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Cancer risk in first generation migrants in North-Holland/Flevoland, The Netherlands, 1995–2004

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ABSTRACT

As migrant studies can offer important information with regard to cancer aetiology, we estimated the cancer risk in first generation migrants using data of the Amsterdam Cancer Registry.

The risk among western migrants was almost equal to the risk of the native population. Migrants from former Dutch colonies had a low cancer risk (standardised incidence ratios 0.69–0.81), while the lowest risks were observed for Turkey (0.66), Morocco (0.53) and sub-Sahara Africa (0.59).

High risks in migrants from non-western countries were observed for cancer of the nasopharynx (China 51, Morocco 22), liver (China 13), gallbladder, cervix and thyroid, as well as for Kaposi's sarcoma, Hodgkin's lymphoma and mature T/NK-cell lymphoma. Cancer risk for breast, colorectum, lung, prostate, skin and testis was generally low.

Although cancers related to infectious disease were relatively common among migrants from non-western countries, the low risks for mainly lifestyle related cancers resulted in a low overall risk.

1. Introduction

The incidence of cancer shows large world-wide variations. Cancer incidence is particularly low in North- and West-Africa, as well as in South-Asia (India, Indonesia), while most western countries have high cancer incidence rates.[1] Comparison of cancer incidence rates between countries, as well as migrant studies can offer important information with regard to the aetiology of cancer. The studies of Japanese migrants to Hawaii have shown that the cancer incidence of the migrant population (Japanese) gradually converges to the incidence of the native population (Americans) within two generations, with incidence of the first generation closest to the incidence in the country of origin and the incidence of the second generation closest to the incidence of the native population.[2] Cancer mortality rates among migrants in the Netherlands also show convergence to the rates of the native Dutch population.[3] This convergence indicates that lifestyle and environmental factors are important factors with regard to cancer risk, while the rate of convergence may also give an indication for the nature of the factors involved.

In the last decades, extensive immigration has changed the composition of the population of the Netherlands, especially in the large cities. On 1st January 2005, 11% of the population of the Netherlands and even 29% of the population of Amsterdam were foreign-born.[4] Migrants originate primarily from the former Dutch colonies (Indonesia [former name: Dutch East-Indies], Surinam and the Netherlands Antilles [including the island of Aruba, which was granted a 'status aparte' on 1st January 1986]), Turkey, Morocco, neighbouring countries (Germany, the United Kingdom, Belgium) and China. Since the beginning of the 1990s, many applicants

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for asylum came to the Netherlands. They originate from a large variety of countries, including the former Yugoslavia, Iraq, Iran, Afghanistan and Somalia. In Amsterdam, there is also a large Ghanese community.

Previous studies in the Netherlands revealed that the risk for breast cancer and the risk for cervical cancer in migrant women differed considerably from the risk in women who were born in the Netherlands.[5,6] In this paper, we present cancer risks according to cancer site for all major migrant groups in the north-western part of the Netherlands.

2. Patients and methods

2.1. The Amsterdam Cancer Registry

The Amsterdam Cancer Registry (ACR) is a regional, population-based cancer registry with complete regional coverage since 1st January 1988. The region of the ACR covers two out of 12 provinces of the Netherlands: North-Holland and Flevoland. Its population numbered 2.96 million on 1st January 2005, about 18% of the total population of the Netherlands. 445,000 residents of North-Holland/Flevoland (15%) were born outside the Netherlands, which is about 26% of the total migrant population of the Netherlands.[4]

The ACR is part of the nation-wide Netherlands Cancer Registry, whose data are included in Cancer Incidence in Five Continents as of volume VII.[7,8] Cases diagnosed in a hospital outside the ACR region but with residence in the ACR region are routinely obtained from the national registry and included in the regional registry.

The information for the registry is extracted from the medical records by registration clerks. Apart from demographic data, data are collected on tumour site and morphological classification (according to the International Classification of Diseases for Oncology). The place of birth or, for foreign-born patients, the country of birth is also registered.

2.2. Migrant population

Population data of all legal residents in the Netherlands are available from the national population network, which records all events (birth, death, migration, etc.) in the more than 400 Dutch municipalities on a daily basis. Because of these excellent population registers, a population census in the Netherlands has become redundant. Among other items, the country of birth and nationality are available in the registers, but there is no information regarding ethnicity. Since the mid 1990s, all municipal registers are part of a national electronic network for exchanging data. Statistics Netherlands is also part of that network, which enables them to publish detailed and reliable population data. For our study, we used annual population data from Statistics Netherlands according to gender, age group (0–14, 15–29, 30–44, 45–64 and 65 years or older) and country of birth of residents of the provinces of North-Holland and Flevoland, covering the period 1995–2004.[4] We did not use nationality, as people may change nationality, may have multiple nationalities and nationality is generally unknown in the hospitals.

2.3. Study population

For this study, we selected all primary invasive cancers diagnosed in 1995–2004 in residents of the provinces North-Holland and Flevoland (n = 122,127). We defined first generation migrants as the residents who were born outside the Netherlands. Cases with unknown country of birth (n = 15,712; 13% of all cases) were excluded, leaving a total of 106,415 cases for the analysis. The country of birth was initially collected in the hospitals, but for all cases who had died (about two-thirds of all cases) as well as for women who participated in the regional breast cancer screening programme we were able to verify the country of birth with information from the national population network. In case of a discrepancy, the information from the national population network was used.

