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# Cancer incidence among Iranian immigrants in Sweden and Iranian residents compared to the native Swedish population

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## ABSTRACT

**Background and goals:** Comparing cancer incidence by migrant studies is one of the main approaches to generate hypotheses on the aetiology of cancer. Immigrant studies are most informative when cancer incidence data are available from both the source and the host country.

**Methods:** The age standardised incidence rate (ASR) and standardised incidence ratio (SIR) of cancers among the Iranian immigrants were compared to the native Swedish population as the standard population by using the Swedish Family-Cancer Database (FCD) from 1958 to 2006. We also compared SIRs between Iranian immigrants and Iranian residents for whom the data were derived from the Iranian national cancer registry report of 2006.

**Results:** Among the 65,501 Iranian immigrants, the median age at immigration was 26 years and the median length of stay was 16 years. Their all-cancer ASR was 175.3 and 153.1 per 100,000 person years for males and females, respectively, during the period from 1996 to 2006, higher than for the Iranian residents. The ASRs increased among the male Iranian immigrants during the past two decades but were stable among females. The risk for all-cancers among Iranian immigrants was lower than that for the native Swedish population. The Iranian immigrants had a significantly increased risk for male urinary bladder (SIR = 1.40) and thyroid cancers (2.64) compared to the Swedes.

**Conclusion:** The reasons for the decreased risk for all-cancers among the Iranian immigrants remain to be established. The ASR difference between the Iranian immigrants and the Iranian residents may be due to the differences between the registry systems, selected immigrant groups and environmental exposures.

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## 1. Introduction

Global cancer incidence varies extensively between developed and developing countries. However, the differences between incidence rates at site-specific cancers are usually much lar-

ger than those between overall rates. This is due to the low incidence rate for all cancers in developing countries, but very high risk for site-specific cancers such as liver, oesophageal, stomach and cervical cancers.<sup>1,2</sup> Studies of migrants may provide valuable insight into the aetiology of cancer. Classical

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cancer studies on immigrants to the USA and Australia showed that the incidence in common cancers adapts to the level of the new host country in one or two generations.<sup>3</sup> These findings were fundamental to the understanding of the environmental aetiology of human cancer. Studies in Sweden have shown that the second generation immigrants, those born in Sweden, have already adopted the Swedish cancer incidence rates. The first two decades of life are important in setting the pattern for cancer development in subsequent life.<sup>4,5</sup> In all, Sweden is an excellent choice of country for an immigrant cancer study because of a uniform cancer registration, the health care system and the large number of immigrants, around 13% of the population, from practically all around the world.

Immigrant studies are most informative when cancer incidence data are available from both the source and host countries, a requirement that has been met by few previous studies on non-European populations. The Iranian national cancer registry programme has been developed during recent years and can be used to estimate the incidence in the source country. The number of Iranian immigrants in Sweden is 3.7% of all immigrants. In the present study, we focus on Iranian migrants to compare their cancer risks to the native Swedish population and to Iranian residents. The results of this study might be used to gain insight into the causes of cancers and the prevention of cancer.

## 2. Materials and methods

The Swedish Family-Cancer Database (FCD) was first assembled from the national databases in 1996 and since then it has been periodically updated.<sup>6</sup> The FCD contains information pertaining to those born in Sweden since 1932 together with their biological parents' data. Additionally, data on immigrants are also included. This database is the largest in the world on familial cancer and its updated version (2008, VIII),<sup>7</sup> which has been supplied with longitudinal demographic and socio-economic data from national censuses, has been used for this study. The details of this database have been explained elsewhere.<sup>8</sup>

The Iranian immigrants were defined according to their birth country. Follow-up was started on date of immigration or January 1, 1958, whichever came latest. The total number of Iranian immigrants was 65,501; there were 308 immigrants with missing dates of immigration, and for those cases, their

