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Participation in cervical cancer screening among immigrants and Danish-born women in Denmark

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ABSTRACT

In this nationwide register-based cohort study, we examined cervical cancer screening participation among immigrants in Denmark by country and region of origin. Furthermore, we assessed whether differences in screening participation between immigrants and Danish-born women were explained by sociodemographic or health-related characteristics, and examined predictors of participation among immigrants. Using high-quality registries, we identified women invited for cervical cancer screening during 2008–2009 and retrieved individual-level data on sociodemographic-, health- and immigration-related characteristics. A total of 610,907 women were followed for up to 2.9 years after screening invitation. We estimated the probability of participation using the Aalen-Johansen estimator and the hazard ratios (HRs) of participation using Cox regression. The probability of participation within follow-up was 74.5% (95% CI, 74.4%–74.6%) in Danish-born women; 61.2% (95% CI, 60.4%–62.1%) in Western immigrants; and 61.3% (95% CI, 60.9%–61.8%) in non-Western immigrants. Participation in immigrants varied by region of origin from 44.3% (95% CI, 41.4%–47.4%) in immigrants from North America, New Zealand and Australia to 67.8% (95% CI, 65.4%–70.3%) in immigrants from South- and Central America. Substantial variation was seen between specific countries of origin. Differences in participation between immigrants and Danish-born women were not explained by sociodemographic or health-related characteristics. Predictors of low participation in immigrants included lower income, unemployment, being unmarried, having a history of schizophrenia or other psychoses, and ≤ 5 years' stay in Denmark. In conclusion, cervical cancer screening participation in immigrants varied by region and country of origin, but all immigrant groups had lower participation than Danish-born women.

1. Introduction

The number of immigrants in Denmark has been growing over the past decade, and as of January 2018 immigrants constituted 10% of the total population (Statistics Denmark, 2018a). The Danish health care system is largely tax financed and is based on a principle of free and universal access to health care for all residents (Olejaz et al., 2012; Danish Health Act, 2018). This includes access to preventive health care such as the national cervical cancer screening program (Danish National Board of Health, 2012; Danish National Board of Health, 2018).

Studies from Denmark and other countries indicate that immigrants are less likely than the native populations to utilize preventive health care measures, such as vaccination (Fernández de Casadevante et al., 2015), mammography (Jensen et al., 2012; Kristiansen et al., 2012;

Rondet et al., 2014), colorectal cancer screening (Frederiksen et al., 2010) and cervical cancer screening (Rondet et al., 2014; Kristensson et al., 2014; Leinonen et al., 2017; Møen et al., 2017; Azerkan et al., 2012; Idehen et al., 2017; Broberg et al., 2018; Harder et al., 2018a). Immigrants may face barriers for screening participation such as poor language proficiency, lower literacy, lower awareness of the objective of screening, and lower perceived cancer risk compared with Danish-born women (Marlow et al., 2015a; Marlow et al., 2015b; Abdullahi et al., 2009). Length of stay and country of origin may also influence screening participation among immigrants (Leinonen et al., 2017; Møen et al., 2017). Furthermore, low screening participation among immigrants may to some extent be explained by lower socio-economic position (Statistics Denmark, 2018b) or higher risk of physical or mental illness (Jervelund et al., 2017) in some immigrant groups, as these factors have in some studies been found associated with decreased

Abbreviations: CI, confidence interval; HR, hazard ratio; GP, general practitioner; PIN, personal identification number

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screening participation (Kristensson et al., 2014; Harder et al., 2018a).

Although previous studies found that immigrants in Denmark are less likely to participate in cervical cancer screening than Danish-born women (Kristensson et al., 2014; Harder et al., 2018a), no previous Danish studies have investigated screening participation among immigrants from specific countries or regions, and no Danish studies have analyzed predictors of screening participation in immigrants.

In this study, we describe cervical cancer screening participation among immigrants in Denmark from different countries and world regions. Furthermore, we attempt to assess whether differences in screening participation between immigrants and Danish-born women are explained by socio-demographic or health-related characteristics. Lastly, we identify determinants of screening participation in immigrants.

2. Methods

2.1. Cervical cancer screening in Denmark

Denmark has a nationwide cervical cancer screening program offering free-of-charge screening to women aged 23–64 years (Danish National Board of Health, 2012; Danish National Board of Health, 2018). Screening is recommended every three years for women aged 23–49 and every five years for those aged 50–64 (Danish National Board of Health, 2012, 2018). A nationwide register, the Pathology Databank (Erichsen et al., 2010), serves as the administrative system for the program. The register contains information on all cervical cytologies, biopsies and cones performed in the country, and information on screening invitations, reminders and unsubscriptions. Invitations are sent to women with no cervical smear registered within the recommended interval. The invitation encourages the woman to make an appointment for smear-taking with her general practitioner (GP) or gynecologist. Immigrants are invited for screening when they obtain a personal identification number (PIN). A unique PIN is assigned to all Danish residents at birth or, for immigrants, when they have been granted residence permit and have an address of residence in Denmark (Pedersen, 2011; Danish Act on the Central Person Register, 2017). The PIN is used in all health- and administrative registers, making it possible to securely link information from different registers.

2.2. Data sources

The study is a prospective, nationwide, registry-based cohort study. Using the PIN, we linked information from the Civil Registration System (Pedersen, 2011), the Pathology Databank (Erichsen et al., 2010), the National Patient Register (Lyngge et al., 2011), the National Health Service Register (Andersen et al., 2011), the Medical Birth Register (Knudsen and Olsen, 1998), the Psychiatric Central Register (Mors et al., 2011), and the Income and Employment Registers in Statistics Denmark (Thygesen et al., 2011).

2.3. Study population

Fig. 1 depicts the study population. In the Pathology Databank, we identified all women invited for cervical cancer screening during 2008–2009 ($n = 703,547$). We excluded women born in Denmark to immigrant parents (so-called “descendants”/“second-generation immigrants”) ($n = 5641$); women who could not be classified as Danish-born, immigrants or descendants ($n = 16,565$); and immigrants with unknown country of origin ($n = 193$). Furthermore, we excluded women who were not residing in Denmark ($n = 2585$), had unsubscribed ($n = 337$) or were fully hysterectomized ($n = 13,205$) at time of invitation. Pregnant women ($n = 32,898$) were also excluded, because screening is not recommended during pregnancy (Danish National Board of Health, 2012). We additionally excluded women whose invitation letter was returned to sender ($n = 700$) and women

with missing socio-demographic data ($n = 2167$). Finally, we excluded women who had not resided continuously in Denmark during the year before invitation ($n = 18,353$), in order to measure covariates in the registries during that year. The final study population consisted of 610,907 women.

2.4. Country and region of origin

Information on country of origin was obtained from the Civil Registration System. In accordance with Statistics Denmark, immigrants were defined as women born outside Denmark by parents born outside Denmark. Danish-born women were born in Denmark or born abroad to at least one Danish parent. Country of origin was based on the mother's origin if this was known, otherwise the father's origin was used. If the origins of both parents were unknown, we used the woman's birth country (Statistics Denmark, 2018b). Immigrants were subdivided into Western and non-Western origin. Western immigrants were from Western Europe, North America, New Zealand or Australia. All other immigrants were considered non-Western. Western and non-Western immigrants were further subdivided by geographical region of origin (Western immigrants: Western Europe; North America, New Zealand and Australia. Non-Western immigrants: Eastern Europe; Mid- and Eastern Asia; North Africa and Western Asia; Sub-Saharan Africa; South and Central America).