2.4. Statistical analysis

Based on the annual population data according to gender and age group (0–14, 15–29, 30–44, 45–64 and 65 years or older) and the gender- and age group-specific incidence of the 97,000 patients born in the Netherlands, the expected numbers of cancer for each migrant group were calculated. The expected numbers were compared with the observed numbers and standardised incidence ratios (SIRs) were calculated as the ratio between the observed and the expected numbers. Exact 95% confidence intervals (CIs) based on the Poisson distribution of O were calculated using STATA 9.1 (STATA Corporation, College Station, TX, USA). Because of small numbers the age groups 0–14 and 15–29 were combined in the tables, but these age groups were calculated separately.

3. Results

Out of a total of 106,415 cancer cases, 9271 cancer cases (9%) were diagnosed among residents born abroad (Table 1). The number of cases was highest for patients born in Indonesia (2404 cases), followed by Surinam (1368 cases), Germany (1178 cases), Turkey (533 cases), Morocco (506 cases), the UK (331 cases) and the Netherlands Antilles (302 cases). Sixty percent of the migrants were born in western countries (including Indonesia), 40% in non-western countries.

Fig. 1 shows that the cancer risk for all cancers combined was statistically significantly decreased for all major countries, with the exception of Germany (SIR 1.04), the UK (SIR 0.92), Belgium (SIR 1.01) and Italy (SIR 0.89). Moderately decreased cancer risks were observed for migrants from the former Dutch colonies (SIR Indonesia 0.81, Surinam 0.69, Netherlands Antilles 0.75), while very low cancer risks were observed in migrants from the Middle East and North-Africa (SIR Turkey 0.66, Morocco 0.53) and sub-Sahara Africa (SIR 0.58).

3.1. Gender and age-groups

The low cancer risks in migrants from non-western countries were present both in males and in females and generally more apparent among older migrants (45 years or older) than among younger migrants (Tables 2–4). The effect of a decreasing

cancer risk with increasing age was specifically prominent in Turkish females (SIR 0–29 years, 1.1; 30–44 years, 0.7; 45–64 years, 0.5; 65 years or older, 0.4).

In none of the age groups of the selected countries, a statistically significantly increased cancer risk was observed.

Table 1 – Number of invasive cancers according to country of birth in North-Holland/Flevoland, the Netherlands 1995–2004[a]

	Number of cases	%
The Netherlands	97,144	91.3
Foreign-born	9271	8.7
Western countries	5593	5.3
Indonesia	2404	2.3
Germany	1178	1.1
United Kingdom	331	0.3
Belgium	217	0.2
Italy	173	0.2
Other western countries	1290	1.2
Non-western countries	3678	3.5
Surinam	1368	1.3
Turkey	533	0.5
Morocco	506	0.5
The Netherlands Antilles	302	0.3
China	178	0.2
Other non-western countries	791	0.7
Total	106,415[a]	

a Excluding 15,712 cases with unknown country of birth.

3.2. *Cancer site*

The results according to cancer site and country of origin are shown in Tables 2–4. Although the overall cancer risks are low among migrants, several cancer sites are more common among migrants than among residents born in the Netherlands. The highest SIR is observed for cancer of the nasopharynx among Chinese (SIR 51), but also among migrants from Morocco (SIR 22), Turkey (SIR 8), sub-Sahara Africa (SIR 6), Surinam (SIR 4.6) and Indonesia (SIR 1.2) increased rates for nasopharyngeal cancer are observed.

Relatively high risks are also observed for cancer of the liver (SIR China 14, sub-Sahara Africa 6.9, Turkey 4.6, Surinam 3.3), gallbladder (Netherlands Antilles 6.5), cervix uteri (Surinam 1.7, Morocco 1.6) and thyroid gland (Turkey 2.9, Morocco 2.3), as well as for Kaposi's sarcoma (EU 6.8, Netherlands Antilles 5.5, sub-Sahara Africa 5.4), Hodgkin's lymphoma (Surinam 1.8) and mature T/NK-cell neoplasms (sub-Sahara Africa 6.1, Surinam 2.6). The stomach cancer risk was also increased in migrants from most non-western countries, but did not reach statistical significance.

The cancer risk for the most common cancer sites in the population born in the Netherlands (breast, colorectum, lung, and prostate gland) was generally (very) low in migrants from non-western countries, with the exception of prostate cancer among men born in Surinam (SIR 1.5) and lung cancer among men born in Turkey (SIR 1.2, 95% CI 0.9–1.4). Skin cancer was rare among non-western migrants, especially skin melanoma (SIR Turkey 0.1, Morocco 0.0, Surinam 0.1, Netherlands Antilles 0.1), while – to a lesser extent – other skin cancers were

