4.8	0.4	2.3	0.5–6.8	1.3	0.3–3.8	2.2	0.4–6.4
		Canada	1	1.9	3.4	0.3	2.3	0.0–12.8	1.3	0.0–7.2	2.2	0.0–12.0
	1979–83	Circumpolar	11	4.5	7.4	0.3	3.6	1.8–6.4	2.2	1.1–4.0	3.1	1.5–5.5
		Alaska	5	6.0	9.1	0.2	4.7	1.5–11.0	3.0	1.0–6.9	4.1	1.3–9.6
		Greenland	3	2.9	4.6	0.4	2.0	0.4–5.7	1.2	0.2–3.6	1.7	0.3–5.0
		Canada	3	4.9	14.7	0.4	6.2	1.3–18.2	3.8	0.8–11.0	5.2	1.0–15.2
	1984–88	Circumpolar	10	3.7	5.1	0.2	3.0	1.4–5.5	2.0	0.9–3.6	2.4	1.1–4.3
		Alaska	8	8.2	10.9	0.3	6.4	2.8–12.7	4.2	1.8–8.4	5.1	2.2–10.1
		Greenland	1	0.9	1.0	0.1	0.7	0.0–3.6	0.4	0.0–2.4	0.5	0.0–2.9
		Canada	1	1.5	3.0	0.0	1.7	0.0–9.5	1.1	0.0–6.3	1.3	0.0–7.4

Pancreas (ICD9-157)

Results. A total of 94 pancreatic cancers were reported during the study period, 49 in men and 45 in women (Table 10). Incidence rates among Inuit men were highest in Alaska and Greenland in the earlier years, and although the lowest ASRs occurred among Canadian Inuit in all four time periods, the Canadian ASRs moved closer over time to those for Alaska and Greenland (Fig. 13). Among Inuit women (Fig. 14) ASRs were comparable for Alaska and Greenland, with Canadian rates fluctuating widely.

Age-specific incidence rates for Inuit (Tables 4, 5) did not deviate from international patterns (5). However, ASRs did place Inuit women in the top ten and Inuit men in the top 20 of incidence registries world-wide. SIRs for pancreatic cancer revealed no significant differences among the Inuit and comparison populations.

Cancer of the pancreas is difficult to treat by surgery, and biopsy is less frequently used for diagnosis because of possible complications from proteolytic enzymes floating from the biopsy site into the abdominal cavity. Conse-

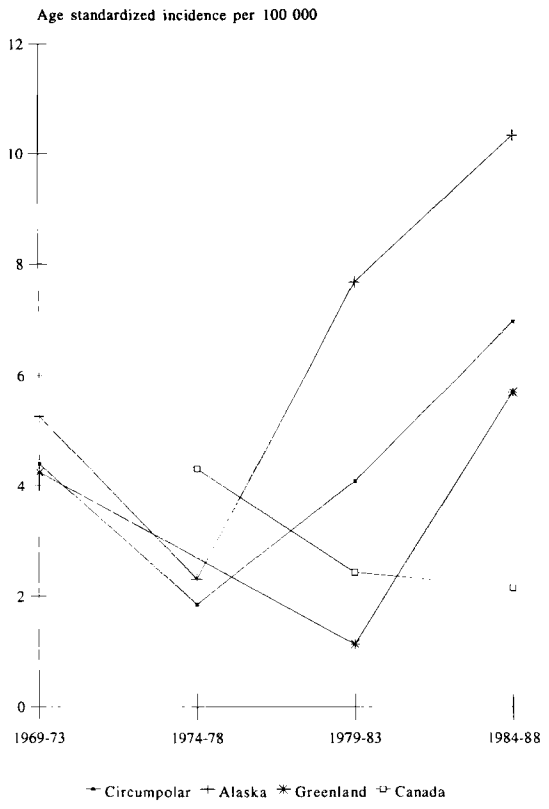

Fig. 11. Trends in cancer incidence among Inuit: ICD9 Gallbladder, Men.