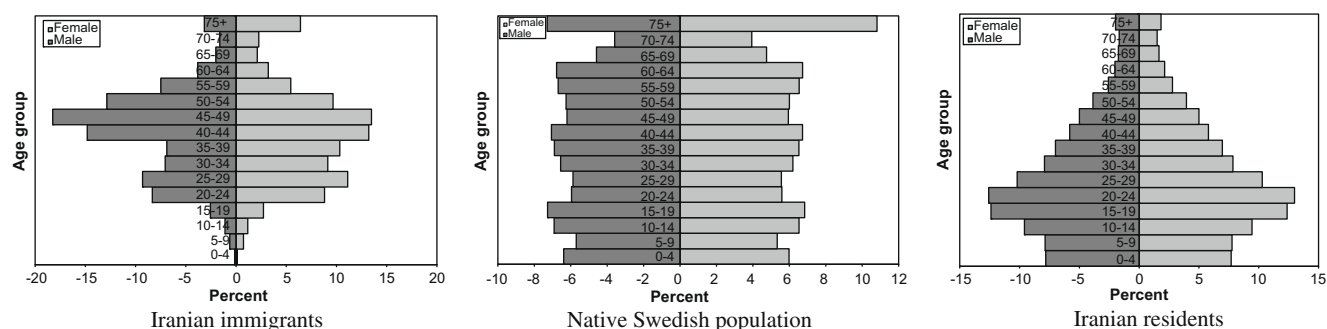
presence on national censuses from 1960, 1970, 1980, 1990 and 2000 was assumed as the start year of immigration. Follow-up was terminated on diagnosis of cancer, death, emigration, last year presence at census or the closing date of our study, December 31, 2006.

Age-standardised rate (ASR), which is a summary measure of a rate that a population would have if it had a standard age structure, was calculated. The world population was used for this standardisation. It is expressed per 100,000 populations at risk (person years). The ASR for Iranian immigrants was calculated for a 10-year period from 1996 to 2006, because the population size for 1 year was not sufficient to calculate the ASR.

The Iranian cancer registry is a revised form of a population-based cancer registry which registers only pathological records by a cross sectional method. The population at risk is the population at the mid time of the survey. It is known as a 'pathologic-based cancer registry' in Iran. About 60,000 new cancer cases were registered in 2006; with its completeness and reliability, the most valid report detailing Iranian residents was reported in a previous publication.<sup>9</sup> The ratio of ASR among Iranian immigrants and Iranian residents was calculated so as to compare their cancer incidence ratio.

The International Classification of Disease, revision 7 (ICD-7) ([www.wolfbane.com/icd](http://www.wolfbane.com/icd)), has been used in the FCD, and the Iranian cancer registry is based on the International Classification of Diseases for Oncology, 3rd Edition (ICD-O) ([www.who.int/classifications/icd](http://www.who.int/classifications/icd)). To compare the ASR between the study populations, the classification of cancers in the FCD was modified to ICD-O.

Standardised incidence ratios (SIRs) were calculated as the ratio of observed to expected number of cases. The expected numbers were calculated from 5-year age ranges, sex, region (seven regions of Sweden), time period (10-year bands from 1985 to 2006) and site-specific cancers' standard incidence rates. Due to the low number of cases and the small population of Iranian immigrants before 1985, this year was selected for the starting point of the SIRs calculations. Cancer incidence for the native Swedish populations was used as reference. Confidence intervals (95% CI) were calculated assuming a Poisson distribution. Time trend analysis was used by regression, and a P-value less than 0.05 was selected as the significance point. SAS software ver.9.1 was used for data analysis.



**Fig. 1 – Population pyramids for the Iranian immigrants compared to the native Swedish population and Iranian residents in 2006. P-value < 0.00001.**

**Table 1 – The ASR per 100,000 by site-specific cancers for the Iranian immigrants<sup>a</sup> compared in to the native Swedish population and Iranian residents in 2006.**

