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ORIGINAL ARTICLE

Diagnoses of infectious diseases among Norwegian-born children to immigrant parents – the role of parental socioeconomic position

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Abstract

Aims: Children of immigrants have a higher incidence of infectious disease than native children. Our aim was to assess the role of parental socioeconomic position for diagnoses of infectious disease among children of immigrants. *Methods:* Data from the Norwegian Patient Registry (on diagnoses from secondary/tertiary care), Medical Birth Registry of Norway, and Statistics Norway were linked by the national personal identification number. Seven diagnostic infection categories were included from 2008 onwards. The study population included children born in Norway aged 0–10 years between 2008 and 2018 (N = 988,647). Hazards of infection diagnoses by parental region of origin (adjusted for sex, birth year, parental education, household income and mother's parity) and by parental education and household income were assessed by Cox regression. *Results:* High parental education was associated with lower hazard of infection diagnoses among children of Norwegian-born parents, but associations were less consistent among children with immigrant parents. Lower household income was related to hazard of most infectious diagnoses among children with both Norwegian-born and immigrant parents. Assessed by region diagnoses of viral and bacterial infections and infections of the musculoskeletal system and soft tissue were not associated with household income. Parental education and household income did not explain differences in hazard of infection diagnoses between children born to immigrant versus Norwegian-born parents. ***Conclusions:* Socioeconomic disadvantage did not explain differences in hazard of being diagnosed with infectious disease in secondary/tertiary care between children with immigrant versus Norwegian-born parents.**

Keywords: *Infection, immigrant, children, socioeconomic position, Norway*

Introduction

Migrants may be more exposed to infectious diseases than the general population, before, during and after migration [1]. Rates and risk of various infections vary with country of origin [1] and with factors in the host country such as living conditions, including many household members and crowded or poor housing [2]. Studies suggest that children coming to Europe as immigrants from other regions are at higher risk of some types of infections [3–6] than native children. The risk decreased with the time spent in the host county [5, 6], but was positively associated with frequency of visits to the children`s country of origin [4].

Children born in the host county to immigrant parents are a growing group in Norway/Europe and there is so far, limited knowledge about their health [7]. While they do not themselves have a migration experience, they do share environmental circumstances with their parents, such as living conditions and family ties to country of origin, with possible visits to and from this country. Moreover, parental

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proficiency in the host language, health literacy and knowledge about the host country's healthcare system will influence the health of these children. An Italian study found higher rates of avoidable hospitalizations due to gastroenteritis, bacterial pneumonia and upper respiratory tract infections among children of parents from high-migration-pressure countries compared to children with an Italian background, suggesting barriers to access to using primary healthcare for such conditions [8]. In Europe, children with immigrant parents are overrepresented in families with low income and with low parental education. Children living in socially disadvantaged circumstances have higher risk of various poor health outcomes, including infectious diseases [2, 9, 10]. All these factors vary considerably with parental region of origin and proximity to host culture both geographically, economically and culturally. The association between parental socioeconomic position (SEP) and children's health has been shown to vary with region of origin [9]. There is a paucity of evidence about the prevalence of, risk factors for and treatment of infections among children born in the host country to immigrant parents.

A Norwegian study points towards the importance of factors in the host country [11]. It showed that the risk of respiratory tract infection diagnosis from primary healthcare was higher among native children in Norway than among children who themselves had migrated to Norway, but lower than among children born in Norway to immigrant parents [11]. During the COVID-19 pandemic, immigrant groups have experienced a disproportionate burden of disease, in Norway [12], as in other European countries [13]. Proposed reasons for this include differences in exposure, susceptibility and healthcare. Related to exposure, patterns of socializing and travel, SEP and housing conditions [14] are among the factors suggested. However, disadvantaged SEP has not fully explained differences in incidence or in hospitalization between immigrants and non-immigrants [2, 15].

In a study on somatic disease diagnoses in secondary/tertiary healthcare among children born in Norway with different immigrant backgrounds, we have previously shown higher hazards of infectious diseases diagnoses, including intestinal infections, tuberculosis, viral infections, fungal and parasitic infections and skin infections, among children born in Norway to immigrant parents compared to children with a Norwegian background [16]. In the current article we aim to assess whether household income and parental education is associated with infectious disease diagnoses by parental region of origin, and whether parental education and household income can explain previously described differences in hazard of infectious disease diagnoses by region of origin. Knowledge about whether SEP is of importance to differences in hazard of being diagnosed with infections between children with and without immigrant parents is important for planning preventive and health-promoting measures. We hypothesize that household income is related to living conditions of importance to risk of infection, such as standard of housing and household crowding, and possibly to outdoor environments and the state of the neighbourhood. Further, educational level of the parents could influence health literacy, including awareness of disease and symptoms, knowledge about how to prevent infections and what to do if falling ill, and knowledge about the host country's healthcare system.

