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COVID-19 vaccination rates among adolescents (12–17 years) by immigrant background and sociodemographic factors: A nationwide registry study in Norway

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ABSTRACT

Purpose: Lower COVID-19 vaccination rates have been observed among some adult immigrant populations in Norway, and there appears to be an association with sociodemographic factors. However, knowledge is lacking on the distribution of vaccination rates and role of sociodemographic factors among adolescents. This study aims to describe COVID-19 vaccination rates among adolescents according to immigrant background, household income, and parental education.

Methods: In this nationwide registry study, we analyzed individual-level data on adolescents (12–17 years) from the Norwegian Emergency preparedness register for COVID-19 until September 15th, 2022. We estimated incidence rate ratios (IRR) for receiving at least one COVID-19 vaccine dose by country background, household income and parental education, using Poisson regression, adjusting for age, sex, and county.

Results: The sample comprised 384,815 adolescents. Foreign-born and Norwegian-born with foreign-born parents, had lower vaccination rates (57 % and 58 %) compared to adolescents with at least one Norwegian-born parent (84 %). Vaccination rates by country background varied from 88 % (Vietnam) to 31 % (Russia). Variation and associations by country background, household income, and parental education were greater among 12–15-year-olds than 16–17-year-olds. Household income and parental education were positively associated with vaccination. Compared to the lowest income and education category, IRRs for household income ranged from 1.07 (95 % CI 1.06–1.09) to 1.31 (95 % CI 1.29–1.33) among 12–15-year-olds, and 1.06 (95 % CI 1.04–1.07) to 1.17 (95 % CI 1.15–1.18) among 16–17-year-olds. For parental education, from IRR 1.08 (95 % CI 1.06–1.09) to 1.18 (95 % CI 1.17–1.20) among 12–15-year-olds, and 1.05 (95 % CI 1.04–1.07) to 1.09 (95 % CI 1.07–1.10) among 16–17-year-olds.

Conclusion: COVID-19 vaccination rates varied by immigrant background and age group, with lower rates especially among adolescents with background from Eastern Europe and among younger adolescents. Household income and parental education were positively associated with vaccination rates. Our results may help target measures to increase vaccination rates among adolescents.

1. Introduction

The immigrant populations in Norway have been harder hit by the COVID-19 pandemic than the general population, with higher rates of infections and hospital admissions in some immigrant groups [1–3]. Furthermore, lower COVID-19 vaccination rates in some immigrant groups have been observed, compared to Norwegian-born with Norwegian-born parents [4], with immigrants from Eastern Europe having the lowest vaccination rates. Studies from other countries show higher COVID-19 vaccine acceptance among individuals with higher education and high income [5]. In Norway, 55 percent of children and adolescents aged 12–15 years, and 83 percent of adolescents aged 16–17, had received one vaccine dose, per December 4th, 2022 [6]. However, knowledge is lacking on how vaccination rates for COVID-19 vaccines are distributed among children and adolescents according to immi-

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grant background and sociodemographic factors, and whether patterns of vaccination rates among adult immigrants are reflected among their children.

Previous studies have shown that parents' acceptance of COVID-19 vaccination of their children is strongly associated with their own vaccination uptake [7–10], but also with child's age, with parents being more willing to vaccinate older children [11,12]. In fact, willingness of children and adolescents to have a COVID-19 vaccine has been found to be higher among older adolescents compared to younger children and adolescents [13]. Furthermore, sociodemographic factors have also been found to impact parents' willingness to vaccinate their children. Parents from lower-income households have been found less likely to accept a COVID-19 vaccine for their children in both England [14] and Canada [11], with the latter study also finding more willingness to vaccinate their children among those born in Canada. In a recent systematic review of parental acceptance of COVID-19 vaccine for their children, the majority of the studies included on economic status found that higher economic status among parents were positively associated with willingness to vaccinate [15]. Parent's education level has also been linked to whether they want their children vaccinated with COVID-19 vaccines, where parents with higher levels of education have been found more willing to vaccinate their children [9–10]. Willingness to get vaccinated among children and adolescents has also been associated with sociodemographic factors [13].

