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Ethnicity and immunization coverage among schools in Israel

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ABSTRACT

Objective. Recent years have seen a global trend of declining immunization rates of recommended vaccines that is more pronounced among school-age children. Ethnic disparities in child immunization rates have been reported in several countries. We investigated an effect of ethnicity on the vaccination rates of immunizations routinely administered within schools in Israel.
Design. Data were collected from the Ministry of Health database regarding immunization coverage for all registered Israeli schools (3736) in the years 2009–2011. Negative binomial regression was used to assess the association between school ethnicity and immunization coverage while controlling for school characteristics.
Results. The lowest immunization coverage was found in Bedouin schools (median values of 75.1%, 81.5% and 0% for the first, second and eighth grades, respectively) in 2011. During this year, vaccination coverage in the first and second grades in Jewish schools was 1.51 and 1.35 times higher, respectively, compared to Bedouin schools. In the years 2009 and 2010, no significant increase in risk for lower vaccination rate was observed in Bedouin schools, and children in Arab and Druze schools were more likely to have been vaccinated.
Conclusion. The lower vaccination refusal rate found in Bedouin schools supports the hypothesis that difficulties related to accessibility constitute the main problem rather than noncompliance with the recommended vaccination protocol for school-age children, featuring higher socio-economic status groups. Our study emphasizes the importance of identifying, beyond the national-level data, subpopulation groups at risk for non-vaccination. This knowledge is essential to administrative-level policy-makers for the allocation of resources and the planning of intervention programs.

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Background

The potential for infectious disease outbreaks depends on, among other factors, the number of susceptible people and their distribution in the population (Anderson and May 1985). From an epidemiological perspective, herd immunity against an infectious

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disease is achieved by a high rate of immunization combined with a lack of geographical clustering of susceptible individuals (Gordis 2009). Given these factors, the recent global trend of declining compliance with vaccination recommendations is worrying (Luthy et al. 2011). Immunization coverage is especially low in later childhood compared with infancy (Theeten et al. 2009).

Factors that may explain the decline in vaccination rates can be divided into two major categories: the accessibility of the service provided (Knesset-Israel 2008; Balicer et al. 2011) and personal characteristics. Among personal characteristics (Knesset-Israel 2008; Theeten et al. 2009; Fernandez, Awofeso, and Rammohan 2011; Mollema et al. 2012), ethnicity has previously been reported to be associated with difference in immunization rates. Janks et al. studied the factors affecting parental acceptance of the H1N1 vaccine in the UK and found a higher intention to accept vaccination among parents of non-White primary school children (2012). Findings from the 2012 national and state vaccination coverage report of 13–17-year-old children in the USA showed higher meningococcal conjugate (MenACWY) and human papillomavirus (HPV) vaccination coverage among non-White racial groups. Completion of the entire three-dose series of the HPV vaccination, however, was lower among Hispanics and African-American children compared with Whites. Measles, mumps, and rubella (MMR) and hepatitis B vaccination coverages were also lower among Hispanics compared with Whites (CDC 2012).

In Israel, routine vaccines are provided in schools within the framework of school health services. The Israeli public school system comprises primary schools for children aged 6–12 years (1st–6th grades), middle schools for children aged 12–15 years (7th–9th grades), and high schools for children aged 15–18 years (10th–12th grades). Most schools in Israel are subsidized by the state and are subordinate to the Ministry of Education (MOE). A small portion of the schools are independent, informal schools, the majority of which serve the orthodox religious sector.

All school health services in Israel are provided free of charge, as stipulated by the National Health Insurance Law (Ministry of Health [MOH] 2010), regardless of the schools legal status. Routine vaccinations for children older than 6 years are provided by school health services in the first (MMRV: measles, mumps, rubella and varicella), second (dTap-IPV: diphtheria, tetanus, acellular pertussis and polio) and eighth (dTap) grades.

In the past, school health services were provided by the MOH. School nurses were a part of the routine school staff, providing first aid, vaccinations and surveillance tests. In 2010 the service was fully decentralized and the provision of all school health services was by a private organization. Services are still provided free of charge, but the change was accompanied by extensive consequences in terms of manpower, the availability of nurses in schools and working methods (Grotto 2008; Levental 2008). As school nurses are no longer a part of the school staff, they visit the schools under their jurisdiction to provide vaccinations and surveillance tests on scheduled days.