Methods

Study population

Leveraging the Norwegian Patient Register (NPR), we include infection diagnoses given in secondary and tertiary healthcare from 2008 (start of the NPR) to 2018. Secondary and tertiary care refers to specialist treatment, almost always requires referral from primary healthcare and includes both inpatient and outpatient care. The study population included children who were born in Norway and who were 0–10 years of age between 2008 and 2018 (i.e. children born between 1998 and 2017). Data from the Medical Birth Registry of Norway (MBRN) and the NPR were linked by the national personal identification number and also to data from Statistics Norway on immigrant background, parental country of origin, parental education, household income and mother's parity. We excluded children who had one immigrant parent and one Norwegian-born parent (N = 142,332), children who were registered as emigrated (data on emigration year were not available) (N = 23,744), children who were registered as stillborn (N = 9010) or late abortions (N = 4520), children who died prior to 2008 (N = 2176), children without information on immigrant background (N = 867), as well as those without any information on parental education (N =15,106; 1.5%) and/or on household income (N = 11,513; 1.2%), leaving a sample of 988,647 children for the analysis. The proportion with missing information on education was lowest among Norwegian-born parents (0.2%), highest among parents from EU/EEA/USA/Canada (19.6%) and between 5.6% and 7.2% among parents from other regions. The proportion with missing values for household income was lowest among those with Norwegian background (0.8%), highest among children with parents born in Africa (10.3%) and between 6.2 and 7.8% among children with parents from other regions.

Variables

We included seven diagnostic categories of infections: intestinal infectious diseases, viral infections, bacterial infections, influenza and other acute lower respiratory tract infections, infections of the skin and subcutaneous tissue, urinary tract infections and infections of the musculoskeletal system and soft tissue. Children who had a specific infection diagnosis at least once during the specified age and time frame were classified as having the respective diagnosis. Categories of infectious diseases corresponded to our previous article [16], but we did not include separate categories for four diagnostic categories with a low number of cases; tuberculosis, infections of the central nervous system, fungal and parasitic infections and genital infections (all with $N < 3500$). All 11 categories of infection diagnoses are included in the variable total infections. See Supplementary Table I for included ICD-10 codes.

Among children born in Norway to immigrant parents, region of origin was classified according to national standards [17], by parents' country of birth (if different; mother's); "EU/European Economic Area (EEA), Oceania, United States of America (USA) and Canada", "Europe outside the EU/EEA", "Asia", "Africa" and "Latin America". Children born to two Norwegian-born parents were referred to as having a "Norwegian background".

Parental education was recorded as highest attained education in year 2018 by either parent, and categorized into "primary school", "upper secondary school", "university/university college, lower" and "university/university college, higher". Household income was recorded as yearly household income (including social benefits, in NOK) after tax, divided by number of consumptions units (EU-scale) in the household, and included in analyses as a time-varying covariate. Tertiles of household income were made based on average over time. Mother's parity was included in regressions as a proxy for family size and household crowding. Information on parity was from MBRN and indicates number of births before the index child; "0", "1", "2", "3", "4" and "⩾5".

Analyses

In Cox proportional hazard regressions, associations between parental education and infection diagnoses and between household income (in tertiles) and infection diagnoses were assessed by Cox regressions within each region of origin, adjusted for sex and year of birth. Further, the importance of parental education and household income for differences in infectious diagnoses were assessed by calculating hazard ratio (HR) with 95% confidence intervals for each diagnosis for each region of origin compared to children of Norwegian background, adjusted for sex and year of birth and additionally for parental education, household income and parity. As maternal education may be more important than paternal education for children's health, sensitivity analyses were performed where we included maternal education instead of highest parental education. Each participant was followed from 2008 or year of birth (if later than 2008) until year of diagnosis, year of death, year of reaching 10 years of age (if earlier than 2018), or until the end of 2018. Analyses were performed in STATA 16.

Results

The largest proportion of children with high household income was found among children with Norwegian background (Table I). Parental education levels varied between groups. The lowest proportion of parents with primary education only was among Norwegian-born parents and highest among parents from Africa and Asia. The largest proportion with highest educational level was among parents from EU, EEA, Oceania, USA and Canada (Table I). The proportion of mothers with three or more children older than the index child was highest among mothers from Africa (Table I). Of the immigrant mothers, 2.5 % had immigrated to Norway before the age of 18.

Associations between parental education and infectious disease diagnoses by immigrant background

Higher parental education was associated with lower hazard of most infection diagnoses among children with Norwegian background (Table II). The exceptions were higher hazards of diagnoses of infections of the musculoskeletal system and soft tissue and of the skin and subcutaneous tissues among those with high parental education (Table II). The associations between infection diagnoses and parental education were less consistent among children with immigrant background. In the analyses that included all children with immigrant parents, there was an educational gradient for diagnoses of infections in total (HR highest versus lowest group 0.79 (CI 0.76, 0.83), p for trend <0.001), influenza and other lower respiratory infections (HR 0.76 (0.70. 0.83), p for trend <0.001), infections in the intestines (0.70 (0.64, 0.76), p for trend <0.001), skin and subcutaneous tissue (0.75 (0.66, 0.84), p for trend <0.001), and musculoskeletal system and soft tissue (1.37 (1.07, 1.75), p for trend 0.021) (Table II). Among children with background from EU, EEA, Oceania,

Table I. Characteristics of the sample; Norwegian-born children aged 0–10 years between 2008 and 2018.

