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Cervical, endometrial and ovarian cancers among immigrants in Sweden: Importance of age at migration and duration of residence

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ABSTRACT

In order to compare the risk of gynaecologic cancer among foreign-born women to the risk among those born in Sweden and to elucidate risk of cancer in relation to age at migration and duration of residence, we followed a cohort of 5.3 million women between 1969 and 2004 in Sweden.

Through linkage with the national cancer register, we estimated cancer risk as rate ratios (RRs) with 95% confidence intervals (CIs) using Poisson regression. We reported RRs adjusted for age, calendar year of follow-up and years of education. Overall, 18,247 cases of cervical, 35,290 cases of endometrial and 32,227 cases of ovarian cancers occurred during 117 million person-years of follow-up. We found that adjusted RRs of all the three cancers were lower or the same among foreign-born women compared to those born in Sweden. As for cervical cancer, women aged 35–49 years born in Poland and Bosnia and women aged 50 years or more born in South America showed an increased risk, which was related to increasing age at migration. The risk was lowest among women born in Iran, Iraq, Organisation for Economic Cooperation & Development (OECD) and Finland, and highest among women born in Bosnia and Eastern Europe during their first 5 years since immigration. RRs for endometrial and ovarian cancers did not vary by duration of residence or by age at migration.

Health care providers should be aware of the higher risk of cervical cancer among immigrants from high-risk areas, especially among those who immigrate at older ages. On the other hand, protective factors for ovarian and endometrial cancers seem to be retained upon migration.

1. Introduction

The major gynaecologic cancers, i.e. ovarian, endometrial and cervical cancers, constitute a considerable part of morbidity in women worldwide. According to international statistics, they account for about 20% of the estimated new cases of cancer among women in the world,[1,2] and are thus a major public health problem. The incidence of cervical cancer is generally low in developed countries, but it is the most common gynaecologic cancer in developing countries.[1] Endometrial and

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ovarian cancers rank the first and the second most common gynaecologic cancers in developed countries, respectively, while they have low incidence in developing countries.[1,3] In Sweden, the incidence of endometrial and ovarian cancers is one of the highest in Europe.[4]

Studies on migrants provide a valuable tool for assessing the role of genetic and environmental factors in the development of cancer. Furthermore, duration of residence of immigrants in the host country and their age at migration can give insight into the relative influence of acculturation on cancer patterns.

In Sweden, with more than 12% foreign-born residents,[5] there are unique opportunities to conduct such studies, capitalising on an established system of population-based registers that encompass both demographic and medical information. In this study, we compared foreign-born women and native Swedish women with regard to the risk of ovarian, endometrial and cervical cancers.

2. Materials and methods

2.1. Study cohort

The study cohort consisted of two groups, the foreign-born and the Swedish-born group. The foreign-born group comprised 600,087 women aged 15 years or older and with known date of immigration. The Swedish-born group comprised 4,751,448 women aged 15 years or older. All were either alive and free of cancer at the start of the follow-up in 1969, or born or immigrated thereafter. We limited the Swedish-born group to women whose both parents were born in Sweden.

The date of immigration and place of birth were obtained through the total population register held by Statistics Sweden.[6] Data on highest acquired level of education were obtained from the National Population and Housing Census, and also from the longitudinal integration database for health insurance and labour market studies (LISA) 1990–2003.[7] Data on the birthplace of parents of the cohort members were obtained through linkage to the multi-generation register.[6] This register provides parental information on all Swedish inhabitants born after 1931 and alive in 1960.[6]

2.2. Follow-up

All Swedish residents can be identified by their 10-digit national registration number.[8] The linkages have been completed by Statistics Sweden and Centre for Epidemiology at the National Board of Health and Welfare by using this unique identifier. To ensure confidentiality, the national registration numbers were replaced by serial numbers through Statistics Sweden. The study was approved by the Regional Board of The Ethical Committee, Stockholm.

The cohort members were followed until the date of cancer diagnosis (International Classification of Diseases, Seventh Revision codes: 171 Malignant Neoplasm of Cervix Uteri, 172 Malignant Neoplasm of Corpus Uteri and 175 Malignant Neoplasm of Ovary), emigration, death or end of the follow-up (31st December 2004), whichever occurred first. Follow-up was achieved through linkage with the following databases: (1) the cancer register containing data on all cases of cancer since 1958. The completeness of cancer registration and the percentage of cytologically or histologically verified cases are considered to be close to 100%,[9] (2) the total population register, and (3) the cause of death register, which contains information on date of death and the underlying cause of death since 1952. The present completeness of this register is estimated to be 99%.[6]

2.3. Classification of the country of birth

Foreign-born women were classified into 12 groups according to their country of birth. We assigned one category for large immigrant groups, such as immigrants from Finland, Iraq, Chile, Poland, Bosnia, Iran and Turkey, by the individual country of birth. Because of the small numbers of immigrants from other Arabic and Latin American countries, we pooled them into the Iraq and the Chile categories, respectively. We created groups for the remaining immigrants based on a combination of geographic location and number of immigrants. This classification resulted in the following categories:

- OECD countries (Organisation for Economic Cooperation & Development) not specified in other groups (United States (USA), Canada, Australia, New Zealand, Western Europe except for Finland).
- Finland.
- South Europe (Portugal, Spain, Italy, Cyprus, Greece and the former Yugoslavia).
- Eastern Europe (Estonia, Latvia, Lithuania, Romania, Slovakia, the Czech Republic, Hungary, Albania, Bulgaria, Croatia, Macedonia, Moldavia, Slovenia, Russia, the Soviet Union, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kirgizstan, Tadzhikistan, Turkmenistan, Ukraine, Uzbekistan).
- Poland.
- Bosnia.
- South America (Chile and other Latin American countries).
- Asia (except Turkey, Iran, Iraq and Arabic-speaking countries).
- Turkey.
- Iraq and other Arabic countries.
- Iran.
- Africa (except Arabic-speaking countries of North Africa).

2.4. Statistical analyses

We analysed data in a grouped form, with foreign-born woman being the main exposure. We used Poisson models estimated by the maximum likelihood method and with rate ratios (RRs) of cancer incidence as the measure of relative risk. The 95% confidence interval (CI) was calculated on the assumption that the observed numbers of cancers follow a Poisson distribution.

