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Research Article

ARCHIVES OF
CLINICAL AND
BIOMEDICAL RESEARCH
ISSN: 2572-5017

Incidence Rates of Malignant Diseases in Swedish Fishermen

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Abstract

A cohort of fishermen was identified by Statistics Sweden by using the national census registration carried out from 1960 to 1990. The occupational title fisherman was used as surrogate for exposure to persistent organic pollutants (POPs) due to high fish consumption.

For each fisherman, 4 matched population based referents were drawn. Swedish cancer register 1960-1998, the causes of death registry 1960-1997, and notifications of deaths 1998-1999 were used to identify cancer cases. Mantel-Haenszel analysis was performed to calculate incidence rate ratios (IRR) and 95% confidence intervals (CI) for the different malignant diagnoses. An overall increased incidence rate ratio of cancer, IRR=1.17, 95% CI =1.11-1.23 was found in fishermen. This was mainly caused by an increased risk for smoking related cancer sites such as lip, hypopharynx and lung. Increased IRR was also found for stomach cancer. An increased IRR was found for non-melanoma skin cancer probably caused by chronic exposure to UV-light among fishermen due to their out-door work.

Keywords: Fishermen; Case-control study; Cancer; Sweden

Introduction

A first comprehensive general description of chemical damage to the environment was given by Rachel Carlson in her book Silent Spring published in 1962 [1]. She published evidence of the bioaccumulation of the insecticide DDT (para,para′-DDT –1,1′-(2,2,2-trichloro-ethylidene)bis (4-chloro benzene)). Also other persistent organic pollutants (POPs) such as dioxins, polychlorinated biphenyls (PCBs), and chlorinated pesticides bioaccumulate in the food chain. Several health effects have been associated with exposure to POPs such as cancer, immune system suppression, cognitive and neurobehavioral function, but also hypertension, cardiovascular disease, and diabetes [2].

A major concern has been contamination of POPs in fish, especially in the Baltic Sea that is an inland sea with limited circulation of the water to the West Coast Ocean. Pollutants in the water are accumulated in fish leading to bio-accumulation in fatty tissues, both in the fish and in their consumers [3]. Higher intake of fish has been reported in Swedish fishermen and their wives compared to the general population [4-6], that correlates with higher plasma levels of certain POPs [7]. Higher levels of e.g. polychlorinated biphenyls (PCBs) and dioxins were reported among fishermen from the Swedish east coast compared to west coast fishermen due to higher consumption of contaminated fatty fish [6].

Of special concern has been exposure to POPs in children during foetal time period and during breast feeding [8]. The concentrations increased in Swedish breast milke during the time period 1972 to 1997 [9]. However, downward temporal trends in the levels in Swedish breast milk of PCBs and dioxins were reported for the time period 1996 to 2017 [10].

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Citation: Lennart Hardell. Incidence Rates of Malignant Diseases in Swedish Fishermen. Archives of Clinical and Biomedical Research. 9 (2025): 502-508.

Received: November 17, 2025
Accepted: November 25, 2025
Published: December 08, 2025

Hardell L., Arch Clin Biomed Res 2025
DOI:10.26502/acbr.50170495

In previous studies the highest PCB levels were found in the mothers consuming fatty fish most frequently [11,12]. However, these levels have decreased [9] but of special concern is the increasing levels in breast milk of polybrominated diphenyl ethers (PBDEs) in Sweden during the study period [13].

Duration of breast-feeding was associated with increased risk for Non-Hodgkin's lymphoma in childhood in our previous study, but was based on low numbers [14]. Certain POPs have been associated with an increased risk for NHL [15]. Due to the higher consumption of fish among fishermen and their wives it was pertinent to study cancer risk in that population group.

In a register-based study the risks of childhood malignant diseases in the offspring of Swedish fishermen were analysed. Having a fisherman as a parent was used as surrogate for exposure to POPs [16]. Children to fishermen had an overall increased incidence rate ratio of cancer (IRR) =1.38, 95% confidence interval (CI)=0.96-2.00. For specific cancer sites an increased incidence rate ratio was observed for acute lymphatic leukaemia (ALL), IRR=2.65, 95% CI=1.005-6.97, and in west coast children for non-Hodgkin's lymphoma, IRR=3.19, 95% CI=0.98-10.4.