	Norwegian background (N=870 653)	Children of immigrants, total (N=117 994)	EU, EEA, Oceania, USA, Canada (N=25 420)	Europe, except EU, EEA (N=14 432)	Asia (N=50 287)	Africa (N=26 025)	Latin America (N=1 830)
Household income, tertiles (%)							
Low	28.7	67.5	44.3	61.1	71.5	86.6	58.3
Middle	35.1	20.4	31.8	24.7	18.4	10.5	23.8
High	36.2	12.1	23.9	14.2	10.1	2.9	17.9
Parental education (%)							
Primary	4.9	27.4	8.9	18.1	31.0	44.5	16.8
Upper Secondary	33.0	29.5	25.7	37.3	30.2	27.3	31.2
Higher, low	42.1	25.0	30.2	25.8	25.1	19.3	26.0
Higher, high	19.9	18.1	35.2	18.8	13.7	8.8	26.0
Mother`s parity (%)							
0	41.5	37.7	48.2	39.5	35.9	29.8	41.6
$\geqslant$3	5.6	13.1	3.6	9.5	12.2	23.8	8.5
Diagnosis of infectious disease (%)							
Infections total	114 102 (13.1)	19 907 (16.9)	4089 (12.5)	2460 (15.3)	9040 (16.2)	6551 (21.4)	321 (15.3)
Intestinal infectious diseases	26 687 (3.1)	5713 (4.8)	826 (3.2)	657 (4.6)	2436 (4.8)	1720 (6.6)	80 (4.4)
Viral infections	28 320 (3.3)	4544 (3.9)	833 (3.3)	563 (3.9)	2033 (4.0)	1030 (4.0)	85 (4.6)
Bacterial infections and sexually transmitted diseases	9165 (1.1)	1318 (1.1)	292 (1.2)	170 (1.2)	511 (1.0)	328 (1.3)	17 (0.9)
Influenza and other acute lower respiratory tract infectons	45 514 (5.2)	6787 (5.8)	1049 (4.1)	724 (5.0)	2852 (5.7)	2072 (8.0)	90 (4.2)
Infections of the skin and subcutaneous tissue	12 519 (1.4)	3320 (2.8)	544 (2.1)	327 (2.3)	1491 (3.0)	910 (3.5)	48 (2.6)
Urinary tract infection	8013 (0.9)	1289 (1.1)	286 (1.1)	208 (1.4)	570 (1.1)	208 (0.8)	17 (0.9)
Infections of the musculoskeletal system and soft tissue	5256 (0.6)	603 (0.5)	142 (0.6)	83 (0.6)	233 (0.5)	137 (0.5)	8 (0.4)

USA and Canada there was a positive association between parental education and viral infection diagnoses (p = 0.006). The same was true for viral infections (p = 0.030) and infections of the musculoskeletal system and soft tissue (p = 0.020) among the children with background from Asia. Among children with background from Europe outside EU/EEA there was an inverse association between parental education and intestinal infections (p = 0.007). Among children with parents from Africa and Latin America there was an inverse association for infections in total (p = 0.022/p = 0.048), and for intestinal infectious diseases among children with background from Africa ($p < 0.001$).

Associations between household income and infectious disease diagnoses by immigrant background

Higher household income was associated with lower hazard of diagnoses of intestinal infectious diseases (HR highest versus lowest income tertile 0.52 (0.50, 0.54)), viral infections (0.70 (0.67, 0.72)), bacterial infections (0.63 (0.59, 0.67)), influenza and other lower respiratory tract infections (0.52 (0.51, 0.54)), infections of the skin and subcutaneous tissue (0.79 (0.75, 0.83)), urinary tract infections (0.59 (0.55, 0.63)) and infections of the musculoskeletal system and soft tissue (0.77 (0.71, 0.83)) among children with Norwegian background (p for trend all >0.001) (Table III). In the total group of children of immigrants, the associations between income and infection diagnoses mostly followed the same pattern as for children with Norwegian background (Table III), but with higher hazards of diagnoses of infections in the musculoskeletal system and soft tissue associated with higher household income (p for trend 0.017) (Table III). Assessed by region of origin, hazard of diagnoses of viral and bacterial infections and infections in the musculoskeletal system and soft tissue were not associated with household income, except for a negative association for bacterial infections among children with African background. Diagnoses of other infections were generally associated with lower household income, but with no association for intestinal infections for children with parents from Europe except EU and Latin America, for influenza and other lower respiratory tract infections among children with background from Latin America and for infections of the skin and subcutaneous tissue among children with parents from Africa (Table III).

Importance of parental education and household income for differences in diagnoses by immigrant background

Compared to children with Norwegian background, the sex and year of birth adjusted model indicated that children of immigrants in total had higher hazards of diagnoses of infections in total (HR 1.14; 1.12, 1.16),

Table II. Hazard ratio (95 % confidence interval) of diagnosis of infectious disease given in secondary/tertiary health care between 2008 and 2018 among children aged 0–10 years by parental education and according to parental region of origin. From Cox regressions, adjusted for sex and year of birth. Reference category: Primary school.