Adjustments were made for attained age (in 5-year categories: 15–29, 30–34, 35–39, . . . , 75–79, 80 years or more), calendar period of follow-up (three categories: 1969–1978; 1979–1988; 1989–2004) and years of education (0–9; 10–12; 13 years or more). In an attempt to study the possible influence of lifestyle and environmental exposures, we stratified the immigrants by their age at migration (0–34, 35–49 and 50 years or more) or duration of residence in Sweden (0–4, 5–9, and 10 years or more).

Since prevalent cases are more likely to be diagnosed shortly after immigration, we repeated the analyses after exclusion of subjects with cancer diagnosis within one year after immigration. The results did not change and are therefore not presented. We used the cancer incidence in the entire cohort of the Swedish-born women as the reference when we calculated rate ratios for each category of age at migration or duration of residence. We stratified attained age into four categories (0–34, 35–49, 50–59 and 60-years-old or more), and used the incidence of the comparable age stratum in the Swedish-born group as the reference. Tests for trend for duration of residence and age at migration were performed as linear regression tests.

3. Results

Age at exit, age at migration and duration of residence of the cohort are presented in Table 1. Foreign-born women were, on average, younger than the Swedish-born women in Sweden, with women born in Africa being the youngest group (mean age 35.4 ± SD 12.6).

During the 35 years of follow-up, 18,247 cases of cervical, 35,290 cases of endometrial and 32,227 cases of ovarian cancers occurred during 117 million person-years of follow-up. We observed an overall RR of 0.82 (95% CI 0.78–0.88) for cervical, RR of 0.79 (95% CI 0.75–0.83) for endometrial and RR of 0.57 (95% CI 0.54–0.61) for ovarian cancers among foreign-born women compared to Swedish-born women after adjustment for attained age, calendar period of follow-up and education (Table 2).

3.1. *Cervical cancer*

Analyses of each immigrant group (Table 2) revealed statistically significant 20–80% lower risk of cervical cancer among women born in Africa, Finland, Iran, Iraq, Turkey and Southern Europe compared with women born in Sweden. Women born in Poland and Bosnia, however, had significantly higher risk compared to women born in Sweden. The remaining immigrant groups had risk of cervical cancer at the same level as women born in Sweden.

As shown in Table 3, the overall reduced risk by attained age for cervical cancer in women born in Iran, Iraq, South Europe and Turkey was confined to younger women (<50-years-old). Observed excess risk of cervical cancer among women born in Bosnia and Poland was confined to women aged 35–49 who had a doubled risk compared to Swedish-born women. In contrast, the increased risk among women born in South America was confined to women older than 50.

Overall, the risk of cervical cancer was increased by increasing age at migration (Fig. 1a). The risk was reduced by 30% among women who immigrated at younger ages and increased by 60% among women who immigrated at older ages (p for trend < 0.01). The observed increasing risk of cervical cancer by increasing age at migration showed a significant trend in most immigrant groups including women born in Asia, Finland, Iran, Iraq and other Arabic countries, Poland, South America and South Europe. The lowest risk was observed among women born in Iraq and Africa who immigrated before 35 years of age, and the highest risk was observed among women born in South America, Asia and

Table 1 – Age at exit, age at migration and duration of residence among Swedish-born women and foreign-born women by country of birth

	Population	Age at exit		Age at migration		Duration of residence	
		Mean (±SD)	Median	Mean (±SD)	Median	Mean (±SD)	Median
Swedish-born women	4,751,448	60.3 (±22.8)	63.1	–	–	–	–
Foreign-born women	600,087	45.2 (±18.2)	42.4	25.4 (±14.6)	24.0	17.9 (±12.1)	14.9
Organisation for Economic Cooperation & Development (OECD)[a]	109,177	48.3 (±19.6)	45.1	25.7 (±13.2)	24.6	18.8 (±13.9)	16.0
Finland	137,838	51.1 (±18.4)	52.8	22.4 (±11.7)	21.4	24.7 (±13.3)	32.5
South Europe	56,392	45.0 (±17.6)	43.3	26.4 (±15.1)	24.4	17.9 (±12.1)	12.1
Eastern Europe	39,979	48.7 (±19.4)	46.2	29.7 (±15.2)	27.7	16.7 (±11.6)	13.6
Poland	28,864	49.6 (±16.7)	49.7	29.5 (±14.7)	27.4	19.4 (±09.4)	19.3
Bosnia	26,563	42.8 (±17.7)	41.0	33.1 (±18.1)	31.0	09.7 (±03.3)	10.8
South America	33,650	40.4 (±15.9)	38.0	24.8 (±16.4)	25.2	15.6 (±08.3)	15.7
Asia	52,131	36.6 (±13.4)	34.4	21.7 (±15.5)	23.8	14.9 (±09.4)	13.8
Turkey	16,956	44.2 (±17.9)	40.5	26.1 (±17.6)	21.5	18.0 (±09.0)	17.4
Iraq/Arab countries	48,967	37.4 (±14.7)	35.3	26.4 (±14.7)	24.5	11.0 (±06.7)	10.5
Iran	26,224	41.1 (±16.0)	39.7	27.6 (±16.4)	26.4	13.4 (±05.6)	14.6
Africa	23,346	35.4 (±12.6)	34.2	23.4 (±12.5)	23.1	11.9 (±07.0)	11.1

SD = standard deviation.
a OECD: United States (USA), Canada, Australia, New Zealand and Western Europe except for Finland.