In Norway, COVID-19 vaccines are available, free for both adults and children and provided on a voluntary basis. Parental consent for vaccination is required for children below the age of 16, while adolescents aged 16 or over can consent to vaccination without parental approval [16]. The first COVID-19 vaccine in Norway was administered on December 27th, 2020 and vaccines were offered to defined risk groups for the first part of 2021 before being made available to the broader part of the population. Adolescents with specific, severe underlying diseases aged between 16 and 17 years were recommended the vaccine from February 8th, 2021 [17], and adolescents between 12 and 15 years from June 15th, 2021 [18]. Adolescents without the specified diagnoses and aged 16–17 years were recommended vaccines from mid-August 2021. Adolescents in the age group 12–15 years, without known diagnoses, could receive COVID-19 vaccine if they and their parents wished from end of August 2021, but there was no general recommendation to be vaccinated.

With this background, the aim of this paper was to study COVID-19 vaccination rates in adolescents (12–17 years) in Norway up until September 15th, 2022. In this nationwide registry study, we assessed whether vaccination rates varied with immigrant background, household income, and parents' education levels. All analyses were stratified by age groups (12–15 and 16–17 years) because of differing recommendations and the need for parental consent for those below 16 years of age. Among adolescents with immigrant background, we also assessed differences in vaccination rates by being born inside or outside Norway and by parents' vaccination status.

2. Material and methods

2.1. Data sources

We leveraged the Norwegian Emergency preparedness register for COVID-19, Beredt C19, which links individual-level data from multiple national registers [19], to assess data on COVID-19 vaccination rates among adolescents and their sociodemographic factors. Data originating from the National Population Register was used to retrieve county of residency, age, and sex. Data from the Norwegian Immunization Registry SYSVAK was utilized to gain information on vaccination status, and data from Statistics Norway provided information on immigrant category, country background, household income, and parents' education levels.

2.2. Study population

The study population comprised adolescents in Norway aged 12–17 years. The age groups 12–15 years and 16–17 years were analyzed separately due to differences in vaccine recommendations and need for parental consent to be vaccinated [20]. We included individuals that were registered as residents with a Norwegian national identity number during the study period (n = 384,815). Individuals with a temporary identification number were not included, i.e., temporary residents (n = 11,335).

2.3. Outcome

The outcome variable was restricted to *at least one dose of COVID-19 vaccine*, due to differences in recommendations on the number of vaccine doses for those between 12 and 17 years. The variable encompasses all individuals that were vaccinated from the first COVID-19 vaccine was administrated on December 27th, 2020, until September 15th, 2022.

2.4. Exposure and covariates

Our main exposure variables were *immigrant category* and *country background. Immigrant category* was defined according to Statistics Norway's definition of an immigrant and divided into three groups. The first "Adolescents with at least one Norwegian-born parent", the second "Norwegian-born with foreign-born parents", and the third "Foreign-born with foreign-born parents". Country background was based on the country of birth of the adolescents or, if born in Norway with two foreign-born parents, the parents' (if different, mother's) country of birth [21]. Those with one Norwegian-born and one foreign-born parent were assigned country background Norway. We included 42 country backgrounds for which the minimum number of residents per country background was 300. All others with foreign-born parents were grouped together and assigned to "other countries".

The two other exposure variables were *household income* and *parents' education level*. Household income was defined as annual household income after tax, divided by the number of consumption units (EU-scale), and categorized into deciles (1–10). Parents' education level comprised the highest education level achieved among the parents and were grouped into the following categories: lower secondary school, high school/vocational school, higher education short (≤4 years) and higher education long (>4 years). Adolescents for which data was missing for household income (n = 2,762) and parents' combined education level (n = 37,009), were included in the sample as "Unknown income" and "Unknown education", respectively.

Our model includes exposure variables, as well as a set of covariates. The coefficients should be interpreted as the partial effect of each exposure variable (country background, household income, parents' education level) holding everything else constant. Covariates included age (dummy-coded), sex (female/male) and area of residency (categorized as counties).

For the supplementary analyses, in which we did robustness checks of our models, we included two other variables of interest. The first one was *birthplace*, that is, whether the adolescents were born within or outside of Norway. The second one was *parents' vaccination status* (at least one COVID-19 vaccine dose by at least one parent compared to no COVID-19 vaccine dose by any parent). Information was missing for 10,399 fathers and 1,070 mothers,

and for 216 children for both parents. If vaccination status was missing for only one parent, the status of the other parent was used.

2.5. Statistical model

Descriptive statistics of COVID-19 vaccination rates by *immigrant category* and *country background* are presented as percentages.

