Cancer risk diversity in non-western migrants to Europe: An overview of the literature

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ABSTRACT

Background: Cancer risk varies geographically and across ethnic groups that can be monitored in cancer control to respond to observed trends as well as ensure appropriate health care. The study of cancer risk in immigrant populations has great potential to contribute new insights into aetiology, diagnosis and treatment of cancer. Disparities in cancer risk patterns between immigrant and autochthonous populations have been reported many times, but up to now studies have been heterogeneous and may be discordant in their findings. The aim of this overview was to compile and compare studies on cancer occurrence in migrant populations from non-western countries residing in Western Europe in order to reflect current knowledge in this field and to appeal for further research and culturally sensitive prevention strategies.

Methods: We included 37 studies published in the English language between 1990 and April 2010 focussing on cancer in adult migrants from non-western countries, living in the industrialised countries of the European Union. Migrants were defined based on their country of birth, ethnicity and name-based approaches. We conducted a between-country comparison of age-adjusted cancer incidence and mortality in immigrant populations with those in autochthonous populations.

Findings: Across the board migrants from non-western countries showed a more favourable all-cancer morbidity and mortality compared with native populations of European host countries, but with considerable site-specific risk diversity: Migrants from non-western countries were more prone to cancers that are related to infections experienced in early life, such as liver, cervical and stomach cancer. In contrast, migrants of non-western origin were less likely to suffer from cancers related to a western lifestyle, e.g. colorectal, breast and prostate cancer.

Discussion: Confirming the great cancer risk diversity in non-western migrants in and between different European countries, this overview reaffirms the importance of exposures experienced during life course (before, during and after migration) for carcinogenesis. Culturally sensitive cancer prevention programmes should focus on individual risk patterns and specific health care needs. Therefore, continuously changing environments and subsequently changing risks in both migrant and autochthonous populations need to be observed carefully in the future.

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1. Background

Studies on cancer risk in migrant populations have recently gained increased recognition, but still have rather heterogeneous study populations and methods applied. However, insights into risk diversity deduced from such studies contribute to our understanding of carcinogenesis and might help answer unclear etiology questions.

Migration has become an important phenomenon in Western Europe in terms of population changes and the composition of society during the past decades. In 2005, Western and Central Europe hosted 44.1 million migrants, defined as foreign-born persons. Many of them originate from non-western countries, seeking social security, employment opportunities and a better future.

European societies characterised by an increasing degree of heterogeneity pose major challenges to health care systems and policies. Evidence-based research is therefore a prerequisite for appropriate and individual health care of high quality and effectiveness as well as the implementation of culturally sensitive measures of prevention.

Health is closely related to global movements. The transition of disease and risk patterns over time and across countries have been the scope of many epidemiological research questions. Accordingly, infectious diseases become less important as populations advance in terms of westernisation and the role of chronic health conditions, such as cancer and cardio-vascular diseases, becomes predominant.

Hence, migrants from non-western countries are equipped with a unique constellation of risk factors that are determined by exposure and disease patterns experienced in both their home as well as their host country. This sudden change in the stage of epidemiological transition as well as environmental determinants has a major impact on an individual’s lifetime disease risk.

Many theories have been developed to explain differences in mortality and morbidity between migrants and the population of their host and home countries, respectively, one of them being the healthy migrant effect. Thus, migrants are subject to selection processes that initially underlie good physical and mental health. Those health advantages after migration are the result of heterogeneity that initially underlie good physical and mental health. Those health advantages after migration are the result of heterogeneity and possibly early life experiences (as the first step in carcinogenesis) have a great impact and play a major role in the effects of exposure and their association with cancer risks.

Investigating the occurrence of cancer in migrant populations may allow for a better understanding of cancer etiology and of biological factors that can be integrated into prevention and treatment programmes.

The purpose of this article is to compile and compare results from studies conducted all over Europe dealing with cancer in non-western migrant populations. The resulting overview can serve as a guide, reflecting the present state of knowledge in this field, and as an appeal for further research and prevention.

2. Methods

2.1. Inclusion criteria of studies

We included studies focussing mainly or partly on cancer incidence and mortality in adult migrants from non-western countries, living in the industrialised countries of the European Union, published in English between 1990 and April 2010. Studies were identified by searching PubMed and other established scientific databases in combination with the following keywords: cancer + ethnicity/ethnic minority/(immigrant) + country of birth. A further inclusion criterion was a comparison of the migrant population with the native population of the country of the study (no studies conducted within migrant populations).

2.2. Study descriptions

We identified 37 studies conducted in the following seven countries: Denmark (3), France (4), Germany (6), Spain (1), Sweden (7), The Netherlands (5) and the United Kingdom (11). In 51% of the studies (19/37) incidence data were analysed, in 41% (15/37) mortality data and in 8% (3/37) both. All studies were based on the retrospective cohort design.

Owing to the heterogeneous measures of association applied in the studies, we described tendencies instead of combined rate ratios (RRs) or odds ratios (ORs) to indicate differences in risks as follows: significantly elevated, elevated, no difference, decreased and significantly decreased. Age-adjustment procedures had been carried out in all the studies included. Other covariates are listed in Table 1.

In general 70% of the studies (26/37) involved all-cancer comparisons and 24% of the studies (9/37) focused on only one specific cancer site. The most commonly investigated sites were breast (28 studies) and lung cancer (26 studies) as well as stomach and colorectal cancer (24 studies each).