Table 2 – Rate ratio (RR) and 95% confidence interval (CI) for cervical, endometrial and ovarian cancer among Swedish-born women and foreign-born women by country of birth

	Cases	Person-years	RR[b]	95% CI	RR[c]	95% CI
Cervical cancer						
Swedish-born women	17,070	107,246,414	1	Reference	1	Reference
Foreign-born women	1177	9,873,543	0.88	0.83–0.94	0.82	0.78–0.88
OECD[a]	304	1,946,429	1.03	0.92–1.16	0.99	0.88–1.11
Finland	357	3,273,908	0.76	0.68–0.84	0.70	0.63–0.78
South Europe	121	939,238	0.98	0.82–1.17	0.82	0.68–0.98
Eastern Europe	95	636,780	1.00	0.82–1.23	1.03	0.84–1.26
Poland	92	533,016	1.24	1.01–1.52	1.25	1.01–1.53
Bosnia	38	231,195	1.40	1.02–1.93	1.34	0.97–1.85
South America	56	432,066	1.14	0.88–1.48	1.03	0.79–1.34
Asia	60	581,230	1.02	0.79–1.31	0.87	0.67–1.13
Turkey	23	276,873	0.72	0.48–1.09	0.56	0.37–0.84
Iraq/Arab countries	14	473,724	0.28	0.17–0.47	0.23	0.14–0.39
Iran	9	306,458	0.25	0.13–0.49	0.25	0.13–0.47
Africa	8	242,626	0.33	0.17–0.66	0.27	0.13–0.54
Endometrial cancer						
Swedish-born women	33,658	107,138,423	1	Reference	1	Reference
Foreign-born women	1632	9,874,946	0.78	0.74–0.82	0.79	0.75–0.83
OECD[a]	479	1,947,044	0.84	0.77–0.92	0.84	0.77–0.92
Finland	639	3,273,432	0.81	0.75–0.88	0.81	0.75–0.88
South Europe	107	939,892	0.64	0.53–0.77	0.65	0.54–0.79
Eastern Europe	161	636,425	0.91	0.78–1.06	0.92	0.79–1.07
Poland	92	533,375	0.86	0.70–1.06	0.89	0.72–1.09
Bosnia	33	231,244	0.75	0.53–1.05	0.89	0.63–1.26
South America	33	432,311	0.61	0.44–0.86	0.64	0.46–0.90
Asia	25	581,540	0.56	0.38–0.83	0.59	0.40–0.87
Turkey	18	276,931	0.43	0.27–0.69	0.47	0.29–0.74
Iraq/Arab countries	26	473,695	0.56	0.38–0.83	0.62	0.42–0.92
Iran	12	306,437	0.30	0.17–0.54	0.34	0.19–0.60
Africa	7	242,622	0.50	0.24–1.04	0.54	0.26–1.14
Ovarian cancer						
Swedish-born women	31,070	107,318,227	1	Reference	1	Reference
Foreign-born women	1157	9,881,257	0.59	0.55–0.62	0.57	0.54–0.61
OECD[a]	298	1,949,667	0.60	0.54–0.67	0.59	0.53–0.66
Finland	416	3,275,865	0.57	0.52–0.63	0.55	0.50–0.61
South Europe	95	940,071	0.57	0.47–0.70	0.52	0.43–0.64
Eastern Europe	99	637,284	0.63	0.52–0.77	0.64	0.53–0.79
Poland	82	533,604	0.78	0.63–0.97	0.80	0.64–0.99
Bosnia	33	231,300	0.85	0.60–1.19	0.93	0.66–1.31
South America	23	432,376	0.40	0.27–0.60	0.39	0.26–0.58
Asia	37	581,390	0.67	0.48–0.92	0.62	0.45–0.86
Turkey	11	276,976	0.27	0.15–0.49	0.24	0.13–0.44
Iraq/Arab countries	32	473,682	0.63	0.45–0.89	0.59	0.42–0.84
Iran	21	306,422	0.52	0.34–0.80	0.54	0.35–0.83
Africa	10	242,620	0.52	0.28–0.97	0.47	0.25–0.88

a OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland.
b Adjusted for age and calendar year of follow-up.
c Adjusted for age, calendar year of follow-up and education.

Poland who immigrated in their fifties or later. Further stratification of age at migration in the probable periods before and after initiation of sexual activities (0–14 and 15–34 years) showed the same pattern of increasing risk by increasing age at migration (data not shown).

Overall, there was no variation in rate ratios for cervical cancer by duration of residence in all immigrant groups combined (Fig. 1b). The rate ratio of cervical cancer was lowest in the first 5 years since immigration among women born in Iran, Iraq/Arab countries, Finland and OECD, and slightly higher thereafter, but remained lower compared to the risk among Swedish-born women. The reverse was observed among women born in other countries. A significant excess risk was apparent within the first 5 years since immigration among women born in Bosnia and Eastern Europe which converged towards the risk of the Swedish-born women thereafter.

3.2. *Endometrial cancer*

All immigrant groups had a lower endometrial cancer risk than women born in Sweden. The risk, however, was not sta-

Table 3 – Rate ratio (RR)[b] for cervical cancer among Swedish-born women and foreign-born women by attained age and country of birth

	Attained age							
	15–34		35–49		50–59		60+	
	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)
Swedish-born women	2306	1 (Reference)	4621	1 (Reference)	2987	1 (Reference)	7156	1 (Reference)
Foreign-born women	205	0.60 (0.51–0.69)	529	0.86 (0.78–0.64)	194	0.88 (0.76–1.02)	249	0.96 (0.84–1.10)
OECD[a]	52	0.91 (0.68–1.20)	129	1.06 (0.89–1.26)	52	0.92 (0.70–1.21)	71	1.00 (0.79–1.27)
Finland	61	0.52 (0.40–0.68)	149	0.67 (0.57–0.79)	68	0.75 (0.59–0.95)	79	0.89 (0.71–1.11)
South Europe	22	0.55 (0.36–0.84)	62	0.91 (0.71–1.17)	16	0.79 (0.48–1.30)	21	1.05 (0.68–1.62)
Eastern Europe	17	1.11 (0.69–1.80)	39	1.08 (0.79–1.49)	15	0.93 (0.56–1.55)	24	0.96 (0.64–1.43)
Poland	11	0.69 (0.38–1.24)	54	1.58 (1.21–2.07)	10	0.90 (0.48–1.68)	17	1.28 (0.79–2.07)
Bosnia	3	0.43 (0.14–1.34)	27	2.12 (1.45–3.10)	3	1.06 (0.34–3.32)	5	0.65 (0.26–1.62)
South America	14	0.76 (0.45–1.29)	19	0.78 (0.50–1.23)	10	1.88 (1.01–3.51)	13	1.92 (1.11–3.34)
Asia	16	0.60 (0.36–0.98)	31	1.06 (0.74–1.52)	7	1.57 (0.75–3.31)	6	1.12 (0.50–2.51)
Turkey	3	0.23 (0.07–0.72)	11	0.66 (0.37–1.20)	6	1.47 (0.65–3.32)	3	0.43 (0.14–1.33)
Iraq/Arab countries	3	0.14 (0.04–0.43)	3	0.12 (0.04–0.37)	4	0.97 (0.36–2.62)	4	0.62 (0.23–1.68)
Iran	0	N/A	1	0.06 (0.01–0.42)	3	1.03 (0.33–3.21)	5	0.88 (0.36–2.13)
Africa	3	0.23 (0.08–0.73)	4	0.34 (0.13–0.91)	0	N/A	1	0.53 (0.07–3.83)

N/A: not applicable.
a OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland.
b Analyses are adjusted for age, calendar period of follow-up and education.

tistically significant for women born in Africa, Bosnia, Eastern Europe and Poland (Table 2). The risk was lowest among women born in Iran (RR 0.34; 95% CI 0.19–0.60).