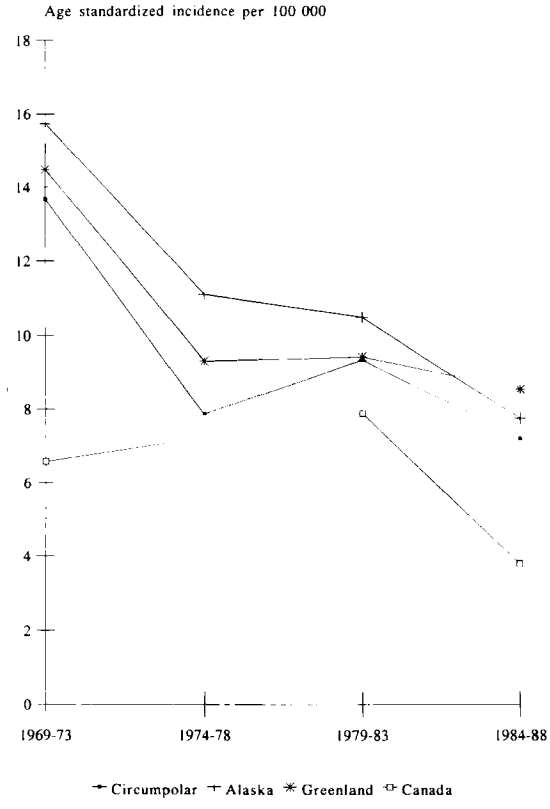

Fig. 13. Trends in cancer incidence among Inuit: ICD9 157 Pancreas, Men.

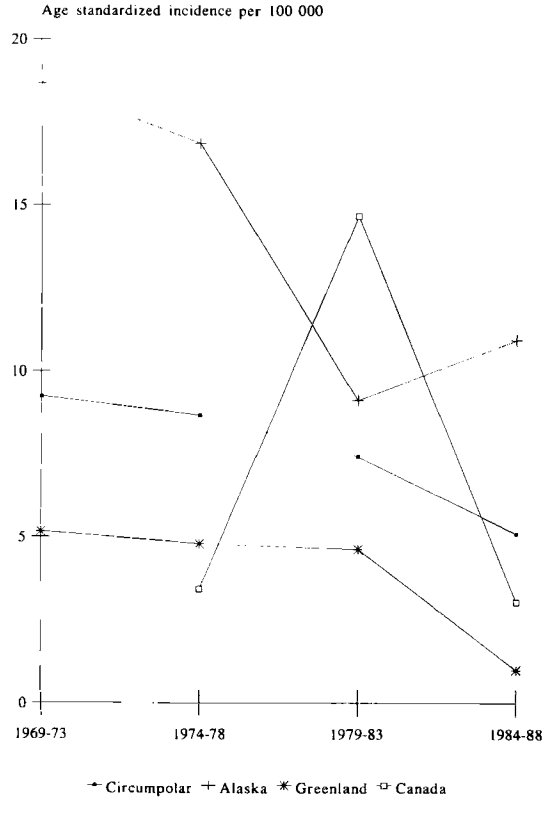

Fig. 12. Trends in cancer incidence among Inuit: ICD9 Gallbladder, Women.

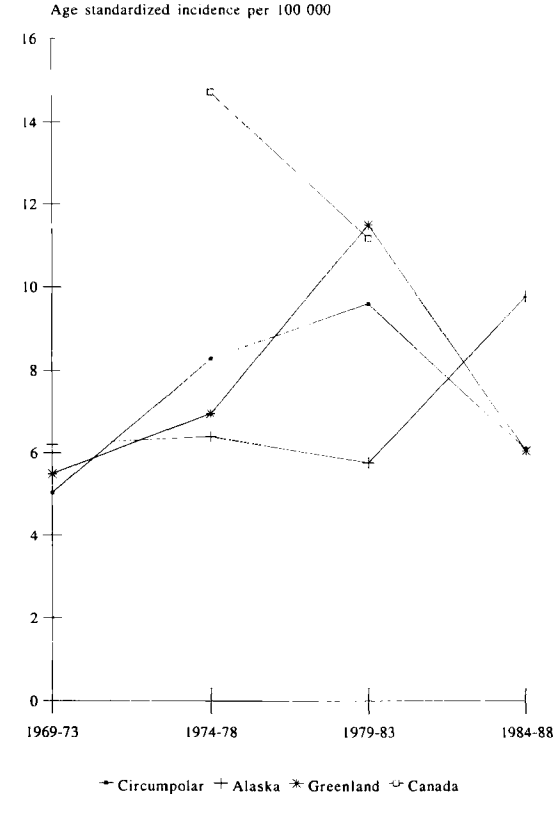

Fig. 14. Trends in cancer incidence among Inuit: ICD9 157 Pancreas, Women.