We used a Poisson regression with robust standard errors to estimate the incidence rate ratio (IRR) for having at least one COVID-19 vaccine, by the exposure variables. The regression was adjusted for age, sex, and county of residency. All three models were stratified by age group (12–15 years or 16–17 years). The analyses were done using Stata 16.0.

Several supplementary and sensitivity analyses were performed to explore whether *birthplace, parents' vaccination status* and *unknown income and education* could explain any of the differences in the IRR of being vaccinated. Analyses with country background as exposure were performed stratified on whether the adolescent was born within or outside Norway, and by parents' vaccination status (at least one parent being vaccinated with at least one dose or not). In order to assess the extent to which our results could be explained by parents' vaccination status, we estimated the models on the sub-sample of adolescents who had at least one vaccinated parent. In a related exercise, we estimated a set of models to assess whether our estimated effects of country of origin-effects were specific to adolescents, using the same set of predictors and covariates. Finally, we estimated the models on a sample where observations with missing values for either household income or parents' education level were excluded from the sample.

3. Results

The study population includes adolescents in Norway aged between 12 and 17 years (n = 384,815), approximately equally distributed between male (51.3 %) and female (48.7 %). Overall, foreign-born and Norwegian-born adolescents with foreign-born parents had lower vaccination rates (57 and 58 %, respectively) compared to adolescents with at least one Norwegian-born parent (84 %) (Table 1). There was great variation in vaccination rates by country background, with the highest rates being among adolescents with background from Vietnam (88 %), the Philippines (87 %) and Thailand (85 %), and the lowest rates among adolescents from Russia (31 %), Bulgaria (32 %) and Romania (40 %) (Table 1). The differences by country background were similar across the two age groups. Consistently across all country backgrounds, older adolescents (16–17 years) had higher vaccination rates compared to younger adolescents (12–15 years).

The estimated incidence rate ratio (IRR) of being vaccinated with at least one dose COVID-19 vaccine varied with country background, adjusted for sociodemographic variables when compared with Norway as reference (Fig. 1). Differences were more pronounced among 12–15-year-olds than among 16–17-year-olds. The IRR of being vaccinated was higher among younger adolescents (12–15 years) with background from Myanmar (IRR = 1.16; 95 % confidence interval (CI) 1.10–1.23), the Philippines (IRR = 1.16; 95 % CI 1.13–1.19), Vietnam (IRR = 1.16; 95 % CI 1.13–1.19), Thailand (IRR = 1.12; 95 % CI 1.09–1.16) and India (IRR = 1.05; 95 % CI 1.02–1.09) compared to those with at least one Norwegian-born parent (Supplementary Table 1). Conversely, the IRR of being vaccinated was lowest among younger adolescents with background from Bulgaria (IRR = 0.35; 95 % CI 0.29–0.43) and

Table 1
Percentage (%) of adolescents 12–15 years and 16–17 years that have received at least one dose COVID-19 vaccine, by immigrant category and country background (cut-off at n ≥ 300), per September 15th, 2022.