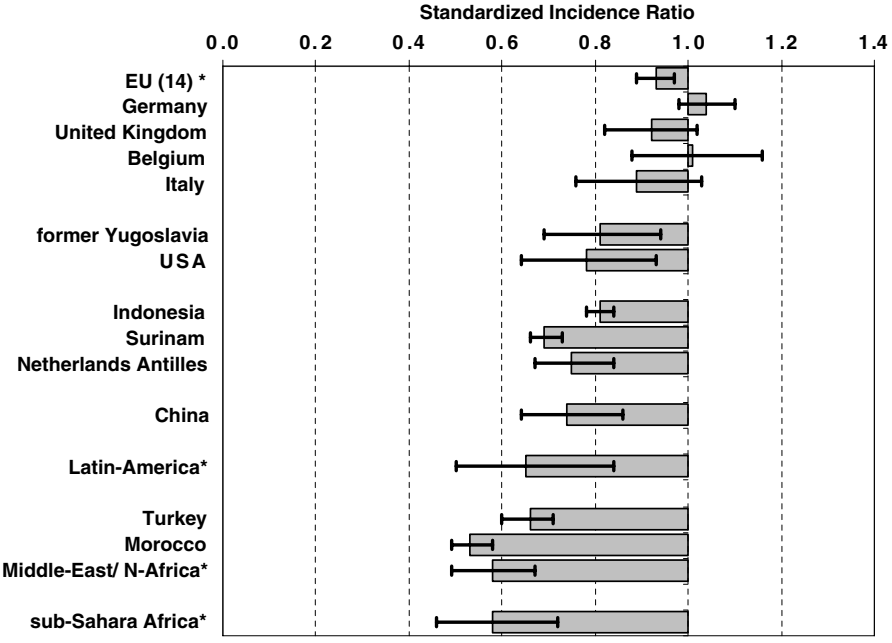

Fig. 1 – Standardised incidence ratio with 95% confidence intervals of all cancers combined according to country of birth, North-Holland/Flevoland, the Netherlands 1995–2004 (reference population: population born in the Netherlands). *EU(14): Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Portugal, Spain, Sweden, United Kingdom; Latin America: Brazil, Colombia, Dominican Republic; other Middle-East/N-Africa: Afghanistan, Egypt, Iran, Iraq, Pakistan; sub-Sahara Africa: Ethiopia, Ghana, Somalia.

Table 2 – Cancer incidence in first generation migrants from former Dutch colonies, North-Holland/Flevoland, the Netherlands 1995–2004 (reference population: population born in the Netherlands)

	Country of birth								
	Indonesia			Surinam			The Netherlands Antilles		
	Cases	SIR	(95% CI)	Cases	SIR	(95% CI)	Cases	SIR	(95% CI)
Gender and age group									
Males	1121	**0.8**	(0.7–0.8)	630	**0.8**	(0.7–0.8)	124	**0.8**	(0.6–0.9)
0–29 years	2	1.0	(0.1–3.7)	13	0.7	(0.4–1.3)	5	0.8	(0.2–1.8)
30–44 years	12	0.9	(0.5–1.6)	83	1.1	(0.9–1.4)	20	1.1	(0.7–1.7)
45–64 years	320	0.9	(0.8–1.0)	253	**0.7**	(0.6–0.8)	55	**0.6**	(0.5–0.8)
65 years or older	787	**0.7**	(0.7–0.8)	281	**0.7**	(0.7–0.8)	44	1.0	(0.7–1.3)
Females	1283	**0.8**	(0.8–0.9)	738	**0.6**	(0.6–0.7)	178	**0.7**	(0.6–0.9)
0–29 years	1	0.4	(0.0–2.4)	13	0.8	(0.4–1.3)	–	**0.0**	(0.0–0.7)
30–44 years	32	0.9	(0.6–1.3)	147	**0.8**	(0.7–0.9)	28	0.7	(0.5–1.1)
45–64 years	498	0.9	(0.8–1.0)	340	**0.6**	(0.5–0.7)	110	**0.8**	(0.6–0.9)
65 years or older	752	**0.8**	(0.7–0.9)	238	**0.6**	(0.6–0.7)	40	0.8	(0.5–1.0)
Site									
Oral cavity	22	**0.6**	(0.4–1.0)	15	**0.6**	(0.3–1.0)	3	0.5	(0.1–1.6)
Nasopharynx	2	1.2	(0.1–4.4)	7	***4.6***	(1.9–9.5)	–	0.0	(0.0–10)
Other pharynx	11	**0.5**	(0.3–0.9)	4	**0.2**	(0.1–0.6)	2	0.5	(0.1–1.9)
Oesophagus	40	**0.6**	(0.5–0.9)	10	**0.3**	(0.1–0.5)	4	0.5	(0.1–1.4)
Stomach	35	**0.4**	(0.2–0.5)	68	1.3	(1.0–1.6)	16	1.6	(0.9–2.6)
Colon/rectum	345	0.9	(0.8–1.0)	163	**0.8**	(0.6–0.9)	33	0.8	(0.6–1.1)