Table 10

Cancer in Circumpolar Inuit 1969–1988 by site (ICD 9). Total number of cases, crude-, age standardized (ASR world)- and cumulative (Cum 64) incidence rates by sex, region and 5-year time period. Standardized incidence ratios (SIR) and 95% confidence interval (95% CI) compared with Connecticut, Denmark and Canada

157 Pancreas			Total No.	Crude rate	ASR world	Cum 64	Connecticut		Denmark		Canada	
							SIR	95% CI	SIR	95% CI	SIR	95% CI
Males	1969–88	Circumpolar	49	5.0	9.1	0.5	1.1	0.8–1.4	1.0	0.8–1.3	1.1	0.8–1.5
		Alaska	21	6.2	10.4	0.6	1.2	0.7–1.8	1.1	0.7–1.7	1.2	0.7–1.8
		Greenland	23	5.5	10.2	0.6	1.2	0.8–1.8	1.1	0.7–1.7	1.2	0.8–1.8
		Canada	5	2.1	4.3	0.3	0.6	0.2–1.4	0.5	0.2–1.3	0.6	0.2–1.4
	1969–73	Circumpolar	13	6.0	13.7	0.9	1.5	0.8–2.5	1.3	0.7–2.3	1.5	0.8–2.6
		Alaska	5	7.0	15.7	0.6	1.5	0.5–3.4	1.4	0.4–3.2	1.6	0.5–3.7
		Greenland	7	7.2	14.5	1.2	1.8	0.7–3.8	1.7	0.7–3.5	1.9	0.8–4.0
		Canada	1	2.1	6.6	0.8	0.6	0.0–3.3	0.5	0.0–3.0	0.6	0.0–3.5
	1974–78	Circumpolar	10	4.2	7.9	0.4	0.9	0.4–1.7	0.9	0.4–1.6	1.0	0.5–1.9
		Alaska	5	6.3	11.1	0.5	1.2	0.4–2.8	1.1	0.4–2.6	1.3	0.4–3.0
		Greenland	5	4.9	9.3	0.6	1.1	0.4–2.6	1.0	0.3–2.4	1.2	0.4–2.8
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1979–83	Circumpolar	14	5.5	9.3	0.4	1.2	0.7–2.0	1.1	0.6–1.8	1.1	0.6–1.9
		Alaska	6	6.9	10.5	0.5	1.3	0.5–2.8	1.2	0.4–2.5	1.2	0.4–2.6
		Greenland	5	4.7	9.4	0.2	1.0	0.3–2.4	0.9	0.3–2.2	1.0	0.3–2.2
		Canada	3	4.7	7.9	0.8	1.4	0.3–4.1	1.3	0.3–3.7	1.3	0.3–3.8
	1984–88	Circumpolar	12	4.3	7.2	0.5	0.9	0.5–1.6	0.9	0.4–1.5	0.9	0.5–1.5
		Alaska	5	5.0	7.7	0.8	0.9	0.3–2.2	0.9	0.3–2.1	0.9	0.3–2.1
		Greenland	6	5.3	8.5	0.5	1.1	0.4–2.4	1.0	0.4–2.3	1.1	0.4–2.3
		Canada	1	1.5	3.8	0.0	0.4	0.0–2.1	0.4	0.0–2.0	0.4	0.0–2.1
Females	1969–88	Circumpolar	45	4.7	7.3	0.5	1.3	0.9–1.7	1.2	0.9–1.6	1.4	1.0–1.9
		Alaska	15	4.6	7.3	0.5	1.2	0.7–2.0	1.1	0.6–1.9	1.4	0.8–2.3
		Greenland	23	5.7	7.8	0.5	1.3	0.9–2.0	1.2	0.8–1.9	1.5	1.0–2.3
		Canada	7	3.1	6.2	0.6	1.2	0.5–2.4	1.1	0.4–2.2	1.3	0.5–2.7
	1969–73	Circumpolar	6	2.8	5.0	0.2	0.9	0.3–2.0	0.8	0.3–1.8	1.1	0.4–2.4
		Alaska	3	4.3	6.2	0.5	1.4	0.3–4.2	1.3	0.3–3.7	1.7	0.3–4.8
		Greenland	3	3.1	5.5	0.1	0.9	0.2–2.7	0.8	0.2–2.5	1.1	0.2–3.2
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–
	1974–78	Circumpolar	12	5.2	8.3	0.5	1.6	0.8–2.8	1.5	0.7–2.5	1.8	0.9–3.1
		Alaska	3	3.9	6.4	0.2	1.2	0.2–3.4	1.1	0.2–3.1	1.3	0.3–3.9
		Greenland	5	5.0	7.0	0.5	1.3	0.4–3.1	1.2	0.4–2.9	1.5	0.5–3.5
		Canada	4	7.6	14.7	0.9	3.2	0.9–8.1	2.9	0.8–7.5	3.6	1.0–9.1
	1979–83	Circumpolar	15	6.1	9.6	0.7	1.6	0.9–2.6	1.4	0.8–2.3	1.7	1.0–2.9
		Alaska	3	3.6	5.8	0.0	0.9	0.2–2.7	0.8	0.2–2.4	1.0	0.2–2.9
		Greenland	9	8.8	11.5	0.8	1.9	0.9–3.7	1.7	0.8–3.2	2.1	1.0–4.0
		Canada	3	4.9	11.2	1.4	2.0	0.4–5.7	1.7	0.3–5.0	2.1	0.4–6.2
	1984–88	Circumpolar	12	4.4	6.1	0.5	1.0	0.5–1.8	1.0	0.5–1.7	1.1	0.6–2.0
		Alaska	6	6.2	9.8	0.9	1.4	0.5–3.0	1.4	0.5–2.9	1.5	0.6–3.3
		Greenland	6	5.6	6.1	0.5	1.1	0.4–2.4	1.1	0.4–2.4	1.2	0.5–2.7
		Canada	0	0.0	0.0	0.0	0.0	–	0.0	–	0.0	–