2.5. Screening participation and follow-up

The outcome was participation in cervical cancer screening within 2.9 years after invitation. We chose 2.9 years' follow-up to ensure that women were not re-invited for a second screening round. Screening participation was defined as having a cervical cytology (Systematized Nomenclature of Medicine codes T8X2* and T8X3*) registered in the Pathology Databank during follow-up.

2.6. Other variables

2.6.1. Socio-demographic characteristics

Age and civil status (married/unmarried) at invitation was obtained from the Civil Registration System. Employment status (employed/unemployed/retired) and income in the year of invitation were obtained from Statistics Denmark. Income was defined as total income after taxes categorized into quartiles.

2.6.2. Mental and physical health

Psychiatric diagnoses were obtained from the Psychiatric Central Register, which holds information on psychiatric hospital contacts (inpatients since 1970 and outpatients since 1995) (Thygesen et al., 2011). We considered diagnoses of anxiety and adjustment disorders (International Classification of Diseases version 10 (ICD-10) codes F40–43; ICD-8 code 300); affective disorders (ICD-10: F30–39; ICD-8: 296, 298.0–1); schizophrenia and other psychoses (ICD-10: F20–29; ICD-8: 295, 297, 298.3); and alcohol and intoxicant abuse (ICD-10: F10–19; ICD-8: 291, 294.3, 303–304). Using the National Patient Registry, we calculated Charlson's comorbidity index (Charlson et al., 1987) as a proxy measure for severe physical illness diagnosed from the start of the register in 1977 until screening invitation. Data on live births were obtained from the Medical Birth Register. The aforementioned health-related variables were measured as “never/ever” at time of invitation. Finally, using the National Health Service Register we calculated number of GP and dentist visits in the year before invitation.

2.6.3. Migration-related variables

For immigrants, we used the Civil Registration System to calculate the number of years since first immigration to Denmark and the number of re-migrations in and out of Denmark. These variables were intended as proxies for affiliation to Denmark.

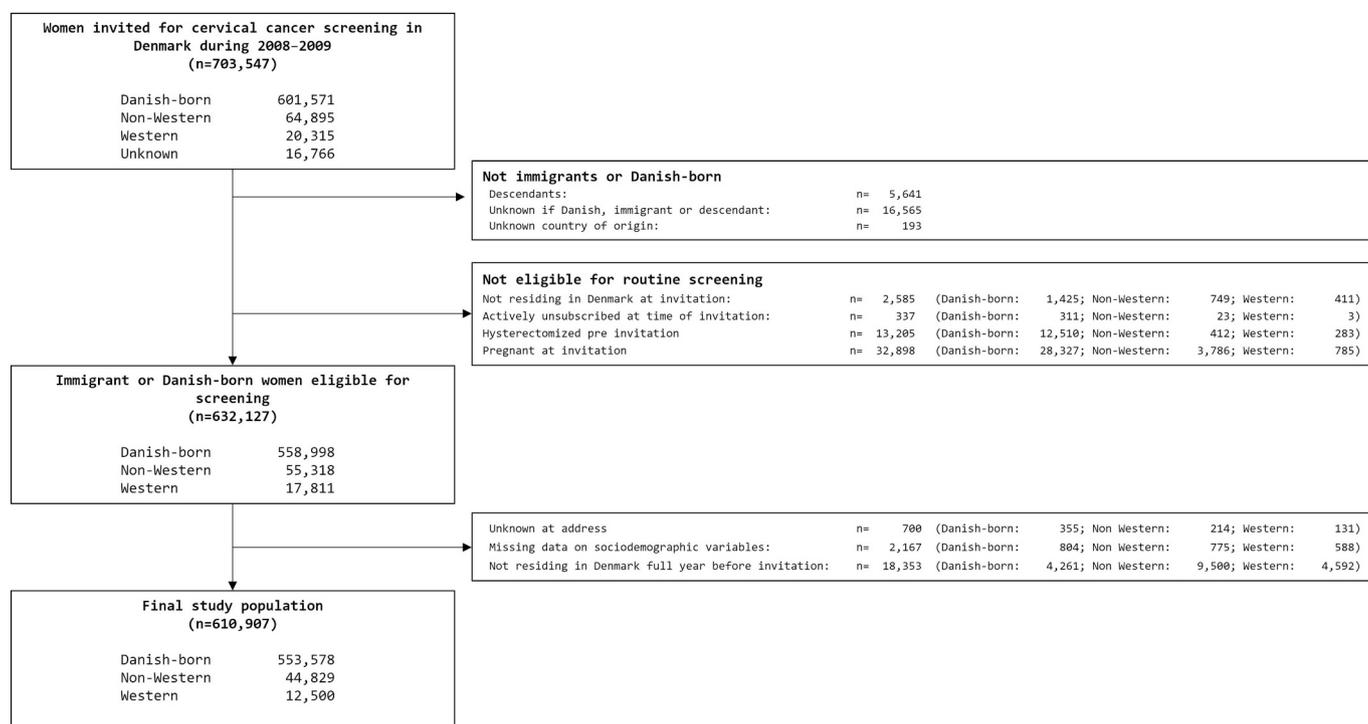


Fig. 1. Selection of the study population of women invited for cervical cancer screening in Denmark during 2008–2009.

2.7. Statistical analysis

We assessed the probability of screening participation by country and region of origin using the Aalen-Johansen estimator, which estimates the cumulative incidence of screening participation in the presence of competing risks (Andersen et al., 2012). Pregnancy, unsubscription from screening, death and full hysterectomy were considered competing risks, while women were censored at emigration or end of study.

Secondly, we used Cox proportional hazards regression to estimate hazard ratios (HRs) with 95% confidence intervals (CIs) of screening participation in immigrants compared with Danish-born women. To assess whether crude differences in screening participation were explained by socio-demographic differences, we adjusted for age, civil status, employment and income. Subsequently, we additionally adjusted for live births, psychiatric disorders and Charlson's index to investigate whether differences in screening participation were attributed to differences in mental or physical health. The proportional hazards assumption was checked by plots of the Schoenfeld residuals which showed no substantial deviations from proportionality.

Thirdly, we used Cox regression to examine potential determinants of screening participation in Western and non-Western immigrants, including socio-demographic, health-related and migration-related characteristics. Potential determinants were initially examined in unadjusted models, and subsequently adjusted for socio-demographic characteristics. In additional models, we also adjusted for years since first immigration and number of re-migrations. The adjustment variables were selected a priori based on a hypothesis that they could potentially confound associations between other predictors and screening participation. Aalen-Johansen estimates of participation in strata defined by socio-demographic, health- and migration-related variables were calculated for Western- and non-Western immigrants.