Primary sites	ICD Classification		Native Swedish population				Iranian immigrants				Iranian residents				Incidence Ratio <sup>b</sup> : Iranian immigrants to Iranian residents	
			Male		Female		Male		Female		Male		Female		Male	Female
	ICD-O	ICD-7	N	ASR	N	ASR	N	ASR	N	ASR	N	ASR	N	ASR		
Upper aerodigestive tract	00–06 09–13	140–141 143–148	329	4.9	201	2.7	10	3.1	8	2.2	708	2.4	500	2.0	1.3	1.1
Oesophagus	15	150	226	3.2	73	0.8	6	1.8	2	0.8	1772	6.3	1403	6.1	0.3	0.1
Stomach	16	151	354	4.5	230	2.4	13	5.7	13	4.6	4299	15.2	1603	6.7	0.4	0.7
Colon, rectum, and anus	18–21	153–154	2078	27.4	1828	20.6	55	20.8	39	12.4	2525	9.0	1967	8.2	2.3	1.5
Liver and gall bladder	22–24	155–156	296	4.1	277	3.1	8	3.7	4	1.7	476	1.7	462	1.8	2.2	1.0
Pancreas	25	157	332	4.8	306	3.9	6	2.3	3	1.0	179	0.7	114	0.5	3.6	2.0
Lung	33–34	162–163	1216	16.4	1094	14.9	27	12.4	16	5.2	1491	5.4	452	1.9	2.3	2.8
Breast	50	170	25	0.4	4988	79.9	1	0.4	188	58.3	218	0.8	6456	25.1	0.6	2.3
Cervix	53	171			354	7.1			7	2.4			530	2.1		1.1
Uterus and endometrium	54	172–173			1025	13.4			10	4.3			617	2.6		1.7
Ovary	56	175			586	8.7			18	6.0			838	3.2		1.9
Prostate	61	177	7651	104.1			79	39.3			2814	9.6			4.1	
Testis	62	178	263	7.1			12	2.9			459	1.3			2.3	
Kidney	64–65	180	429	6.8	286	4.1	13	4.9	3	1.2	646	2.4	395	1.6	2.1	0.8
Urinary bladder	67	181	1195	15.1	393	4.3	45	17.7	11	4.1	3347	11.7	705	3.0	1.5	1.4
Skin (including melanoma)	44	190–191	1958	25.6	1898	23.1	16	7.3	6	1.9	5515	20.2	3290	13.9	0.4	0.1
Nervous system and eye	70–72	192–193	486	10.0	587	11.4	25	7.3	28	9.2	863	2.8	602	2.0	2.6	4.5
Thyroid gland	73	194	58	1.0	138	2.8	12	3.9	22	5.3	403	1.3	1135	3.8	3.0	1.4
Lymphatic system	77	200–202	660	10.9	513	7.6	39	11.9	23	7.5	1171	3.6	722	2.3	3.3	3.3
Haematologic system	42	203–209	795	12.4	693	9.6	32	13.9	20	6.7	2148	6.8	1263	4.4	2.0	1.5
All cancers	00–80	140–209	19513	276.6	17060	242.4	444	175.3	472	153.1	33770	117.3	26016	102.4	1.5	1.5

a The ASR was calculated for the period 1996 to 2006.

b Ratios greater than one are shown in bold font.

### 3. Results

Out of 65,501 Iranian immigrants in the FCD, 62,471 lived in Sweden at the end of 2006. The fifth decade was the main age group (about 30% of the population); over 48% of the Iranian immigrants immigrated to Sweden between 1985 and 1990 (during the war between Iran and Iraq) with a median age at immigration of 26 (range = 0 to 86) years and a median length of stay of 16 (range = 1 to 58) years at the end of 2006.

The population pyramids by age and sex for the three populations are shown in Fig. 1. The Iranian immigrant population differed markedly from the native Swedish population and the Iranian residents. The elderly population (age  $\geq 65$  years) accounted for 8.6%, 5.2% and 17.5% for the Iranian immigrants, Iranian residents and native Swedish population, respectively, in 2006.

The total person years were 557,059 and 427,857 for male and female Iranian immigrants for whom 1293 cancer cases were recorded. The median age at cancer diagnosis was 53 years, lower than for the Iranian residents (60 years) and for the Swedes (70 years). The all-cancer ASRs were 175.3 and 153.1 per 100,000 person years for immigrant males and females during the years 1996 to 2006 (Table 1). The Iranian immigrants had lower risk than the Iranian residents for oesophagus, stomach, kidney (females) and skin cancers. The ASRs for stomach, bladder (males), thyroid and lymphatic system cancers among the Iranian immigrants were higher than those in the native Swedish population.