Results for all malignant diseases are also available for Swedish fishermen in this cohort. The results have not been published previously. Thus, the aim of this study was to investigate the risk of malignant diseases in Swedish fishermen since they are more exposed to POPs than the general population.

Materials and Methods

This study was register based. A cohort of fishermen was identified by Statistics Sweden using the national census registration. The national population and housing registration has been carried out in 1960, 1970, 1975, 1980, 1985 and 1990 and contains several individual registration parameters. We selected the individuals having occupation as fisherman, their identification number, socio-economic (SEI) code, and residence code. For each fisherman, 4 population-based referents were drawn from the census. The referents were matched for sex, age within 5-year strata, SEI-code and population density. The referents were population based from the entire country, not only local. For the 1975 census SEI-code was missing and for 1985 population density area was missing. Referents to fishermen first appearing in either census 1975 or 1985 were selected from the 1980 census. From the 1960 census the fourth referent was missing for 91 fishermen, from the 1980 census 4 fishermen did not have the third and fourth referent since they did not meet the inclusion criteria.

The data files were matched against the Swedish Cancer Register for the time period 1960 to 1998, the causes of death registry 1960 to 1997 and notifications of deaths 1998 to 1999. The Swedish Cancer Register started in 1958 and reporting to the registry is compulsory. The processing of the data was done by Statistics Sweden.

From the Cancer Register information on site code (ICD-7) and histology code was obtained. In the analysis we also divided the fishermen into two main groups, west and east coast fishermen. The west coast fishermen were residing in counties on the west coast in Sweden by the fishing waters of Kattegatt and Skagerrak. The east coast fishermen resided in counties along the Baltic and Bothnia Sea, classified as a "closed" sea due to lower water exchange with the oceans. Furthermore, the contamination with POPs in fish differs between the west coast and east coast with higher levels in fishermen from the Swedish east coast [6].

Statistical methods

The incidence rates of all malignant diseases combined as well as for the separate ICD-7 codes were calculated using the number of the identified cases and by calculating the person years the fishermen and the referents contributed. Calculation of number of person years started at the year of inclusion of the subject in the census. The number of person years was calculated until the year of cancer diagnosis, and until the end of the study period (1998). The incidence rate ratios (IRR) and 95 % CIs for all malignant diseases combined and for the different ICD codes in the fishermen compared to the referents were calculated using Mantel-Haenszel analysis, adjusted for age and gender using the incidence rate of the referent as reference value. All analyses were done using Stata/SE 8.2 (Stata/SE 8.2 for Windows; StataCorp, College Station, TX, USA).

Results

In total, 13 939 fishermen and 55 625 referents were identified. The majority of fishermen were men and less than 3% were women. Most were identified from the 1960 census, see Table 1, mainly male fishermen. An increased incidence rate ratio for all malignant diseases was found, IRR = 1.17, 95% CI = 1.11-1.23, in men IRR = 1.16, 95 % CI = 1.10-1.23, Table 2. An increased IRR was also found in female fishers yielding IRR = 1.33, 95% CI = 0.95-1.85, although based on relatively few cases. Most of the fishermen were based on Census 60. Using 10-year latency time gave similar results (data not in Table).

Regarding different sites statistically significant increased risk of cancer in men was found for lip (IRR = 2.42, 95% CI = 1.87-3.14), salivary gland (IRR = 2.33, 95 % CI = 1.11-4.88), hypopharynx (IRR = 3.11, 95% CI = 1.16-8.36), stomach (IRR=1.23, 95% CI = 1.05-1.44), trachea, bronchus,

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DOI:10.26502/acbr.50170495

lung (IRR = 1.61, 95% CI = 1.37-1.89), lung, unspecified (IRR = 2.08, 95% CI = 1.09-3.97), skin, non-melanoma (IRR=1.69, 95% CI = 1.45-1.96), and bladder, other urinary organ (IRR = 1.38, 95 % CI = 1.15-1.64.

Table 1: Total number of fishermen and referents in the different census and regions.

	Table	
	Fishermen	Referents
Census		
-Census 60	8 979	35 825
-Census 70	1 624	6 496
-Census 80	1 840	7 320
-Census 85	983	3 932
-Census 90	513	2 052
Regions		
-West coast	6 381	4 160
-East coast	7 040	30 514
-Inland	517	20 944
-No information	1	7
Total	13 939	55 625

Table 2: Mantel-Haenszel incidence rate ratios (MH-IRR) for fishermen. Matched results on first tumour after inclusion in the respective census. Results for different ICD-7 codes are given.