In sensitivity analyses, we repeated the analyses including women with missing information on socio-demographic variables ($n = 2167$) and women without full stay in Denmark in the year before invitation ($n = 18,353$). In the main analysis, women with missing information on years since immigration ($n = 2969$) were included in regression

models, but we repeated the analyses excluding these women. Furthermore, because variables on live births, psychiatric disorders and Charlson's index may be underreported in the registries for immigrants with short stay in Denmark, we repeated analyses of these variables including only immigrants aged < 20 years at immigration. Statistical analyses were performed using R version 3.4.2 (R Development Core Team, R Software, 2017).

3. Results

3.1. Baseline characteristics

Table 1 shows baseline characteristics of the study population. Western and non-Western immigrants were younger than Danish-born women, and a higher proportion of immigrants than Danish-born women were unemployed and had low income. Being married was more common in non-Western immigrants, and less common in Western immigrants, than in Danish-born women. There were only slight differences between groups in the proportion of women with previous psychiatric diagnoses. Non-Western immigrants had more, while Western immigrants had fewer, live-born children than Danish-born women. Western immigrants were slightly less likely than Danish-born women to have a Charlson's index of ≥ 1 , and both immigrant groups were less likely than Danish women to have had GP or dentist contacts in the year before invitation. One fourth of Western immigrants had been in Denmark for only 1–5 years, while 62% of non-Western immigrants had immigrated > 10 years before invitation. Of the Western immigrants, 28% had ≥ 1 re-migrations, while most non-Western immigrants (85%) did not re-migrate after first immigration.

3.2. Screening participation by region and country of origin

Of 553,578 Danish-born women invited for screening, 411,898 (74.4%) were screened during follow-up, while 18,707 (3.4%) became pregnant, 15,726 (2.8%) unsubscribed, 1732 (0.3%) died, 1300 (0.2%) emigrated, and 582 (0.1%) had full hysterectomy. Among non-Western immigrants ($n = 44,829$), 27,307 (60.9%) were screened, 3087 (6.9%)

Table 1
Baseline characteristics of study population of women invited for cervical cancer screening in Denmark during 2008–2009, by region of origin.

	Danish-born women		Western immigrants		Non-Western immigrants	
	(n = 553,578)		(n = 12,500)		(n = 44,829)	
	n	(%)	n	(%)	n	(%)
Sociodemographic characteristics						
<i>Age^a</i>						
23–29	95,662	(17)	3118	(25)	10,344	(23)
30–39	140,067	(25)	2948	(24)	15,490	(35)
40–49	177,473	(32)	3437	(27)	14,168	(32)
50–59	81,678	(15)	1599	(13)	3271	(7)
60–65	58,698	(11)	1398	(11)	1556	(3)
<i>Employment status^a</i>						
Employed	441,567	(80)	8489	(68)	25,988	(58)
Unemployed	41,305	(7)	2810	(22)	14,626	(33)
Retired	70,706	(13)	1201	(10)	4215	(9)
<i>Annual income^a</i>						
Q1 (EUR < 18,930)	128,249	(23)	5320	(43)	19,158	(43)
Q2 (EUR 18,930–25,196)	137,341	(25)	2233	(18)	13,153	(29)
Q3 (EUR 25,196–31,429)	142,454	(26)	2170	(17)	8103	(18)
Q4 (EUR ≥ 31,248)	145,534	(26)	2777	(22)	4415	(10)
<i>Civil status^a</i>						
Married	296,016	(53)	5956	(48)	29,170	(65)
Unmarried	257,562	(47)	6544	(52)	15,659	(35)
Mental and physical health						
<i>Anxiety and adjustment disorders^b</i>						
Never	529,614	(96)	12,083	(97)	42,424	(95)
Ever	23,964	(4)	417	(3)	2405	(5)
<i>Affective disorders^b</i>						
Never	536,341	(97)	12,162	(97)	43,424	(97)
Ever	17,237	(3)	338	(3)	1405	(3)
<i>Schizophrenia and other psychoses^b</i>						
Never	547,479	(99)	12,382	(99)	44,131	(98)
Ever	6099	(1)	118	(1)	698	(2)
<i>Alcohol and intoxicant abuse^b</i>						
Never	547,660	(99)	12,363	(99)	44,696	(100)
Ever	5918	(1)	137	(1)	133	(< 1)
<i>Live-born children^b</i>						
0	367,974	(66)	9195	(74)	24,840	(55)
1	90,070	(16)	1737	(14)	9958	(22)
2–3	93,451	(17)	1525	(12)	9231	(21)
≥ 4	2083	(< 1)	43	(< 1)	800	(2)
<i>Charlson comorbidity index^b</i>						
0	481,504	(87)	11,317	(91)	39,559	(88)
≥ 1	72,074	(13)	1183	(9)	5270	(12)
<i>GP contacts^c</i>						
None	60,125	(11)	2905	(23)	6094	(14)
≥ 1	493,453	(89)	9595	(77)	38,735	(86)
<i>Dentist contacts^c</i>						
None	155,841	(28)	6126	(49)	27,524	(61)
≥ 1	397,737	(72)	6374	(51)	17,305	(39)
Migration-related characteristics						
<i>Years since first immigration to Denmark^a</i>						
1–5	Not applicable		3178	(25)	5567	(12)
5–10			1968	(16)	9872	(22)
10–20			2987	(24)	18,867	(42)
20–30			1797	(14)	7231	(16)
≥ 30			971	(8)	1922	(4)
Missing			1599	(13)	1370	(3)
<i>Number of re-immigrations to Denmark^a</i>						
0	Not applicable		7414	(59)	38,156	(85)
1			2834	(23)	4603	(10)
≥ 2			653	(5)	700	(2)
Missing			1599	(13)	1370	(3)

EUR: euros; GP: general practitioner.

^a At the time of screening invitation.

^b Ever/never at the time of screening invitation.

^c During the year before screening invitation.

became pregnant, 1812 (4.0%) unsubscribed, 831 (1.9%) emigrated, 64 (0.1%) died, and 46 (0.1%) were hysterectomized. Among Western immigrants (n = 12,500), 7537 (60.3%) were screened, 997 (8.0%) unsubscribed, 530 (4.2%) emigrated, 385 (3.1%) became pregnant, 38

(0.3%) died, and 13 (0.1%) were hysterectomized.

Table 2 shows the probability of screening participation during follow-up by region and country of origin. Overall, participation was lower in Western (61.2%; 95% CI, 60.4%–62.1%) and non-Western

Table 2

Cumulative probability of participation in cervical cancer screening during up to 2.9 years of follow-up, among 610,907 women invited for cervical cancer screening in Denmark 2008–2009; by region and country of origin.