	Norwegian background	Norwegian-born to immigrant parents, total	EU, EEA, USA, Canada, Oceania	Europe except EU/EEA	Asia	Africa	Latin America
Education							
Infections total							
Upper Secondary	0.90 (0.88, 0.93)	0.88 (0.85, 0.91)	1.02 (0.88, 1.19)	0.91 (0.80, 1.04)	0.97 (0.91, 1.03)	0.94 (0.88, 1.02)	0.88 (0.61, 1.27)
Higher, low	0.82 (0.81, 0.87)	0.89 (0.85, 0.93)	0.97 (0.84, 1.13)	1.04 (0.91, 1.20)	1.05 (0.98, 1.12)	0.94 (0.86, 1.02)	0.82 (0.56, 1.21)
Higher, high	0.83 (0.80, 0.85)	0.79 (0.76, 0.83)	1.03 (0.89, 1.19)	0.82 (0.70 0.93)	0.96 (0.89, 1.04)	0.90 (0.80, 1.00)	0.67 (0.45, 1.00)
P for trend	<0.001	<0.001	0.764	0.115	0.916	0.022	0.048
Intestinal infectious diseases							
Upper Secondary	0.85 (0.80, 0.90)	0.81 (0.75, 0.87)	0.94 (0.70, 1.27)	0.99 (0.78, 1.25)	0.90 (0.80, 1.02)	0.87 (0.76, 0.98)	0.83 (0.42, 1.66)
Higher, low	0.72 (0.68, 076)	0.83 (0.77, 0.89)	0.99 (0.74, 1.32)	0.99 (0.77, 1.27)	0.99 (0.88, 1.12)	0.89 (0.77, 1.02)	0.74 (0.36, 1.53)
Higher, high	0.69 (0.65, 0.73)	0.70 (0.64, 0.76)	0.99 (0.74, 1.31)	0.64 (0.48, 0.86)	0.93 (0.80, 1.07)	0.82 (0.67, 1.00)	0.58 (0.27, 1.25)
P for trend	<0.001	<0.001	0.813	0.007	0.538	<0.001	0.153
Viral infections							
Upper secondary	0.87 (0.82, 0.92)	0.93 (0.85 1.01)	1.02 (0.75, 1.40)	1.09 (0.83, 1.42)	0.95 (0.84, 1.07)	0.95 (0.80, 1.12)	0.73 (0.38, 1.42)
Higher, low	0.82 (0.77, 0.86)	1.05 (0.96, 1.15)	1.16 (0.85, 1.57)	1.23 (0.93, 1.63)	1.13 (1.00, 1.28)	1.00 (0.83, 1.20)	0.76 (0.38, 1.50)
Higher, high	0.81 (0.76, 0.86)	1.04 (0.95, 1.15)	1.31 (0.97, 1.77)	1.13 (0.83, 1.54)	1.11 (0.95, 1.29)	0.99 (0.77, 1.27)	0.79 (0.39, 1.60)
P for trend	<0.001	0.105	0.006	0.264	0.030	0.934	0.617
Bacterial infections and sexually transmitted diseases							
Upper secondary	0.82 (0.74, 0.91)	0.93 (0.78, 1.10)	1.12 (0.64, 1.96)	0.82 (0.49, 1.40)	1.00 (0.76, 1.31)	0.87 (0.64, 1.19)	-
Higher, low	0.79 (0.71, 0.87)	1.03 (0.86, 1.22)	1.05 (0.60, 1.82)	1.18 (0.71, 1.99)	1.17 (0.89, 1.53)	0.97 (0.70. 1.37)	-
Higher, high	0.72 (0.75, 0.80)	0.94 (0.78, 1.14)	1.18 (0.69, 2.03)	0.99 (0.56, 1.76)	0.94 (0.67, 1.32)	0.87 (0.54, 1.41)	-
P for trend	<0.001	0.862	0.580	0.576	0.773	0.608	-
Influenza and other acute lower respiratory tract infections							
Upper secondary	0.88 (0.84, 0.92)	0.89 (0.83 0.96)	1.14 (0.88, 1.48)	0.80 (0.63, 1.01)	1.07 (0.96, 1.20)	0.97 (0.86, 1.10)	0.61 (0.31, 1.19)
Higher, low	0.81 (0.77, 0.85)	0.93 (0.86, 1.00)	0.98 (0.75, 1.27)	1.00 (0.79, 1.27)	1.20 (1.07, 1.34)	1.03 (0.90, 1.18)	0.82 (0.34, 1.53)
Higher, high	0.77 (0.74 0.81)	0.76 (0.70. 0.83)	1.07 (0.83, 1.38)	0.68 (0.51, 0.8\9)	0.98 (0.86, 1.13)	0.99 (0.83, 1.19)	0.60 (0.32, 1.14)
P for trend	<0.001	<0.001	0.858	0.068	0.267	0.879	0.243
Infections of the skin and subcutaneous tissue							
Upper secondary	0.97 (0.88, 1.07)	0.93 (0.84, 1.03)	1.08 (0.75, 1.56)	0.72 (0.51, 1.00)	1.00 (0.87, 1.17)	1.109(0.92, 1.29)	-
Higher, low	0.99 (0.90, 1.09)	0.89 (0.80, 0.98)	1.03 (0.72, 1.47)	0.83 (0.59, 1.18)	1.03 (0.88, 1.19)	0.94 (0.77, 1.15)	-
Higher, high	1.16 (1.05, 1.27)	0.75 (0.66, 0.84)	0.87 (0.62, 1.27)	1.0 (0.69, 1.44)	0.84 (0.69, 1.03)	0.92 (0.70, 1.21)	-
P for trend	<0.001	<0.001	0.173	0.682	0.262	0.492	-
Urinary tract infections							
Upper secondary	0.82 (0.77, 0.97)	1.10 (0.92, 1.31)	0.98 (0.58, 1.67)	1.50 (0.91, 2.47)	0.99 (0.76, 1.27)	0.77 (0.50, 1.20)	-
Higher, low	0.83 (0.74, 0.93)	1.12 (0.93, 1.34)	1.00 (0.59 1.69)	1.54 (0.92, 2.58)	0.94 (0.72, 1.23)	1.06 (0.68, 1.65)	-
Higher, high	0.78 (0.69, 0.88)	0.90 (0.72, 1.11)	0.88 (0.52, 1.48)	0.75 (0.48, 1.42)	0.83 (0.59, 1.16)	0.79 (0.41, 1.54)	-
P for trend	<0.001	0.582	0.523	0.448	0.553	0.708d	-
Infections of the musculoskeletal system and soft tissue							
Upper secondary	1.10 (0.95, 1.27)	1.16 (0.92, 1.46)	1.30 (0.63, 2.70)	1.45 (0.71, 3.00)	1.18 (0.82, 1.70)	1.05 (0.69, 1.60)	-
Higher, low	1.18 (1.02, 1.36)	1.15 (0.91, 1.46)	1.06 (0.51, 2.21)	1.58 (0.75, 3.34)	1.27 (0.87, 1.83)	1.02 (0.64, 1.63)	-
Higher, high	1.29 (1.02 1.38)	1.37 (1.07, 1.75)	1.44 (0.71, 2.93)	1.74 (0.81, 3.76)	1.64 (1.10, 1.47)	0.79 (0.39, 1.60)	-
P for trend	0.006	0.021	0.360	0.170	0.020	0.706	-