2.3. Defining the migrant status, generations involved and pooling of migrant origins

The indicator for defining the migrant population under study ranged from country of birth (of the patient or in combination with the parental country of birth) in 73% (27/37), name-based approaches in 14% (5/37), (self-assigned) ethnicity in 11% (4/37) and a combination in one study.

The applied indicator or proxy for ethnicity is highly dependent on the availability and completeness of potential variables in the particular host country. However, country of birth is the most widely used and accepted proxy although it has some validity limitations with regard to cultural and ethnic identity.
Table 1 - Methodological features of the studies included.

<table>
<thead>
<tr>
<th>Country, area and year of study</th>
<th>Study aim: to explore</th>
<th>Data source</th>
<th>Period</th>
<th>Outcome/measure of association (incidence)</th>
<th>Cohort acquisition/re- and exclusion criteria</th>
<th>Methodological peculiarities</th>
<th>Definition of ethnicity</th>
<th>Reference population</th>
<th>Size and composition of study</th>
<th>Demands explanations for first differences</th>
<th>Study limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>The aetiology of rectal cancer risk</td>
<td>Study population: civil registration system linked to Danish Cancer Registry through unique personal identification number (population-based)</td>
<td>1968–2001</td>
<td>Incidence RR (age, calendar year, parental birthplace in different periods)</td>
<td>Male gender born between 1950 and 2010; residents of Denmark born between 3rd April 1950 and 31st December 2010; known place of birth; exclusion of individuals born in Greenland</td>
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<td>Adjustments for maternal and paternal birthplace in different periods; age at immigration (unrelated)</td>
<td>[parents] + [country of birth (collected through registry system from index card in municipality registration offices)]</td>
<td>Men born in Denmark of parents born in Denmark (2nd generation migrants)</td>
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<td>Controls = 2,103,405 (1st generation migrants)</td>
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<td>Early environmental exposure/predator in uteri, salmon bias</td>
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<td>Small number of cases in second-generation immigrants</td>
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<tr>
<td>Norredam et al. (2008)</td>
<td>Differences in cancer stage at diagnosis between migrant women and native Danish women</td>
<td>Study population: Statistical Department at The Danish Immigration Service; linkage of civil registration numbers of the study cohort with Danish Cancer Registry (population-registered cohort)</td>
<td>1985–1999 (cohort)/2001 (cases)</td>
<td>Incidence RR (age, region of origin, migrant type, duration of residence)</td>
<td>Women aged 18+, migrants with residence permit as refugees or through family reunification in Denmark between 1st January 1993 and 31st December 1999; only first diagnostic cancers; only cancer types allowing categorization of stage; exclusion criteria: missing civil registration number; duplicates, unclear or missing data on nationality</td>
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<td>1.6 matching-on age and sex on population level; 1-4 matching-on an individual level on age and sex through a random sampling procedure; comparison of local with national statistics on tumour incidence over time in migrants; immigrant status as proxy for pre- and post-migration circumstances</td>
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<td>Nationality according to WHO's classification system</td>
<td>Danish-born residents with Danish-born parents (identified through Statistics DK)</td>
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<td>Study cohort: Case (first generation migrants): n = 6,446; Controls (Danish-born) = 2,498; (cancer cases: n = 2,634)</td>
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<td>Differences in tumour biology between migrants and host population; barriers to access to healthcare (language, culture, health care systems); poor screening uptake; salmon bias</td>
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<td>Small number of cases; high number of cases with unknown stage; nationality as poor socio-cultural proxy of ethnicity, no SES adjustments possible</td>
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<tr>
<td>Norredam et al. (2007)</td>
<td>Incidence of cancer among 1st generation migrants compared with native Danish, including time trends</td>
<td>Study population: Statistical Department at The Danish Immigration Service; linkage of civil registration number of the study cohort with Danish Cancer Registry (population-registered cohort)</td>
<td>1993–2003</td>
<td>Incidence RR (age, region of origin, migrant type, duration of residence)</td>
<td>Men and women aged 10-80, residence permit as refugees or through family reunification in Denmark between 1st January 1993 and 31st December 1999; only first diagnostic cancers; only cancer types allowing categorization of stage; exclusion criteria: missing civil registration number; duplicates, unclear or missing data on nationality</td>
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<td>1.6 matching-on age and sex upon arrival in Denmark and 1-4 matching-on an individual level on age and sex through a random sampling procedure in the study cohort; migrant status as proxy for pre- and post-migration circumstances</td>
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<td>Lifestyle patterns (breast and colorectal cancer), smoking, decline in incidence-over time in migrant women related to increased cancer diagnostic activities such as screening and better access to healthcare services</td>
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<td>Small number of cases; high number of cases with unknown stage; no SES adjustments possible; trend analysis irrespective of duration of stay which may dilute effects</td>
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<td>France</td>
<td>Cancer mortality among 1st generation migrants to France</td>
<td>Population data: &quot;Institut National de la Statistique et des Etudes Economiques&quot; (INSEE), derived from the French 1982 census; mortality data: &quot;Institut National de la santé et de la recherche médicale&quot; (INSERM)</td>
<td>1974–1985</td>
<td>Mortality RR (age, gender, social class, area of residence)</td>
<td>Men and women of all ages, records of deaths in resident population of France from 1974 to 1985 (provided by INSERM)</td>
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<td>Stratified analyses by socioeconomic subgroup</td>
<td>Country of birth</td>
<td>Individual-born in metropolitan France (native French)</td>
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<td>Cancer deaths among migrants: n = 27,352 (3.4% of all cancer deaths)</td>
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<td>Four quality of French morbidity data, small number of cancer deaths among French-hostile migrants, heterogeneity within migrant groups</td>
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<tr>
<td>Rouchardy et al. (1999)</td>
<td>Cancer mortality in sub-Saharan African migrants to France</td>
<td>Population data: &quot;Institut National de la Statistique et des Etudes Economiques&quot; (INSEE), derived from the French 1982 census; mortality data: &quot;Institut National de la santé et de la recherche médicale&quot; (INSERM)</td>
<td>1974–1985</td>
<td>Mortality RR (age group, gender, social class, area of residence)</td>
<td>Men and women of all ages, records of deaths in resident population of France from 1974 to 1985 (provided by INSERM)</td>
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<td>Cancer deaths among migrants: n = 28,506 (3.2% of all cancer deaths)</td>
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<td>Review of studies</td>
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<td>Cancer deaths among Maghrebian migrants: n = 1,262</td>
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<td>Rouchardy et al. (1994)</td>
<td>Cancer patterns in Chinese and South East Asian migrants to France</td>
<td>Population data: &quot;Institut National de la Statistique et des Etudes Economiques&quot; (INSEE), derived from the French 1982 census; mortality data: &quot;Institut National de la santé et de la recherche médicale&quot; (INSERM)</td>
<td>1974–1985</td>
<td>Mortality RR (age, social class, sex of residence)</td>
<td>Men and women of all ages, records of deaths in resident population of France from 1974 to 1985 (provided by INSERM)</td>
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<td>Computation of differences in risk between migrants using a case-control approach</td>
<td>Country of birth</td>
<td>Metropolitan-born population in France</td>
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<td>Migrants in population data: n = 3,274; Cancer deaths among migrants: n = 975</td>
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<td>Consumption of rackled and preserved foods (nasopharyngeal cancer), generic susceptibility, high and early exposure to hepatitis B virus and aftertains, chronic infection with lower flukes (liver cancer)</td>
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<td>Four quality of French morbidity data, small number of deaths in Chinese-born migrants</td>
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Table 1 – continued