Immigrant category	At least one dose of COVID-19 vaccine, n (%)		
	Total	12–15 y	16–17 y
Adolescents with at least one Norwegian-born parent	319 234 (84 %)	214 652 (80 %)	104 582 (92 %)
Norwegian-born with foreign-born parents	31 207 (58 %)	22 302 (51 %)	8 905 (75 %)
Foreign-born with foreign-born parents	34 374 (57 %)	22 301 (50 %)	12 073 (70 %)
Country background			
Vietnam	1 902 (88 %)	1 257 (83 %)	645 (96 %)
The Philippines	1 404 (87 %)	915 (84 %)	489 (93 %)
Thailand	1 278 (85 %)	756 (82 %)	522 (90 %)
India	968 (83 %)	698 (79 %)	270 (91 %)
Myanmar	447 (81 %)	344 (79 %)	103 (88 %)
The Netherlands	499 (77 %)	303 (73 %)	196 (84 %)
China	555 (76 %)	395 (72 %)	160 (86 %)
Sri Lanka	1 442 (75 %)	872 (66 %)	570 (89 %)
Denmark	431 (75 %)	276 (69 %)	155 (85 %)
Iceland	599 (72 %)	426 (66 %)	173 (84 %)
Iran	1 561 (71 %)	970 (64 %)	591 (83 %)
Sweden	921 (71 %)	651 (66 %)	270 (83 %)
Pakistan	2 963 (70 %)	1 960 (63 %)	1 003 (85 %)
Germany	1 526 (70 %)	1 008 (66 %)	518 (77 %)
Great Britain	503 (66 %)	358 (59 %)	145 (83 %)
Afghanistan	1 755 (65 %)	1 204 (59 %)	551 (78 %)
Iraq	3 894 (60 %)	2 495 (52 %)	1 399 (75 %)
Spain	549 (60 %)	390 (57 %)	159 (67 %)
Palestine	487 (58 %)	307 (49 %)	180 (73 %)
Syria	5 009 (53 %)	3 547 (47 %)	1 462 (69 %)
Eritrea	2 402 (53 %)	1 644 (47 %)	758 (66 %)
Democratic Republic of the Congo	497 (51 %)	336 (44 %)	161 (66 %)
Kosovo	1 591 (50 %)	1 079 (40 %)	512 (70 %)
Ethiopia	1 112 (50 %)	770 (41 %)	342 (69 %)
Sudan	499 (49 %)	362 (44 %)	137 (63 %)
Poland	5 721 (49 %)	4 035 (43 %)	1 686 (63 %)
Uganda	310 (48 %)	243 (42 %)	67 (73 %)
Bosnia-Herzegovina	1 190 (47 %)	818 (39 %)	372 (66 %)
Ukraine	311 (47 %)	213 (39 %)	98 (65 %)
Germany	1 511 (46 %)	978 (37 %)	533 (62 %)
Latvia	750 (46 %)	528 (40 %)	222 (59 %)
North-Macedonia	305 (46 %)	209 (37 %)	96 (65 %)
Morocco	946 (45 %)	601 (35 %)	345 (63 %)
Greece	358 (44 %)	253 (38 %)	105 (56 %)
Lithuania	2 469 (43 %)	1 761 (35 %)	708 (61 %)
Somalia	5 334 (42 %)	3 647 (33 %)	1 687 (61 %)
Croatia	326 (41 %)	228 (35 %)	98 (55 %)
Serbia	663 (40 %)	481 (35 %)	182 (53 %)
Romania	761 (40 %)	543 (34 %)	218 (53 %)
Bulgaria	419 (32 %)	302 (25 %)	117 (50 %)
Russia	1 739 (31 %)	1 143 (25 %)	596 (41 %)
Other countries	7 674 (62 %)	5 297 (56 %)	2 377 (75 %)