The risk of endometrial cancer was the same in all age strata (Table 4). Contrary to cervical cancer, we observed for endometrial cancer a slight risk decrease by increasing age at migration in all immigrant groups combined (Fig. 2a). When stratifying by migrant group, we found a significantly decreased risk of endometrial cancer by increasing age at migration only in women born in Asia and Turkey. The lowest risk was observed among women born in Asia, Iran and Turkey, who had immigrated to Sweden at the age of 50 years or later. Women from the same countries were at a similar risk as Swedes if immigrated at the age of 35 years or younger.

The rate ratios for endometrial cancer in foreign-born women were not affected by duration of residence and were lower than or similar to those in the Swedish-born women regardless of the time since immigration (Fig. 2b).

3.3. *Ovarian cancer*

The risk of ovarian cancer was 10–80% lower in all immigrant groups than in women born in Sweden. The risk, however, was not statistically significant for women born in Bosnia (Table 2).

In all age strata, the risk of ovarian cancer was the same or lower among foreign-born women compared to Swedish-born women (Table 5). The lowest risk was observed among women born in Asia, South America and Turkey.

Overall, ovarian cancer risk was reduced by 40% among immigrant women and did not vary by age at migration (Fig. 3a). A significantly decreased risk of ovarian cancer by increasing age at migration was observed only in women born in South Europe (p for trend 0.03) and Asia (p for trend 0.02). The risk increased significantly by age at migration among women born in Bosnia (p for trend 0.04).

The rate ratios for ovarian cancer among foreign-born women were lower than or the same as those among the Swedish-born women regardless of the time since immigration (Fig. 3b).

4. Discussion

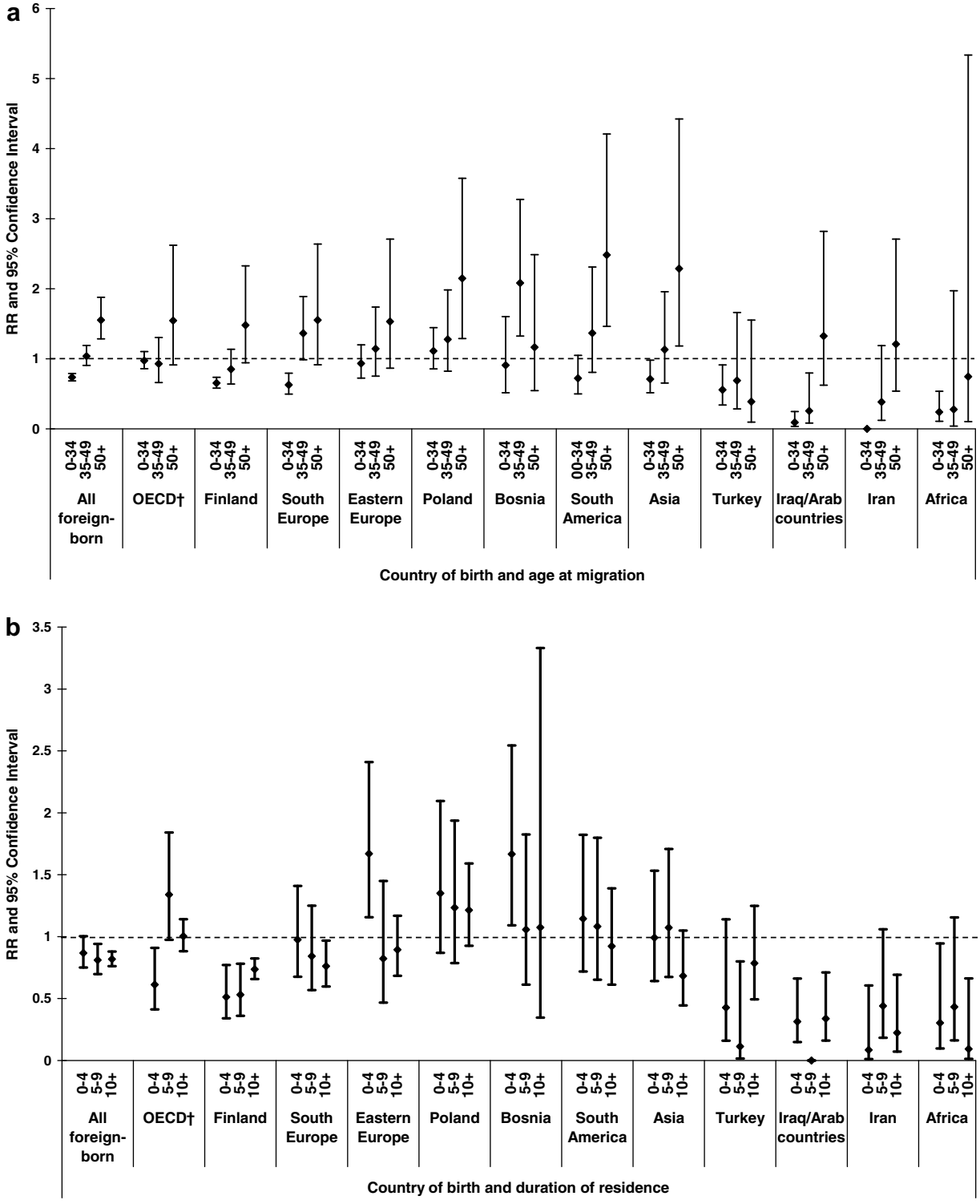
We found that foreign-born women overall had a lower risk of cervical, endometrial and ovarian cancers than Swedish-born women. The risk for cervical cancer was particularly low among women who were young at migration, and high among those who were 50 years or more at migration. The risk for endometrial and ovarian cancers was not affected by age at migration or duration of residence.