Liver	32	***2.6***	(1.8–3.7)	25	***3.3***	(2.2–4.9)	2	1.3	(0.2–4.7)
Gallbladder	14	1.7	(0.9–2.8)	10	***2.3***	(1.1–4.3)	5	***6.5***	(2.1–15)
Extrahepatic bile ducts	15	0.7	(0.4–1.1)	9	0.7	(0.3–1.3)	–	0.0	(0.0–1.5)
Pancreas	59	**0.7**	(0.5–0.9)	37	0.8	(0.6–1.1)	9	1.0	(0.5–1.9)
Larynx	10	**0.3**	(0.2–0.6)	5	**0.3**	(0.1–0.6)	1	0.3	(0.0–1.4)
Lung, males	201	**0.7**	(0.6–0.8)	89	**0.6**	(0.4–0.7)	17	**0.6**	(0.3–0.9)
Lung, females	119	0.9	(0.7–1.0)	45	**0.4**	(0.3–0.6)	9	**0.4**	(0.2–0.8)
Melanoma	50	**0.6**	(0.4–0.8)	6	**0.1**	(0.0–0.1)	3	**0.1**	(0.0–0.4)
Other skin	80	**0.6**	(0.5–0.8)	18	**0.3**	(0.2–0.4)	8	0.7	(0.3–1.4)
Mesothelioma	22	0.8	(0.5–1.2)	5	**0.3**	(0.1–0.8)	–	0.0	(0.0–1.3)
Kaposi's sarcoma	5	2.5	(0.8–5.9)	11	***3.0***	(1.5–5.3)	5	***5.5***	(1.8–13)
Bone/soft tissue	18	0.9	(0.5–1.4)	19	1.0	(0.6–1.6)	2	0.5	(0.1–1.7)
Breast	426	0.9	(0.8–1.0)	235	**0.6**	(0.5–0.7)	79	0.9	(0.7–1.1)
Cervix uteri	32	1.4	(0.9–1.9)	58	***1.7***	(1.3–2.2)	8	1.1	(0.5–2.1)
Corpus uteri	61	0.9	(0.7–1.2)	42	0.9	(0.7–1.2)	9	0.9	(0.4–1.7)
Ovary	70	1.2	(0.9–1.5)	29	**0.6**	(0.4–0.9)	8	0.8	(0.4–1.6)
Prostate	213	**0.8**	(0.7–0.9)	179	***1.5***	(1.3–1.7)	22	1.1	(0.7–1.7)
Testis	3	0.5	(0.1–1.5)	4	**0.2**	(0.1–0.5)	–	**0.0**	(0.0–0.6)
Kidney	40	**0.6**	(0.5–0.9)	27	0.7	(0.5–1.0)	7	0.9	(0.4–1.9)
Urinary tract	69	**0.6**	(0.5–0.7)	14	**0.2**	(0.1–0.4)	5	0.5	(0.2–1.1)
Central nervous system	28	0.7	(0.5–1.1)	9	**0.2**	(0.1–0.5)	4	0.5	(0.1–1.2)
Thyroid gland	16	1.7	(0.9–2.7)	14	1.3	(0.7–2.2)	1	0.4	(0.0–2.4)
Other sites	37	**0.6**	(0.4–0.8)	24	**0.6**	(0.4–0.8)	2	**0.2**	(0.0–0.8)
Unknown primary site	98	**0.8**	(0.6–0.9)	47	**0.7**	(0.5–0.9)	8	0.6	(0.3–1.2)
Hodgkin's lymphoma	6	1.1	(0.4–2.4)	17	***1.8***	(1.0–2.8)	3	1.2	(0.3–3.6)
Mature B-cell neoplasms	179	***1.2***	(1.0–1.4)	79	0.8	(0.7–1.0)	17	0.9	(0.5–1.4)
Mature T/NK-cell neoplasms	7	0.9	(0.4–1.9)	15	***2.6***	(1.4–4.2)	2	1.6	(0.2–5.7)
Precursor cell neoplasms	4	2.0	(0.5–5.0)	8	1.9	(0.8–3.6)	2	1.4	(0.2–5.1)
Myeloid neoplasms	35	0.8	(0.6–1.2)	21	0.7	(0.5–1.1)	6	1.0	(0.4–2.2)