<table>
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<tr>
<th>Country, authors and year of study</th>
<th>Study aims</th>
<th>Data source</th>
<th>Period</th>
<th>Outcome/measure of association (cohort)</th>
<th>Methodological peculiarities</th>
<th>Definition of ethnicity</th>
<th>Reference population</th>
<th>Size and composition of study population</th>
<th>Discussed explanations for risk differences</th>
<th>Study limitations</th>
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<tbody>
<tr>
<td>Germany Spiekly et al. (2000)†</td>
<td>Cancer incidence in Turkish migrants in Hamburg</td>
<td>Study cohort: Hamburg Cancer Registry; Reference population: population registry</td>
<td>1990–2004</td>
<td>Incidence RR (year of birth)</td>
<td>Stratification by birth cohorts to adjust for age-period interaction</td>
<td>Life course perspective</td>
<td>Repatriate population sample of Hamburg</td>
<td>n = 1346</td>
<td>Different nutritional patterns (cancer of Digestive, urinary tract and breast); early-life experiences and infections (e.g. HPV and EBV); higher smoking prevalence among Turkish males; different reproductive behaviour.</td>
<td>Methodological and incomplete identification cannot be ruled out due to use of name-based approach; small number of Turkish cases; possible under-estimation due to non-notification.</td>
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<tr>
<td>Weidler et al. (2005)§</td>
<td>Cancer mortality and incidence in FSU migrants in Germany</td>
<td>Cancer mortality: sample of migrant cohort in North Rhine-Westphalia, cancer incidence: sample of migrant cohort in North Rhine-Westphalia; linkage with local population registers, local notification centre, Swabian Cancer Registry; MBK statistical office and local health offices</td>
<td>1990–2005</td>
<td>SMR, SR (age, calendar year)</td>
<td>Date of survival approximated by passenger data; person-year estimation using German mortality rates</td>
<td>Benefits from FSU of German ethnicity</td>
<td>The entire population of Germany</td>
<td>n = 708; Mortality Study (incidence cohort): n = 34393, Deaths in cohort: n = 2580, Cancer deaths: n = 708; Incidence Study (incidence cohort): n = 18019, Cancer cases: n = 985</td>
<td>Similar SMR and SMR patterns in mortality (sex-adjusted survival difference, big impact of smoking prevalence similar to country of origin); R. pylori prevalence (endoscopy); alcohol consumption and hepatitis B infection (case-cancer); higher birth rate (female cancer).</td>
<td>Slightly different populations used for standardization, follow-up estimation.</td>
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<tr>
<td>Benfell-Freund et al. (2009)</td>
<td>Stomach cancer mortality in FSU migrants in Germany</td>
<td>Study population: sample of migrants from FSU to German federal state North Rhine-Westphalia; linked with municipal population registry; linkage with mortality data (cause of death database) through year of birth and death, last residence as identifiers (registry-based)</td>
<td>1990–2005</td>
<td>SMR (age, calendar year)</td>
<td>Follow-up assurance through electronic record linkage with municipal population registries and a state death database, vital status ascertainment, cause of death retrieval</td>
<td>Benefits from FSU of German ethnicity</td>
<td>The entire population of Germany</td>
<td>n = 34393, deaths in cohort: n = 2580, stomach cancer deaths n = 68</td>
<td>Long latency often exposes to risk factors usually life (e.g. HP infection, consumption of lifestyle and behaviours (e.g. alcohol/baby); changes in lifestyle conditions, better treatment options, improved access to healthcare.</td>
<td>Restricted data availability; differences in study populations; no information on actual tumour location.</td>
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<tr>
<td>Ott et al. (2008)‡</td>
<td>Mortality of causes of possibly infectious/origin in migrants from FSU to Germany</td>
<td>Study population: sample of migrants from FSU to German federal state North Rhine-Westphalia; linked with municipal population registry; linkage with mortality data (cause of death database) through year of birth and death, last residence as identifiers (registry-based)</td>
<td>1990–2005</td>
<td>SMR (sex, 5-year age group, calendar year, mortality RR)</td>
<td>All-cause, cause and calendar year specific mortality rates of the German population obtained using WHO's Mortality Database; Effect of length of residence analysis</td>
<td>Benefits from FSU of German ethnicity</td>
<td>The entire population of Germany</td>
<td>n = 34393, deaths in cohort: n = 2800</td>
<td>R. pylori and hepatitis B virus infection, nutritional factors (low fruit/vegetable consumption, high intake of saturated and trans fats), high alcohol consumption (per capita and liver cancer), living conditions in Germany, differences in health-seeking behaviour.</td>
<td>Restricted data availability; differences in study populations; no information on actual tumour location.</td>
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<tr>
<td>Sperling et al. (2006)</td>
<td>Differences in cause mortality between German immigrants and the native German population</td>
<td>Study population: sample of migrants from FSU to German federal state North Rhine-Westphalia; linked with municipal population registry; linkage with mortality data (cause of death database) through year of birth and death, last residence as identifiers (registry-based)</td>
<td>1990–2001/2002</td>
<td>SMR (age, calendar year, annual period, mortality RR)</td>
<td>All-cause, cause and calendar year specific mortality rates of the German population obtained using WHO's Mortality Database; Analysis of secular trends and effect of length of residence, directly standardized death rates calculated for all-causes and lung cancer</td>
<td>Benefits from FSU of German ethnicity</td>
<td>The entire population of Germany</td>
<td>n = 245143, Cancer deaths (migrant cohort): n = 469</td>
<td>Differences in risk factors: smoking; alcohol consumption, diet, physical activity, reproductive factors, lifestyle, health care utilization, geographic factors, viral infections, cancer mortality mainly influenced by pre-migration risk factors (country of origin effect).</td>
<td>Assessment of current or pre-migration individual risk profiles of migrants impossible; incomplete FC for some migrant cohorts.</td>
</tr>
<tr>
<td>Zehl et al. (2002)†</td>
<td>The transition in cancer mortality patterns among Turkish migrants residing in Germany</td>
<td>Mortality data: death registration records, reference-year West Germany; Cancer incidence: cancer registry</td>
<td>1970–1988 (incidence) and 1988–1987 (mortality)</td>
<td>SMR, PCIR (age)</td>
<td>Men and women aged 0–64; use of same-based approach; based on Turkish birth and registration data for proxy for ethnicity</td>
<td>Increasing crude and age-standardized death rates in all-years and for both genders; increased mortality among Turkish migrants.</td>
<td>Native German population</td>
<td>n = 163</td>
<td>Cancer deaths among migrants: n = 604, incident cancer cases among migrants: n = 183</td>
<td>Potential risk factors: unfavourable living conditions in Turkey; higher prevalence of R. pylori infections among Turkish males; high dietary energy intake (breast cancer); cumulative risk, hepatitis B infection (liver cancer); healthy migrant effect on migration of E. coli infection (colon cancer); lifestyle changes, socio-cultural factors affecting population and quality of clinical treatment.</td>
</tr>
</tbody>
</table>
Spain
Regidor et al. (2008)\(^\text{11}\) Whether mortality in immigrants in the region of Madrid differs from mortality in Spanish in-country migrants
- Mortality data: Mortality Registry, population data: Municipal Population Register, reasons data: both sources provided by Madrid Institute of Statistics, unlinked study
- Mortality rate (age, per caput, in/country, sex of resident)
- Men aged 20-64 Per capita income estimated based on income tax returns for the year 2004, question of distribution assigned to each individual based on census level of residence
- Country of birth: Spanish in-country migrants; population ratio in Madrid
- Cancer deaths among migrants: n = 335
- Healthy-migrant effect; differences in demographics; stage of smoking
- Heterogeneity within migrant group: information on population and death from different source (incorporated/ de-identified information basis) no information on duration of residence