The major strengths of our study are the large size of our cohort, the long period of follow-up and its reliance on an established system of population-based registers and the uniform health care system of Sweden.

Although we grouped some countries in order to gain statistical power, we attempted to pay attention to the economy and geographical location of each country. However, we acknowledge that the grouping of countries may have led to misclassification of exposure, birth place, and thus diluted or overestimated the true risk for the individual countries.

Lack of information on the individual risk factors of the cancers studied is another important weakness of our study.

Selective return migration to the country of birth after becoming seriously ill, Salmon bias, could explain the observed decreased risk in migrants. On the other hand, return to country of birth after retirement, while cancer cases still stay in Sweden because of its high quality health care system, might explain the observed increased risk in some groups. One study in Sweden on migrants who were 51–80-years-old



* Adjusted for age, calendar period of follow up and education.
† OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland.
RR for Sweden=1

Fig. 1 – Rate ratio (RR)* for cervical cancer among Swedish-born women and foreign-born women by age at migration (a), duration of residence (b) and country of birth.

found a conscious plan to retire in the home country after the end of the working life abroad.[10] The return rates were highest among migrants from Italy and Greece and lowest among migrants from Poland, Turkey and Chile. Thus, the observed

Table 4 – Rate ratio (RR)[b] for endometrial cancer among Swedish-born women and foreign-born women by attained age and country of birth

	Attained age							
	15–34		35–49		50–59		60+	
	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)
Swedish-born women	72	1 (Reference)	2091	1 (Reference)	7853	1 (Reference)	23,642	1 (Reference)
Foreign-born women	10	0.98 (0.49–1.95)	187	0.80 (0.68–0.93)	559	0.82 (0.75–0.89)	876	0.77 (0.72–0.83)
OECD[a]	1	0.47 (0.06–3.80)	47	0.85 (0.64–1.14)	164	0.93 (0.80–1.09)	267	0.79 (0.70–0.89)
Finland	5	1.62 (0.65–4.05)	71	0.77 (0.60–0.97)	238	0.84 (0.74–0.96)	325	0.79 (0.71–0.88)
South Europe	0	N/A	14	0.61 (0.36–1.03)	37	0.61 (0.44–0.85)	56	0.70 (0.54–0.91)
Eastern Europe	0	N/A	17	1.11 (0.69–1.78)	48	0.94 (0.70–1.24)	96	0.89 (0.73–1.09)
Poland	1	1.99 (0.27–14.64)	17	1.33 (0.82–2.15)	27	0.76 (0.52–1.12)	47	0.85 (0.64–1.14)
Bosnia	0	N/A	3	0.84 (0.27–2.62)	7	0.72 (0.34–1.51)	23	0.99 (0.65–1.52)
South America	0	N/A	1	0.14 (0.02–1.00)	6	0.34 (0.15–0.76)	26	1.00 (0.68–1.47)
Asia	1	0.81 (0.10–6.67)	6	0.81 (0.36–1.82)	9	0.65 (0.34–1.24)	9	0.45 (0.24–0.87)
Turkey	1	1.86 (0.24–14.39)	5	1.15 (0.48–2.79)	6	0.57 (0.26–1.28)	6	0.26 (0.12–0.58)
Iraq/Arab countries	1	1.01 (0.12–8.18)	5	0.85 (0.35–2.06)	8	0.64 (0.32–1.28)	12	0.55 (0.31–0.98)
Iran	0	N/A	1	0.22 (0.03–1.60)	7	0.70 (0.33–1.47)	4	0.19 (0.07–0.51)
Africa	0	N/A	0	N/A	2	0.55 (0.14–2.20)	5	0.84 (0.35–2.03)

N/A: not applicable.

a OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland.

b Analyses are adjusted for age, calendar period of follow-up and education.

increased risk of cervical cancer among migrants from South America is not likely to be explained by the return of retired women.

Socioeconomic position (SEP) has an important implication on cancer risk and screening.[11,12] We adjusted years of education as an indicator of socioeconomic position, which is shown as a preferable surrogate factor for socioeconomic position.[13] We found a slight attenuation of the risk of cervical cancer after adjustment for education, while the adjustment did not affect the risk for endometrial or ovarian cancer. This is in line with the known confounding effect of socioeconomic status on the risk of cervical cancer, which might be explained by the different sexual behaviours and higher prevalence of human papillomavirus (HPV) in women with low socioeconomic position.[14]