Cancer incidence trends are shown in Fig. 2; because of the few cases and the small population of the Iranian immigrants before 1985, the graph was restricted to the years after 1985. For the immigrants, the male incidence trend increased during the two decades ( $P$ -value = 0.06) while for females no change was noted ( $P$ -value = 0.57). For the Swedes, the rates increased for both sexes significantly ( $P$ -value = 0.02). There was no comparable data for the Iranian residents over this period.

The SIRs for immigrants in all cancers among males, females and both sexes were 0.56, 0.63 and 0.60, respectively, compared to the native Swedish population (Table 2). For most cancers, the Iranian male immigrants had a significantly lower risk than the Swedish native male population, particularly for cancers of the gastro-intestine, lung, prostate, testis, and nervous system. However, the male immigrants had a significantly higher risk for urinary bladder (1.40) and thyroid (2.61) cancers. The Iranian female immigrants had a significantly lower risk than the native Swedish female population with regard to cancers of the gastro-intestine, lung, breast, female genitalia and kidney; they had a higher risk for thyroid cancer (2.65).

### 4. Discussion

This study compared the incidence trends and risks between the three populations. Immigrants are always a selected population, and usually a healthy one.<sup>3</sup> However, residing in Sweden for 16 years allows time for exposure to environmental risk factors prevailing in the country. Wide variations in the incidence of breast, colon and stomach cancers have been shown in Iran, with North Iran having much higher incidence rates for stomach and oesophageal cancers than other parts of Iran; inversely, colon, breast and bladder cancers have higher incidence rates in South and Central Iran.<sup>9–13</sup> However, the data on the birth province of the Iranian immigrants were not available in the FCD. The observed differences in ASRs between the Iranian immigrants and the Iranian residents may be due to different methods of cancer registration.<sup>9,14</sup> As a general finding, the risk for cancers among the Iranian immigrants was significantly lower than for the native Swedish population. The exceptions were significantly increased risks for male urinary bladder and thyroid cancer.

The ASR for stomach cancer is high in many Asian countries,<sup>1,15</sup> but our study found that the risk for the Iranian immigrants was significantly lower than for the Iranian

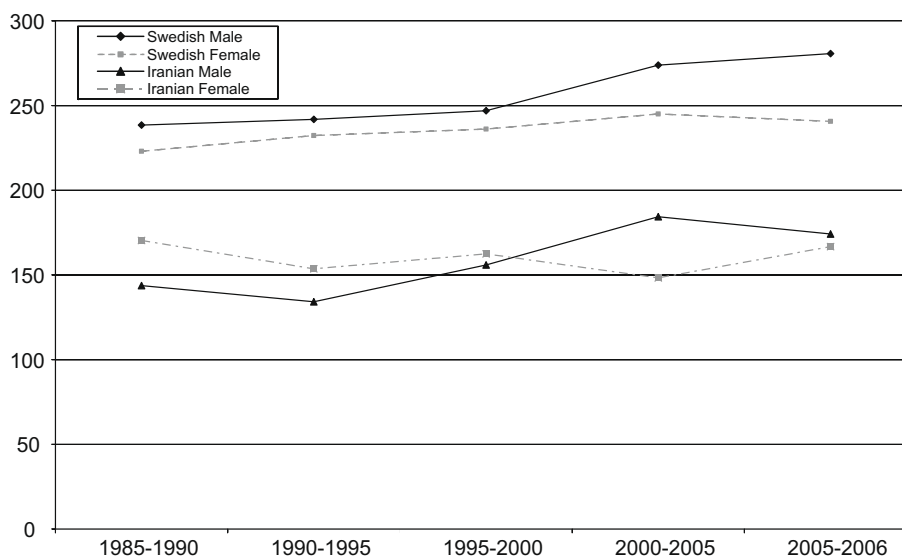


Fig. 2 – Cancer incidence (ASR) trend<sup>a</sup> among the Iranian immigrants compared to the native Swedish population from 1985–2006. <sup>a</sup>The time trend analysis: Swedish male ( $P$ -value = 0.0212); Swedish female ( $P$ -value = 0.0279); Iranian male ( $P$ -value = 0.0649); Iranian female ( $P$ -value = 0.5746).