Region and country of origin	N invited	n screened	% screening participation ^a	95% CI
Denmark	553,578	411,898	74.5	74.4–74.6
Western countries	12,500	7537	61.2	60.4–62.1
Western Europe	11,451	7078	62.8	61.9–63.7
Sweden	1907	1334	71.0	69.0–73.1
Holland	599	410	69.3	67.3–71.3
Norway	2088	1410	68.8	65.2–72.6
Island	877	577	67.9	64.8–71.2
Finland	451	299	66.9	62.7–71.4
Great Britain	984	633	64.8	61.9–67.9
Germany	2663	1545	58.7	56.8–60.6
Italy	288	130	45.8	40.3–52.0
France	470	198	43.0	38.7–47.8
Spain	402	149	37.6	33.1–42.7
Other countries ^b	722	393	55.2	51.7–59.0
North America, New Zealand and Australia	1049	459	44.3	41.4–47.4
USA	646	312	49.0	45.2–53.0
Other countries ^b	403	147	36.9	32.4–41.9
Non-Western countries	44,829	27,307	61.3	60.9–61.8
Eastern Europe	12,892	7831	61.3	60.4–62.1
Bosnia-Herzegovina	2999	2023	67.6	65.9–69.3
Russia	964	623	65.0	62.0–68.1
Yugoslavia	2157	1347	62.6	60.6–64.7
Bulgaria	208	124	60.3	54.0–67.4
Poland	2674	1576	59.7	57.9–61.6
Macedonia	349	205	58.8	53.9–64.3
Rumania	594	333	56.5	52.6–60.7
Latvia	294	157	53.9	48.4–59.9
Lithuania	584	308	53.6	49.7–57.9
Hungary	229	119	52.6	46.5–59.6
Ukraine	660	305	48.5	44.7–52.6
Other countries ^b	1180	711	60.7	58.0–63.6
Mid- and Eastern Asia	14,363	8773	61.5	60.7–62.3
Vietnam	1627	1167	71.8	69.7–74.1
Iran	1617	1141	71.1	68.9–73.4
Thailand	2442	1633	67.0	65.2–68.9
Afghanistan	1178	718	61.2	58.4–64.0
Sri Lanka	1362	822	60.8	58.2–63.5
Japan	203	116	57.7	51.2–64.9
Philippines	1562	871	56.3	53.8–58.8
India	439	238	54.8	50.3–59.7
China	1401	684	50.4	48.1–52.9
Pakistan	1648	827	50.0	47.4–52.7
Other countries ^b	884	556	63.2	60.1–66.5
North Africa and Western Asia	12,749	8042	63.3	62.5–64.1
Syria	363	233	65.0	63.7–66.2
Turkey	5717	3707	64.8	60.1–70.0
Iraq	2814	1762	62.8	61.1–64.7
Lebanon	2148	1334	62.5	60.4–64.6
Morocco	857	532	62.2	59.1–65.6
Other countries ^b	850	474	56.1	52.8–59.5
South and Central America	1396	938	67.8	65.4–70.3
Brazil	379	264	70.3	65.8–75.1
Other countries ^b	1017	674	66.8	64.0–69.8
Sub-Saharan Africa	3429	1723	50.6	49.0–52.3
Ghana	211	152	72.5	66.7–78.9
Uganda	215	132	62.1	55.9–69.0
Somalia	1523	490	32.6	30.3–35.1
Other countries ^b	1480	949	64.4	62.0–66.9

CI, confidence interval.

^a Aalen-Johansen estimates.

^b Countries with ≤ 200 immigrants were included in the “other” category.

immigrants (61.3%; 95% CI, 60.9%–61.8%) than in Danish-born women (74.5%; 95% CI, 74.4%–74.6%). Participation was lowest among immigrants from North America, New Zealand and Australia (44.3%; 95% CI, 41.4%–47.4%) and Sub-Saharan Africa (50.6%, 95% CI, 49.0%–52.3%). Large differences were seen by country of origin.

Among immigrants, women from Ghana (72.5%; 95% CI, 66.7%–78.9%), Vietnam (71.8%; 95% CI, 69.7%–74.1%), Sweden (71.0%; 95% CI, 69.0%–73.1%) and Iran (71.1%; 95% CI, 68.9%–73.4%) had highest participation, while participation was lowest in immigrants from Somalia (32.6%; 95% CI, 30.3%–35.1%),

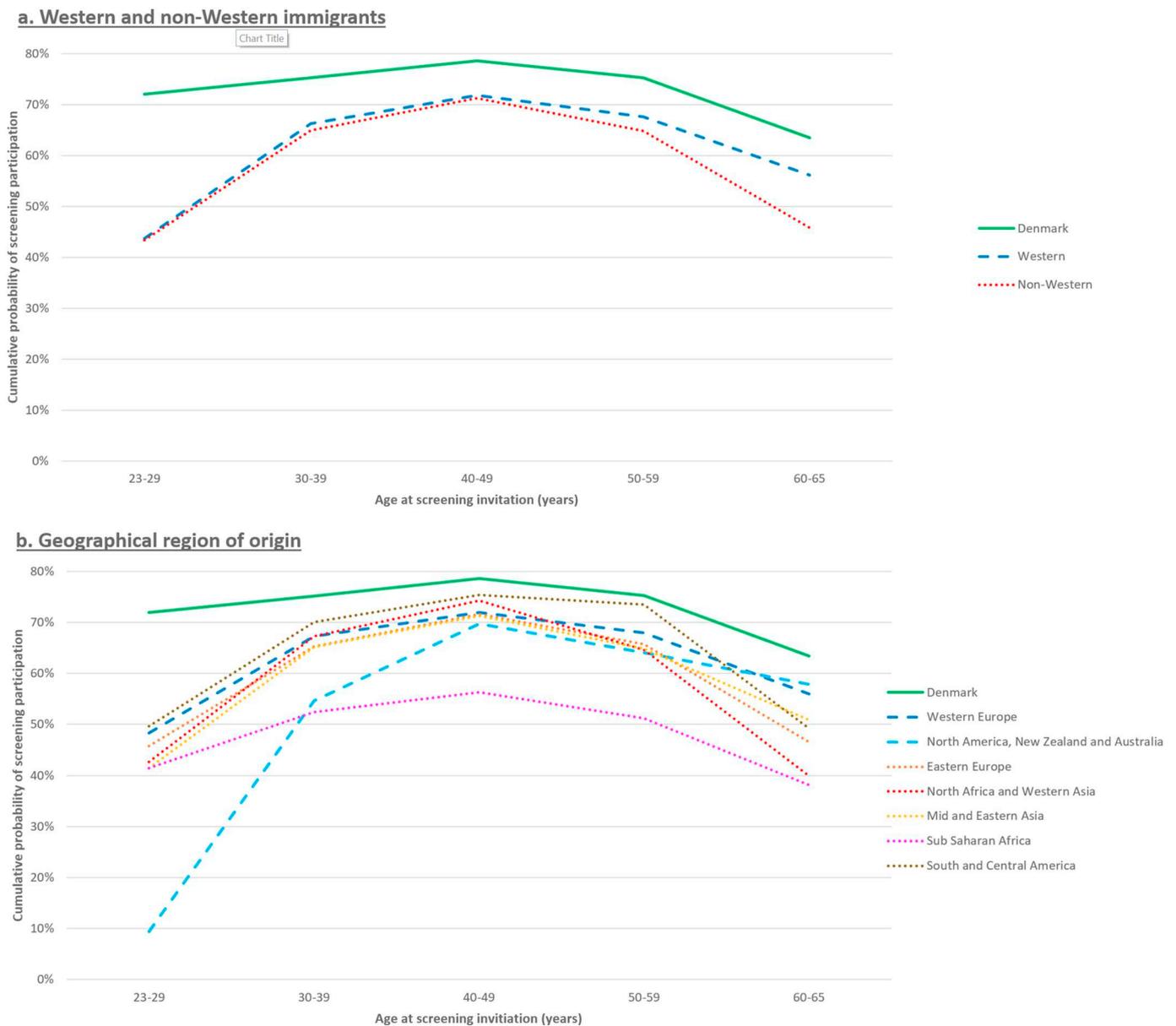


Fig. 2. Probability of cervical cancer screening participation during up to 2.9 years of follow-up, by region of origin and age.