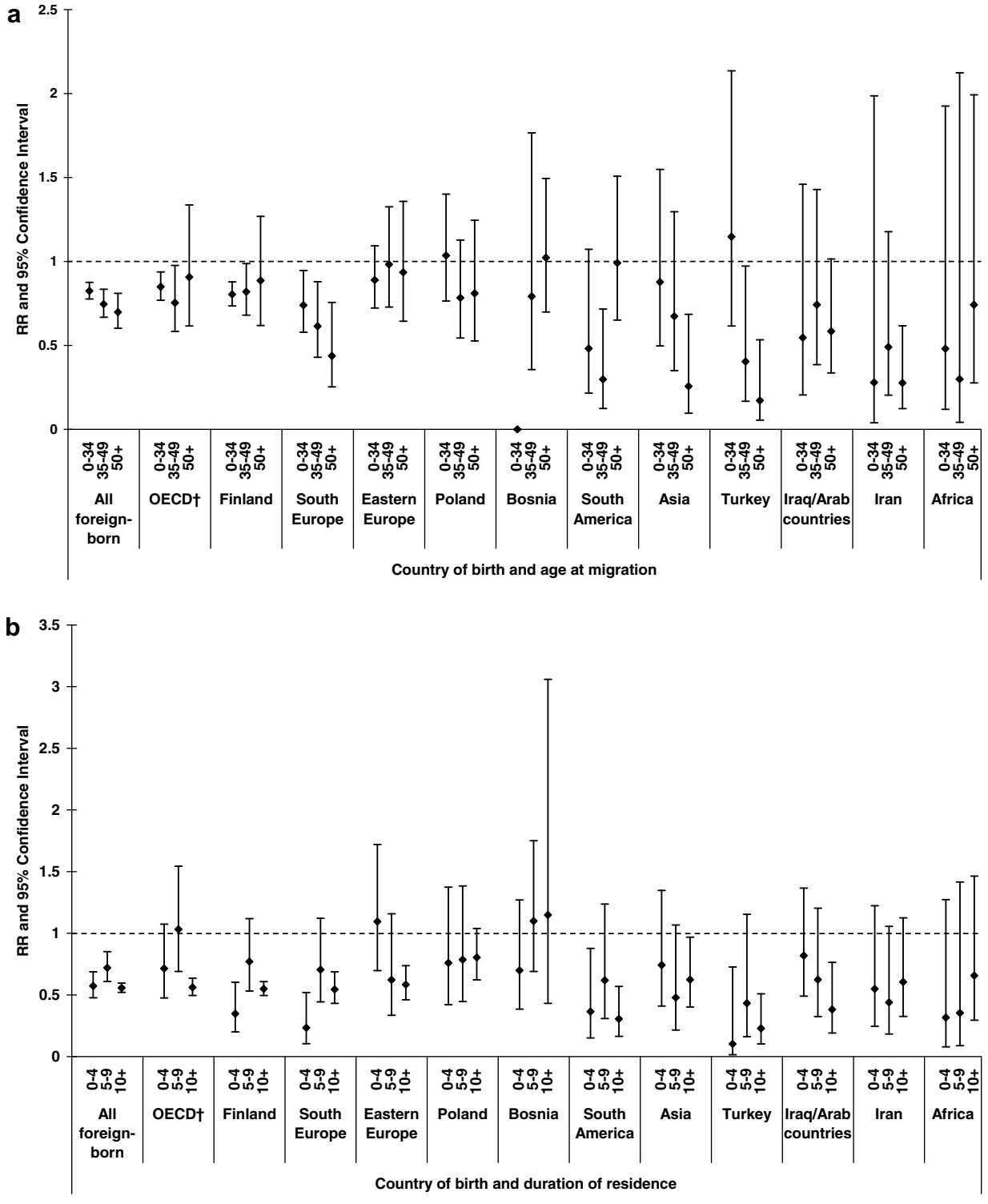
4.1. *Cervical cancer*

The risk of cervical cancer was reduced among women who were young at migration and increased among those who were 50 years or older at migration. This risk modification by age at migration was more evident among women who emigrated from high risk regions such as Asia, Bosnia, Poland and South America. This is in agreement with the previous findings, with the current understanding that lifetime risk of cervical cancer is determined by exogenous or environmental factors, such as HPV earlier in life.[15]

Our findings are in line with several previous studies on first-generation immigrants in Sweden, New South Wales and the Netherlands.[16–18] In contrast, a previous Swedish study has shown a decreased risk of cervical cancer among immigrants from Poland compared to natives.[16] However, their study cohort was limited to subjects with cancer diagnoses up to 1998 and to women who gave birth after immigration to Sweden. This resulted in a smaller number of incident cases than in our study. Also, a study of immigrants in New South Wales showed an increased risk of cervical cancer among immigrants from Iraq.[17] The limited number of cases resulted in a standardised incidence ratio (SIR) of 14.7 with a wide confidence interval (2.8–40.3) among the immigrants from Iraq.

Human papillomavirus (HPV) has been suggested as necessary cause for cervical cancer.[15] Other factors such as smoking, multiparity, oral contraceptive use and age at first intercourse probably act as risk modifiers of HPV-associated cervical cancer.[19] Differences in HPV prevalence between Eastern Europe and Sweden can hardly explain the observed increased risk among women from Eastern Europe immigrating at the age of 50 and more. A meta-analysis on HPV prevalence in Europe found an estimated HPV prevalence of 8.1% among women with normal cytology.[20] At the regional level, the estimated prevalence and the types of HPV found in Eastern Europe were similar to the ones in Northern Europe. However, only one study from Russia (Eastern Europe) with a small number of women was included in this meta-analysis. In another meta-analysis on the prevalence of HPV in invasive cervical cancer, overall detection of HPV DNA was similar in different regions (83–89%).[21]

The decreased risk of cervical cancer among women from Africa, Iran, Iraq/Arab countries and Turkey might be explained by the different sexual behaviours reflected by Islam, the dominant religion among these women.[22] Prohibited extramarital sexual activities might lead to later age at first intercourse and fewer sexual partners.[23] However, the increased risk of cervical cancer found in this study among Polish and Eastern European women who migrated after the age of 50 could hardly be explained by a more tolerant attitude towards sexual behaviours at a younger age. Sexual attitudes in 24 countries were analysed by Widmer and colleagues.[24] Countries were grouped according to similar responses to four questions regarding pre-marital sex, sex before the age of 16, extramarital sex and homosexuality. Poland was as-



* Adjusted for age, calendar period of follow up and education.
† OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland.
RR for Sweden=1

Fig. 2 – Rate ratio (RR)* for endometrial cancer among Swedish-born women and foreign-born women by age at migration (a), duration of residence (b) and country of birth.

signed to a cluster termed 'sexual conservatives' and showed a stronger than average level of disapproval for all forms of non-marital sex. In the cluster called 'teen permissives' including Sweden, there were relatively high levels of accep-

Table 5 – Rate ratio (RR)[b] for ovarian cancer among Swedish-born women and foreign-born women by attained age and country of birth