SIR = standardised incidence ratio; CI = confidence interval.
Decreased rates ($p < 0.05$) are in bold; increased rates ($p < 0.05$) are in bold italics.

less frequent among migrants as well (SIR Turkey 0.3, Morocco 0.3, Surinam 0.3, Netherlands Antilles 0.7, Indonesia 0.6). Testicular cancer risk was also very low among non-western migrants (SIR Turkey 0.2, Morocco 0.1, Surinam 0.2, Netherlands Antilles 0.0).

Apart from Hodgkin's lymphoma and mature T/NK-cell neoplasms which were generally increased among migrants, the risk of haematological malignancies among migrants did not differ much from the risk of the population born in the Netherlands.

Table 3 – Cancer incidence in first generation migrants from selected countries in the Middle East and North Africa, North-Holland/Flevoland, the Netherlands 1995–2004 (reference population: population born in the Netherlands)

	Country of birth								
	Turkey			Morocco			Other countries[a]		
	Cases	SIR	(95% CI)	Cases	SIR	(95% CI)	Cases	SIR	(95% CI)
Gender and age group									
Males	310	**0.8**	(0.7–0.9)	317	**0.6**	(0.5–0.6)	89	**0.5**	(0.4–0.6)
0–29 years	12	0.8	(0.4–1.5)	14	0.7	(0.4–1.2)	8	0.9	(0.4–1.7)
30–44 years	55	1.0	(0.7–1.3)	47	0.8	(0.6–1.1)	29	**0.7**	(0.5–1.0)
45–64 years	177	0.9	(0.8–1.0)	174	**0.7**	(0.6–0.8)	38	**0.4**	(0.3–0.5)
65 years or older	66	**0.5**	(0.4–0.6)	82	**0.4**	(0.3–0.5)	14	**0.4**	(0.2–0.6)
Females	223	**0.5**	(0.5–0.6)	189	**0.5**	(0.4–0.5)	90	**0.7**	(0.6–0.9)
0–29 years	14	1.1	(0.6–1.8)	17	1.0	(0.6–1.6)	8	1.3	(0.6–2.6)
30–44 years	60	**0.7**	(0.5–0.9)	54	**0.6**	(0.5–0.8)	34	1.0	(0.7–1.4)
45–64 years	116	**0.5**	(0.4–0.6)	93	**0.4**	(0.3–0.5)	34	**0.6**	(0.4–0.8)
65 years or older	33	**0.4**	(0.3–0.6)	25	**0.4**	(0.3–0.7)	14	**0.6**	(0.3–1.0)
Site									
Oral cavity	8	0.7	(0.3–1.4)	4	**0.3**	(0.1–0.8)	2	0.4	(0.1–1.6)
Nasopharynx	6	**8.2**	(3.0–18)	19	***22***	(13–34)	–	0.0	(0.0–11)
Other pharynx	3	0.4	(0.1–1.1)	2	**0.2**	(0.0–0.7)	1	0.3	(0.0–1.6)
Oesophagus	3	**0.2**	(0.0–0.6)	3	**0.2**	(0.0–0.4)	2	0.3	(0.0–1.2)
Stomach	30	1.4	(0.9–2.0)	34	1.3	(0.9–1.8)	5	0.6	(0.2–1.4)
Colon/rectum	34	**0.4**	(0.3–0.6)	31	**0.3**	(0.2–0.5)	13	**0.4**	(0.2–0.7)
Liver	15	**4.6**	(2.6–7.5)	10	***2.4***	(1.1–4.4)	1	0.7	(0.0–4.0)
Gallbladder	4	3.0	(0.8–7.6)	4	2.9	(0.8–7.5)	2	4.6	(0.6–17)
Extrahepatic bile ducts	4	0.8	(0.2–2.1)	3	0.5	(0.1–1.5)	1	0.5	(0.0–2.9)
Pancreas	16	0.9	(0.5–1.4)	14	0.6	(0.4–1.1)	2	0.3	(0.0–1.0)
Larynx	11	1.2	(0.6–2.2)	7	0.6	(0.2–1.3)	1	0.3	(0.0–1.5)
Lung, males	85	1.2	(0.9–1.4)	71	**0.7**	(0.5–0.9)	4	**0.1**	(0.0–0.3)
Lung, females	12	**0.3**	(0.2–0.6)	8	**0.2**	(0.1–0.5)	2	**0.2**	(0.0–0.7)
Melanoma	3	**0.1**	(0.0–0.2)	1	**0.0**	(0.0–0.1)	1	**0.1**	(0.0–0.3)
Other skin	8	**0.3**	(0.2–0.7)	8	**0.3**	(0.1–0.6)	3	0.4	(0.1–1.1)
Mesothelioma	3	0.5	(0.1–1.4)	1	**0.1**	(0.0–0.6)	2	0.8	(0.1–2.7)
Kaposi's sarcoma	3	1.2	(0.2–3.5)	5	1.8	(0.6–4.2)	4	2.4	(0.7–6.2)
Bone/soft tissue	8	0.8	(0.4–1.7)	7	0.6	(0.3–1.3)	6	1.3	(0.5–2.9)
Breast	72	**0.5**	(0.4–0.6)	49	**0.3**	(0.2–0.4)	42	0.9	(0.6–1.2)
Cervix uteri	22	1.4	(0.9–2.2)	24	***1.6***	(1.0–2.4)	2	0.4	(0.0–1.4)
Corpus uteri	5	**0.3**	(0.1–0.7)	6	**0.4**	(0.1–0.8)	1	0.2	(0.0–1.3)
Ovary	15	0.9	(0.5–1.5)	5	**0.3**	(0.1–0.7)	2	0.4	(0.0–1.5)
Prostate	22	**0.4**	(0.3–0.7)	35	**0.5**	(0.3–0.7)	10	**0.5**	(0.3–1.0)
Testis	3	**0.2**	(0.0–0.5)	1	**0.1**	(0.0–0.3)	4	**0.4**	(0.1–0.9)
Kidney	11	0.7	(0.3–1.2)	10	**0.5**	(0.2–0.9)	6	0.9	(0.3–1.9)
Urinary tract	7	**0.3**	(0.1–0.6)	12	**0.4**	(0.2–0.7)	4	0.4	(0.1–1.1)
Central nervous system	14	0.8	(0.4–1.3)	10	**0.5**	(0.2–0.8)	6	0.7	(0.2–1.4)
Thyroid gland	14	**2.9**	(1.6–4.8)	12	***2.3***	(1.2–4.0)	5	2.5	(0.8–5.8)
Other sites	8	**0.4**	(0.2–0.9)	11	**0.5**	(0.3–1.0)	5	0.7	(0.2–1.6)
Unknown primary site	20	0.7	(0.4–1.1)	31	0.9	(0.6–1.3)	2	**0.2**	(0.0–0.7)
Hodgkin's lymphoma	10	1.6	(0.8–3.0)	5	0.7	(0.2–1.6)	7	2.1	(0.8–4.4)
Mature B-cell lymphoma	33	0.8	(0.6–1.1)	42	0.9	(0.6–1.2)	14	0.8	(0.5–1.4)
Mature T/NK-cell lymphoma	4	1.4	(0.4–3.6)	4	1.2	(0.3–3.0)	3	2.2	(0.4–6.3)
Precursor cell neoplasms	1	0.4	(0.0–2.0)	1	0.3	(0.0–1.7)	2	1.0	(0.1–3.5)
Myeloid neoplasms	16	1.3	(0.7–2.1)	16	1.1	(0.6–1.8)	12	**2.2**	(1.2–3.9)

SIR = standardised incidence ratio; CI = confidence interval.
Decreased rates ($p < 0.05$) are in bold; increased rates ($p < 0.05$) are in bold italics.
a Afghanistan, Egypt, Iran, Iraq, Pakistan.