Spain (37.6%; 95% CI, 33.1%–42.7%), France (43.0%; 95% CI, 38.7%–47.8%), Italy (45.8%; 95% CI, 40.3%–52.0%), Ukraine (48.5%; 95% CI, 44.7%–52.6%) and USA (49.0%; 95% CI, 45.2%–53.0%).

Fig. 2 shows the probability of screening participation by region and age group. In all regions, participation was lowest among the youngest and oldest women. In all age groups and regions, immigrants had lower participation than Danish-born women.

Supplementary Table S1 shows the cumulative probability of competing risks (hysterectomy, pregnancy, unsubscription or death) in immigrants and Danish-born women. The total cumulative probability of being screened or experiencing a competing risk was lower in non-Western (72.6%) and Western (72.9%) immigrants than in Danish-born women (81.1%).

3.3. Hazard ratio of screening participation by region of origin

Table 3 shows the crude and adjusted HRs of screening participation for immigrants from each region compared with Danish-born women. In the crude analysis (model 1), immigrants from all regions had lower participation rates than Danish-born women. The lowest participation

rate relative to Danish-born women was seen in immigrants from North America, New Zealand and Australia ($HR_{crude} = 0.48$; 95% CI, 0.44–0.53) and Sub-Saharan Africa ($HR_{crude} = 0.52$; 95% CI, 0.50–0.55). When adjusting for socio-demographic characteristics (model 2), the associations between region of origin and screening participation were only slightly attenuated and remained statistically significant. When further adjusting for psychiatric diagnoses, live-born children and Charlson's index (model 3), all associations were virtually unchanged.

When we repeated this analysis including only immigrants aged < 20 years at immigration, findings were similar to those reported in Table 3. When women with missing information on sociodemographic variables ($n = 2167$) and women without continuous residence in Denmark during the year before invitation ($n = 18,353$) were included, findings were also similar to those in Table 3.

3.4. Predictors of screening participation in immigrants

We also attempted to identify predictors of screening participation in Western and non-Western immigrants. Table 4 shows the estimated

Table 3

Hazard ratio of participation in cervical cancer screening during up to 2.9 years of follow-up, among 610,907 women invited for cervical cancer screening in Denmark during 2008–2009, according to region of origin.

Region of origin	Model 1 (crude)		Model 2 ^a		Model 3 ^b	
	HR	(95% CI)	HR	(95% CI)	HR	(95% CI)
Denmark	1	(ref)	1	(ref)	1	(ref)
Western countries	0.73	(0.71–0.74)	0.79	(0.77–0.81)	0.79	(0.77–0.81)
Western Europe	0.75	(0.73–0.77)	0.81	(0.79–0.83)	0.81	(0.79–0.83)
North America, New Zealand and Australia	0.48	(0.44–0.53)	0.56	(0.51–0.61)	0.55	(0.51–0.61)
Non-Western countries	0.70	(0.70–0.71)	0.77	(0.76–0.78)	0.77	(0.76–0.78)
Eastern Europe	0.71	(0.70–0.73)	0.77	(0.75–0.78)	0.76	(0.75–0.78)
Mid- and Eastern Asia	0.72	(0.70–0.73)	0.77	(0.76–0.79)	0.77	(0.76–0.79)
North Africa and Western Asia	0.72	(0.71–0.74)	0.80	(0.78–0.82)	0.79	(0.78–0.81)
Sub Saharan Africa	0.52	(0.50–0.55)	0.60	(0.57–0.63)	0.61	(0.58–0.64)
South and Central America	0.84	(0.79–0.90)	0.90	(0.85–0.96)	0.90	(0.85–0.96)

CI, confidence interval; HR, hazard ratio.

^a Adjusted for age, employment status, income, and civil status.

^b Adjusted for same variables as model 2 and additionally for schizophrenia, alcohol and intoxicant abuse, affective disorders, anxiety and adjustment disorders, parity, and Charlson's comorbidity index.

probability of screening participation, and the HRs of screening participation, in relation to socio-demographic, health-related and immigration-related variables in Western and non-Western immigrants. In the crude regression analyses, Western and non-Western immigrants who were unemployed or retired, had low income, or were unmarried had lower participation rate than those who were employed, had higher income or were married. In both Western and non-Western immigrants, a history of schizophrenia/other psychoses or alcohol/intoxicant abuse was associated with decreased participation rate. Women with 1–3 live-births had higher participation rate than women with no live-births in both immigrant groups, but non-Western immigrants with ≥ 4 live-births had lower participation rate than non-Western immigrants with no live-births. In both immigrant groups, women who had seen their GP or dentist in the past year had higher participation rate than women with no GP or dentist contacts. Western and non-Western immigrants who had been in Denmark ≥ 5 years at time of invitation had higher participation rate than those with < 5 years since first immigration. Finally, among non-Western immigrants, those who had re-migrated at least once since their first immigration to Denmark had lower participation rate than those who had stayed continuously in Denmark after their first immigration, whereas this pattern was not seen in Western immigrants.

When the crude models were adjusted for socio-demographic characteristics, the associations between alcohol/intoxicant abuse and screening participation became statistically insignificant in both immigrant groups. All other associations were slightly attenuated, but remained statistically significant. When we further adjusted the analyses of socio-demographic and health-related characteristics for time since immigration and number of re-migrations, estimates were virtually unchanged (*data not shown*).

When the analyses in Table 4 were repeated in models including women with missing socio-demographic information ($n = 2167$) and women without continuous residence in Denmark during the year before invitation ($n = 18,353$), trends were similar to those in Table 4. Likewise, results were similar when women with missing information on time since immigration ($n = 2969$) were excluded. Finally, when the analyses of psychiatric disorders, live-born children and Charlson's index were repeated including only immigrants aged < 20 years at immigration, results were similar to those in Table 4 (*data not shown*).

4. Discussion

In this nationwide study of all women invited for cervical cancer screening in Denmark during 2008–2009, we found lower screening participation in immigrants than in Danish-born women. The

participation rate was lower in immigrants of both Western and non-Western origin, but large variations were seen between immigrants from different countries and world regions. The overall lower participation in immigrants was not fully explained by socio-demographic or health-related characteristics. Predictors of high participation among immigrants included higher income, employment, marriage, no history of schizophrenia, and ≥ 5 years' stay in Denmark.