	Attained age							
	15–34		35–49		50–59		60+	
	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)	Cases	RR (95% CI)
Swedish-born women	953	1 (Reference)	3999	1 (Reference)	6766	1 (Reference)	19,352	1 (Reference)
Foreign-born women	114	0.87 (0.71–1.06)	298	0.58 (0.51–0.65)	308	0.52 (0.47–0.59)	437	0.56 (0.51–0.62)
OECD[a]	23	1.02 (0.67–1.57)	63	0.60 (0.47–0.77)	75	0.51 (0.41–0.64)	137	0.61 (0.52–0.72)
Finland	32	0.68 (0.48–0.98)	96	0.50 (0.41–0.61)	126	0.52 (0.44–0.63)	162	0.58 (0.50–0.68)
South Europe	11	0.67 (0.37–1.23)	36	0.65 (0.47–0.90)	26	0.49 (0.33–0.72)	22	0.39 (0.25–0.59)
Eastern Europe	7	1.18 (0.56–2.49)	22	0.71 (0.47–1.08)	29	0.68 (0.47–0.98)	41	0.55 (0.41–0.75)
Poland	6	1.02 (0.46–2.29)	26	0.89 (0.61–1.31)	28	0.92 (0.63–1.34)	22	0.57 (0.38–0.87)
Bosnia	1	0.39 (0.05–2.78)	5	0.53 (0.22–1.27)	9	1.14 (0.59–2.21)	18	1.09 (0.67–1.77)
South America	6	0.85 (0.38–1.91)	4	0.22 (0.08–0.58)	4	0.26 (0.10–0.70)	9	0.49 (0.25–0.94)
Asia	11	1.04 (0.57–1.91)	20	0.97 (0.63–1.52)	2	0.17 (0.04–0.67)	4	0.28 (0.11–0.76)
Turkey	3	0.61 (0.20–1.90)	3	0.25 (0.08–0.76)	3	0.30 (0.10–0.94)	2	0.11 (0.03–0.46)
Iraq/Arab Countries	7	0.88 (0.41–1.87)	10	0.59 (0.32–1.10)	4	0.38 (0.14–1.01)	11	0.70 (0.38–1.28)
Iran	4	0.98 (0.37–2.62)	10	0.83 (0.45–1.55)	0	N/A	7	0.48 (0.23–1.01)
Africa	3	0.63 (0.20–1.97)	3	0.41 (0.13–1.27)	2	0.63 (0.16–2.53)	2	0.46 (0.12–1.86)

N/A: not applicable.

a OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland.

b Analyses are adjusted for age, calendar period of follow-up and education.

tance for sex among teenagers and before marriage. Furthermore, it is less likely that immigrant women from countries with conservative sexual attitudes are influenced after migrating to a more sex permissive environment of Sweden when they are 50 years and older at the time of migration.

Differences in smoking pattern may also explain the findings. On the whole, reliable data on the prevalence of smoking and other life style factors among immigrants in Sweden are missing. According to international data, smoking rate in most of the countries included in our study is lower than the smoking rate in Sweden.[25] It is not very likely that non-smoking women who immigrated to Sweden after their teenage years become smokers later in life.[26] One cross-sectional study on unhealthy behaviours and risk factors for coronary heart disease carried out in a random sample of migrants in Sweden showed an increased prevalence of smoking among women from OECD countries and Poland, and a decreased prevalence of smoking in women from Iran.[27] Findings from a recently performed health survey in Stockholm County showed that the prevalence of daily smoking is higher among women born in East Europe, Bosnia, Turkey and Finland, and lower among women born in parts of South and Central Africa, compared to Swedish-born women.[28] It means that observed differences in risk of cervical cancer to some extent might be related to different distribution of behavioural risk factors either originating from the country of birth or attained in the host country.

The finding of increased risk of cervical cancer among women who immigrated at the age of 50 years or more and born in Asia, Poland, South America and, to some extent, in Bosnia, Eastern and Southern Europe and of decreased risk among women born in Turkey is in accordance with the available data on cancer rates in the respective countries of origin given in GLOBOCAN.[29] The observed risk after the age of 50 at immigration reflects a rate corresponding reasonably to the rate of the birth country of these immigrants. More importantly, the increased risk among women aged 35–49 at immigration and born in Bosnia and Poland as well as among women older than 50 and born in South America implies that these women may not fully benefit from the screening programme in Sweden. Differences in SEP may explain this disparity. Previous studies have shown segregation in housing and other living conditions among immigrants in Sweden.[30]

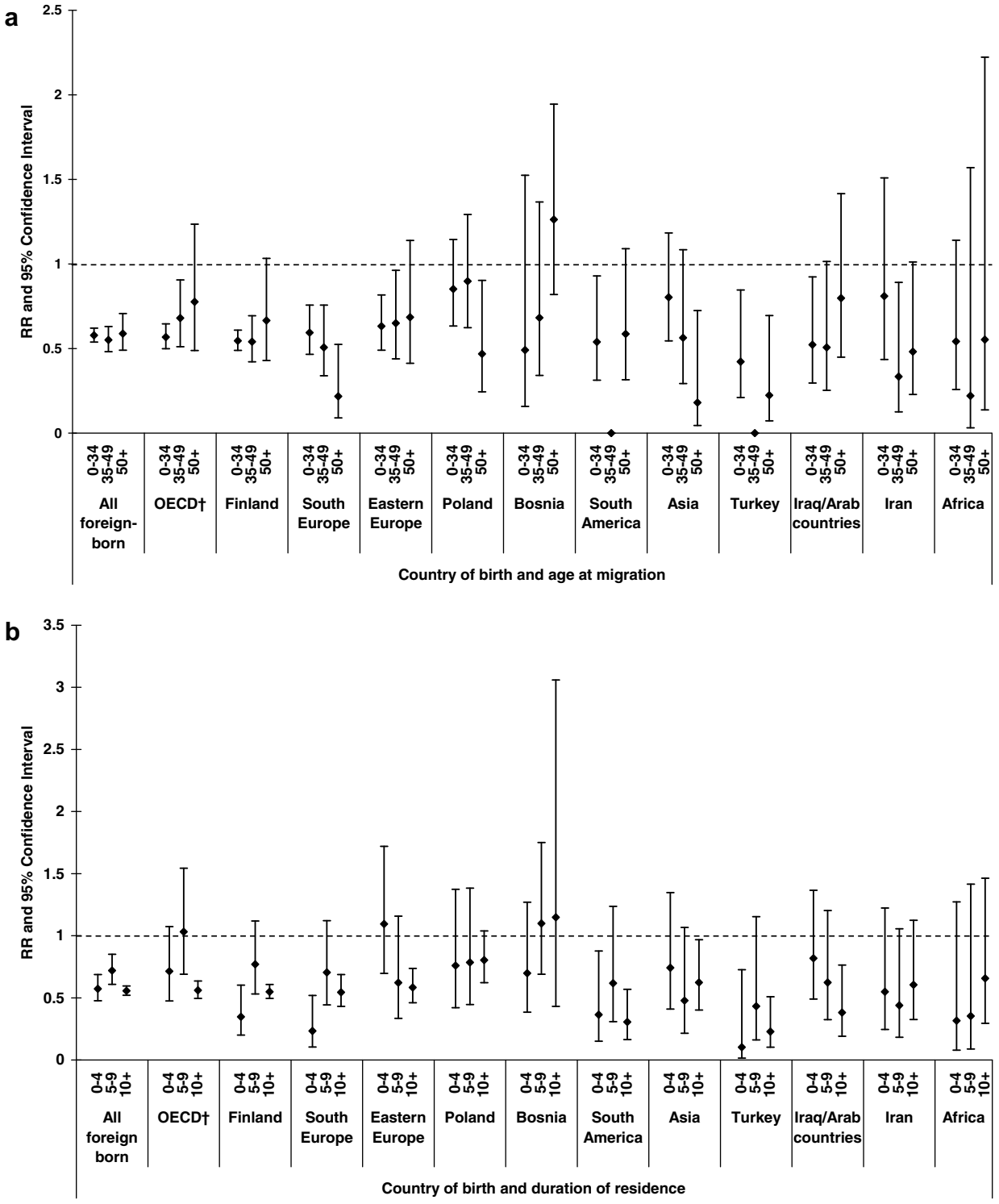
The incidence rates of cervical cancer vary considerably in the world. They are much higher in developing than in developed countries and highest in sub-Saharan Africa and Melanesia.[29] The estimated RR among immigrants from Africa in this study was unexpectedly low. This discrepancy might be explained by the healthy migrant effect, when migration acts as a selection process inducing a migrant population that differs from the whole population of origin in some characteristics such as SEP.[31] Another reason could be misclassification due to the pooling of African countries.

