Obesity diagnoses in children and adolescents in Norway by immigrant background

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Abstract

Aim: Relatively few obese children and adolescents receive specialist treatment. Our aim was to assess associations between risk of receiving an obesity diagnosis in secondary/tertiary health services by socioeconomic position and immigrant background, to ultimately improve equity in health services.

Methods: The study population comprised Norwegian-born children aged 2-18 years between 2008 and 2018 (N=1 414 623), identified via the Medical Birth Registry. Cox regressions were used to calculate hazard ratios (HR) of an obesity diagnosis from secondary/tertiary health services (Norwegian Patient Registry) by parental education and household income and immigrant background.

Results: Higher parental education and household income were associated with lower hazard of obesity diagnosis regardless of Norwegian versus immigrant background. Compared to Norwegian background, background from Latin America (HR 4.12 (95% confidence interval, CI 3.18, 5.34)), Africa (HR 1.54 (CI 1.34, 1.76)) and Asia (HR 1.60 (CI 1.48, 1.74)) was associated with higher hazard of obesity diagnosis. Adjusted for parental education and household income, corresponding HRs were 3.28 (CI 2.95, 3.65) for Latin America, HR 0.95 (CI 0.90, 1.01) for Africa and HR 1.08 (CI 1.04, 1.11) for Asia. Within Asia, those with background from Pakistan, Turkey, Iraq and Iran had higher hazards than those with Norwegian background, while those with background from Vietnam had lower hazards, also after adjustment for parental education and household income.

Conclusion: To ensure more equitable treatment, more knowledge is warranted about health service access and referral patterns, and underlying population prevalences, for obese children and adolescents with different immigrant backgrounds.

Keywords: children; adolescents; immigrant; Norway; obesity; diagnosis

Introduction

Obesity in childhood and adolescence is related to poor physical and mental health and leads to a lifelong increase in morbidity and mortality (1-4). The strong association with socioeconomic position (SEP) means that obesity contributes to the further widening of social and health inequalities (5). The global prevalence of obesity among children and adolescents aged 5-19 years has increased over the last decades, from less than 1% in 1975 to 6% among girls and 8% among boys in 2016 (6). In Europe, the overall prevalence of obesity among primary school children was 9% in girls and 13% in boys in 2017 (7). There are indications that this increase has started to level off in some high-income countries (4), although not all (8). In a European context, socially disadvantaged children, including those with parents with low SEP (9) or with immigrant background (10), have generally not experienced such improvements, and have consistently higher rates of overweight and obesity (8, 10-15). In the Norwegian Child Growth Study, childhood overweight and obesity was associated with lower maternal education, having divorced parents and with living in rural areas (16, 17).

Prevention is key when it comes to childhood and adolescent obesity. For those already obese, however, treatment and medical guidance are necessary. Nevertheless, the proportion of obese children and adolescents receiving treatment in health care services remains low (18). While there is no available data on the characteristics of obese children and adolescents who are referred vs not referred to specialist care in Norway, the criteria for receiving specialist treatment are specified in Norwegian national treatment guidelines, and follow the International Obesity Task Force (IOTF) cut-offs for defining childhood obesity in children aged ≥2 years: It is recommended that children with obesity (iso (age- and sex adjusted) -BMI ≥ 30) and hereditary and/or secondary health problems, or morbid obesity (iso-BMI ≥ 35), are referred to secondary/tertiary treatment (19). Thus, children and adolescents receiving treatment for obesity are probably those with the most severe obesity and/or with obesity related complications. Structural factors, such as available resources in primary health services, as well as treatment options in secondary and tertiary care may vary between urban and

rural areas, as well as between individual city boroughs. Chances of receiving treatment may therefore vary with availability of services. For children with immigrant background, a large proportion live in urban areas. Moreover, parental knowledge about available health care services and health seeking behaviour may vary with SEP and immigrant background, and health professionals' referral practice may also be influenced by a child`s immigrant background (18, 20). In general, immigrants use specialist health services less frequently than non-immigrants (21). Better knowledge about differences in treatment of obesity among children and adolescents by immigration background and SEP is a point of departure to improve equity in health services.

Based on register-data on Norwegian-born persons, we have previously reported higher hazards of a diagnosis of obesity in secondary/tertiary health services among children aged 0-10 years with two immigrant parents compared to children with two Norwegian-born parents (22). The highest hazards were seen among children with parents from Latin America, Africa, and Asia. In this article we aim to assess the role of SEP in these differences in risk of receiving an obesity diagnosis between regions, and also whether certain country backgrounds are drivers of the observed regional differences. We also include both children and adolescents (aged 2-18 years) in our analyses, as the proportion being diagnosed with obesity increases during adolescence.