Sweden
Hemminki et al. (2010)\(^\text{10}\) Liver and gallbladder cancer in immigrants to Sweden
- Study cohort: Swedish Family Cancer Database
- Incidence SIR (5-year age group, sex, period)
- Men and women of all ages; primary liver cancer
- Country of birth: Native Swedish population
- Cancer cases in migrants: n = 1428
- Chronic HBV infection, often transmitted at birth; liver fluke infections; poor living conditions; unavailability of medical care

Mousavi et al. (2010)\(^\text{41}\) Cancer incidence in Iranian immigrants to Sweden
- Study cohort: Swedish Family Cancer Database
- Incidence SIR (5-year age group, sex, region, time period)
- Men and women of all ages
- Country of birth: Native Swedish population
- Cancer cases in migrants: n = 1293
- Environmental, reproductive and socio-economic factors; Hepatitis B (in country of origin), smoking (Mardin origin)

Mousavi et al. (2010)\(^\text{42}\) Nasopharyngeal and hypopharyngeal cancer risk in immigrants to Sweden
- Study cohort: Swedish Family Cancer Database
- Incidence SIR (5-year age group, sex, time period)
- Men and women of all ages
- Country of birth: Native Swedish population
- Cancer cases in migrants: n = 243
- EBV infection in early life; differences in smoking and dietary patterns; chewing tobacco

Nasopharyngeal and hypopharyngeal cancer risk in immigrants to Sweden
- Study cohort: Swedish Family Cancer Database
- Incidence SIR (5-year age group, sex, time period)
- Men and women of all ages
- Country of birth: Native Swedish population
- Cancer cases in migrants: n = 19,542
- Cases per million population
- Data on parental place of birth through linkage with multigeneration register; stratification of results by age at immigration
- Birth region of study population: Women born in Sweden
- Data on parental place of birth through linkage with multigeneration register; stratification of results by age at immigration
- Incident cancer cases: n = 3820, among migrants: n = 50 (1.3%)
- Exposure to environmental risk factors during early life, indices of parental place of birth
- No information on prevalence of risk factors; no information on histological classification

Hemminki and Li (2002)\(^\text{2}\) Cancer risks in adult immigrants to Sweden
- Study cohort: Swedish Family Cancer Database
- Incidence SIR (5-year age group, sex, region, period, tumour type)
- Men and women aged 0-65
- Cancer cases by father’s birth country: n = 866, cancer cases by mother’s birth country: n = 447
- Multiple comparison problem
- Long-lasting environmental and heritable effects (e.g. skin pigmentation, immune response)
- Small number of cases; multiple comparisons

Hemminki et al. (2008)\(^\text{10}\) Cancer risks in adult immigrants to Sweden
- Study cohort: Swedish Family Cancer Database
- Incidence SIR (5-year age group, sex, region, period, tumour type)
- Men and women aged 0-65
- Cancer cases by father’s birth country: n = 866, cancer cases by mother’s birth country: n = 447
- Multiple comparison problem
- Long-lasting environmental and heritable effects (e.g. skin pigmentation, immune response)
- Small number of cases; multiple comparisons

continued on next page
Table 1 – continued

<table>
<thead>
<tr>
<th>Country, authors and year of study</th>
<th>Study aims to explore</th>
<th>Data source</th>
<th>Period</th>
<th>Outcome/measure of association (covariates)</th>
<th>Gilbert acquisition/In- and exclusion criteria</th>
<th>Methodological peculiarities</th>
<th>Definition of reference population</th>
<th>Size and composition of study population</th>
<th>Discussed explanations for risk differences</th>
<th>Study limitations</th>
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<tr>
<td>The Netherlands: Stirbu et al. 2006 (14)</td>
<td>Differences in cancer mortality between migrants and the native Dutch population</td>
<td>Population data from Statistics Netherlands, linked with Study Gilbert: Amsterdam Cancer Registry covering the provinces North Holland and Flevoland, population-based</td>
<td>1985–2000</td>
<td>Mortality rate (age, sex, marital status, urbanisation level, area income)</td>
<td>Men and women of all ages, legal residents of the Netherlands</td>
<td>Age at immigration and duration of residence based on known date of immigration, degree of urbanisation and income household equivalent used to approximate SES calculated based on postal code</td>
<td>Native Dutch population</td>
<td>All deaths in Dutch population during study period: n = 950,146</td>
<td>Healthy migrant/unhealthy-remigrant effect; uptake of western lifestyle (smoking, changes in diet and health-related behaviours); hepatitis B surface antigen (risk factor for liver cancer); importance of lifestyle perspective</td>