Cells with fewer than five cases not shown.

Educational categories: Higher, low: university/university college, lower, Higher, high: university/university college, higher.

Table III. Hazard ratio (95 % confidence interval) of diagnosis of infectious disease given in secondary/tertiary healthcare between 2008 and 2018 among children aged 0–10 years by tertiles of household income and according to parental region of origin. From Cox regressions, adjusted for sex and year of birth. Reference category: lowest tertile of household income.

	Norwegian background	Norwegian-born to immigrant parents, total	EU, EEA, USA, Canada, Oceania	Europe except EU/EEA	Asia	Africa	Latin America
Infections total							
Middle tertile	0.75 (0.74,0.77)	0.75 (0.72, 0.78)	0.85 (0.70, 0.93)	0.88 (0.79, 0.99)	0.82 (0.77, 0.88)	0.76 (0.68, 0.84)	0.82 (0.59, 1.12)
Highest tertile	0.59 (0.58, 0.60)	0.60 (0.64, 0.71)	0.78 (0.70, 0.86)	0.70 (0.60, 0.81)	0.80 (0.74, 0.88)	0.69 (0.56, 0.84)	0.68 (0.46 1.00)
P for trend	<0.001	<0.001	0.014	0.240	<0.001	<0.001	0.167
Intestinal infectious diseases							
Middle tertile	0.72 (0.69, 0.74)	0.71 (0.66, 0.77)	0.82 (0.69, 0.97)	0.79 (0.64, 0.97)	0.82 (0.72, 0.92)	0.76 (0.63, 0.91)	0.77 (0.42, 1.41)
Highest tertile	0.52 (0.50, 0.54)	0.58 (0.52, 0.65)	0.75 (0.61, 0.91)	0.52 (0.39, 0.70)	0.73 (0.62, 0.86)	0.59 (0.40, 0.88)	0.41 (0.17, 0.99)
P for trend	<0.001	<0.001	0.013	0.581	<0.001	<0.001	0.288
Viral infections							
Middle tertile	0.82 (0.79, 0.84)	0.87 (0.80, 0.95)	0.92 (0.78, 1.09)	1.06 (0.86, 1.31)	0.82 (0.71, 0.93)	0.81 (0.64, 1.03)	1.18 (0.68, 2.04)
Highest tertile	0.70 (0.67, 0.72)	0.81 (0.73, 0.90)	0.72 (0.63, 0.93)	0.86 (0.65, 1.15)	0.90 (0.77, 1.07)	0.57 (0.34, 0.97)	1.30 (0.60, 2.49)
P for trend	<0.001	<0.001	0.703	0.762	0. 508	0.001	0.209
Bacterial infections and sexually transmitted diseases							
Middle tertile	0.78 (0.73, 0.82)	0.86 (0.73, 1.01)	1.03 (0.76, 1.39)	0.86 (0.56, 1.33)	0.81 (0.61, 1.07)	0.77 (0.48, 1.21)	-
Highest tertile	0.63 (0.59, 0.67)	0.77 (0.62, 0.95)	0.67 (0.45, 1.99)	1.05 (0.64, 1.74)	0.75 (0.51, 1.08)	0.96 (0.45, 2.04)	-
P for trend	<0.001	0.001	0.461	0.181	0.980	0.400	-
Influenza and other acute lower respiratory tract infections							
Middle tertile	0.71 (0.69, 0.73)	0.71 (0.66, 0.76)	0.81 (0.70 0.95)	0.89 (0.73, 1.08)	0.80 (0.71, 0.89)	0.73 (0.61, 0.88)	0.68 (0.39, 1.21)
Highest tertile	0.52 (0.51, 0.54)	0.66 (0.60, 0.72)	0.74 (0.62, 0.89)	0.69 (0.65, 0.90)	0.86 (0.75, 0.99)	0.69 (0.50, 0.97)	0.50 (0.26, 0.98)
P for trend	<0.001	<0.001	<0.001	<0.001	<0,001	<0,001	0.665
Infections of the skin and subcutaneous tissue							
Middle tertile	0.86 (0.82, 0.90)	0.74 (0.67, 0.82)	0.84 (0.67, 1.04)	0.75 (0.55, 1.01)	0.81 (0.70, 0.95)	0.74 (0.58, 0.97)	-
Highest tertile	0.79 (0.75,0.83)	0.63 (0.55, 0.72)	0.73 (0.57, 0.93)	0.76 (0.52, 1.11)	0.70 (0.56, 0.87)	0.70 (0.42, 1.16)	-
P for trend	<0.001	<0.001	<0.001	0.004	<0.001	0.158	-
Urinary tract infections							
Middle tertile	0.73 (0.68, 0.77)	0.94 (0.80, 1.11)	0.92 (0.67, 1.26)	0.70 (0.46, 1.06)	0.85 (0.65, 1.12)	1.00 (0.58, 1.75)	-
Highest tertile	0.59 (0.55, 0.63)	0.77 (0.61 0.96)	0.61 (0.41, 0.91)	0.59 (0.34, 1.02)	0.67 (0.61, 1.23)	0.52 (0.13, 2.13)	-
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-
Infections of the musculoskeletal system and soft tissue							
Middle tertile	0.88 (0.82, 0.95)	1.24 (1.02, 1.52)	1.22 (0.81, 1.85)	1.73 (1.09, 2.77)	1.13 (0.81, 1.58)	-	-
Highest tertile	0.77 (0.71, 0.83)	1.19 (0.93, 1.53)	1.73 (1.14, 2.62)	0.54 (0.23, 1.29)	1.13 (0.73, 1.75)	-	-
P for trend	<0.001	0.017	0.827	0.638	0.140	-	-

Cells with fewer than five cases not shown.