Consistent with the global trend, vaccination coverage among school children in Israel has been declining in recent years. For example, statistics for the years 2003 and 2007, respectively, recorded declines from 96.3% to 90.4% in the first grade, from 95% to 75% in the second grade and from 93.5% to 75.6% in the eighth grade in all schools in Israel (Knesset-Israel 2008).

In parallel with this decline in immunization coverage of the population, several outbreaks of communicable diseases have occurred. For instance, although the incidence of measles declined dramatically since the update of the routine immunization program in 1990, there was an extensive outbreak in 2007–2008. During this outbreak, 1467 measles cases were reported, and only 4.6% of the affected individuals had been fully vaccinated for their age (Anis et al. 2009). One year later, despite high national immunization coverage (90–97%), Israel experienced a large mumps outbreak with an increased incidence rate mostly among non-vaccinated orthodox yeshiva students (Anis et al. 2012).

Israel is known for its ethnic diversity. The majority of the population (80%) is Jewish, while the remaining 20% is mostly Arab. The non-Jewish minority groups include Druze, Bedouin and Arabs, all three of which are usually characterized by low socio-economic status (SES) and lower education levels (CBS 2013). Note that very few schools in Israel are ethnically integrated, and as such, children from the different ethnic groups usually study in separate schools. Findings from previous studies and reports in Israel about the association of ethnic origin and vaccination showed that it depended on the ages of the children examined, the specific vaccine studied and whether or not the vaccine was subsidized by the state (Novack et al. 2007; Muhsen et al. 2008; Gavrielov-Yusim et al. 2012). Government reports (Knesset-Israel 2008) and studies that focused on infants found that for some vaccines, immunization coverage among Arabs was higher. For example, Muhsen et al. found 94% MMR vaccination coverage among Jewish infants compared to 97% coverage among Arab infants (2008). Given that the threshold required for achieving immunity against measles ranges between 92% and 96% and that several infectious disease outbreaks have been reported in Israel despite the generally high immunization coverage, these observed differences in coverage rates are important (Anderson and May 1985).

However, there is also evidence of lower coverage among Arab children for the less accessible vaccines, that is, vaccines not included in the basic health basket (and therefore, not funded by the state) or vaccines provided to the adult population (Novack et al. 2007, Gavrielov-Yusim et al. 2012). These findings suggest that in cases of lower vaccination rates among the Arab population, various access factors (such as physical and economic) may be significant determinants, but it is not clear from the relevant studies whether these factors or refusal to vaccinate are more important.

In this study, we investigated the association of school ethnicity with routine vaccination rates among school children in the first, second and eighth grades.

Methods

Data source

We retrieved data from the MOE for all elementary and middle schools listed in the database, which includes all state and legal schools in Israel, during the years 2009–2011. In addition, despite lacking formal legal status, some Israeli schools (independent 'religious orthodox' schools) are nevertheless recognized by the MOE, and therefore, they are also represented in this database. Schools not listed in the database (unreported schools or schools within hospitals) were excluded from the analysis.

School data obtained from the database included school level of religiousness, education type, legal status, ethnicity and type of settlement where the school is located.

Variations in school legal status and level of religiosity are representative of different demographical populations, which vary in terms of family SES and parental education. In addition to the schools providing a standard education, there are also special education schools for children with special needs.

We used data from MOH records of school immunization rates in the years 2009–2011 that summarize the overall vaccination rate and refusal rate for each of the schools listed in the MOE database. From 2009 to 2010, data were reported in a paper-based format to the MOH by the school health providers. Reports included overall counts of the number of children eligible for vaccination, the number of children vaccinated and the number of refusals to vaccinate at each school. In 2011 the data were fully computerized and subsequent school immunization and refusal rates have since been retrieved from the national immunization registry (Stein-Zamir et al. 2010). Immunization coverage in Israel is calculated by the up-to-date method (Dayan et al. 2006).