<td>Limited statistical power owing to small numbers and relatively young and highly different age distribution of migrants</td>
</tr>
<tr>
<td>The Netherlands: Bos et al. 2002 (47)</td>
<td>Factors causing a higher or lower mortality in migrants compared with the native population</td>
<td>Population data from Statistics Netherlands, linked with Study Gilbert: Amsterdam Cancer Registry covering the provinces North Holland and Flevoland, population-based</td>
<td>1985–2000</td>
<td>Mortality rate (age, marital status, region, degree of urbanisation, SES by sex)</td>
<td>Men and women of all ages, legal residents of the Netherlands</td>
<td>Country of birth of subject and both parents (non-Dutch if at least one parent born abroad)</td>
<td>Native Dutch population</td>
<td>All deaths in Dutch population during study period: n = 145,904</td>
<td>Healthy migrant/unhealthy-remigrant effect; smoking, dietary habits (adaptation of unhealthy western lifestyle)</td>
<td>No information on within-migrant group variation, risk underestimation in some groups, unregistered emigration</td>
</tr>
<tr>
<td>The Netherlands: Visser et al. 2004 (48)</td>
<td>Breast cancer incidence in migrants in the Netherlands</td>
<td>Population data from Statistics Netherlands, linked with Study Gilbert: Amsterdam Cancer Registry and Cancer Centre West (covering the provinces North Holland and Flevoland), linked to screening data</td>
<td>1980–1998</td>
<td>SEER</td>
<td>Women of all ages</td>
<td>Validation of country of birth information with breast cancer screening programmes to: Cancer registry data, if data in cancer registry discordant or missing, country of birth information from screening data used</td>
<td>Native Dutch women</td>
<td>All deaths in Dutch population during study period: n = 950,146</td>
<td>Healthy migrant/unhealthy-remigrant effect; smoking, dietary habits</td>
<td>Screening attendance, change in reproductive risk factors such as lower parity</td>
</tr>
<tr>
<td>The Netherlands: Visser et al. 2008 (49)</td>
<td>Incidence of cervical cancer in North Holland by country of birth</td>
<td>Population data from Statistics Netherlands, linked with Study Gilbert: Amsterdam Cancer Registry (covering the provinces North Holland and Flevoland), population-based</td>
<td>1980–2006</td>
<td>AISR, O/E rate (age)</td>
<td>Women of all ages with invasive cervical cancer</td>
<td>Dutch resident born abroad</td>
<td>Native Dutch women</td>
<td>HPV infection, changes in lifestyle, screening programme in host country; selection effects</td>
<td>Missing country of birth in 10% of cases; incompleteness of mortality registration; no information on prevalence of risk factors and differences in SES</td>
<td></td>
</tr>
<tr>
<td>United Kingdom: Hadley et al. 2009 (50)</td>
<td>Trends in cancer mortality in England and Wales</td>
<td>Population data from General Register of birth, death, and marriage certificates; England and Wales</td>
<td>1959–2003</td>
<td>Mortality rate (age)</td>
<td>Men and women aged 50–69, consistent country of birth, mortality rates in both deaths and cancer data</td>
<td>Trend analysis (changes in death rates among these time intervals)</td>
<td>Country of birth</td>
<td>English and Welsh born</td>
<td>Changes in risk behaviour (smoking, failure to attend screening programmes); alcohol consumption; delayed uptake and poor quality of clinical management; poor cancer outcome; co-morbidity, illness (cancer, chronic bronchitis); within-ethnic group variation</td>
<td>Possible misclassification of country of birth between census data and death certificates, healthier-migrant effect (selection bias)</td>
</tr>
<tr>
<td>United Kingdom: Jack et al. 2004 (51)</td>
<td>Breast cancer incidence, stage, treatment, and survival in ethnic groups in London and Wales</td>
<td>Population data from General Register of birth, death, and marriage certificates; Office for National Statistics (matched on NHS number), registry- and population-based study</td>
<td>1980–2003</td>
<td>Incidence, RR, HR (age, socioeconomic deprivation, stage at diagnosis, treatment)</td>
<td>Women of all ages, known ethnicity, complete registration information, exclusion criteria: patients registered for death certificate only recorded as asylum seeker, stage, treatment and mortality</td>
<td>Socio-demographic deprivation based on income domain of Index of Multiple Deprivation 2001, divided into quintiles, assigned to record using postcode of residence at diagnosis</td>
<td>Self-assigned ethnicity (using codes from SN and 2001 censuses)</td>
<td>White women</td>
<td>Self-assigned ethnicity (using codes from SN and 2001 censuses)</td>
<td>Ethnicity information not available for large portion of patients (20%), representativeness of ethnic groups within ethnic group variation</td>
</tr>
</tbody>
</table>