Our finding of overall lower screening participation among immigrants compared with Danish-born women is in line with previous Danish registry studies (Kristensson et al., 2014; Harder et al., 2018a), but none of these studies examined screening participation according to specific country or region of origin. In our study, screening participation was generally similar in Western and non-Western immigrants, except among the oldest women aged ≥ 50 years. However, participation varied substantially within Western and non-Western immigrants from different regions and countries. This is in line with previous studies from Sweden (Azerkan et al., 2012; Broberg et al., 2018), whereas Norwegian studies have mostly reported higher screening participation in Western than in non-Western immigrants (Leinonen et al., 2017; Møen et al., 2017). Our findings underline that broad groupings of immigrants such as Western/non-Western may camouflage important within-group differences. For example, the high participation among Vietnamese immigrants in our study may be influenced by a relatively high income and employment rate in this group (Statistics Denmark, 2018b).

Multiple mechanisms may contribute to lower screening participation in immigrants. First, immigrants may lack knowledge to navigate in the Danish health care system, and challenges related to immigration may limit the resources and time needed to acquire this knowledge (Azerkan et al., 2015; Grandahl et al., 2015). Limited Danish language proficiency may contribute to these mechanisms, especially because the screening invitations are in Danish. These notions are supported by our finding that participation was lowest among newly arrived immigrants. In addition, some immigrants may be screened in their country of origin rather than in Denmark (Jackowska et al., 2012; Nielsen et al., 2012). This may partly explain the low screening participation observed among immigrants from countries with well-established screening programs, e.g. Spain, USA, Canada, Australia and New Zealand.

Employment, higher income and marriage were associated with higher participation in immigrants, which is in line with other Scandinavian studies of immigrants (Leinonen et al., 2017; Broberg et al., 2018) and studies of the general Danish population (Harder et al., 2018a). GP and dentist contacts were strongly associated with participation, which was also seen in a study of the general Danish female population (Kristensson et al., 2014). In Denmark, screening is usually

Table 4

Predictors of screening participation among immigrants from Western and non-Western countries, invited for cervical cancer screening in Denmark during 2008–2009.

	Western immigrants (n = 12,500)				Non-Western immigrants (n = 44,829)							
	N	(% screened) ^a	Crude HR		Adjusted HR ^b		N	(% screened) ^a	Crude		Adjusted ^b	
			HR	(95% CI)	HR	(95% CI)			HR	(95% CI)	HR	(95% CI)
Sociodemographic characteristics												
<i>Employment status^c</i>												
Employed	8489	(72)	1	(ref)	1	(ref)	25,988	(66)	1	(ref)	1	(ref)
Unemployed	2810	(30)	0.32	(0.29–0.34)	0.41	(0.38–0.44)	14,626	(53)	0.73	(0.71–0.75)	0.80	(0.78–0.83)
Retired	1201	(57)	0.78	(0.72–0.85)	0.89	(0.81–0.99)	4215	(59)	0.84	(0.80–0.87)	0.90	(0.86–0.95)
<i>Annual income^c</i>												
Q1 (EUR < 18,930)	5320	(45)	1	(ref)	1	(ref)	19,158	(52)	1	(ref)	1	(ref)
Q2 (EUR 18,930–25,196)	2233	(66)	1.72	(1.62–1.84)	1.18	(1.10–1.27)	13,153	(67)	1.49	(1.45–1.54)	1.29	(1.25–1.33)
Q3 (EUR 25,196–31,429)	2170	(74)	2.04	(1.91–2.17)	1.28	(1.19–1.38)	8103	(70)	1.61	(1.55–1.66)	1.33	(1.29–1.38)
Q4 (EUR ≥ 31,248)	2777	(78)	2.21	(2.08–2.34)	1.35	(1.25–1.44)	4415	(72)	1.67	(1.60–1.74)	1.31	(1.25–1.37)
<i>Civil status^c</i>												
Married	5956	(72)	1	(ref)	1	(ref)	29,170	(68)	1	(ref)	1	(ref)
Unmarried	6544	(52)	0.59	(0.56–0.62)	0.71	(0.68–0.75)	15,659	(49)	0.61	(0.59–0.63)	0.71	(0.69–0.73)
Mental and physical health												
<i>Anxiety and adjustment disorders^d</i>												
Never	12,083	(61)	1	(ref)	1	(ref)	42,424	(61)	1	(ref)	1	(ref)
Ever	417	(61)	0.92	(0.81–1.05)	0.97	(0.85–1.10)	2405	(64)	1.04	(0.99–1.10)	1.10	(1.04–1.16)
<i>Affective disorders^d</i>												
Never	12,162	(61)	1	(ref)	1	(ref)	43,424	(61)	1	(ref)	1	(ref)
Ever	338	(65)	1.05	(0.92–1.20)	1.10	(0.96–1.26)	1405	(64)	1.04	(0.98–1.12)	1.07	(1.00–1.14)
<i>Schizophrenia and other psychoses^d</i>												
Never	12,382	(61)	1	(ref)	1	(ref)	44,131	(62)	1	(ref)	1	(ref)
Ever	118	(38)	0.48	(0.36–0.65)	0.55	(0.40–0.74)	698	(49)	0.68	(0.61–0.76)	0.73	(0.66–0.82)
<i>Alcohol and intoxicant abuse^d</i>												
Never	12,363	(61)	1	(ref)	1	(ref)	44,696	(61)	1	(ref)	1	(ref)
Ever	137	(50)	0.71	(0.56–0.90)	0.87	(0.69–1.11)	133	(48)	0.67	(0.52–0.86)	0.79	(0.62–1.01)
<i>Parity^d</i>												
0	9195	(56)	1	(ref)	1	(ref)	24,840	(56)	1	(ref)	1	(ref)
1	1737	(73)	1.49	(1.40–1.58)	1.30	(1.21–1.39)	9958	(69)	1.41	(1.37–1.45)	1.21	(1.18–1.25)
2–3	1525	(80)	1.69	(1.58–1.79)	1.37	(1.27–1.47)	9231	(67)	1.30	(1.26–1.34)	1.16	(1.12–1.20)
≥ 4	43	(73)	1.46	(1.02–2.07)	1.39	(0.97–1.98)	800	(47)	0.76	(0.68–0.84)	0.71	(0.63–0.78)
<i>Charlson's Comorbidity Index^d</i>												
0	11,317	(61)	1	(ref)	1	(ref)	39,559	(61)	1	(ref)	1	(ref)
≥ 1	1183	(63)	1.07	(0.99–1.15)	1.00	(0.92–1.08)	5270	(64)	1.04	(1.00–1.07)	1.01	(0.98–1.05)
<i>GP contacts^e</i>												
None	2905	(29)	1	(ref)	1	(ref)	6094	(34)	1	(ref)	1	(ref)
≥ 1	9595	(71)	3.23	(3.00–3.47)	2.35	(2.18–2.53)	38,735	(66)	2.42	(2.32–2.54)	2.14	(2.04–2.24)
<i>Dentist contacts^e</i>												
None	6126	(45)	1	(ref)	1	(ref)	27,524	(55)	1	(ref)	1	(ref)
≥ 1	6374	(77)	2.42	(2.31–2.54)	1.87	(1.78–1.97)	17,305	(71)	1.55	(1.51–1.59)	1.42	(1.39–1.46)
Immigration-related characteristics												
<i>Years since first immigration^c</i>												
1–5	3178	(41)	1	(ref)	1	(ref)	5567	(44)	1	(ref)	1	(ref)
5–10	1968	(62)	1.70	(1.57–1.84)	1.30	(1.19–1.41)	9872	(60)	1.54	(1.47–1.62)	1.28	(1.22–1.34)
10–20	2987	(71)	2.09	(1.95–2.24)	1.43	(1.31–1.55)	18,867	(64)	1.66	(1.59–1.73)	1.29	(1.23–1.35)
20–30	1797	(71)	2.11	(1.95–2.28)	1.41	(1.28–1.54)	7231	(66)	1.73	(1.65–1.82)	1.32	(1.25–1.38)
≥ 30	971	(69)	2.04	(1.86–2.24)	1.46	(1.30–1.63)	1922	(64)	1.61	(1.50–1.72)	1.19	(1.11–1.28)
Missing	1599	(66)	2.10	(1.94–2.28)	1.58	(1.42–1.77)	1370	(64)	1.64	(1.52–1.78)	1.36	(1.25–1.47)
<i>Number of re-immigrations^c</i>												
0	7414	(60)	1	(ref)	1	(ref)	38,156	(62)	1	(ref)	1	(ref)
1	2834	(63)	1.03	(0.98–1.09)	1.06	(1.01–1.13)	4603	(53)	0.75	(0.71–0.78)	0.85	(0.81–0.89)
≥ 2	653	(62)	0.97	(0.88–1.08)	0.97	(0.87–1.08)	700	(49)	0.69	(0.62–0.77)	0.79	(0.71–0.89)
Missing	1599	(66)	1.27	(1.19–1.36)	1.15	(1.06–1.25)	1370	(64)	1.02	(0.96–1.10)	1.05	(0.98–1.12)