infections in the intestine (1.38; 1.33, 1.42), skin and subcutaneous tissue (1.78; 1.70, 1.86), and viral infections (1.15; 1.11, 1.19) (Table IV), but lower hazards of bacterial infections (0.92; 0.86, 0.98), influenza and other lower respira-tory diseases (0.88; 0.85, 0.90) and in the musculoskeletal system and soft tissue (0.77; 0.70, 0.84). Patterns varied by parental region of origin. Children with background from EU, EEA, Oceania, USA and Canada generally had lower hazards of infectious disease diagnoses. Adjustments for household income, parental education and mother's parity did not explain differences between groups and did not alter estimates in the same direction across diagnostic groups or region of origin (Table IV). In sensitivity analyses including maternal education instead of parental education, no notable changes to results were seen (Supplementary Table II).

Discussion

Lower parental education was associated with higher risk of most included infectious disease diagnoses among children with a Norwegian background, but these associations were less consistent among children of immigrant parents. Lower household income was generally associated with higher hazard of most infectious disease diagnoses among both children with Norwegian-born parents and among children with immigrant parents. Socioeconomic indicators did not explain differences in infectious disease between children with immigrant parents and children with Norwegian-born parents. This reflects studies during the COVID-19 pandemic in Norway [15] and elsewhere [18], where socioeconomic factors, including crowded housing, explain only a minor part of the differences in incidence and hospitalization between immigrants and non-immigrants.

In a study among adult immigrants in Belgium, mortality from infectious disease varied by country of origin and between those who had migrated themselves and those born in Belgium to immigrant parents [19]. Unlike our study, differences to the general population in mortality from infectious diseases were attenuated after adjustment for SEP [19]. The importance of SEP for infectious disease may be larger among adults than among children, as the influence of parents' SEP may be slightly balanced out by mandatory visits to health care centers and school health services and it may also be that parents are more concerned to promote good health for their children than for themselves. The importance of SEP for disease may also be larger for mortality than disease, although our results probably reflect more serious infections treated in secondary and tertiary healthcare.

Although parental education and household income did not explain differences in hazard of being diagnosed with infectious disease in secondary/tertiary healthcare by region of origin, both were associated with the risk of infectious disease diagnoses in various ways. As expected, higher parental education was associated with lower risk of diagnoses of most infectious diseases. These associations were less consistent among children of immigrants. This reflects previous studies showing weaker associations between education and health among immigrants than among others [20, 21]. As hypothesized in the introduction, education relates to knowledge of symptoms, to health literacy, including knowledge about the health care system and to health-care-seeking behaviour, all of which influence the chance that parents seek adequate healthcare for their children if sick. Lack of consistency across regions of origin for associations between parental education and hazards of receiving an infection diagnosis in secondary/tertiary healthcare make it difficult to conclude the role of household income for infections and treatment of them among children.