Methods

Study design and population

The study was a register-based study. The study population included Norwegian-born children and adolescents 2-18 years of age between 2008 and 2018 (i.e. children born in 1990-2017, N=1 684 601), identified via the Medical Birth Registry of Norway (MBRN). Data from MBRN, the Norwegian Patient Register (NPR) and Statistics Norway were linked by the national personal identification number. We excluded children and adolescents who had one immigrant parent and one Norwegian-born parent, were registered as emigrated (data on emigration year were not available), were registered as stillborn or late abortion, died prior to 2008, without information on

immigrant background, those missing information on parental education and/or household income, and those who were registered with an obesity diagnosis before the age of 2 years (as national guidelines refers to children aged ≥ 2 years) (Figure 1).

Variables

Outcome

We included obesity diagnoses from the Norwegian Patient Register (NPR) given from Jan 1st 2008 (first year research data available) to Dec 31st 2018. NPR captures data from secondary/tertiary health services and the reporting is mandated by law. Children and adolescents who had a been given an obesity diagnosis (ICD-10 code E65–E68) in secondary or tertiary care at least once during the specified age and time frame were classified as being diagnosed with obesity.

Exposure

Children and adolescents born to two Norwegian-born parents were referred to as having "Norwegian background". For other children, regional background was based on data on parents' country of birth (if different; mother's) and classified according to national standards by Statistics Norway; "EU/European Economic Area (EEA), Oceania, United States of America (USA), and Canada", "Europe outside the EU/EEA", "Asia", "Africa", and "Latin America". Within the regions Asia and Africa there are large variations in the prevalence of adult obesity by country of origin, e.g. obesity prevalence is 24% among women from Turkey and 3% among women from Vietnam (23). We therefore also analyze results for the largest groups (N>4000) by country background: Asia: Pakistan (18% of region), Iraq (15%), Vietnam (12%), Sri Lanka (9%), Turkey (9%) and Iran (7%) and Africa: Somalia (41%) and Eritrea (14%). For the other regions, proportions with an obesity diagnosis did not vary substantially between the largest countries (Supplementary table 1).

Parental education was recorded as highest attained education at Oct 1st 2017 by either parent and categorized into "primary school" (started or completed/≤ 9 years), "upper secondary school" (12 years), "university/university college, lower" (completed a university/university college education of

≤4 years) and "university/university college, higher" (completed a university/university college education of >4 years). Household income was recorded as annual household income (in NOK) after tax, divided by number of consumptions units (EU-scale) in the household, and included in analyses as a covariate varying over each included year. Tertiles of household income were made based on average income for the years under follow-up.

Analyses

We calculated the distribution of parental income and education categories, and the proportions having received an obesity diagnosis, by regions/countries. Next, hazard ratios (HR) with 95% confidence intervals (CI) for an obesity diagnosis were calculated for educational categories and income tertiles, with the lowest education/income category as the reference, within each region/country background. We adjusted for sex and year of birth, using Cox proportional hazard regressions with risk years (2008-2018) as the underlying time-scale. P-values for trend over education and income categories (included as continuous variables in the models; educational groups given values 1-4 and income tertiles values 1-3) were also reported.

HRs for an obesity diagnosis were then calculated within each background region/country, with children of Norwegian background as the reference category. The models were adjusted for sex and year of birth (continuous variable), and additionally for parental education and household income.

In sensitivity analyses, maternal education was included instead of highest parental education, as maternal education may be more important for children's health than paternal education (24). We also performed sensitivity analyses where children and adolescents whose mother (N=4129) and/or father (N=4338) (total N=7282) were Norwegian-born to two immigrant parents were grouped together with children and adolescents with immigrant background instead of with those with Norwegian background. Parents born in Norway to immigrant parents share knowledge of the Norwegian health system, health literacy and proficiency in the Norwegian language with other Norwegian-born, but may also share genetics, cultural traditions and perceptions with their family 's

country of origin, potentially influencing the health of their children, and their health care seeking behaviour. We also conducted sensitivity analyses with children and adolescents stratified by age at first obesity diagnosis in two groups; "2-11" and "≥12" years, based on the assumption that parental involvement is less in adolescents than in younger children. In the group "≥12 years", those having received an obesity diagnosis at an earlier age were not included in the follow up time.

Each participant was followed from 2008 or year of birth (if later than 2008) until first year of diagnosis, year of death, year of reaching 18 years of age (if earlier than 2018), or until the end of 2018.

Analyses were performed in Stata 16 (StataCorp LLC, College Station; www.stata.com).