Definition of variables

School ethnicities, defined by the MOE, are determined according to the dominant religion of the population residing in the city or settlement in which the school is located. Because each ethnic sector in Israel tends to live in a closed community, schools are naturally divided by ethnicity as well. Therefore, each school is characterized by a specific ethnic group based on the dominant ethnic origin of the residents in the locality/neighborhood in which the school is located. Schools were thus defined as Jewish, Druze, Bedouin or Arab (Christian and Muslim).

The available data included the counts of children who were eligible for vaccination, who were vaccinated and who refused vaccination. Immunization rates of schools were defined as the proportion of children vaccinated with routine vaccinations, in grades one (MMRV), two (dTap-IPV) and eight (dTap) separately, from among the total number of children eligible for vaccination. Children were considered eligible for vaccination in the absence of contra indications to the vaccine components or documentation of immunization due to former illness or vaccination. The refusal rate for vaccination was calculated for each school as the proportion of children who refused vaccination from among the total number of children eligible for vaccination.

The school SES was defined according to the CBS by the overall SES of the population residing in the statistical area in which the school was located. The index is a scale from 1 to 20 indicating the SES level of the population based on demography, education and average income, among other characteristics (CBS 2001). In addition, the proportion of mothers with academic educations (more than 12 years of education) was used as a proxy for the school SES.

Data analysis

Associations of immunization rate and school characteristics were analyzed using a chi-square test, an independent *t*-test, the Mann–Whitney test or the Kruskal–Wallis test, depending on the distribution of the variable. Due to overdispersion, the results of the multivariate analysis were adjusted separately for each grade using negative binomial regression models. In Bedouin middle schools, models were unstable because of zero

inflated distribution, and therefore, regression results for the eighth grade are not represented. Effect estimates are presented as relative risks (RR) and 95% confidence intervals (CI). Changes in immunization rates over the years were evaluated using the Friedman test. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NCM USA). Probability values <.05 were considered statistically significant.

Sensitivity analyses

Approximately 20% of the MOE registered schools were not registered in the MOH immunization reported, and therefore, their data were defined as missing. We performed several sensitivity analyses to exclude the possibility of bias and to verify the consistency of our results. For this analysis, we chose the year of 2011 and used three different missing value imputation methods based on the minimal immunization rates, the median immunization rates and the predicted immunization rate values (Kats 1999). In the third approach, we predicted immunization rates using linear models that included the school characteristics (school district, proportion of parents with an academic education, type of locality in which the school was located (city/rural) and school legal status (school has formal legal status – yes/no).

Results

We identified 3736 schools, of which 1435 were strictly elementary schools (grades 1–6), 1183 comprised both elementary and middle schools, and 1118 were exclusively middle schools (grades 7–8). The majority of the schools were Jewish schools. School characteristics are presented in Table 1. Both the SES index and the maternal education proxy for

Table 1. School characteristics by ethnicity.

	School ethnicity				
School characteristics	Bedouin *n* = 128	Druze *n* = 66	Arab *n* = 486	Jewish *n* = 3122	*p* Value
Religious school, % (*n*)					
No	100 (128)	100 (66)	100 (486)	45.3 (1288)	
Traditional	Not applicable	Not applicable	Not applicable	21.9 (623)	< .01
Orthodox (yeshiva)	Not applicable	Not applicable	Not applicable	32.6 (927)	
Special education schools[a], % (*n*)	4 (5)	7.6 (5)	8.3 (40)	6.9 (197)	.399
Socio-economic index[b]					
Median(Min; Max)	2 (1; 4)	5 (4; 8)	5 (2; 14)	10 (2; 20)	< .01
Percent of mothers with academic education[c]					
Median (Min; Max)	2.7 (0; 40)	9.1 (0; 40)	11.7 (0; 100)	38.2 (0; 100)	< .01
Immunization coverage, First grade					
Median (Min; Max)	75.1 (0; 100)	98.4 (0; 100)	98.2 (0; 100)	91.6 (0; 100)	< .01
Second grade					
Median (Min; Max)	81.5 (0; 100)	98.1 (50; 100)	98.0 (0; 100)	91.0 (0; 100)	< .01
Eighth grade					
Median (Min; Max)	0 (0; 97.5)	92.1 (0; 100)	93.7 (0; 100)	86.5 (0; 100)	< .01

Notes: School baseline characteristics and immunization rates are presented in Table 1 for the year 2011. Categorical characteristics were compared using the chi-square test and continuous characteristics were compared using the Kruskal–Wallis test.