Risk of infection diagnoses were consistently highest in the lowest household income groups among children of Norwegian background and, with the exception of infections of the musculoskeletal system and soft tissue, also among all children of immigrants. Lower income may be related to risk factors for infections related to housing conditions and neighbourhoods and to decreased propensity to seek healthcare. In Norway, a referral from primary care is generally required to access secondary and tertiary care, however both primary and secondary/tertiary care are free for children in the age group included in this study. On the other hand, higher income may be related to opportunities to travel, and thereby increased risk of infections, as seen with associations between risk of malaria and travels to country of origin among children of immigrants in Spain [4]. This may partly explain that we did not find associations between lower income and risk of viral and bacterial infection diagnoses when analysed by region (except for viral infections among children with an African background).

There are several challenges with measuring and interpreting the importance of SEP among immigrants. Firstly, missing information on education and household income was more common among immigrants than among Norwegian-born. For many immigrants, information about education from country of origin will not always be documented and registered in Norway. We assume that the majority of missing cases represents low educational level or low household income, which would lead to larger differences in SEP between immigrants and non-immigrants, and which could have increased the importance of SEP in our

Table IV. Hazard ratio (95% confidence interval) for diagnoses of infectious diseases given in secondary/tertiary healthcare between 2008 and 2018 among children 0–10 years, by parental region of origin. Reference: Norwegian background. From Cox regressions, adjusted for year of birth and sex and additionally for parental education, household income and mother's parity.

	Norwegian-born to immigrant parents, total	EU, EEA, USA, Canada, Oceania	Europe except EU/EEA	Asia	Africa	Latin America
Adjusted for year of birth and sex						
Infections total	1.14 (1.12, 1.16)	0.80 (0.77, 0.83)	1.08 (1.03, 1.13)	1.18 (1.15, 1.21)	1.48 (1.43, 1.52)	1.18 (1.03, 1.34)
Intestinal infectious diseases	1.38 (1.33, 1.42)	0.82 (0.76, 0.88)	1.35 (1.24, 1.47)	1.46 (1.39, 1.53)	1.87 (1.78, 1.97)	1.29 (1.00, 1.66)
Viral infections	1.15 (1.11, 1.19)	0.96 (0.89, 1.04)	1.14 (1.04, 1.25)	1.24 (1.18, 1.30)	1.14 (1.07, 1.23)	1.46 (1.16, 1.84)
Bacterial infections and sexually transmitted diseases	0.92 (0.86, 0.98)	0.87 (0.75, 1.00)	0.97 (0.81, 1.16)	0.87 (0.78, 0.96)	1.05 (0.92, 1.19)	0.73 (0.40, 1.32)
Influenza and other acute lower respiratory tract infections	0.88 (0.85, 0.90)	0.54 (0.50, 0.58)	0.81 (0.74, 0.88)	0.96 (0.92, 1.00)	1.16 (1.10, 1.22)	0.89 (0.71, 1.12)
Infections of the skin and subcutaneous tissue	1.78 (1.70, 1.86)	1.28 (1.16, 1.40)	1. 43 (1.27,1.62)	1.91 (1.80, 2.03)	2.23 (2.07, 2.40)	1.85 (1.36, 2.51)
Urinary tract infections	1.00 (0.93, 1.07)	0.97 (0.84, 1.12)	1.38 (1.17, 1.62)	1.08 (0.98, 1.20)	0.67 (0.56, 0.80)	0.87 (0.48, 1.56)
Infections of the musculoskeletal system and soft tissue	0.77 (0.70, 0.84)	0.77 (0.65, 0.92)	0.89 (0.71, 1.11)	0.73 (0.64, 0.84)	0.78 (0.65, 0.93)	0.57 (0.26, 1.27)
Adjusted for year of birth and sex, parental education, household income, mother's parity						
Infections total	1.22 (1.21, 1.23)	0.91 (0.90, 0.93)	1.11 (1.09, 1.14)	1.23 (1.21, 1.25)	1.63 (1.60, 1.65)	1.29 (1.21, 1.39)
Intestinal infectious diseases	1.40 (1.36, 1.48)	0.86 (0.82, 0.90)	1.34 (1.27, 1.41)	1.48 (1.34, 1.52)	1.95 (1.89, 2.02)	1.33 (1.15, 1.54)
Viral infections	1.21 (1.19, 1.24)	1.08 (1.04, 1.12)	1.20 (1.15, 1.27)	1.30 (1.26, 1.33)	1.15 (1.10, 1.19)	1.77 (1.58, 1.98)
Bacterial infections and sexually transmitted diseases	0.90 (0.87, 0.94)	0.91 (0.84, 0.98)	0.97 (0.88, 1.06)	0.79 (0.75, 0.84)	1.09 (1.01, 1.16)	0.80 (0.60, 1.08)
Influenza and other acute lower respiratory tract infections	0.90 (0.89, 0.92)	0.61 (0.58, 0.63)	0.82 (0.78, 0.86)	0.97 (0.94, 1.00)	1.19 (1.14, 1.22)	0.95 (0.83, 1.09)
Infections of the skin and subcutaneous tissue	1.82 (1.77, 1.86)	1.32 (1.26, 1.39)	1.34 (1.26, 1.44)	1.98 (1.91, 2.04)	2.44 (2.35, 2.55)	1.73 (1.46, 2.05)
Urinary tract infections	0.98 (0.92, 1.00)	1.04 (0.96, 1.12)	1.27 (1.14, 1.38)	1.02 (0.96, 1.08)	0.60 (0.54, 0.67)	0.93 (0.68, 1.27)
Infections of the musculoskeletal system and soft tissue	0.82 (0.78, 0.85)	0.76 (0.70, 0.84)	0.92 (0.82, 1.03)	0.79 (0.74, 0.85)	0.87 (0.79, 0.96)	0.66 (0.45, 0.96)