4. Discussion

To our knowledge, the present study is the largest with cancer incidence data among migrants from non-western countries in Europe. Record linkage with the national population network resulted in a completeness of 87% as far as information regarding the country of birth was concerned. Despite the diverse origin of non-western migrants in the Netherlands, a rather consistent picture emerged of relatively high risks of cancers related to infectious disease, such as nasopharyngeal cancer, liver cancer, Kaposi's sarcoma, cervical cancer and several types of lymphomas,[9] and relatively low risks of more

Table 4 – Cancer incidence in first generation migrants from selected countries, North-Holland/Flevoland, the Netherlands 1995–2004 (reference population: population born in the Netherlands)

	Country of birth								
	EU (14)[a]			China			Ethiopia, Ghana, Somalia		
	Cases	SIR	(95% CI)	Cases	SIR	(95% CI)	Cases	SIR	(95% CI)
Gender and age group									
Males	984	0.9	(0.9–1.0)	96	**0.8**	(0.7–1.0)	28	**0.4**	(0.3–0.6)
0–29 years	19	1.1	(0.7–1.8)	–	0.0	(0.0–2.0)	2	0.4	(0.1–1.6)
30–44 years	79	1.2	(1.0–1.5)	4	0.6	(0.2–1.5)	12	0.6	(0.3–1.1)
45–64 years	430	1.0	(0.9–1.1)	47	1.0	(0.8–1.4)	14	**0.3**	(0.2–0.5)
65 years or older	456	**0.8**	(0.8–0.9)	45	**0.7**	(0.5–0.9)	–	0.0	(0.0–1.0)
Females	1442	**0.9**	(0.9–1.0)	80	**0.7**	(0.5–0.8)	56	**0.8**	(0.6–1.0)
0–29 years	14	0.9	(0.5–1.5)	2	1.0	(0.1–3.7)	8	1.9	(0.8–3.7)
30–44 years	102	**0.7**	(0.6–0.9)	11	0.6	(0.3–1.1)	27	0.8	(0.5–1.2)
45–64 years	481	**0.8**	(0.8–0.9)	42	**0.7**	(0.5–0.9)	18	**0.5**	(0.3–0.8)
65 years or older	845	1.0	(0.9–1.1)	25	**0.7**	(0.4–1.0)	3	0.9	(0.2–2.6)
Site									
Oral cavity	34	1.1	(0.7–1.5)	2	0.7	(0.1–2.4)	1	0.5	(0.0–2.7)
Nasopharynx	1	0.6	(0.0–3.2)	9	**51**	(23–96)	1	6.0	(0.2–33)
Other pharynx	23	1.1	(0.7–1.7)	–	0.0	(0.0–1.8)	–	0.0	(0.0–2.4)
Oesophagus	45	0.9	(0.7–1.2)	5	1.1	(0.3–2.5)	–	0.0	(0.0–1.5)
Stomach	73	1.0	(0.7–1.2)	9	1.3	(0.6–2.5)	1	0.3	(0.0–1.7)
Colon/rectum	306	1.0	(0.9–1.1)	27	1.0	(0.7–1.5)	3	**0.2**	(0.1–0.7)
Liver	20	***2.0***	(1.2–3.0)	14	**14**	(7.8–24)	4	**6.9**	(1.9–18)
Gallbladder	8	1.1	(0.5–2.1)	1	2.1	(0.1–1)	2	***13***	(1.5–45)
Extrahepatic bile ducts	12	0.6	(0.3–1.1)	3	1.9	(0.4–5.6)	–	0.0	(0.0–4.8)
Pancreas	70	1.0	(0.8–1.3)	3	0.5	(0.1–1.5)	1	0.4	(0.0–2.0)
Larynx	8	**0.3**	(0.1–0.7)	–	0.0	(0.0–1.5)	–	0.0	(0.0–2.3)
Lung, males	179	0.9	(0.7–1.0)	14	**0.6**	(0.3–1.0)	1	**0.1**	(0.0–0.5)
Lung, females	122	0.9	(0.7–1.0)	1	**0.1**	(0.0–0.5)	2	0.4	(0.0–1.3)
Melanoma	76	**0.8**	(0.6–1.0)	1	**0.1**	(0.0–0.6)	–	**0.0**	(0.0–0.4)
Other skin	86	0.9	(0.7–1.1)	–	**0.0**	(0.0–0.5)	–	0.0	(0.0–1.3)
Mesothelioma	20	1.0	(0.6–1.6)	–	0.0	(0.0–1.8)	–	0.0	(0.0–3.7)
Kaposi's sarcoma	25	**6.8**	(4.4–10)	–	0.0	(0.0–9.2)	4	**5.4**	(1.5–14)
Bone/soft tissue	17	0.8	(0.4–1.2)	–	0.0	(0.0–1.7)	4	1.7	(0.5–4.3)
Breast	439	**0.9**	(0.8–1.0)	30	0.7	(0.5–1.0)	15	**0.5**	(0.3–0.8)
Cervix uteri	42	1.2	(0.9–1.6)	5	1.4	(0.5–3.4)	5	1.1	(0.4–2.6)
Corpus uteri	62	1.0	(0.7–1.2)	3	0.6	(0.1–1.8)	2	0.9	(0.1–3.2)
Ovary	39	**0.6**	(0.5–0.9)	3	0.6	(0.1–1.9)	2	0.7	(0.1–2.4)
Prostate	144	0.9	(0.8–1.1)	8	**0.4**	(0.2–0.9)	1	**0.2**	(0.0–1.0)
Testis	14	0.7	(0.4–1.2)	–	0.0	(0.0–1.7)	–	**0.0**	(0.0–0.7)
Kidney	49	0.9	(0.7–1.2)	3	0.6	(0.1–1.8)	–	0.0	(0.0–1.3)
Urinary tract	85	1.0	(0.8–1.2)	1	**0.1**	(0.0–0.7)	–	0.0	(0.0–1.1)
Central nervous system	39	0.9	(0.7–1.3)	2	0.5	(0.1–1.7)	5	1.1	(0.4–2.6)
Thyroid gland	14	1.2	(0.7–2.0)	2	1.8	(0.2–6.4)	4	3.2	(0.9–8.3)
Other sites	60	1.0	(0.8–1.3)	6	1.2	(0.4–2.6)	6	1.7	(0.6–3.8)
Unknown primary site	115	1.1	(0.9–1.3)	10	1.1	(0.5–2.1)	2	0.5	(0.1–1.7)
Hodgkin's lymphoma	14	1.4	(0.8–2.4)	–	0.0	(0.0–3.6)	2	1.1	(0.1–4.1)
Mature B-cell lymphoma	142	1.1	(0.9–1.3)	10	0.9	(0.4–1.6)	10	1.4	(0.7–2.5)
Mature T/NK-cell lymphoma	6	0.8	(0.3–1.8)	1	1.4	(0.0–8.0)	4	**6.1**	(1.7–16)
Precursor cell neoplasms	4	0.8	(0.2–2.2)	1	2.0	(0.0–11)	–	0.0	(0.0–4.0)
Myeloid neoplasms	33	0.9	(0.6–1.2)	2	0.6	(0.1–2.1)	2	0.8	(0.1–2.9)