Results

The sample consisted of 1 414 623 children and adolescents (51.4% male, 48.6% female) and was evenly distributed over years of birth (~3.5% born in each year), but the proportion of children born to immigrant parents increased over the study years. The socioeconomic characteristics of the sample are described in Table 1. The proportion of children and adolescents having received a diagnosis of obesity was highest among those with Latin American (2.8%), Asian (1.2%) and African (1.0%) background, and lowest among those with background from EU/EEA/Oceania/USA/Canada (0.5%) and Europe outside EU (0.5%) (Table 2). Among children and adolescents with Asian background, the proportion with an obesity diagnosis was lower among those with background from Vietnam (0.6%), and higher among those with background from Turkey (2.2%), Pakistan (1.7%) Iraq (1.4%) or Iran (1.4%) (Table 2). Among children and adolescents with African background, the proportion with an obesity diagnosis was lower among those with background from Eritrea (0.5%), and higher among those with background from Somalia (1.1%).

Independent of regional/country background, the proportion with an obesity diagnosis was lower among children and adolescents whose parents had high income and high education (Table 2).

Adjusted for sex and birth year, there was a trend that higher parental education and higher household income were associated with lower hazard of an obesity diagnosis across all regional backgrounds (Table 3). Assessed by country, an association between parental education and hazard of an obesity diagnosis was only seen among those with background from Turkey, Iraq and Eritrea, whereas household income was associated with an obesity diagnosis in those with parents born in Iran (Table 3).

The sex and birth year adjusted hazard of an obesity diagnosis was higher among children and adolescents with Latin American (HR 4.12 (CI 3.18, 5.34)), African (HR 1.54 (CI 1.34, 1.76)) and Asian (HR 1.60 (CI 1.48, 1.74)) background compared to those with Norwegian background. After adjustment for parental education and household income hazard of an obesity diagnosis was higher among those with background from Latin America (HR 3.28 (CI 2.95, 3.65)), slightly higher among those with background from Asia (HR 1.08 (CI 1.04, 1.11)), but not among those with background from Africa (HR 0.95 (CI 0.90, 1.01)). Assessed by country, children and adolescents with background from Pakistan, Turkey, Iraq and Iran had higher hazards of an obesity diagnosis than those with Norwegian background, while children with background from Vietnam had lower hazard, both before and after adjustment for socioeconomic indicators (Table 4). Children and adolescents with background from Somalia had higher hazard of an obesity diagnosis than those with Norwegian background before, but lower after, adjustment for socioeconomic indicators (Table 4). Children and adolescents with background from Sri Lanka and Eritrea did not differ from those with Norwegian background in hazard of obesity diagnosis adjusted for sex and birth year but had lower hazards after adjustment for socioeconomic indicators. Among those with background from EU/EEA/Oceania/USA/Canada the HR of an obesity diagnosis was 1.08 (CI 0.89, 1.31) adjusted for sex and birth year, but 1.27 (CI 1.18, 1.37) adjusted for parental education and household income, compared to those with Norwegian background (Table 4).

Results were not substantially changed in sensitivity analyses including maternal education instead of parental education (Supplementary table 2) or when including children with Norwegian-born

parents, but immigrant grandparents in the group with immigrant background (Supplementary table 3 &4). Among children aged 11 year and younger, hazards of an obesity diagnosis among those with immigrant background compared to Norwegian background were higher than in the full sample, and significant for all regions, both before and after adjustment for parental education and household income (Supplementary table 5). Among adolescents aged 12 years and above, these associations were weaker and after adjustments, hazards were significantly higher only for those with background from Latin America and lower for all other regional backgrounds (Supplementary table 5).

Discussion

Children and adolescents with high parental education and household income had lower risk of an obesity diagnosis than children with low parental education and household income both among those with Norwegian background and among those with immigrant parents from the different regional backgrounds. Children and adolescents with background from Latin America, Pakistan, Turkey, Iraq, Iran, and Somalia had higher risk of receiving an obesity diagnosis in secondary/tertiary care than children with a Norwegian background, while the risk was lower among those with background from Vietnam. Adjustment for socioeconomic indicators attenuated these differences, although higher risk was still evident among those with background from Latin-America, Pakistan, Turkey, Iraq, and Iran. Adjusted for socioeconomic indicators, children and adolescents with background from EU/EEA/Oceania/USA/Canada had higher risk of an obesity diagnosis, and those from Sri Lanka and Eritrea had lower risk, than those with Norwegian background.