analyses somewhat. Secondly, immigrants do not always have the opportunity to convert education from their country of origin to a corresponding social position, job or income in their host country. Moreover, the migration process itself, such as the experience of loss of social position could interact with SEP in its association with health and migration experiences could also influence the SEP level achieved in the host country. Further, a healthy migrant effect will flatten the SEP gradient if newly arrived immigrants have good health but low SEP, although this should be less relevant in our study including children born in Norway. This discrepancy between SEP in country of origin and in host country, or the effect of a healthy migrant effect on the SEP gradient, will probably be largest for immigrants coming as refugees and/or from poorer conditions. Thirdly, the proportion with only primary school was low among non-immigrants compared to most regions of origin (except EU/EEA/Oceania/USA/Canada). Thus, parents with low education among non-immigrants may be a more selected group than among immigrants, and low level of parental education may not represent the same set of challenges that potentially influence health across groups. This may be one explanation of stronger associations between parental education and risk of infectious disease among children with Norwegian background compared to with immigrant parents. Fourthly, we hypothesized that parental education could represent health literacy and general health behaviours, and among immigrants also proficiency in the Norwegian language and ability navigating the Norwegian healthcare system, and that household income could represent factors such as housing conditions, neighbourhood environments and nutrition. It might be that education and income do not capture these aspects well. Chen et al [9] suggest that immigrants from some origins may share values and habits across SEP, attenuating any effect of SEP on health. Finally, especially for the youngest children, parents may not have completed their education in 2018. Despite these challenges with measuring SEP among immigrants, if SEP was of large importance for differences in infectious disease incidence among children, we would have expected to have seen evidence of this in our sample.

Number of siblings as measured by mother's parity did not explain differences in risk of infection in our study. Previously, number of siblings in the household has been related to risk of *Helicobacter pylori* infections [22] and to risk of COVID-19 infection [2]; however, crowded housing has not explained differences in risk of COVID-19 infections between immigrants and non-immigrants [15]. Number of siblings may also relate more to common infections than to infections treated in secondary/tertiary healthcare.

Strengths and limitations

Strengths of our study include the use of national register data of diagnoses, with linkage to immigrant-related variables, household income and parental education from Statistics Norway. Among those with Norwegian background, some will have parents born in Norway to immigrant parents (third-generation immigrants). These children might share some circumstances and characteristics with children born to immigrant parents; however, their parents grew up in Norway and are likely to know the Norwegian health system well and to perceive health and have a health literacy more similar to Norwegian-born parents with a Norwegian background, and they constitute $<0.5\%$ of our sample. Thus, we chose to include these children in the Norwegian background group for the purpose of this article. Parity was included as a proxy for number of siblings and degree of household crowding. As data on parity were from the MBRN, only siblings older than the index child were accounted for; however, younger siblings may have been added to the family later.

Our data pertain to diagnoses given in secondary or tertiary care only and not primary care. However, diagnoses given in secondary/tertiary care may be related to use of primary care and referrals from primary to secondary care [8]. Diagnoses from secondary/tertiary care are likely to represent more serious infections and data on diagnoses given in primary care could have nuanced the picture in this study. We included all children in the age range 0–10 years between 2008 and 2018. Thus, time and age of follow-up varied between children. This was handled by using Cox regressions and by adjustment for year of birth.

Conclusion

Differences in SEP did not explain differences in hazard of being diagnosed with infectious disease in secondary/tertiary care between Norwegian-born children with immigrant parents and with Norwegian-born parents. This is in line with findings from the COVID-19 pandemic in Norway. Preventive efforts against the spread of infections are not likely to be effective if the causes are poorly understood. Therefore, further studies are warranted to assess which factors could be important for differences in risk and severity of infectious disease between children of immigrants and children without an immigrant background.

Authors' contributions

The study was initiated by PS. MK conducted the statistical analyses and drafted the manuscript. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Availability of data and material

The dataset analysed during the current study is not publicly available, but anonymous data are available from the corresponding author on reasonable request.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval

The study was approved by the Regional Ethics Committee South-East (REK 2019/1286).

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Supplemental material

Supplemental material for this article is available online.

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