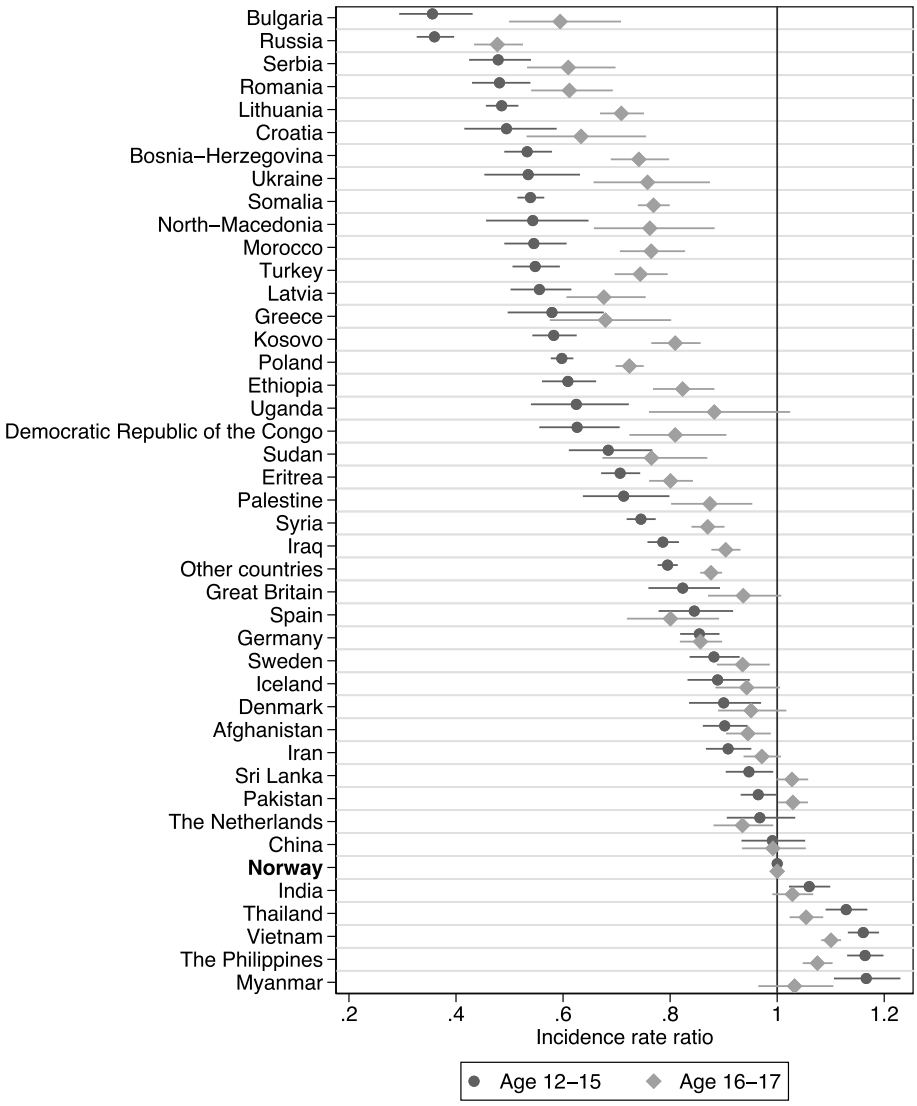

Fig. 1. Incidence rate ratio of being vaccinated with at least one dose COVID-19 vaccine by country background (reference group: Norway), stratified by age group (12–15 years or 16–17 years). Adjusted for the children's age and sex, household income, parents' education level and county of residency.

Russia (IRR = 0.35; 95 % CI 0.32–0.39) compared to those with at least one Norwegian-born parent.

The IRR of being vaccinated increased with increasing household income for both age groups. Household income was more strongly associated with vaccination among younger adolescents (12–15 years) than among older adolescents (16–17 years), although the association was significant ($p < 0.001$) for both groups, when compared to 1st income decile and adjusted for sociodemographic factors (Fig. 2). For the younger adolescents, the IRR ranged from 1.07 (2nd decile) to 1.31 (10th decile). For the older adolescents, the IRR ranged from 1.06 (95 % CI 1.04–1.07) to 1.17 (95 % CI 1.15–1.18) (Supplementary Table 1).

The IRR of being vaccinated with at least one vaccine dose increased with increasing parental education levels for both age groups, when compared to lower secondary school as reference (Fig. 3). The associations between parents' education levels and IRR of being vaccinated was more pronounced among 12–15-year-olds than among 16–17-year-olds (although $p < 0.001$ for both groups). Among the younger adolescents, the IRR of being vaccinated ranged from 1.08 (95 % CI 1.06–1.09) for high school/vocational school to 1.18 (95 % CI 1.17–1.20) for higher education (long). For the older adolescents, the corresponding IRRs were 1.05 (95 % CI 1.04–1.07) and 1.09 (95 % CI 1.07–1.10).

3.1. Supplementary- and sensitivity analyses

Overall, we did not observe any conclusive patterns in the IRR of being vaccinated by country background when we stratified the sample into adolescents who were born within or outside of Norway, compared to Norwegian-born as reference group (Supplementary Fig. 1). That is, the association between country background and vaccination rates appeared to be persistent. Furthermore, when we estimated the models on the sub-sample of adolescents who had at least one vaccinated parent we saw that for most country backgrounds the IRR of vaccination did not vary substantially in the sub-sample and total sample for the different country backgrounds (Supplementary Fig. 5). However, for adolescents with background from Russia, Bulgaria, Romania, Lithuania and Poland, the IRR of being vaccinated was clearly higher for adolescents with at least one vaccinated parent compared to the total group of adolescents from the respective country backgrounds. Conversely, adolescents from Thailand, Myanmar, The Philippines and Vietnam had a slightly lower IRR of being vaccinated if at least one parent was vaccinated compared to the total group of adolescents with the same country background. Moreover, we found that the IRR of being vaccinated by household income was moderately lower for adolescents with at least one vaccinated parent in com-