[a]Schools in Israel provide a standard education or a special education for children with special needs.

[b]The socio-economic index reflects the SES of the population residing in the statistical area in which the school is located.

[c]Academic education refers to more than 12 years of education.

SES indicated higher SES among Jewish schools compared to all of the Arab sectors. In all ethnic groups, the proportion of mothers with academic educations varied widely, with a minimum proportion of 0%. For example, the maximum value among Jewish and Druze schools was 100% compared to a maximum of 40% among Bedouin and Arab schools. Approximately 97% of Druze and Bedouin schools are State schools, that is, they are subject to MOE guidelines. In comparison, only about 50% of the Jewish schools are State schools, and the remainder comprises state-religious and ultra-Orthodox schools.

Ethnicity and immunization rates

The median national immunization coverage in 2011was 92.7% in the first grade, 92% in the second grade and 87.5% in the eighth grade. The highest immunization rates were observed in Arab schools (median values of 98.2%, 98% and 93.7%, in the first, second and eighth grades, respectively). The lowest immunization rates were found in Bedouin

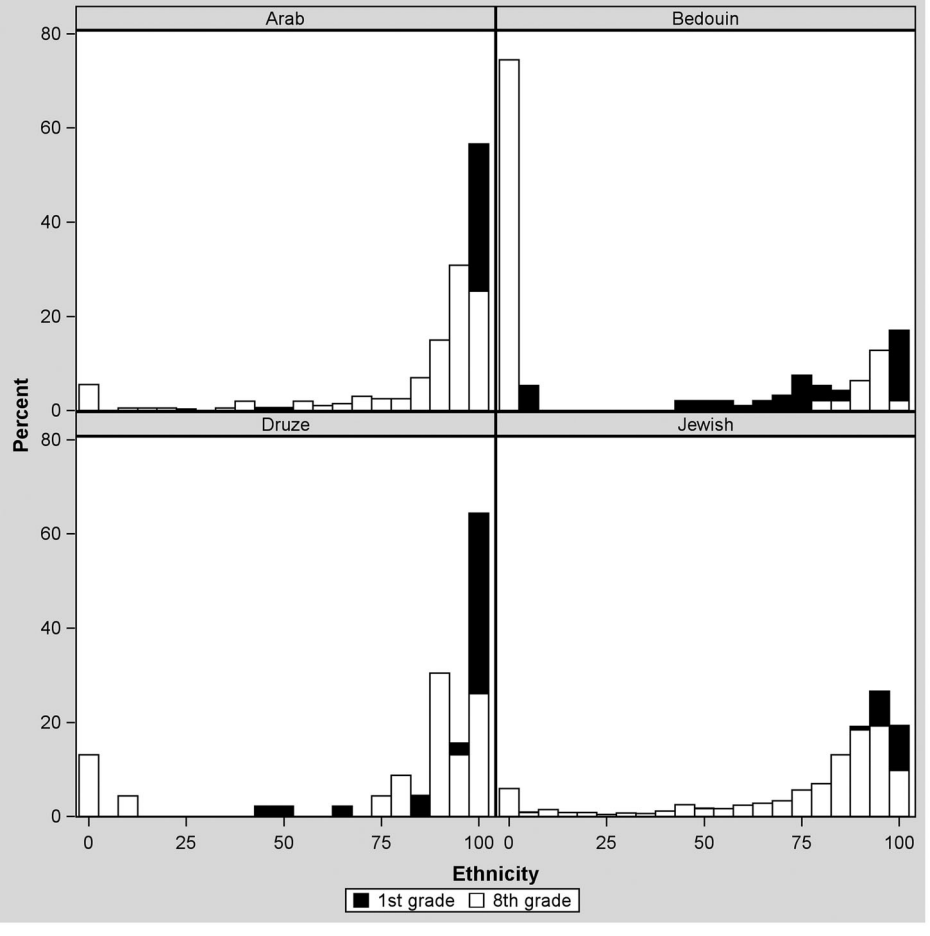

Figure 1. Percent of immunization rates in the first and eighth grades, by ethnicity, in the year 2011. Immunization rates in the second grade, which were similar to those observed in the first grade, are not presented.

schools (median values of 75.1%, 81.5% and 0%, in the first, second and eighth grades, respectively) (Table 1), where the immunization rate in approximately 80% of the middle schools was 0% (Figure 1).