Our findings on differences by immigrant background and the role of SEP in the diagnosis of obesity by immigrant background reflects previous survey-based research on prevalence of overweight and obesity from Europe (10-15). Data from a smaller Norwegian study among preschoolers showed that children with background from the Middle East/North Africa, but not South Asia, had high risk of overweight and obesity compared to children of European origin (25). In our study we used register

data on diagnoses given in secondary/tertiary health care. Thus, our data may, in addition to differences in the prevalence of obesity, reflect differences in health seeking behaviour of the parents, referral patterns of health professionals, and availability of health services due to geographical and urban-rural variations.

A higher prevalence of overweight among children of immigrants has partly been explained by less favourable behaviours related to nutrition and physical activity compared to other children (12, 26, 27). Both obesity and obesity-related behaviour are associated with SEP (5). Parental education and household income were related to receiving an obesity diagnosis in our study, and the increased risk of an obesity diagnosis among children of immigrants compared to children of Norwegian-born parents were attenuated, although not eradicated, when adjusted for indicators. Thus, SEP differences in both obesity-related behaviour and in health care seeking behaviour may partly explain our results. However, other factors may be equally or more relevant, e.g. that children are raised in families belonging to different cultures with varying food cultures and perceptions of health and weight (28). If obesity is not considered as unhealthy, parents may be less likely to contact the health services if their child is obese. A high prevalence of obesity is seen among some groups of adult immigrants in Norway (23). Parents also experience large variations in available resources and barriers to provide a healthy environment for their children, relating to both social and structural factors (5). Moreover, genetic susceptibility to obesity may play a role (29, 30).

The higher risk of an obesity diagnosis among children and adolescents with immigrant parents compared to those with Norwegian background was most pronounced among those aged 11 years and younger and was even reversed among those aged 12 years and above when adjusted for parental education and household income, except among those with background from Latin America. Younger children are more dependent on parental influence on lifestyle behaviour related to nutrition, as well as parental involvement in health seeking behaviour. Thus, health behaviour and health care seeking behaviour among adolescents are less dependent on immigrant background than among younger children.

Obesity among Norwegian children is higher in rural areas (17), yet specialist care for childhood obesity is more available in urban areas, making it more likely for urban residents to receive and attend treatment. Because many with immigrant background live in the largest cities, the proportion of obese children and adolescents receiving a diagnosis in secondary/tertiary care may be higher among those with immigrant background than among others, and thus to some extent explain the higher hazards observed in the current study.

Health seeking behaviour varies with a person's health literacy, education and knowledge of the health system, and are all factors known to also differ between immigrants and non-immigrants (20). Some immigrant parents, although not all, may have limited knowledge about available health care services, possibly in combination with poor proficiency in the Norwegian language and/or low education, and thus use health services less adequately than others. If so, relatively fewer children and adolescents would be diagnosed with obesity compared to those with Norwegian background, and our results would underestimate the differences. In the health services, health professionals may relate differently to families with immigrant background. If they find it more challenging to communicate with immigrant parents about childhood obesity, they may be less likely to refer them to secondary/tertiary health care. Conversely, they may be extra vigilant to the challenge of obesity for families from certain ethnic backgrounds, and thus have a lower threshold for referral.

There are no differences between immigrants (except unregistered, paperless migrants) and non-immigrants in legal or economic access to secondary or tertiary health care in Norway. Still, we know that immigrants use specialist health services in general less than the non-immigrant population, both among children and adults. However, age-adjusted number of visits per 1000 person years for cardiovascular or endocrine disorders among adults vary by country background, but are not consistently lower among immigrants than others (21).

Strengths and limitations

Strengths of our study include the use of national register data and information on parental country of birth, education and household income. Our data is from secondary/tertiary services only, and therefore do not include information about obesity in children and adolescents who have not received a diagnosis and/or treatment at the secondary/tertiary health care level. If we compare the proportion receiving an obesity diagnosis in the age groups 0-10 years (0.4%) (21) to survey data on prevalence among Norwegian children (4%) (17), an estimated 10% of obese children are referred to secondary/tertiary health care in Norway. Our data therefore likely reflects the most severely obese children, and children with obesity-related conditions. Our variable diagnosis of obesity is based on ICD-codes E65-68, which also includes localized obesity, other hyperalimentation and sequela of hyperalimentation, but these diagnoses could not be separated out. We did not have data to adequately adjust for diagnoses which could increase the risk of receiving a diagnosis of childhood obesity.

Measuring and interpreting the importance of SEP among immigrants holds some challenges. Missing information on parental education and household income was more common among participants with immigrant background than among Norwegian background. If most missing cases represented low (or no) education, or low household income, the differences in SEP between immigrants and non-immigrants would have been larger, and the importance of SEP in our analyses somewhat increased. Further, immigrants' education from country of origin is not always linked to a corresponding social position, job or income in their host country. Parents with low education among non-immigrants may be a more homogenous group than among immigrants, and low parental educational level may not represent the same set of challenges that potentially influence health behaviour across groups. Lastly, we had data on household income, but not wealth, which for some could have given a different SEP. As the proportion of children with high parental education and household income was low for some regions and countries, estimates depend largely on the lowest categories. We did not have information about parents` duration of residence in Norway, which could have given valuable information to the interpretation of our results.