References: [47], [48], [49], [50], [51]
Only one study focused entirely on second-generation migrants\textsuperscript{12} (based on the patient's own and parental country of birth) and two other studies included this group explicitly in addition to first-generation migrants.\textsuperscript{13,14} Seven studies included descendants indirectly, owing to the method used for identifying migrants.\textsuperscript{15–21} For instance, the name-based approach does not allow a distinction between generations, which can only be estimated vaguely based on age. There were 27 studies that were aimed at first-generation migrants only.

For reasons of clarity, migrant origins have been pooled into the following categories: Eastern Europe [Former Soviet Union (FSU), Russia], Africa (North, West and East Africa), Middle East (most frequently referring to Iran, Iraq and adjacent countries), Southern Europe/Turkey, Asia (divided into general Asia [mostly China and Vietnam] and South Asia [including India, Bangladesh, Indonesia, Ceylon and Pakistan]) and South America. Owing to inconsistent definitions between the studies, some overlap cannot be excluded.

2.4. Applied methods

Studies investigating cancer incidence used mainly cancer registry data (21/37). Studies assessing cancer mortality drew mostly on vital statistics such as mortality or cause of death registries and databases or surveys (17/37). Population data were obtained from population registers/statistical bureaux (17/37), census data (13/37) – which were primarily used in studies from France and the United Kingdom (UK) – or a population sample (7/37). Most studies were population-/registry-based. In many studies linkage procedures had been performed using a unique identifier such as the ‘Personal Identity Number’ in Sweden and the ‘National Health Service (NHS) number’ in the UK. Two studies used numerator-only analyses.

Some studies adjusted for a socioeconomic proxy and also took important covariables such as duration of stay, age at immigration and calendar year into account.

Table 1 summarises the methodological features, explanations and limitations of the studies included.

3. Findings

Table 2 provides an overview of all findings according to country of study, population of interest and cancer site, expressed in tendencies.

The all-cancer comparison of most studies showed in particular on average a lower cancer risk for first-generation migrants from non-western countries in terms of incidence and mortality, although there were some studies that did not reveal significant differences, sometimes obviously due to small study cohorts. However, male subjects originating from West Africa exhibited significantly elevated cancer mortality in two studies from the United Kingdom.\textsuperscript{22,23} Ambiguous results were attained for migrants from Eastern Europe: Many studies revealed advantageous risks, although in several cases they were not significant.

Since all-cancer morbidity reflects a summary of site-specific results, the aim is to point out cancers with significantly elevated or lowered risks among migrants and to investigate these results according to migrant origin.

3.1. Migrants from Southern Europe

In 35% of all studies (13/37) included from five different countries, migrants from Southern Europe, mostly Turkey, were investigated. According to these studies, all malignant neoplasms together tended to occur significantly less often in this group compared with the general population of the host country.