**Table 2 – SIRs<sup>a</sup> for selected cancers<sup>b</sup> among the Iranian immigrants to Sweden from 1985 to 2006.**

Primary sites	Male				Female				Both sexes			
	N	SIR	95%CI		N	SIR	95%CI		N	SIR	95%CI	
Oral (upper aerodigestive tract)	14	<b>0.44</b>	0.24	0.74	8	0.65	0.28	1.29	22	<b>0.50</b>	0.31	0.76
Oesophagus	7	<b>0.43</b>	0.17	0.89	5	1.16	0.38	2.70	12	0.59	0.30	1.02
Stomach	16	<b>0.53</b>	0.30	0.86	20	1.19	0.73	1.84	36	<b>0.77</b>	0.54	1.06
Colon	40	<b>0.72</b>	0.51	0.98	32	<b>0.57</b>	0.39	0.81	72	<b>0.64</b>	0.50	0.81
Rectum	22	<b>0.58</b>	0.36	0.88	13	<b>0.48</b>	0.25	0.81	35	<b>0.54</b>	0.37	0.75
Liver and gall bladder	9	<b>0.33</b>	0.15	0.62	6	<b>0.26</b>	0.10	0.57	15	<b>0.30</b>	0.17	0.49
Pancreas	7	<b>0.25</b>	0.10	0.53	6	<b>0.28</b>	0.10	0.60	13	<b>0.26</b>	0.14	0.45
Lung	33	<b>0.36</b>	0.25	0.50	20	<b>0.33</b>	0.20	0.51	53	<b>0.35</b>	0.26	0.45
Breast	1	0.67	0.02	3.76	243	<b>0.78</b>	0.69	0.89	244	<b>0.78</b>	0.69	0.89
Cervix					9	<b>0.19</b>	0.09	0.36	9	<b>0.19</b>	0.09	0.36
Endometrium					15	<b>0.28</b>	0.16	0.47	15	<b>0.28</b>	0.16	0.47
Ovary					22	<b>0.44</b>	0.28	0.67	22	<b>0.44</b>	0.28	0.67
Prostate	94	<b>0.50</b>	0.40	0.61					94	<b>0.50</b>	0.40	0.61
Testis	14	<b>0.30</b>	0.16	0.51					14	<b>0.30</b>	0.16	0.51
Kidney	18	<b>0.55</b>	0.33	0.87	3	<b>0.16</b>	0.03	0.46	21	<b>0.41</b>	0.25	0.62
Urinary bladder	69	<b>1.40</b>	1.09	1.78	15	0.79	0.44	1.31	84	1.23	0.98	1.53
Skin	19	<b>0.50</b>	0.30	0.77	8	<b>0.32</b>	0.14	0.64	27	<b>0.43</b>	0.28	0.62
Nervous system	41	<b>0.63</b>	0.46	0.86	44	0.83	0.60	1.11	85	<b>0.72</b>	0.58	0.89
Thyroid gland	18	<b>2.61</b>	1.55	4.13	45	<b>2.65</b>	1.93	3.55	63	<b>2.64</b>	2.03	3.38
Endocrine glands	17	1.12	0.65	1.79	38	1.42	1.00	1.94	55	1.31	0.99	1.70
Bone	7	1.23	0.50	2.54	3	0.99	0.20	2.90	10	1.15	0.55	2.12
Connective tissue	7	0.60	0.24	1.24	8	0.96	0.41	1.89	15	0.75	0.42	1.24
Non-Hodgkin's lymphoma	39	0.85	0.61	1.16	26	0.95	0.62	1.39	65	0.89	0.69	1.13
Hodgkin's disease	16	1.22	0.69	1.97	12	1.43	0.74	2.50	28	1.30	0.86	1.88
Myeloma	11	0.94	0.47	1.69	5	0.60	0.19	1.40	16	0.80	0.46	1.30
Leukaemia	30	0.72	0.48	1.02	23	0.80	0.51	1.20	53	<b>0.75</b>	0.56	0.98
All cancers	577	<b>0.56</b>	0.52	0.61	666	<b>0.63</b>	0.58	0.68	1243	<b>0.60</b>	0.56	0.63

a The native Swedish population was selected as the reference population; the SIRs were adjusted by age (5-year bands), sex, time period (10-year bands from 1985–2006), region (seven counties), socio-economic status (five classes); CI95% was calculated assuming a Poisson distribution, and significant SIRs are shown in bold font.