Implications

We need knowledge on which proportion of obese children and adolescents are referred to secondary/tertiary health care. To evaluate whether there are larger unmet needs in some groups compared to others, we need to know whether differences in hazards of receiving a diagnosis reflects differences in obesity prevalence, or severity of obesity, between children and adolescents with and without immigrant background. Moreover, we need knowledge regarding whether health care seeking behaviour and referral practice related to obesity in children and adolescents does indeed vary by immigrant background. If there are referral biases related to immigrant background, SEP or whether one lives in urban or rural areas this needs to be corrected to offer more accessible and equitable health services.

Conclusion

Children and adolescents whose parents had higher education and household income had lower hazard of an obesity diagnosis in secondary/tertiary care regardless of regional background. Those with background from Latin America, Pakistan, Turkey, Iraq, Iran, and Somalia had higher hazard of receiving an obesity diagnosis than Norwegian background children. Differences were somewhat attenuated by adjustment for parental education and household income. More knowledge about the accessibility of health services for obesity treatment is necessary to ensure equitable treatment.

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Conflicts of interest/Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Availability of data and material

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

Authors' contributions

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

Ethics approval

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

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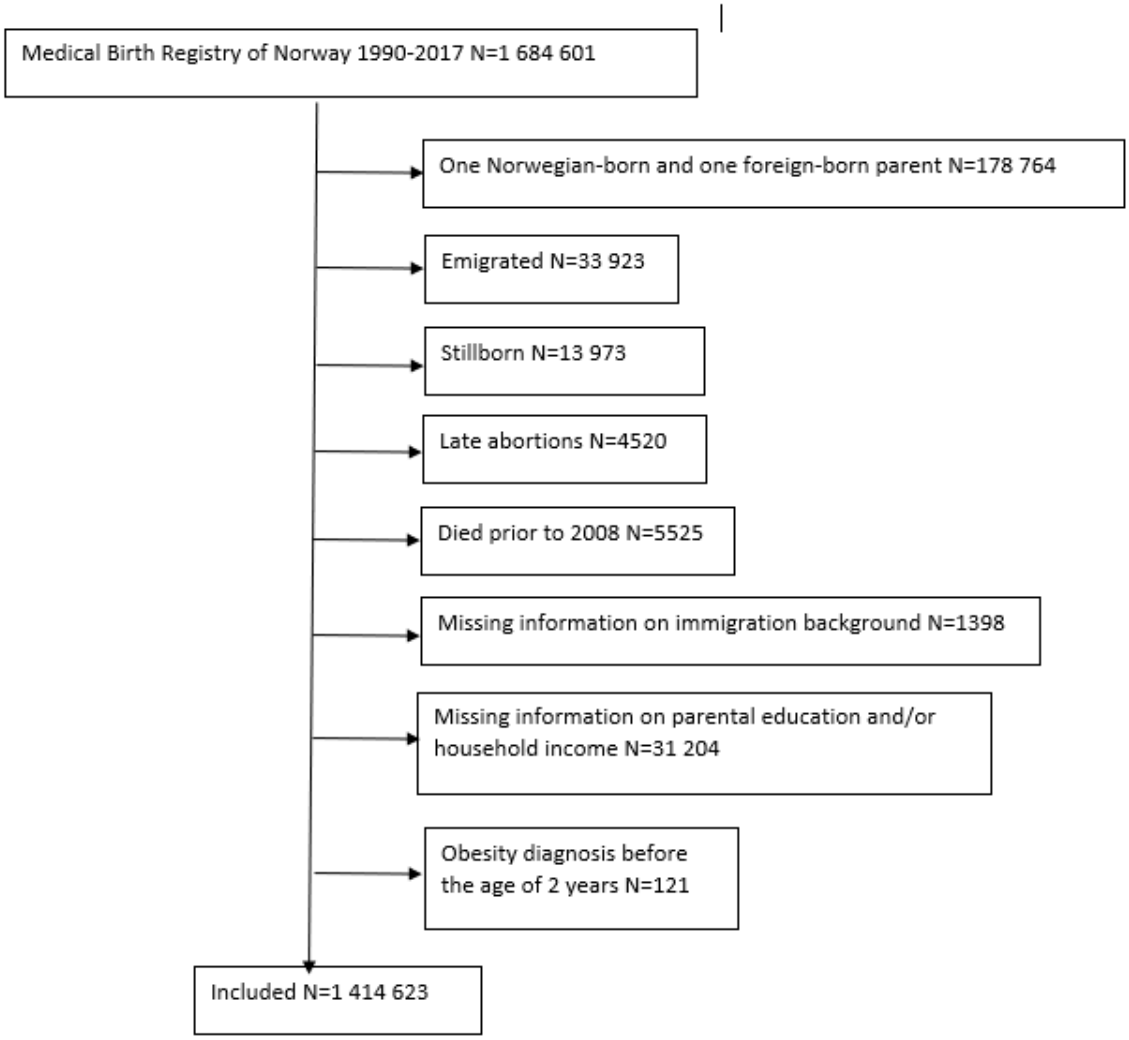