In 2011, compared to first- and second-grade children in Jewish non-orthodox schools, children in Bedouin schools were less likely to be vaccinated (RR 0.66, $p < .001$ and RR = 0.75, $p < .001$, respectively), and children in Arab schools were more likely to be vaccinated (RR 1.08, $p < .01$ in both the first and second grades). In the years 2009 and 2010, compared to Jewish non-orthodox schools, no significant increase in risk for non-vaccination was observed in Bedouin schools, Moreover, children in Arab and Druze schools were more likely to be vaccinated than children in Jewish non-orthodox schools (Table 2).

When comparing median immunization rates over the years, we found a decline in the coverage in Bedouin schools. Immunization coverage declined to 75.1% among first grade students, 81.5% among second grade students and 0% among eighth grade students in 2011 (p value < .01). Among Jewish and Druze schools, immunization rates remained similar over the studied years. In Arab schools, immunization rates declined slightly only in the eighth grade (p value < .01) (Figure 2).

Refusal rates

Despite the generally higher immunization rates of Jewish children, vaccination refusal rates were higher in Jewish schools than in Bedouin schools in all the years analyzed (Table 3).

Table 2. RR for the association of immunization coverage and school characteristics, based on negative binomial regression results, for the years 2009–2011.

	2009		2010		2011	
	RR (95% CI)	*p* Value	RR (95% CI)	*p* Value	RR (95% CI)	*p* Value
First grade						
Ethnicity						
Jewish non-orthodox	Reference		Reference		Reference	
Jewish orthodox	0.99 (0.96; 1.02)	.882	1.00 (0.96; 1.04)	.835	0.97 (0.89; 1.05)	.518
Arab	**1.05 (1.03; 1.07)**	<.001	**1.08 (1.05; 1.12)**	<.001	**1.08 (1.02; 1.14)**	.002
Druze	**1.08 (1.03; 1.12)**	<.001	**1.12 (1.05; 1.20)**	<.001	1.03 (0.92; 1.16)	.528
Bedouin	0.98 (0.95; 1.02)	.558	1.00 (0.95; 1.06)	.769	**0.66 (0.61; 0.73)**	<.001
Education type						
Standard	Reference		Reference		Reference	
School for children with special needs	**0.88 (0.86; 0.91)**	**<.001**	**0.70 (0.67; 0.73)**	<.001	**0.66 (0.58; 0.75)**	**<.001**
Second grade						
Ethnicity						
Jewish non-orthodox	Reference		Reference		Reference	
Jewish orthodox	**1.04 (1.02; 1.07)**	<.001	1.01 (0.97; 1.06)	.484	0.99 (0.92; 1.06)	.850
Arab	**1.05 (1.03; 1.07)**	<.001	**1.09 (1.06; 1.12)**	<.001	**1.08 (1.04; 1.13)**	.001
Druze	**1.08 (1.04; 1.12)**	<.001	**1.10 (1.03; 1.18)**	.002	1.07 (0.97; 1.18)	.145
Bedouin	1.01 (0.98; 1.04)	.402	1.05 (0.99; 1.11)	.059	**0.75 (0.69; 0.81)**	<.001
Education type Standard						
School for children with special needs	Reference **0.79 (0.77;0.81)**	<.001	Reference **0.62 (0.59;0.64)**	<.001	Reference **0.49 (0.43;0.55)**	<.001

Note: Relative risks and 95% confidence intervals shown for the association of school characteristics and immunization coverage of the MMRV vaccine in the first grade and dTap-IPV vaccine in the second grade. Models were performed in each year separately and were adjusted for school district and for the percent of mothers with academic education as a proxy for school SES level.