SIR = standardised incidence ratio; CI = confidence interval.
Decreased rates ($p < 0.05$) are in bold; increased rates ($p < 0.05$) are in bold italics.
a Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Portugal, Spain, Sweden, United Kingdom.

lifestyle related cancers, such as colorectal cancer, skin cancer and breast cancer. The cancer risk of migrants from neighbouring countries was close to the risk of residents born in the Netherlands.

Although the country of birth was available in a high percentage of all cases, we cannot exclude that among cases with unknown country of birth a slightly different risk pattern was present. As we calculated SIRs which are not affected by missing cases as such, our results would have been influenced if the missing cases are biased by country of birth. However, we have no indication for such bias. Besides, as the missing cases only contributed 13%, it is unlikely that a different risk pattern in these patients would alter our results significantly. Moreover, as was to be expected, the results for

migrants from Germany are very similar to the results for patients born in the Netherlands, which supports the assumption that completeness of country of birth information is satisfactory.

Selective migration may also have influenced our results. This effect is most likely for non-permanent migrants, such as migrants from the USA, who often stay in the Netherlands for relatively short periods. These migrants are likely to return to their homeland in case of disease and this probably explains the relatively low cancer incidence in migrants from the USA, several European countries, such as France and Italy, and Japan (results not shown). This effect is less likely among migrants from, for example, Turkey, Morocco and Surinam, as they are more permanent residents and health facilities in their country of origin are worse than in the Netherlands.

In general, first generation migrants from Indonesia have cancer risks more closely to the risks of the native Dutch population than migrants from other former colonies (Table 2). This can be explained by the fact that the majority of the first generation Indonesian migrants are Indonesian-born offspring of native Dutch who emigrated to Indonesia before World War II. The vast majority of them returned to the Netherlands before the independence of Indonesia in 1949. Consequently, in the Netherlands migrants from Indonesia are considered to be migrants from a western country (Table 1). Notwithstanding this consideration, many migrants from Indonesia are partly or even completely ethnic Indonesian and/or maintain Indonesian dietary habits which differ considerably from the Dutch diet.

For most countries of origin of the larger migrant groups in the Netherlands, no reliable cancer incidence data are available from cancer registries. However, for all major countries estimations from the International Agency for Research on Cancer are available for the common cancers.[1] The relatively high risks for cancers related to infectious disease in migrants from non-western countries are in accordance with the worldwide statistics for these cancers.[9] In international statistics, gallbladder and the extrahepatic bile ducts are often combined, but our results clearly show increased risks of gallbladder cancer and generally low risks of cancers of the extrahepatic bile ducts among migrants from non-western countries. Our observation supports the assumption that besides gallstones and cholecystitis, infection is involved in the carcinogenesis of gallbladder cancer.[10]

The relatively low cancer risk for lifestyle related cancers among migrants from non-western countries is encouraging in the view of the worldwide battle against cancer. One would hope that these migrants maintain their relatively healthy lifestyle habits. However, as was previously shown for breast cancer which is already increasing among younger migrants,[6] a gradual increase of cancer risk as a consequence of changing lifestyle is more likely. This effect is already observed for lung cancer among Turkish males, which is even more common among Turkish males than among males born in the Netherlands (SIR 1.2, 95% CI 0.9–1.4). Apparently the percentage of smokers among Turkish males is relatively high. Besides, lung cancer incidence among males in Turkey is also relatively high.[1] A recent study of Stirbu et al. on cancer mortality among migrants in the Netherlands also supports a gradual change in risk factors among migrants.[3] This study shows already some degree of convergence of the low cancer mortality risk towards the rates of the native Dutch population. But even second generation migrants still have a lower risk of cancer death. As far as first generation migrants are concerned, the relative risks of death due to cancer as described by Stirbu et al. are in accordance with our findings on cancer incidence.