Figure 1. Flow chart of inclusion to analyses

Table 1. Characteristics of the sample.

	Norwegian background (N=1 278 731)	Children of immigrants, total (N=135 892)	EU, EEA, Oceania, USA, Canada (N=26 683)	Europe, outside EU, EEA (N=16 282)	Asia (N=62 064)	Africa (N=28 310)	Latin America (N=2 553)	
Girls (%)	48.6	48.8	48.6	48.4	48.8	49.3	47.9	
Household income (%)								
Low	29.6	68.9	46.8	62.3	72.2	87.0	61.7	
Middle	34.8	19.5	29.8	24.1	18.1	10.1	23.7	
High	35.7	11.6	23.4	13.6	9.7	3.0	14.6	
Parental education (%)								
Primary	5.5	27.8	8.8	17.7	31.9	43.5	16.2	
Upper Secondary	37.2	30.5	25.6	38.5	31.5	27.9	33.7	
Higher, low	39.7	24.8	30.5	26.1	24.3	19.8	28.2	
Higher, high	17.6	16.9	35.2	17.6	12.3	8.8	21.9	
			Asia				Africa	
	Pakistan (N=11 115)	Iraq (N=9 480)	Sri Lanka (N=5 786)	Turkey (N=5 529)	Iran (N=4 087)	Vietnam (N=7 688)	Somalia (N=11 606)	Eritrea (N=4 076)
Girls (%)	48.7	48.7	49.2	47.9	48.2	48.6	48.4	50.1
Household income (%)								
Low	82.7	86.7	58.0	81.3	59.1	63.0	95.6	85.6
Middle	12.6	9.1	30.8	13.1	23.3	25.5	3.8	11.5
High	4.7	4.3	11.3	5.6	17.6	11.6	0.6	2.9
Parental education (%)								
Primary	41.2	35.3	24.0	43.6	18.4	31.5	58.5	48.4
Upper Secondary	32.4	26.9	44.2	39.3	26.6	41.0	24.9	30.4
Higher, low	18.6	28.0	25.1	13.5	34.5	18.3	13.5	15.8
Higher, high	7.8	9.8	6.7	3.5	20.6	9.1	3.1	5.4

Educational categories: Primary: started or completed/≤ 9 years, Upper secondary: 12 years completed, Higher, low: completed a university/university college education of ≤4 years, Higher, high: completed a university/university college education of >4 years. Household income: Annual household income divided by number of consumptions units (EU-scale) in the household, in tertiles.

Table 2. Diagnosis of obesity given in secondary/tertiary health care between 2008 and 2018 among children aged 2-18 years: N (%) by parental regional background and by parental educational level and tertiles of household income

	Norwegian background	Children of immigrants, total	EU, EEA, Oceania, USA, Canada	Europe, outside EU, EEA	Asia	Africa	Latin America
Total	9 808/1 278 731 (0.8)	1 306/135 892 (1.0)	109/26 683 (0.5)	126/16 282 (0.5)	745/62 064 (1.2)	255/28 310 (1.0)	71/2 553 (2.8)
Household income (%)							
Low	5 191/377 898 (1.4)	1 087/93 645 (1.2)	73/12 485 (0.6)	104/10 137 (1.0)	618/44 825 (1.4)	235/24 623 (1.0)	57/1 575 (3.7)
Middle	3 147/444 985 (0.7)	153/26 556 (0.6)	19/7 945 (0.3)	17/3 924 (0.5)	90/11 232 (0.8)	16/2 849 (0.6)	11/606 (1.8)
High	1 470/455 848 (0.3)	66/15 691 (0.5)	17/6 253 (0.4)	5/2 221 (0.3)	37/6 007 (0.7)	-	-
Parental education (%)							
Primary	1 125/70 614 (1.6)	488/37 781 (1.3)	18/2 353 (0.9)	30/2 887 (1.0)	304/19 810 (1.6)	114/12 319 (1.0)	22/412 (5.6)
Upper Secondary	5 207/475 685 (1.1)	436/41 399 (1.1)	42/6 826 (0.7)	57/6 268 (0.9)	228/19 542 (1.2)	79/7 902 (1.0)	30/861 (3.5)
Higher, low	2 894/507 507 (0.6)	290/33 750 (0.9)	28/8 126 (0.4)	31/4 256 (0.7)	164/15 058 (1.1)	52/5 590 (1.0)	15/720 (2.1)
Higher, high	582/224 925 (0.3)	92/22 962 (0.5)	21/9 378 (0.3)	8/2 871 (0.3)	49/7 654 (0.7)	10/2 499 (0.5)	-