ICD-7	Localisation	Fishermen/referents	MH-IRR	95 % CI
140-209	Total	2376/8444	1.17	1.11 – 1.23
	-Men	2317/8253	1.16	1.10 – 1.23
	-Women	59/191	1.33	0.95 – 1.85
140	Lip	92/152	2.42	1.87 – 3.14
	-Men	92/152	2.42	1.87 – 3.14
	-Women	0/0	-	-
141	Tongue	8/21	1.51	0.67 – 3.41
	-Men	8/21	1.51	0.67 – 3.41
	- Women	0/0	-	-
142	Salivary gland	11/19	2.33	1.11 – 4.88
	-Men	11/19	2.33	1.11 – 4.88
	-Women	0/0	-	-
147	Hypopharynx	7/9	3.11	1.16 – 8.36
	-Men	7/9	3.11	1.16 – 8.36
	-Women	0/0	-	-
150	Oesophagus	28/84	1.34	0.87 – 2.06
	-Men	28/83	1.35	0.88 – 2.08
	-Women	0/1	-	-
151	Stomach	213/686	1.25	1.07 – 1.46
	-Men	209/682	1.23	1.05 – 1.44
	-Women	4/4	4.00	1.00 – 15.99
153	Colon	180/647	1.11	0.94 – 1.31

	-Men	177/630	1.12	0.95 – 1.33
	-Women	3/17	0.71	0.21 – 2.41
154	Rectum	153/528	1.16	0.97 – 1.39
	-Men	152/520	1.17	0.97 – 1.40
	-Women	1/8	0.48	0.06 – 4.01
155	Liver, biliary passage	43/178	0.97	0.69 – 1.35
	-Män	42/175	0.96	0.68 – 1.35
	-Women	1/3	1.33	0.14 – 12.82
156	Liver, unspecified	12/36	1.33	0.69 – 2.56
	-Men	12/34	1.41	0.73 – 2.73
	-Kvinnor	0/2	-	-
157	Pancreas	68/292	0.93	0.71 – 1.21
	-Men	67/286	0.94	0.72 – 1.22
	-Women	1/6	0.65	0.07 – 5.72
160	Nose, nasal cavity, middle ear	10/23	1.74	0.83 – 3.66
	-Men	10/23	1.74	0.83 – 3.66
	-Women	0/0	-	-
161	Larynx	21/54	1.55	0.94 – 2.57
	-Men	21/54	1.55	0.94 – 2.57
	-Women	0/0	-	-
162	Trachea, bronchus, lung	211/532	1.60	1.36 – 1.88
	-Men	208/523	1.61	1.37 – 1.89
	-Women	3/9	1.33	0.36 – 4.93
163	Lung, unspecified	15/27	2.23	1.19 – 4.19
	-Men	14/27	2.08	1.09 – 3.97
	-Women	1/0	-	-
170	Breast	15/48	1.25	0.69 – 2.26
	-Män	5/7	2.87	0.91 – 9.03
	-Women	10/41	0.96	0.47 – 1.96
177	Prostate	546/2 331	0.93	0.85 – 1.03
180	Kidney	88/326	1.08	0.85 – 1.37
	-Men	85/320	1.06	0.83 – 1.35
	-Women	3/6	2.00	0.50 – 8.00
181	Bladder, other urinary organ	166/489	1.36	1.14 – 1.63
	-Men	165/481	1.38	1.15 – 1.64
	-Women	1/8	0.50	0.06 – 4.00
190	Melanoma of the skin	62/219	1.14	0.86 – 1.51
	-Men	60/209	1.15	0.86 – 1.54
	-Women	2/10	0.80	0.18 – 3.65
191	Skin, other than melanoma	249/600	1.68	1.45 – 1.95
	-Men	246/590	1.69	1.45 – 1.96
	-Women	3/10	1.33	0.36 – 4.93
193	Brain, nervous system	61 /243	1.00	0.76 – 1.33
	-Men	57/238	0.96	0.72 – 1.28
	-Women	4/5	3.20	0.86 – 11.91
194	Thyreoid gland	10/40	1.00	0.50 – 2.00