CI: confidence interval; GP: general practitioner; HR: hazard ratio.

^a Estimated with the Aalen-Johansen estimator.^b Adjusted for age, employment status, income and civil status.^c Measured at the time of screening invitation.^d Measured as ever/never at the time of screening invitation.^e Measured during the year before screening invitation.

performed by the GP. For immigrants, registration with a GP occurs automatically when he/she registers a Danish residence address in the Civil Registration System. However, it is the woman's own responsibility to book an appointment when she receives the screening invitation. Familiarity with the GP is thus likely to facilitate participation.

The association between dentist contacts and screening participation may reflect propensity for preventive health behavior and ability to navigate in the health care system, but also socioeconomic position, since dental services require a co-payment in Denmark. When we adjusted for socio-economic characteristics, the association between

dental services and screening participation was attenuated but did not disappear, indicating that socioeconomic was not the sole explanation.

Diagnoses of schizophrenia or other psychoses were associated with lower participation. No previous Scandinavian register studies have examined this association in immigrants, but a Danish study found similar results in the general female population (Harder et al., 2018a). This may reflect considerable barriers to adequate health care behavior in women with severe mental illness, whether immigrant or Danish-born.

Women who recently immigrated to Denmark had substantially lower participation than those who immigrated > 5 years before invitation. This may reflect that longer duration of residence entails growing understanding of the health care system, less immigration-related stress, or better Danish language proficiency. Furthermore, earlier immigrants in our study have most likely received more screening invitations than later immigrants, because earlier immigrants have resided in Denmark during more screening rounds. A higher number of life-time invitations could increase the likelihood of participation.

This study has several strengths. Using comprehensive Danish registers we included all women invited for cervical cancer screening during 2008–2009, thus eliminating selection bias. Furthermore, since all cervical cytologies are registered in the Pathology Databank, we ensured complete follow-up of screenings performed in Denmark, thus eliminating information bias associated with self-reported outcomes. This bias was also avoided with respect to covariates, since they were obtained through individual linkages to registries with high coverage and validity.

However, the study also has limitations. First, we did not have information on the legal basis for the immigrants' residence permit, e.g. refugee status, family reunification, or study-/work visa. Different types of residence permit may entail different resources and motivation for integration into the Danish society and different expectations for duration of stay, which may in turn influence screening participation. Furthermore, previous studies found that provider-level characteristics such as sex of and distance to the GP can influence participation (Leinonen et al., 2017; Møen et al., 2017), but such information was not available for this study. A further potential limitation is that immigrants were more likely than Danish-born women to emigrate during follow-up. For immigrants from countries with established screening programs, we may have underestimated the screening rate if the women postponed screening until returning to their country of origin. Finally, covariates measured as ever-never may be underestimated in immigrants if the event happened before immigration to Denmark. However, sensitivity analyses restricted to immigrants aged < 20 years at immigration did not yield significantly different results.

In conclusion, despite free and universal access to health care in Denmark, immigrants had lower participation in cervical cancer screening than Danish-born women, and this was not explained by socio-demographic or health-related characteristics. Although participation varied greatly by country and region of origin, our findings indicate that immigrants experience specific barriers to screening participation. The study highlights the challenges of providing health care in a globalized world with an increasingly mobile population. Efforts to increase screening participation in immigrants should be initiated, and potential strategies may include translating the invitation letter to multiple languages (Danish National Board of Health, 2018); developing culturally sensitive and tailored educational interventions (Rees et al., 2018); using personal telephone reminders (Eaker et al., 2004); offering screening in mobile clinics or without a pre-booked consultation (Danish National Board of Health, 2018); and/or offering human papillomavirus self-sampling (Harder et al., 2018b; Tranberg et al., 2018). Future studies should explore the effect of such interventions in different immigrant groups.