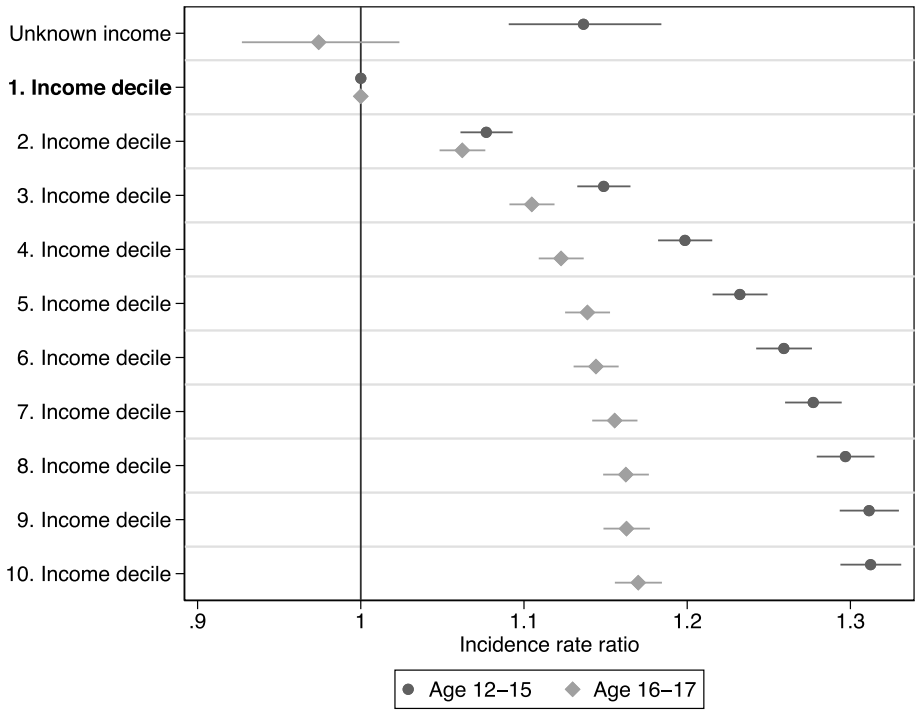

Fig. 2. Incidence rate ratio of being vaccinated with at least one dose COVID-19 vaccine by household income (reference group: 1st income decile), stratified by age group (12–15 years or 16–17 years). Adjusted for country background, the children's age and sex, parents' education level and county of residency.

parison with adolescents without vaccinated parents (Supplementary Fig. 6). Regardless, for both sub-groups, we saw that an increase in IRR of vaccination was associated with increasing household income. The same findings were observed when we examined the relation between the IRR of vaccination and parents' education level (Supplementary Fig. 7).

In a related exercise, in which we plotted the estimated IRRs for parents' vaccination rates by country background against each other, using the same set of predictors and covariates, we estimated a slope coefficient close to one (Coefficient: 0.99; 95 % CI 0.5–1.48) (Supplementary Fig. 8).

In our primary estimation results, observations with missing household income and parents' education level data were retained in the sample. As a final sensitivity analysis, we ran the main models excluding those with unknown income and education (Supplementary Figs. 2–4). These models showed a slightly attenuated association between household income and vaccination (lower IRRs compared to the second model in Fig. 2), whereas the association between parental education and vaccination was largely unchanged from the third model in Fig. 3.

4. Discussion

The estimated incidence rate ratio (IRR) of being vaccinated with at least one dose of COVID-19 vaccine varied between adolescents with immigrant parents and at least one Norwegian-born parent, and with country background. The variation was more pronounced among those aged 12–15 years than among those aged 16–17 years. Overall, household income and parents' education were positively correlated with the adolescents' vaccination. Furthermore, household income and parents' education level had less importance for the older adolescents (16–17 years) than for the younger adolescents (12–15 years).

The findings from this nationwide registry study are in keeping with other studies also having found associations between sociodemographic factors and COVID-19 vaccination among parents and their children [5,22–24]. The existing literature on COVID-19 vaccination coverage in Norway [4] has found significant differences in vaccination rates among adults by country of origin. These effects are qualitatively consistent with our findings, in that adult immigrants from Eastern European countries tend to have the lowest vaccination rates, while immigrants from Asian countries have a higher vaccination rate for both adults and adolescents.

The vaccination rates of immigrant groups tend to be similar as the rates in their country of birth [25]. A study from Norway showed a correlation between the vaccination rates of European-born immigrants and vaccination rates in their country of birth [26]. To understand the mechanisms at work for vaccination among immigrants, this relationship may be fruitful to explore further. Thus, we were interested in further exploring whether there might be differences in vaccination rates according to the time spent in the host country for both immigrants and adolescents with immigrant parents. Differences in vaccine behavior across birth countries might diminish over time if individual attitudes toward vaccinations gradually converge to those of the host country. To analyze this possibility, we estimated a model separately for adolescents born in Norway and adolescents born abroad. If there is assimilation over time in the willingness to get vaccinated, we would expect country background to have smaller impacts for the former group relative to the latter. The association between country background and vaccination rates, however, appeared to be persistent. It is consistent with the findings from the Norwegian study by Vinjerui et al. [26] in which the authors found an association between COVID-19 vaccination rates among immigrants in Norway born in Europe and the vaccination rates in their country of birth. This suggests that the choice to receive a COVID-19 vaccine may be positively linked to attitudes and desires from countries of origin, which in turn may explain some differences between different immigrant backgrounds in Norway.