**p Value < 0.05.

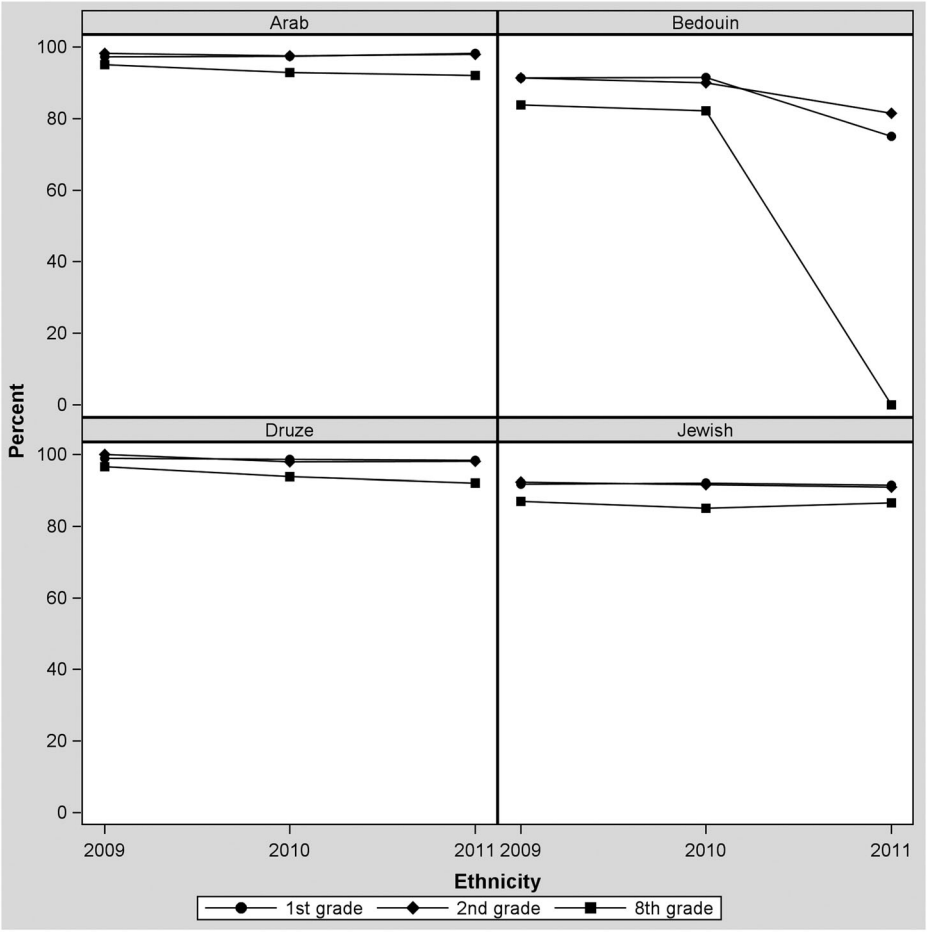

Figure 2. Median immunization coverage by school ethnicity, in the first, second and eighth grades, from 2009 to 2011. Immunization rates are not normally distributed; therefore, median immunization rates are represented. Difference of immunization rates over time were evaluated using Friedman's test for each ethnic sector and each grade separately. *p* Value < .05 was considered significant. *p* Values for the differences in immunization rates in the first, second and eighth grades were as follows: .448, <.001 and .007 in Jewish schools; .948, .09 and .08 in Druze schools. All immunization rate differences were significant in Arab and Bedouin schools ($p < .01$).

Sensitivity analyses

The distribution of school characteristics in our data-set was similar to that observed in schools with missing immunization data. Thus, approximately 85% of the schools with missing immunization data were Jewish schools, of which 29% were religious orthodox schools. The median SES index and the proportion of mothers with academic educations were similar in both databases. The proportion of schools for children with special needs was higher among schools with missing data compared to those for which data were available (12% versus 6%).

All imputation methods performed in the sensitivity analyses were consistent with our main results, which showed lower immunization rates in Bedouin schools and in schools

Table 3. Mean refusal rates for vaccination and absence from school, by ethnicity, in the years 2009–2011.