b Cancer sites with less than five cases among the Iranian immigrants are not included in this table.

residents and the male Swedish population. This finding agrees with a study on Iranian immigrants to Canada, suggesting a role for the environment, habits and socio-economic factors.<sup>10,16</sup>

Although accurate cancer registry information is limited, very high incidence rates for oesophageal cancer have been reported for both genders in northern Iran, provinces of north-central China, certain areas of Kazakhstan and also among native Siberians. These populations form a “Central Asian Oesophageal Cancer Belt”, although it is not known whether these extremely high rates are due to a common risk factor.<sup>15</sup> Poor diet, environmental and familial factors relating to a low socio-economic status may be important in the aetiology of this cancer in Iran.<sup>17–19</sup> The observed decrease in risk suggests that genetic influence may be limited while environmental factors may play a key role.<sup>20</sup>

In Iran, the predominant aetiology of hepatocellular carcinoma is hepatitis B and hepatitis C.<sup>21,22</sup> The prevalence of hepatitis B surface antigen (HBS-Ag) positivity among the Iranian residents (2.6%) is higher than among the native Swedish population (0.06%) while data are lacking for the Iranian immigrants.<sup>23–25</sup> However, the high HBS-Ag positivity among the Iranian residents and their low risk for all liver cancer, which was also shared by the Iranian immigrants, was puzzling. Future studies on site-specific liver cancers may clarify this.

The ASR for prostate cancer was 39 per 100,000 person years for Iranian immigrants; it was four times higher than for Iranian residents (10/100,000) and less than half of the native Swedish population (104/100,000). The lack of any prostate cancer screening programme in Iran and use of opportunistic screening with prostate specific antigen (PSA) in Sweden since the early 1990s may be likely reasons for this gap, in addition to the ‘western lifestyle’.<sup>26,27</sup> Such causes may also explain the difference between the ASRs for breast cancer. However, one study found that immigrants from non-Nordic countries were more than twice as likely to be non-attendees compared with Swedish-born women for invited breast cancer screening programmes.<sup>28</sup> The low risk among the Iranian immigrants may be due to the differences in reproductive factors, habits, family history and environmental exposures.<sup>13,29</sup>

The Iranian immigrants have a higher incidence rate for bladder cancer than the native Swedish population and the Iranian residents, probably explained by smoking and other environmental exposures. A study reported that the age-adjusted risk of smoking was higher in Iranian women and men in Sweden and a survey on non-communicable disease risk factors in Iran estimated that the prevalence of daily smoking was 18% in 2005, two times higher than reported in previous studies in the late 1980s. However, smoking data has not been included in the FCD.<sup>30–34</sup>



A previous study showed an excess risk for thyroid cancer among Iranian immigrants when compared to the native Swedish population.<sup>35</sup> These findings are in line with the data that different environmental risk factors are associated with this cancer. Further studies focusing on the histological type and genetics of thyroid cancer should be done to find the cause of this difference.

Of the 26 selected cancer sites, SIRs were significantly lower than unity for 13 male and 11 female cancers among the Iranian immigrants compared to the native Swedish population. The main conclusion of the present study is that the risk for all cancers was decreased among the Iranian immigrants. The difference between the Iranian immigrants and the Iranian residents may be due to the differences between the registry systems, healthy immigrant effect (or selection bias) and environmental exposures. Following up these populations further and studying their second and third generations may provide valuable clues about cancer causation. Population-based survival analyses and further histology-specific studies appear worthwhile, particularly for cancers for which the immigrants show distinct rates.

### Conflict of interest statement

None declared.

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