Some potential drivers behind the differences we see in vaccination rates between the age groups may be connected to differing

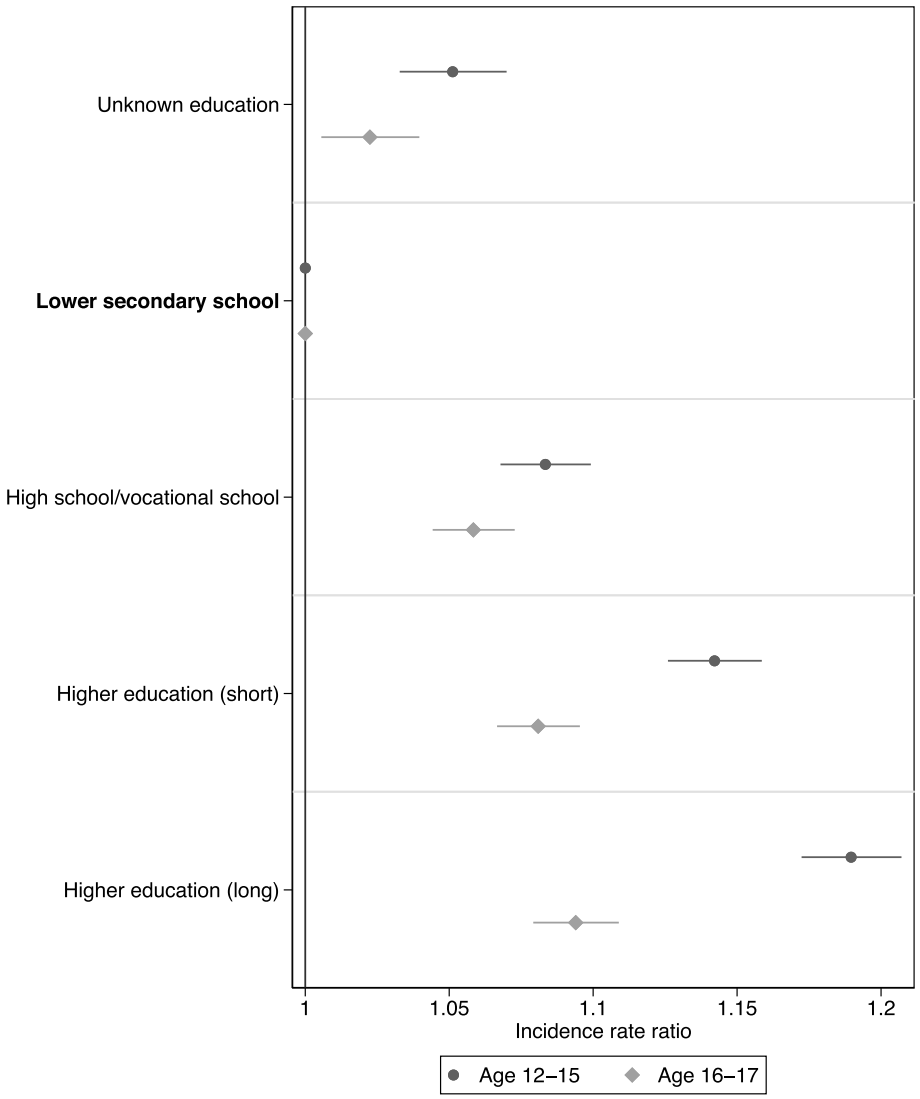

Fig. 3. Incidence rate ratio of being vaccinated with at least one dose COVID-19 vaccine by parents' education level (reference group: lower secondary school), stratified by age group (12–15 years or 16–17 years). Adjusted for country background, the children's age and sex, household income and county of residency.

recommendations and offers of vaccination(s) from the Norwegian health authorities. Although the vaccine was made available for both age groups examined in this study during Autumn 2021, only the older group of adolescents (16-17) was recommended the vaccine, whereas there was never a general recommendation to vaccinate the young adolescents (12-15). Previous studies have shown parents of adolescents to be more willing to vaccinate their children than those of young children [11,12], which might also impact the vaccination rates of the younger group. Furthermore, differences in vaccination rates may also potentially be driven by the fact that the younger group of adolescents required parental consent to be vaccinated, while adolescents above 16 could consent to their own medical care, including vaccinations.