Apart from lifestyle factors, genetic factors may play a role in the relatively high prostate cancer risk in males from Suriname. Roughly 40% of the population of Suriname has its roots in West-Africa and is therefore related to the African Americans in the USA. Like Surinamese men in the Netherlands, African Americans have a higher prostate cancer risk than white Americans.[11]

The low risk of testicular cancer in non-western migrants is remarkable. We found a SIR of 0.2, 0.1, 0.2 and 0.0 for migrants from Suriname, Morocco, Turkey and the Netherlands Antilles, respectively. During the last decades, this cancer has become increasingly common in the Netherlands with a doubling of the incidence rate between 1989 and 2003.[12] The reason for this increase is unknown, but the low risk among non-western migrants suggests that factors in early life might influence the risk on testicular cancer during adulthood. A low risk of testicular cancer was also observed in Israel in first generation migrants from North-Africa.[13] In the second generation a lower risk persisted to some degree, suggesting that inherited susceptibility may also influence the risk of testicular cancer. Unfortunately, the study on cancer mortality of Stirbu et al. was inconclusive as far as a generation effect of testicular cancer was concerned due to low numbers of deaths from testicular cancer.[3]

In conclusion, first generation migrants from non-western countries in the Netherlands experience a low cancer risk. This low cancer risk is most prominent for lifestyle related cancers in older age groups, which compensates a relatively high risk for cancer related to infectious disease. The low risk for testicular cancer among non-western migrants might offer a suitable reference group for a study concerning the fast increase of testicular cancer in the Netherlands. It will also be of interest to examine the cancer risk in second generation migrants in future studies.

Conflict of interest statement

None declared.

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REFERENCES

1. Ferlay J, Bray F, Pisani P, Parkin DM. GLOBOCAN 2002: Cancer Incidence, Mortality and Prevalence Worldwide. *IARC Cancer Base No. 5. version 2.0.* Lyon: IARC Press; 2004.

2. Maskarinec G, Noh JJ. The effect of migration on cancer incidence among Japanese in Hawaii. *Ethn Dis* 2004;**14**:431–9.
3. Stirbu I, Kunst AE, Vlems FA, et al. Cancer mortality rates among first and second generation migrants in the Netherlands: convergence toward the rates of the native Dutch population. *Int J Cancer* 2006;**119**:2265–72.
4. Statistics Netherlands. Statline. Available from: http://statline.cbs.nl/StatWeb/start.asp?LA=nl&lp=Search/Search, accessed 15-01-2005.
5. Visser O, Busquet EH, van Leeuwen FE, Aaronson NK, Ory FG. Incidentie van baarmoederhalskanker in Noord-Holland naar geboorteland in 1988–1998. [Incidence of cervical cancer in women in North-Holland by country of birth from 1988 to 1998]. *Ned Tijdschr Geneeskd* 2003;**147**:70–4.
6. Visser O, van der Kooy K, van Peppen AM, Ory FG, van Leeuwen FE. Breast cancer risk among first-generation migrants in the Netherlands. *Br J Cancer* 2004;**90**:2135–7.
7. Van der Sanden GA, Coebergh JWW, Schouten LJ, Visser O, van Leeuwen FE. Cancer incidence in the Netherlands in 1989 and 1990. First results of the nationwide Netherlands Cancer Registry. *Eur J Cancer* 1995;**31**:1822–9.
8. Parkin DM, Whelan SL, Ferlay J, Raymond L, Young J, editors. Cancer incidence in five continents, vol. VII. Lyon: IARC Scientific Publication No. 143; 1997.
9. Parkin DM. The global health burden of infection-associated cancers in the year 2002. *Int J Cancer* 2006;**118**:3030–44.
10. Kumar S, Kumar S, Kumar S. Infection as a risk factor for gallbladder cancer. *J Surg Oncol* 2006;**93**:633–9.
11. Ries LAG, Harkins D, Krapcho M, et al, editors. SEER cancer statistics review, 1975–2003, National Cancer Institute, Bethesda, MD. Available from: http://seer.cancer.gov/csr/1975_2003/, accessed 13-10-2006.
12. Siesling S, Visser O, van Dijck JAAM, Coebergh JWW. Sterk variërende trends in incidentie en sterfte van kanker in de periode 1989–2003 in Nederland suggereren een gunstig resultaat van de kankerbestrijding [Trends in the incidence and death from cancer from 1989 to 2003 in The Netherlands]. *Ned Tijdschr Geneeskd* 2006;**150**:2490–6.
13. Parkin DM, Iscovich J. Risk of cancer in migrants and their descendants in Israel II. Carcinomas and germ-cell tumours. *Int J Cancer* 1997;**70**:654–60.