Significantly elevated risks for this migrant group could be observed for cancers of the stomach, liver, lung among males and thyroid gland. In addition, increased risks were reported for Hodgkin’s disease and lymphomas. In contrast, significantly lower risks were found for cancers of the oesophagus, colorectum, lung among females, skin, breast, prostate and testis and bladder.

3.2. Migrants from Eastern Europe

In 32% of studies from five countries (12/37) came from the Eastern part of Europe, mostly parts of the former Soviet Union. Lower all-cancer morbidity and mortality were confirmed by the majority of these studies.

The site-specific results were ambiguous, but strongly consistent on the elevated risks for stomach and lung cancer in males, whereas consistently decreased risks could be observed for breast cancer in females and melanoma.

3.3. Migrants from Africa

Migrants originating from the African continent had to be categorised into ‘Africa’ (if no subgroups were available), ‘North Africa’, ‘West Africa’ and ‘East Africa’.

In 16% of studies from four countries (6/37) migrants from Africa without further regional classifications were investigated. However, only three studies covered all-cancer morbidity which resulted in advantageous risks for migrants. The most striking similarities in the study results could be observed for liver cancer due to strongly elevated risks and colorectal cancer as well as cancer of male and female genital organs due to decreased risks.

North African migrants were studied in 12 studies (32%) from five countries (Denmark, France, Sweden, Netherlands and the UK). All-cancer morbidity was lower or not significant in all studies. Elevated risks were observed for cancers of the nasopharynx, liver, gallbladder and cervix uteri. Significantly decreased risks were found for almost all other cancer sites, especially for colorectal, lung and breast cancer as well as melanoma.

Migrants from the western part of Africa represent an exceptional group among migrants from non-industrialised countries. Only 4 out of 37 studies (11%) from France and the UK looked at this group but all of them presented quite detailed results that allowed us to look at many possible parallels. All-cancer mortality was significantly elevated among males residing in the United Kingdom, but the opposite was the case for males living in France. The studies coincide in increased risks for cancers of the liver, pancreas and prostate as well as...
Table 2 – Site-specific cancer occurrence in male and female migrants from different regions residing in selected European countries.

<table>
<thead>
<tr>
<th>Region Origin</th>
<th>South America</th>
<th>South-East Asia</th>
<th>Asia</th>
<th>Middle East</th>
<th>East Africa</th>
<th>West Africa</th>
<th>North Africa</th>
<th>Africa</th>
<th>Eastern Europe</th>
<th>Southern Europe</th>
<th>Turkey</th>
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</table>
lymphomas. Other cancer sites showed ambiguous results, for
eexample, significantly elevated mortality due to breast cancer
in the studies from the UK as opposed to study results from
France, which showed a significantly decreased risk among
West African women. This implies important regional risk
diversity in similar migrant groups across European countries
and is certainly an interesting subject for further research.

Another four studies from Sweden and the UK focussed on
East African migrants. The three British studies agreed on
lower all-cancer mortality in this group and revealed elevated
risks for cancer of the oral cavity and leukaemia. All other
cancer sites showed continuously decreased risks, most
remarkably for cancers of the colon and rectum, lung and
genital organs. The Swedish study yielded a significantly
decreased risk of cancer of the cervix uteri in this migrant group.

3.4. **Migrants from the Middle East**

In 24% of the studies (9/37) migrants originating from the Mid-
dle East were investigated, investigating only few cancer sites.
All-cancer occurrence appeared to be significantly less fre-
quent in three studies. Moreover, decreased risks could be ob-
served for colorectal, lung, prostate, testis and breast cancer
in studies carried out in Denmark, the United Kingdom and
Sweden, where an increased risk of cancer of the thyroid
gland was also revealed.

3.5. **Migrants from Asia**

Many studies took migrants from Asia into account. With re-
gard to the vastness of this continent, it made sense to distin-
guish between Asia in general, mostly referring to China and
Vietnam, and South East Asia, which included India, Ceylon,
Bangladesh, Indonesia and sometimes Pakistan (depending
on the definition).

Cancer risks among migrants from Asia in general were
examined in 30% of the studies from six different European
countries (11/37), all of them exhibiting lower all-cancer mor-
tality and morbidity rates. Consistent findings of elevated
risks were found for cancers of the nasopharynx, stomach, li-
ver and endocrine glands as well as lymphomas. Parallel, de-
creased risks could in particular be observed for colorectal,
lung, breast and bladder cancer as well as for melanoma and
cancers of the cervix, ovary, prostate and testis.

Migrants from South East Asia showed surprisingly similar
results between the studies for many cancers. In total, 41% of
all studies included (15/37), performed in France, Sweden,
The Netherlands and the UK focussed on this migrant group,
varying little in the definition of South East Asian countries.
All-cancer mortality and morbidity risks appeared to be con-
sistently lower in all studies that covered this general compar-
ison. Uniformly elevated risks were revealed for migrants with
cancers of the oral cavity, nasopharynx, liver, gallbladder and
thyroid gland. Moreover, a higher risk of lymphomas and leu-
kaemia was observed in several studies, whereas lowered risks
were found for stomach, colorectal, lung, breast, ovary, pro-
state, testis, kidney and bladder cancer as well as melanoma.