In addition, Byrne et al. found that the greatest predictor of COVID-19 vaccine acceptance among adolescents (16 years and older) was their parents' acceptance of the vaccine [27]. Other studies have also found that parents' acceptance of COVID-19 vaccine for their children is of importance [22,28,29]. If differences in parents' vaccination status were a primary driver of our results, we would expect to estimate smaller effects when children of unvaccinated parents are excluded from the sample. In our study, we saw that for most country backgrounds, the IRR of vaccination did not vary substantially between adolescents per country background when we included adolescents with vaccinated parents. Moreover, in a related exercise in which we used the same predictors and covariates, the pattern suggested that the estimated country of origin-effects reflect factors that affect both adolescents and adults, even though this exercise was somewhat underpowered (wide CI).

Finally, the age groups studied had experienced strict social restrictions throughout the pandemic, which potentially could have made an impact on their decision-making process regarding COVID-19 vaccination. While limited information exists on adolescent's motivations to get vaccinated, some studies link COVID-19 vaccination willingness with desire to stay healthy, protect others, and minimize spread of COVID-19, to adolescents' motivation to get vaccinated [30,31]. Additionally, vaccination willingness has been linked to getting the vaccine as a means to lift COVID-19 restrictions and end the pandemic [32]. However, social restrictions applied to both age groups during the pandemic, thus it is uncertain to which extent this would directly impact large differences in their vaccination status.

The potential drivers we have proposed may not affect the differences in vaccination rates alone, but together they may

influence the differences we have observed in vaccination rates by immigrant background, household income and parents' education.

The are several strengths connected to the data used in this study. First, access to high-quality administrative register data and individual-level data covering the entire population in Norway. Second, the possibility to link data from several administrative sources, which enabled us to provide important information on the study population, such as immigrant background and sociodemographic status of those who received COVID-19 vaccines. Third and finally, the data availability, which enabled us to study the population from the first COVID-19 vaccine was administered up until September 2022.

There are also some limitations that may have influenced the certainty of our observations. First, we don't have full access to information on COVID-19 vaccines that have been taken in other countries, e.g. those who have been vaccinated in their country of birth. Survey data indicates that the share of adult immigrants in Norway that report receiving one or more vaccine doses abroad is low [33]. This finding in turn suggests that it is unlikely that unregistered vaccination abroad can explain the large differences in vaccination rates. Second, in order to make the necessary data linkages, only individuals who have a permanent identity number were included in the sample. Consequently, our analysis excluded some groups of immigrants, primarily undocumented immigrants and immigrants on short-term stays (up to six months).

The data available do not allow us to study the specific reasons that some adolescents have lower COVID-19 vaccination rates. However, some studies propose that parents' vaccine acceptance or hesitancy, among other potential explanations, can be drivers or barriers to vaccination [7–10,12,14,15,22,23,27–29]. Future studies should explore why some groups have lower COVID-19 vaccination rates than others.

Finally, it appeared in this study that immigrant background and sociodemographic factors among parents should be seen in coherence when we study differences in COVID-19 vaccination rates. Future studies on social inequality and COVID-19 vaccination should further explore associations between immigrant background and sociodemographic factors.

5. Conclusion

COVID-19 vaccination rates among adolescents varied by immigrant background and age group, with lower rates especially among adolescents with background from Eastern European countries and among younger adolescents. Both higher household income and higher parental education level were associated with higher vaccination rates among adolescents. We observed that older adolescents had higher vaccination rates than younger adolescents, and associations with parental sociodemographic factors were stronger in the younger age group. More focus should be directed at vulnerable groups in future pandemics. Furthermore, our results may help target measures to increase vaccination rates among adolescents.

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Data availability

The authors of this study are not permitted to share the data as the data is not publicly available, due to privacy laws/regulations. However, data from the registries in Beredt C19 are accessible to authorized researchers after application and ethical approval through https://www.helsedata.no, which is administrated by the Norwegian Directorate of eHealth. Requests to access datasets and do-files from Stata should be directed to helsedata.no by online submission.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2023.04.079.

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