			Asia				Africa	
	Pakistan	Iraq	Sri Lanka	Turkey	Iran	Vietnam	Somalia	Eritrea
Total	213/11 115 (1.7)	133/9 480 (1.4)	59/5 786 (1.0)	126/5 529 (2.2)	57/4 087 (1.4)	45/7 688 (0.6)	114/11 606 (1.1)	17/4 076 (0.5)
Household income (%)								
Low	178/9 187 (1.9)	129/8 218 (1.5)	47/3 354 (1.4)	112/4 497 (2.5)	41/2 415 (1.7)	31/4 840 (0.6)	112/11 092 (1.1)	17/3 490 (0.5)
Middle	20/1 402 (1.3)	7/858 (0.8)	7/1 781 (0.5)	11/723 (1.2)	13/951 (1.4)	11/1 957 (0.6)	-	-
High	5/526 (0.6)	7/404 (1.6)	5/651 (0.9)	5/309 (1.0)	-	-	-	-
Parental education (%)								
Primary	94/4 584 (2.0)	54/3 348 (1.6)	19/1 390 (1.4)	72/2 411 (3.0)	13/752 (1.7)	20/2 425 (0.8)	61/6 790 (1.0)	11/1 972 (0.7)
Upper Secondary	62/3 596 (1.6)	39/2 549 (1.5)	26/2 555 (1.1)	42/2 170 (1.9)	14/1 086 (1.3)	15/3 151 (0.5)	30/2 888 (1.1)	5/1 240 (0.4)
Higher, low	40/2 069 (1.7)	31/2 650 (1.2)	11/1 454 (0.7)	10/753 (1.1)	23/1 409 (1.6)	6/1 410 (0.4)	20/1 568 (1.3)	-
Higher, high	7/866 (0.7)	9/933 (1.0)	-	-	7/840 (1.0)	-	-	-

Educational categories: Primary: started or completed/≤ 9 years, Upper secondary: 12 years completed, Higher, low: completed a university/university college education of ≤4 years, Higher, high: completed a university/university college education of >4 years. Household income: Annual household income divided by number of consumptions units (EU-scale) in the household, in tertiles. Cells with less than 5 cases not shown.

Table 3. Hazard Ratio (95 % confidence interval) of diagnosis of obesity disease given in secondary/tertiary health care between 2008 and 2018 among children aged 2-18 years by parental education and tertiles of household income and according to parental regional background and selected countries. From Cox regressions, adjusted for sex and year of birth.

	Norwegian background	Children of immigrants, total	EU, EEA, USA, Canada, Oceania	Europe ouside EU/EEA	Asia	Africa	Latin America
Household income							
Low	1	1	1	1	1	1	1
Middle	0.51 (0.48, 0.53) ***	0.54 (0.45 0.65) ***	0.40 (0.24, 0.68) **	0.51 (0.30, 0.86) *	0.61 (0.48, 0.77) ***	0.65 (0.39, 1.10)	0.36 (0.16, 0.79) *
High	0.24 (0.23, 0.26) ***	0.47 (0.36, 0.61) ***	0.45 (0.26, 0.76) **	0.34 (0.14, 0.84) *	0.57 (0.40, 0.80) **	-	-
P for trend	<0.001	<0.001	<0.001	0.001	<0.001	0.048	0.003
Parental education							
Primary	1	1	1	1	1	1	1
Upper Secondary	0.62 (0.58, 0.66) ***	0.75 (0.65, 0.86) ***	0.65 (0.37, 1.15)	0.75 (0.47, 1.19)	0.78 (0.64, 0.94) **	0.77 (0.56, 1.06)	0.48 (0.26, 0.87) *
Higher, low	0.32 (0.30, 0.35) ***	0.67 (0.57, 0.78) ***	0.36 (0.20, 0.66) **	0.71 (0.43, 1.20)	0.72 (0.58, 0.89) **	0.85 (0.60, 1.21)	0.28 (0.14, 0.56) **
Higher, high	0.15 (0.14, 0.17) ***	0.42 (0.31, 0.52) ***	0.26 (0.13, 0.48) ***	0.33 (0.14, 0.76) **	0.59 (0.42, 0.79) **	0.40 (0.20, 0.79) **	-
P for trend	<0.001	<0.001	<0.001	0.012	<0.001	0.015	<0.001