3.6. **Migrants from South and Central America**

In 41% of all studies included in this overview (15/37) cancer
risks were determined for migrants coming from South and
Central American countries, most frequently Caribbean coun-
tries that used to be European colonies. All-cancer mortality
and morbidity risks were consistently lower for migrants
from this part of the world. Particularly elevated risks could
be observed for cancers of the nasopharynx, liver, cervix uteri,
prostate and lymphomas. In contrast, notably lowered risks
were revealed for cancers of the oesophagus, colon and rec-
tum, lung, breast, skin, ovary and bladder.

3.7. **Second-generation migrants**

Studies on cancer risk in second-generation migrants are still
scarce and were included in this overview for the sake of
completeness only. However, a convergence of risks towards
the rates of the host population as well as less extreme risks
was revealed by Hemminki and Li. In addition, studies
assessing the effects of duration of residence or age at migration indicate an adaptation of rates, which also indicates a change of risk over time, i.e. after migration. Investigating cancer occurrence in second-generation migrants will become more relevant in future, due to the increasing age and size of this population group.

4. Discussion

Our findings suggest that migrants from non-western countries were more likely to develop cancers that are related to infectious diseases, compared with the general population of their industrialised host country. This is especially true for cancers of the oral cavity, nasopharynx, stomach, liver, gallbladder, cervix uteri, prostate and lymphomas. In contrast, almost all studies found lower risks for cancers that are strongly related to a ‘western’ lifestyle (poor diet, physical inactivity, reproductive factors, etc.), irrespective of the migrant origin. This is in particular the case for colorectal cancer and cancers of the pancreas, lung, breast, ovary, kidney and bladder. Some elevated risks could also be explained partly by important covariables such as socioeconomic status, especially for migrants originating from West Africa.

We also found that in most studies, migrants show cancer risks that are in between the corresponding risk of the native populations in their home and their host country. The majority of the findings tend to be in accordance with the rates, visualised in Fig. 1.

Whereas all-cancer incidence in the more developed countries amounts to 314 [age-standardised rate (ASR(W)) per 100,000] among males and 228 among females, less well-developed countries show an average of 159 for males and 129 for females. 24

It can be observed that cancer sites with a comparatively high incidence in less well-developed regions also exhibit a high incidence for migrant populations from non-western countries residing in industrialised countries. This applies particularly for cancers of the liver, oesophagus, stomach and nasopharynx among males and cervix, stomach, liver, oesophagus and nasopharynx among females. In the same manner, low incidences in less well-developed regions are reflected by low incidences among migrant groups originating from these countries. This pattern could be confirmed in a recent study by Zanetti and colleagues,25 who analysed cancer incidence in North Africa.

Mortality data show a similar picture, although the differences are less clear, which is mainly attributable to disparities in access to care and suboptimal communication on the dilemmas of treatment.

Our findings also concur with those of others from non-European countries and continents that host non-western migrants. McCredie and colleagues26 for instance observed lower cancer incidences for migrants from various non-western origins in Australia and McDonald and Neily27 could confirm similar results for migrant women in the United States.

A close relationship with individual exposure experienced during a life span could be confirmed for migrants of various origins. In addition to individual factors and health behaviour, the causal roles of exposure in the home country, i.e. before migration, during migration itself and in the host country, as well as the influence of social factors, certainly represent key factors in carcinogenesis.

Exposure to risk factors and adaptation to changing environments evolve over time and therefore cancer risk diversifies with the duration of residence, new exposures and new generations. Prospectively, a convergence of cancer risk (a simultaneous decrease in cancers with high incidence in migrants and an increase in those with a currently low incidence) towards the level of the rates in the native population of the host country can be expected over time and across migrant generations.6,14,16,28

Of course there are limitations to the comparisons conducted in this overview. Firstly, the definitions of the migrant groups and the study populations varied among studies and countries. Ethnicity proxies, such as ‘self-assigned ethnicity’ and name-based approaches, are in particular prone to misclassification bias, since a distinction between generations or for example intercultural marriages is not possible. Second, the comparability of studies is also limited with regard to the size, composition and time window of the study populations. It is also important to note that in some studies population data from censuses or surveys were used (instead of population-based registers), which is always a biased underestimate of the population at risk because as a rule only the head of the household is considered.

Third, migrant origins may sometimes have been collected in an inconsistent way, which was unavoidable in some cases (e.g. the allocation of Pakistan or Turkey).

Fourth, studies investigating both mortality and morbidity have been included, given the assumption of parallel effects, although mortality is mainly driven by (access to) treatment and the varying fatality rates of different cancers. Consequently, different measures of association have been pooled and compared on the basis of tendencies. The comparisons therefore lack a magnitude and only provide a rough estimation of risk disparities. Meta-analysis was not the aim of this overview.

The healthy migrant effect could partly explain the advantageous risks of migrants, but since effects seem to persist, its influence is probably marginal. Several studies also discussed the possible effects of the so-called salmon-bias, which assumes that migrants tend to return to their roots when they become ill. This is in most instances unlikely due to the fact that health services and treatment are often better in the host country and many migrants have already been joined by and settled with their families.

This is to our knowledge the first direct comparison of studies on cancer occurrence in migrant populations in Europe. Despite the limitations mentioned above, broad comparisons are feasible and will gain importance in the future. Prospectively, a transnational study of cancer occurrence in migrant populations could surmount many of these difficulties. This primarily concerns the definition of migrant groups requiring close networking between countries. In doing so, the results would be more reliable and the magnitude of the risk diversity could be studied in more detail. In order to appreciate the change in risk after migration, a comparison with data from the country of birth would be ideal.
Conflict of interest statement

None declared.

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References