Mean refusal rates (%)	Bedouin 94 elementary schools 47 middle schools	Druze 44 elementary schools 23 middle schools	Arab 317 elementary schools 199 middle schools	Jewish 1771 elementary schools 1182 middle schools
2009				
first grade	3.32	2.11	6.06	9.96
second grade	3.29	3.81	4.73	9.33
eighth grade	3.90	1.39	9.76	12.62
2010				
first grade	1.00	0.02	0.56	3.51
second grade	1.51	0.07	0.85	2.97
eighth grade	1.82	0.10	2.19	3.56
2011				
first grade	0.23	0.00	0.25	2.87
second grade	0.41	0.17	0.18	2.39
eighth grade	0.06	0.14	0.60	2.03

Note: Refusal rates were calculated as the proportion of children who refused vaccination and the proportion of children absent from school on the day that vaccines were provided. The mean refusal and absence proportions are presented according to school ethnicity for the years 2009–2011.

for children with special needs. In the latter group, however, although the effect size estimates obtained from the different models were unstable, the direction of the associations remained unchanged (Table 4).

In addition, the results of a sensitivity analysis with SES index data included in the model were in accordance with our findings and did not change our inference.

Table 4. Sensitivity analysis for missing data imputation using the (a) original, (b) minimal, (c) median and (d) predicted immunization rates obtained from a linear regression, for the year 2011.

	RR (95% CI) Original immunization rates	RR (95% CI) Imputation with minimal immunization rate	RR (95% CI) Imputation with median immunization rate	RR (95% CI) Imputation with predicted immunization rates*
First grade				
Ethnicity				
Jewish non-orthodox	Reference	Reference	Reference	Reference
Jewish orthodox	0.97 (0.89;1.05)	0.94 (0.79;1.12)	0.99 (0.90;1.08)	0.97 (0.89;1.07)
Arab	**1.08 (1.02;1.14)**	1.06 (0.94;1.18)	**1.09 (1.02;1.16)**	**1.09 (1.02;1.16)**
Druze	1.03 (0.92;1.16)	1.02 (0.79;1.31)	1.02 (0.89;1.18)	1.02 (0.89;1.17)
Bedouin	**0.66 (0.61;0.73)**	**0.62 (0.51;0.76)**	**0.70 (0.63;0.78)**	**0.70 (0.62;0.78)**
Education type				
Standard	Reference	Reference	Reference	Reference
School for children with special needs	**0.66 (0.58;0.75)**	**0.26 (0.23;0.30)**	**0.92 (0.86;0.98)**	**0.85 (0.79;0.91)**
second grade				
Ethnicity				
Jewish non-orthodox	Reference	Reference	Reference	Reference
Jewish orthodox	0.99 (0.92;1.06)	0.96 (0.81;1.14)	0.99 (0.91;1.08)	0.98 (0.90;1.07)
Arab	**1.08 (1.04;1.13)**	1.11 (0.99;1.25)	1.08 (1.02;1.15)	1.09 (1.03;1.15)
Druze	1.07 (0.97;1.18)	1.02 (0.79;1.32)	1.08 (0.95;1.23)	1.08 (0.95;1.23)
Bedouin	**0.75 (0.69;0.81)**	0.66 (0.55;0.81)	0.81 (0.73;0.90)	0.79 (0.71;0.87)
Education type				
Standard	Reference	Reference	Reference	Reference
School for children with special needs	**0.49 (0.43;0.55)**	**0.20 (0.18;0.23)**	**0.84 (0.78;0.89)**	**0.78 (0.73;0.83)**

*Predicted immunization rates were obtained from a linear model that included school characteristics [the school district, the proportion of parents with academic educations, the type of locality in which the school is located (city/rural) and the schools' legal status (i.e. school has formal legal status – yes/no)].

Discussion

Despite national immunization coverage in Israel that is higher than the threshold needed for herd immunity, there have been several outbreaks of infectious diseases in the last decade (ECDC 2012). Anis et al. described a measles outbreak that occurred in Israel in 2003 (2009), when 96% national immunization coverage was reported (Knesset-Israel 2008), a finding that emphasizes the importance of achieving high immunization coverage in population subgroups (Anis et al. 2009). Vaccination disparities between subgroups of the population may be due to differences related to service providers, infrastructures and vaccine subsidies. In addition to these factors, personal characteristics such as the trend of refusing some or all of the recommended childhood vaccines may also play a significant role (Knesset-Israel 2008). Our results revealed lower vaccination rates in schools within the Bedouin population.