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References

- Abdullahi, A., Copping, J., Kessel, A., Luck, M., et al., 2009. Cervical screening: Perceptions and barriers to uptake among Somali women in Camden. *Public Health* 123, 680–685.
- Andersen, J.S., Olivarius, NdF, Krasnik, A., 2011. The Danish National Health Service Register. *Scand J Public Health* 39 (7 Suppl), 34–37.
- Andersen, P.K., Geskus, R.B., de Witte, T., Putter, H., 2012. Competing risks in epidemiology: possibilities and pitfalls. *Int. J. Epidemiol.* 41, 861–870.
- Azerkan, F., Sparén, P., Sandin, S., Tillgren, P., et al., 2012. Cervical screening participation and risk among Swedish-born and immigrant women in Sweden. *Int. J. Cancer* 130, 937–947.
- Azerkan, F., Widmark, C., Sparén, P., Weiderpass, E., et al., 2015. When life got in the way: how Danish and Norwegian immigrant women in Sweden reason about cervical screening and why they postpone attendance. *PLoS One* 10, e0107624.
- Broberg, G., Wang, J., Östberg, A.L., Adolfsson, A., et al., 2018. Socio-economic and demographic determinants affecting participation in the Swedish cervical screening program: a population-based case-control study. *PLoS One* 13, e0190171.
- Charlson, M.E., Pompei, P., Ales, K., MacKenzie, R., 1987. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J. Chronic Dis.* 40, 373–383.
- Danish Act on the Central Person Register. Law number 646 of 2 June 2017. Available at: <https://www.retsinformation.dk/Forms/r0710.aspx?id=191719>, accessed 16 Jan 2019.
- Danish Health Act. Law number 1286 of 2 November 2018. Available at: <https://www.retsinformation.dk/forms/R0710.aspx?id=203757>, accessed 16 Jan 2019.
- Danish National Board of Health, 2012. Screening against cervical cancer – recommendations [in Danish]. Danish National Board of Health, Copenhagen.
- Danish National Board of Health, 2018. Screening for cervical cancer – recommendations [in Danish]. Danish National Board of Health, Copenhagen.
- Eaker, S., Adami, H.O., Granath, F., Wilander, E., 2004. Sparen P. A large population-based randomized controlled trial to increase attendance at screening for cervical cancer. *Cancer Epidemiol. Biomark. Prev.* 13, 346–354.
- Erichsen, R., Lash, T.L., Hamilton-Dutoit, S.J., Bjerregaard, B., et al., 2010. Existing data sources for clinical epidemiology: the Danish National Pathology Registry and Data Bank. *Clin Epidemiol* 2, 51–56.
- Fernández de Casadevante, V., Gil Cuesta, J., Cantarero-Arévalo, L., 2015. Determinants in the uptake of the human papillomavirus vaccine: a systematic review based on European studies. *Front. Oncol.* 5, 141.
- Frederiksen, B.L., Jørgensen, T., Brasso, K., Holten, I., et al., 2010. Socioeconomic position and participation in colorectal cancer screening. *Br. J. Cancer* 103, 1496–1501.
- Grandahl, M., Tydén, T., Gottval, M., Westerling, R., et al., 2015. Immigrant women's experiences and views on the prevention of cervical cancer: a qualitative study. *Health Expect.* 18, 344–354.
- Harder, E., Juul, K.E., Jensen, S.M., Thomsen, L.T., et al., 2018a. Factors associated with non-participation in cervical cancer screening – a nationwide study of nearly half a million women in Denmark. *Prev. Med.* 111, 94–100.
- Harder, E., Thomsen, L.T., Hertzum-Larsen, R., Albieri, A., et al., 2018b. Determinants for participation in human papillomavirus self-sampling among non-attenders to cervical cancer screening in Denmark. *Cancer Epidemiol. Biomark. Prev.* 27, 1342–1351.
- Idehen, E.E., Korhonen, T., Castaneda, A., Juntunen, T., et al., 2017. Factors associated with cervical cancer screening participation among immigrants of Russian, Somali and Kurdish origin: a population-based study in Finland. *BMC Womens Health* 17, 19.
- Jackowska, M., von Wagner, C., Wardle, J., Juszczak, D., et al., 2012. Cervical screening among migrant women: a qualitative study of Polish, Slovak and Romanian women in London, UK. *J Fam Plan Reprod Health Care* 38, 229–238.
- Jensen, L.F., Pedersen, A.F., Andersen, B., Vedsted, P., 2012. Identifying specific non-attending groups in breast cancer screening – population-based registry study of participation and socio-demography. *BMC Cancer* 12, 518.
- Jervelund, S.S., Malik, S., Ahlmark, N., Villadsen, S.F., et al., 2017. Morbidity, self-perceived health and mortality among non-western immigrants and their descendants in Denmark in a life phase perspective. *J. Immigr. Minor. Health* 19, 448–476.
- Knudsen, L.B., Olsen, J., 1998. The Danish Medical Birth Registry. *Dan. Med. Bull.* 45, 320–323.
- Kristensson, J.H., Sander, B.B., von Euler-Chelpin, M., Lyngé, E., 2014. Predictors of non-participation in cervical screening in Denmark. *Cancer Epidemiol.* 38, 174–180.
- Kristiansen, M., Thorsted, B.L., Krasnik, A., von Euler-Chelpin, M., 2012. Participation in mammography screening among migrants and non-migrants in Denmark. *Acta Oncol.* 51, 28–36.
- Leinonen, M.K., Campbel, S., Ursin, G., Tropé, A., et al., 2017. Barriers to cervical cancer screening faced by immigrants: a registry-based study of 1.4 million women in Norway. *Eur. J. Pub. Health* 27, 873–879.
- Lyngé, E., Sandegaard, J.L., Rebolj, M., 2011. The Danish National Patient Register. *Scand J Public Health* 39 (7 Suppl), 30–33.
- Marlow, L.A.V., Waller, J., Wardle, J., 2015a. Barriers to cervical cancer screening among ethnic minority women: a qualitative study. *J Fam Plann Reprod Health Care* 41, 248–254.
- Marlow, L.A., Wardle, J., Waller, J., 2015b. Understanding cervical screening non-attendance among ethnic minority women in England. *Br. J. Cancer* 113, 833–839.

- Møen, K.A., Kumar, B., Qureshi, S., Diaz, E., 2017. Differences in cervical cancer screening between immigrants and nonimmigrants in Norway: a primary healthcare register-based study. *Eur. J. Cancer Prev.* 26, 521–527.
- Mors, O., Perto, G.P., Mortensen, P.B., 2011. The Danish Psychiatric Central Research Register. *Scand J Public Health* 39 (7 Suppl), 54–57.
- Nielsen, S.S., Yazici, S., Petersen, S.G., Blaakilde, A.L., et al., 2012. Use of cross-border healthcare services among ethnic Danes, Turkish immigrants and Turkish descendants in Denmark: a combined survey and registry study. *BMC Health Serv. Res.* 12, 390.
- Olejaz, M., Juul Nielsen, A., Rudkjøbing, A., Okkels Birk, H., et al., 2012. Denmark: Health System Review. *Health Systems in Transition* 14, 1–192.
- Pedersen, C.B., 2011. The Danish civil registration system. *Scand J Public Health* 39 (7 Suppl), 22–25.
- R Development Core Team, R Software. R: A Language and Environment for Statistical Computing. 2017.
- Rees, I., Jones, D., Chen, H., Macleod, U., 2018. Interventions to improve the uptake of cervical cancer screening among lower socioeconomic groups: a systematic review. *Prev. Med.* 111, 323–335.
- Rondet, C., Lapostolle, A., Soler, M., Grillo, F., et al., 2014. Are immigrants and nationals born to immigrants at higher risk for delayed or no lifetime breast and cervical cancer screening? The results from a population-based survey in Paris metropolitan area in 2010. *PLoS One* 9, e87046.
- Statistics Denmark, 2018a. StatBank Denmark [online resource]. Available from: <https://www.statistikbanken.dk>, Accessed date: 23 February 2018.
- Statistics Denmark. Immigrants in Denmark 2018b [in Danish]. Copenhagen: Statistics Denmark, 2018.
- Thygesen, L.C., Daasnes, C., Thaulow, I., Brønnum-Hansen, H., 2011. Introduction to Danish (nationwide) registers on health and social issues: structure, access, legislation, and archiving. *Scand J Public Health* 39 (7 Suppl), 12–16.
- Tranberg, M., Bech, B.H., Blaakjær, J., Jensen, J.S., et al., 2018. HPV self-sampling in cervical cancer screening: the effect of different invitation strategies in various socioeconomic groups – a randomized controlled trial. *Clin Epidemiol* 10, 1027–1036.