4.2. *Endometrial cancer*

All foreign-born women had a lower risk of endometrial cancer compared to the Swedish-born women, without any effect modification by age at migration or duration of residence.

According to the available information, e.g. GLOBOCAN, on cancer rates in countries of origin, endometrial cancer incidences are low in southern and eastern Asia and the highest incidences are in North America and Europe.[1] Sweden has one of the highest rates in Europe and in the world.[4] Our results indicate either that the immigrant women retained their lower risk for this cancer form without convergence to the risk in the host country or that medical surveillance of immigrants is poorer than that among native residents.

We had no information on the individual risk factors associated with endometrial cancer, such as parity, use of oral contraceptives and menopausal oestrogen therapy, age at menarche and menopause, or obesity.[32] Reliable data on the



* Adjusted for age, calendar period of follow up and education.
† OECD: USA, Canada, Australia, New Zealand and Western Europe except for Finland. RR for Sweden=1

Fig. 3 – Rate ratio (RR)* for ovarian cancer among Swedish-born women and foreign-born women by age at migration (a), duration of residence (b) and country of birth.

prevalence of all these factors among immigrants in Sweden are lacking. However, findings from a recently performed health survey in Stockholm County[28] and results from other studies[33,34] showed that the prevalence of obesity is higher among women born in Turkey, Iraq, Chile and South America, Bosnia, South Europe, Finland and Iran than among Swedish-

born women. On the other hand, obesity has been associated with increased risk of endometrial cancer by increasing peripheral production of oestrogen,[32] which is in contrast to the observed decreased risk of endometrial cancer among immigrant women in our study.

Increased risk of endometrial cancer caused by exposure to unopposed oestrogen among Swedish women could explain the increased risk of endometrial cancer among Swedish-born women.[35] The use of unopposed oestrogen was common in Sweden in the 1970s among menopausal women.[35]

Fertility rates in Sweden have been low and around 1.7 for several decades, in fact among the lowest in the world.[36] One study on childless women aged 20–41 years showed a higher first birth rate in most foreign-born women compared to native Swedish women.[37] The highest rates were found among women from Iraq and other Arabic-speaking countries, and from Bosnia, Turkey and Somalia. If first birth rate is an indicator of multiparity, then decreased risk of endometrial cancer among migrants might be explained by the higher first birth rates. In general, our results are comparable to the results of a study on different ethnic groups in USA[38], which showed that the distribution of known risk factors of endometrial cancer could not explain the observed reduced risk among different ethnic populations.

4.3. *Ovarian cancer*

In general, the observed decreased risk of ovarian cancer among foreign-born women is in agreement with the available data on ovarian cancer rates in countries of origin. The incidence of ovarian cancer is lower in African and Asian countries than in many Western countries, and it is highest in the Northern European countries.[1] Our findings are also in line with other studies on different migrant and ethnic groups in the United States and Britain.[39–41] A lower incidence of ovarian cancer has been reported among first-generation migrants from Africa and Caribbean than among white native women in Britain, even after correction for reproductive factors and menstrual history.[39,40] The risk of ovarian cancer was also found to be lower among black women, Japanese and Chinese immigrants in the United States compared to the US-whites.[41]

Contrary to cervical and endometrial cancers, little is known about the aetiology of ovarian cancer. Older age and family history of ovarian cancer are positively associated with ovarian cancer, while oral contraceptive use and parity are inversely associated.[42] Obesity, talc use, early menarche, late menopause and endometriosis are other probable risk factors.[42] In our study, foreign-born women were younger than Swedish-born women. However, the decreased risk of ovarian cancer was observed in all strata of attained age. Therefore, the observed lower risk of ovarian cancer among immigrants cannot be explained by age. We did not have information on other risk indicators. Prevalence of obesity was higher among many immigrant groups compared to Swedish-born women in the previous studies[27,33,34], which is in contrast to the observed decreased risk of ovarian cancer in our study. On the other hand, higher first birth rate, as a probable indicator of multiparity, could explain part of the observed decreased risk of ovarian cancer among foreign-born women.[37] However, none of these studies are population-based, and thus one should be careful not to draw any conclusions based on their results.

5. Conclusions and recommendations

We have shown that the risk of ovarian and endometrial cancers is lower among women who have migrated from low incidence countries, and remains low even after a long stay in the host country. However, risk of cervical cancer is increased in women from countries with a high prevalence of HPV infection.

Since variations in cancer risk among migrant populations give important clues to understanding mechanisms of disease, we recommend that cancer incidence is followed and monitored carefully in migrant populations, in countries with high quality cancer registers.

If the lower risk of some cancer forms in immigrant women can be confirmed, the mechanisms should be clarified in order that preventive efforts can be implemented in countries with a higher incidence.

Health care providers should be aware of the higher risk of cervical cancer among women from areas with a high prevalence of HPV infection who immigrate after their fifties and with probable persistent HPV infection. It is important that screening programmes are targeted also to immigrant women who may have less easy access to health services.

Conflict of interest statement

The funding association had no role in the design, the data collection, the analysis and interpretation of the results, or in the writing of the manuscript.

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