quently, other diagnostic procedures, such as ultrasound, are used. As a result, a low proportion of cases was histologically verified (61%), with 33% verified by other means, and 6% by death certificate only (Table 2). These findings are similar to the Danish experience where in 1989 about 20% were diagnosed without histology, and 2% from death certificates (39). Although more cases were diagnosed in Greenland by other means than histology compared to the other areas, no apparent change in diagnostic procedure occurred during the study period in any of the three Inuit populations.

Discussion. Cancer of the pancreas comprises about 3% of incident cases in the developed countries (18). The highest incidence rates in the world have been recorded among black populations in the USA, with ASRs frequently about 15 per 100 000 for men and 10 per 100 000 for women. In contrast, ASRs less than one-third that rate are found among Chinese in Singapore, Hong Kong and Tianjin, while intermediate rates predominate in Causcasian populations in northern Europe and the USA, and among Chinese in the San Francisco Bay Area (5).

The high incidence of pancreatic cancer in the Inuit populations was not unexpected, given that the best described risk factors are smoking and alcohol (40). Up to 30% of all pancreatic cancers world-wide can be attributed to cigarette smoking (41–46). Use of tobacco, particularly

cigarette smoking, has long been prevalent in all Inuit populations and in both sexes (7, 10, 47–52). Beer drinking, diabetes mellitus and gall-stones due to a fatty diet, have also been identified as risk factors (41). Both the alcohol-related etiology for pancreatic cancer, and its relation to gall-stones correlates well with the cancers observed in excess among Inuit (oesophagus, colo-rectal, liver and gall-bladder and biliary tract). The widespread exposure to alcohol and smoking in the comparative populations largely explains our observation that the incidence of pancreatic cancer among the Inuit does not deviate from that of Connecticut, Canada and Denmark.

Detailed tabular material by 5-year calendar periods 1969–1988 is available upon request. Please contact the Danish Cancer Registry, Danish Cancer Society, Strandboulevarden 49, DK-2100 Copenhagen, Denmark.

ACKNOWLEDGEMENT

This project was supported by the Danish Cancer Society (Grant No. 90-7617).

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