			Asia				Africa	
	Pakistan	Iraq	Sri Lanka	Turkey	Iran	Vietnam	Somalia	Eritrea
Household income								
Low	1	1	1	1		1	1	1
Middle	0.86 (0.51, 1.45)	0.63 (0.28, 1.43)	0.34 (0.14, 0.83) *	0.80 (0.43, 1.50)	0.65 (0.31, 1.34)	0.97 (0.47, 1.98)	-	-
High	0.61 (0.22, 1.64)	1.70 (0.79, 3.65)	0.72 (0.25, 2.05)	0.53 (0.17, 1.69)	-	-	-	-
P for trend	0.275	0.630	0.081	0.215	0.025	0.450		
Parental education								
Primary	1	1	1	1		1	1	1
Upper Secondary	0.93 (0.64, 1.35)	0.97 (0.64, 1.47)	0.99 (0.48, 2.06)	0.69 (0.46, 1.05)	0.70 (0.32, 1.54)	0.69 (0.33, 1.44)	0.82 (0.50, 1.32)	0.25 (0.06, 0.97) *

Higher, low	1.13 (0.73, 1.74)	0.70 (0.44, 1.10)	0.52 (0.19, 1.41)	0.47 (0.22, 0.98) *	0.74 (0.35, 1.54)	0.60 (0.23, 1.56)	1.14 (0.66, 1.98)	-
Higher, high	0.74 (0.34, 1.62)	0.54 (0.25, 1.13)	-	-	0.38 (0.13, 1.07)	-	-	-
P for trend	0.873	0.037	0.475	0.017	0.101	0.434	0.994	0.019

Educational categories: Primary: started or completed/≤ 9 years, Upper secondary: 12 years completed, Higher, low: completed a university/university college education of ≤4 years, Higher, high: completed a university/university college education of >4 years. Household income: Annual household income divided by number of consumptions units (EU-scale) in the household, in tertiles. Cells with less than 5 cases not shown.

*** p-value<0.001, ** p-value<0.01, * p-value<0.05

1

2

Table 4. Hazard Ratio (95% confidence interval) for diagnoses of obesity given in secondary/tertiary health care between 2008 and 2018 among children 2-18 years, by parental regional background and selected countries. From Cox regressions.

	Norwegian background	Children of immigrants, total	EU, EEA, USA, Canada, Oceania	Europe outside EU/EEA	Asia	Africa	Latin America		
Model 1	1	1.52 (1.42, 1.61) ***	1.08 (0.89, 1.31)	1.17 (0.97, 1.41)	1.60 (1.48, 1.74) ***	1.54 (1.34, 1.76) ***	4.12 (3.18, 5.34) ***		
Model 2	1	1.08 (1.05, 1.11) ***	1.27 (1.18, 1.37) ***	0.89 (0.83, 0.95) ***	1.08 (1.04, 1.11) ***	0.95 (0.90, 1.01)	3.28 (2.95, 3.65) ***		
				Asia				Africa	
		Pakistan	Iraq	Sri Lanka	Turkey	Iran	Vietnam	Somalia	Eritrea
Model 1	1	2.02 (1.72, 2.37) ***	2.19 (1.83, 2.61) ***	0.91 (0.67, 1.24)	2.76 (2.27, 3.34) ***	1.90 (1.43, 2.52) ***	0.71 (0.51, 0.97) *	1.69 (1.39, 2.06) **	1.06 (0.63, 1.79)
Model 2	1	1.15 (1.08, 1.23) ***	1.42 (1.33, 1.51) ***	0.59 (0.52, 0.66) ***	1.50 (1.39, 1.62) ***	1.59 (1.43, 1.78) ***	0.47 (0.41, 0.53) ***	0.87 (0.80, 0.94) ***	0.65 (0.52, 0.81) ***

Educational categories: Primary: started or completed/≤ 9 years, Upper secondary: 12 years completed, Higher, low: completed a university/university college education of ≤4 years, Higher, high: completed a university/university college education of >4 years. Household income: Annual household income divided by number of consumptions units (EU-scale) in the household.
Model 1: Adjusted for sex and year of birth. Model 2: Additionally adjusted for parental education and household income.
*** p-value<0.001, ** p-value<0.01, * p-value<0.05