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DOI:10.26502/acbr.50170495

	-Men	10/38	1.05	0.53 – 2.11
	-Women	0/2	-	-
195	Other endocrine glands	30/80	1.50	0.98 – 2.28
	-Men	27/74	1.45	0.94 – 2.26
	-Women	3/6	2.00	0.50 – 8.00
197	Connective tissue	13/58	0.90	0.49 – 1.63
	-Men	13/57	0.91	0.50 – 1.66
	-Women	0/1	-	-
200	Non-Hodgkin lymphoma	68/274	0.99	0.76 – 1.29
	-Men	68/271	1.00	0.77 – 1.31
	-Women	0/3	-	-
201	Hodgkin’s disease	11/75	0.59	0.31 – 1.11
	-Men	10/72	0.56	0.29 – 1.08
	-Women	1/3	1.33	0.14 – 12.82
203	Myelomatosis	44/175	1.00	0.72 – 1.40
	-Men	43/175	0.98	0.70 – 1.37
	-Women	1/0	-	-
204	Lymphatic leukaemia	26/127	0.82	0.54 – 1.24
	-Men	25/125	0.80	0.52 – 1.22
	-Women	1/2	2.00	0.18 – 22.09
205	Myeloid leukaemia	24/104	0.93	0.59 – 1.44
	-Men	23/102	0.90	0.58 – 1.42
	-Women	1/2	2.00	0.18 – 22.09

Discussion

Data from Swedish National Registers on Statistics Sweden were used to identify the fishermen and the referents. The Swedish Cancer Register was used to identify subjects diagnosed with a malignant disease. This register is compulsory and regulated by law. The unique Swedish person numbers were used to identify the subjects in the different registers.

This study showed an increased incidence rate ratio of malignant diseases in Swedish fishermen compared to referents. Most of the cancer sites with statistically significant increased IRR have been associated with smoking habits. Examples are cancers of the air ways such as lip, hypopharynx, and lung. The results on lung cancer were based on a fairly large number of subjects and smoking is a well-known risk factor [17]. Unfortunately no smoking data were available in this register based study. Also the results on stomach cancer were based on a fairly large number of subjects. Smoking and alcohol are known risk factors for stomach cancer. Chronic inflammation of the mucous membrane in the stomach is another risk factor. Infection with the bacteria Helicobacter pylori may cause chronic inflammation in the stomach that is a risk factor for cancer [18].

A statistically significant increased IRR was found for skin cancer other than melanoma, mostly squamous cell carcinoma. Prolonged sun exposure is an established risk factor for non-melanoma skin cancer that is obviously the situation for fishermen [19]. On the other hand acute sunburn is a risk factor for melanoma of the skin [20]. Obviously acute sunburn would not be expected to be common in fishermen, and this study showed no statistically significant increased risk for melanoma of the skin.

Exposure to certain POPs has been associated with an increased cancer risk [21], especially non-Hodgkin lymphoma [22-24]. However this study showed no increased IRR for NHL or Hodgkin’s disease. Since the study was register-based, the exposure assessment to POPs is quite coarse in contrast to other studies based on analysis of POPs in blood or adipose tissue. It should be noted that the concentrations decreased for all POPs in the Swedish population during 1993-2007 [25], which is part of the study period. Analyses of concentrations of dioxins and PCBs in Swedish fish from the Baltic Sea were published for the time period 2000-2011 [26], i.e. part of our study period. Clearly the levels of PCBs had declined whereas no change was seen for the levels of dioxins.

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DOI:10.26502/acbr.50170495

Summary

This register based study on Swedish fishermen showed increased IRR for smoking related cancer sites. The increased risk for non-melanoma skin cancer could be explained by chronic exposure to UV light in fishermen due to their mainly out-door work. There is a potential for increased exposure to certain POPs such as PCBs and dioxins through high consumption of fish. However, no increased IRR was found for malignant diseases such as malignant lymphoma that have been associated with certain POPs.

Acknowledgements: Not applicable.

Funding: The study was supported by grants from Cancer och Allergifonden.

Availability of data and materials: The information generated and analyzed during the current study is available from the corresponding author on reasonable request.

Author's contributions: The author contributed to the conception, design and writing of the manuscript.

Ethics approval and consent to participate: Approved by Ethics Committee of Örebro County Council

Patient consent for publication: Not applicable.

Competing interests: The author declares no competing interests.

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