One factor that is strongly related to the refusal to comply with a recommended childhood vaccination regime is the SES of the family. While most of the studies showed that lower SES and lower maternal education were associated with decreased compliance (Bundt and Hu 2004; Haynes and Stone 2004; Hak et al. 2005), we found a higher refusal rate among the Jewish population, which is characterized by a relatively high SES and a greater percentage of mothers who have received academic educations. In accordance with our finding, Owen et al. found that lower compliance was associated with higher maternal education level (2005).

Studies that compared immunization rates across ethnic groups in Israel, in the presence of an accessible health-care service (i.e. vaccines prescribed by the national health insurance law or vaccines provided for infants in the maternal and child health clinics), found higher immunization rates among Arab infants (Knesset-Israel 2008; Muhsen et al. 2008). Likewise, the highest immunization rates found in our study were among the Arab and Druze minorities.

In our study, lower vaccination rates in schools within the Bedouin population were found only in 2011. This finding could not be explained by higher refusal rates for vaccination, suggesting that refusal for vaccination was not the major determinant affecting the immunization coverage in these schools. Since school health services in Israel are provided within the schools, and since routine vaccinations are subsidized by the state and are given free of charge to all citizens, lack of accessibility depends on the functioning of the system rather than on the student's resources. Our results showed a lower probability of vaccination among Bedouin schools only in 2011. These findings, together with the reported extreme decrease in immunization coverage among eighth grade students in Bedouin schools during this year, imply that the Bedouin schools differ in terms of physical accessibility to the service provided. As mentioned, the decentralization process of the school health services that began in 2007 was completed in 2010. The dramatic change observed in Bedouin schools occurred in 2011, the year after school health services in Israel were fully decentralized. Although services were still provided free of charge, the supplier was a private organization rather than the MOH. This change was accompanied by extensive changes in manpower, the availability of nurses in schools and working methods (Grotto 2008; Levental 2008; IMA 2011; MOH 2011). Considering that approximately 40% of the Bedouin population in southern Israel resides in temporary houses in unrecognized localities, it is possible that the decrease in immunization rates was especially

pronounced in unrecognized Bedouin villages due to difficulties related to accessibility (e.g. lack of proper roads, reduced availability of health-care personnel).

A major strength of our study is the ability to identify, beyond the national immunization coverage data, susceptible subpopulations at risk for non-vaccination. This knowledge is essential for the administrative-level officials who make resource allocation decisions and who plan intervention programs. In Israel, for instance, the declining immunization rates led to a partial policy revision. Therefore, in an effort to increase accessibility, school health services in the southern district were nationalized in 2012 and are no longer provided by a private operator. At the end of July 2012, despite financial difficulties and a shortage of nurses, immunization rates were 20% higher than those achieved by the private provider (MOH 2013).

Among the limitations of our study is its ecological nature, that is, our assumption that children studying in a certain school are of the same ethnic group. Second, since the SES index was available for only 50% of the schools included in the study, we used maternal education to control for school SES for all schools that lacked SES data. We performed sensitivity analyses with the SES index added to the models and verified that our inferences were consistent with the observed data. In addition, according to the CBS, the highest school dropout rate has been among Bedouin children (CBS 2010). Since school immunization coverage refers only to children who are registered in the school system, the disparities between the Jewish and Bedouin schools may be even greater than those shown in our study. Finally, the computing process of the vaccination database was incomplete at the time this study was performed, and therefore, approximately 20% of the immunization coverage data were missing from our database. We verified that schools with and without missing data did not differ in terms of school characteristics, and therefore, the data are most probably missing at random. In addition, we performed sensitivity analyses to ensure that our results are consistent. The effect found for schools for special needs children was unstable, and as such, it should be interpreted with caution. Finally, a portion of the differences observed between immunization rates over the years may be due to differences in the service providers and in the qualities of immunization reports.

Key message

In conclusion, in a large population-based study, we were able to characterize, beyond the national immunization coverage data, subpopulations at risk for non-vaccination. Taken together, the lower refusal rate for vaccination and the higher immunization rates observed in Bedouin schools prior to the decentralization of school health services in 2010 supports our hypothesis that difficulties related to accessibility constitute the main problem rather than noncompliance with the recommended vaccination regimen. Our study emphasizes the importance of identifying the subpopulation groups at risk for non-vaccination, a factor that is not evident in national-level immunization coverage data.

Disclosure statement

No potential conflict of interest was reported by the authors.

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