Introduction

The main goal of a National Immunisation Programme (NIP) is to prevent disease and mortality through vaccination. In The Netherlands, at present, vaccination against diphtheria, pertussis, tetanus, poliomyelitis, Haemophilus influenzae serotype b (Hib) disease, mumps, measles, rubella, meningococcal C disease, hepatitis B, pneumococcal disease and human papillomavirus infection is included in the NIP. Vaccinations within the Dutch NIP are administered free of charge and voluntary. The overall national vaccine uptake is high: for newborns, 95% or higher. However, there are socio-geographically clustered groups that refuse vaccination on religious grounds. In addition to this well-known group of refusers, the remaining group that does not (fully) comply with the NIP is less well described. Recent experiences with human papillomavirus vaccination show that participation in nationwide vaccination programmes is not self-evident. The Netherlands is one of the few countries that register vaccine uptake on individual level since long time. In 2005, a new national vaccine register Præventis has an electronic connection with the Gemeentelijke Basisadministratie (GBA) and Præventis has an electronic connection with the GBA. Præventis includes a record for each child irrespective of participation in the NIP. A more detailed description of Præventis has been published previously. Children who had less chance to become fully vaccinated owing to migration or premature death were excluded from the analysis because they had less chance to get fully vaccinated owing to reasons that cannot be influenced by the NIP. The remaining population concerned 180456 individuals.

Methods

Study population

The study population consisted of all children living in The Netherlands and born in 2005 as registered in the national immunization register Præventis (reference date, 2 October 2009). Because all persons in The Netherlands are registered in the population register (gemeentelijke basisadministratie (GBA)) and Præventis has an electronic connection with the GBA, Præventis includes a record for each child irrespective of participation in the NIP. A more detailed description of Præventis has been published previously. Children who had less chance to become fully vaccinated owing to migration or premature death were excluded from the analysis because they had less chance to get fully vaccinated owing to reasons that cannot be influenced by the NIP. The remaining population concerned 180456 individuals.

Data collection

Individual data on vaccine uptake according to the valid vaccination schedule for newborns (table 1) for DTaP-IPV-Hib, MMR and Men C were extracted from Præventis (reference date, 2 October 2009). Hepatitis B vaccination was not included because only 19% of the study population was eligible for this vaccination (at that
newborns born in 2005

proxy for religious objection to vaccination. It is known that
left to high SES (=a low status score) on the right.

To make graphs for SES more easy to interpret, we have chosen
score reflects a low SES, whereas a low status score reflects a high

/C21

(0–4% SGP voters, 5–9% SGP voters, 10–14% SGP voters and

/C0

was used as a proxy for SES. This score that can range from ap-

/C20

was available at individual level in Præventis.

The percentage of voters for the Reformed Political Party (SGP) at
the elections of 2006, available at municipal level, was used as a proxy
for religious objection to vaccination. It is known that voters for this party are predominantly orthodox reformers
adherents who refuse vaccination for religious reasons.20

For data that were not available at individual level (the proxies for
SES and religious objection to vaccination), all children in a given
geographic area (i.e. postcode or municipality) were given the value
of that area.

Table 1 Vaccination schedule (until the age of 14 months*) for
newborns born in 2005

<table>
<thead>
<tr>
<th>Age</th>
<th>Injection 1</th>
<th>Injection 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months</td>
<td>DTaP-IPV/Hib</td>
<td>Hep B*</td>
</tr>
<tr>
<td>3 months</td>
<td>DTaP-IPV/Hib</td>
<td></td>
</tr>
<tr>
<td>4 months</td>
<td>DTaP-IPV/Hib</td>
<td></td>
</tr>
<tr>
<td>11 months</td>
<td>DTaP-IPV/Hib</td>
<td>Hep B*</td>
</tr>
<tr>
<td>14 months</td>
<td>MMR</td>
<td>Men C</td>
</tr>
</tbody>
</table>

DTaP-IPV/Hib, combination vaccine against diphtheria, tetanus,
pertussis, polio and H. influenzae type b; MMR, combination
vaccine against measles, mumps and rubella; Men C, vaccine
against meningococcal C disease; Hep B, vaccine against hepatitis B.

a: The vaccinations offered after the age of 14 months are not included in the analysis because coverage data for these vaccinations were not yet complete for birth cohort 2005 by 2 October 2009.
b: Only for children whose at least one parent was born in a country where hepatitis B is moderately or highly endemic and children
whose mothers tested positive for HBsAg (risk groups).

time, hepatitis B vaccination was offered to risk groups only). Vaccinations offered after the age of 14 months were also not included in the analysis because coverage data for these vaccinations were not yet complete for birth cohort 2005 by 2 October 2009.

Data on background characteristics were gathered at different levels of aggregation. For most children (96%), the country of
birth of their parents (a proxy for ethnic background) was
available at individual level in Præventis.

The ‘status score’ 2006, available at 4-digit postcode level,
was used as a proxy for SES. This score that can range from approx-
imately -4 to +4 is computed through principal component
analysis by The Netherlands Institute for Social Research, and takes
into account the average income per household in a given postcode
area as well as the percentage of households with low income,
without paid job and with low level of education.5 A high status
score reflects a low SES, whereas a low status score reflects a high
SES. To make graphs for SES more easy to interpret, we have chosen
to display the axis going from low SES (=a high status score) on the
left to high SES (=a low status score) on the right.

The percentage of voters for the Reformed Political Party (SGP) at
the elections of 2006, available at municipal level, was used as a proxy
for religious objection to vaccination. It is known that voters for this party are predominantly orthodox reformers
adherents who refuse vaccination for religious reasons.20

For data that were not available at individual level (the proxies for
SES and religious objection to vaccination), all children in a given
geographic area (i.e. postcode or municipality) were given the value
of that area.

Data analysis

In the descriptive analysis, we distinguished three different vaccine
uptake groups: ‘fully vaccinated’ = fully vaccinated for DTaP-IPV,
Hib, MMR and Men C; ‘partially vaccinated’ = fully vaccinated for
some, but not for all, of these vaccines; and ‘not vaccinated’ = for
none of these vaccines fully vaccinated. In this article, we focused on
the combined uptake for all vaccines together; the results per single
vaccine are included in the Supplementary Appendix and are only
mentioned briefly in the ‘Results’ section.

With regard to ethnic background, we defined separate categories
for those non-Western countries of birth that occur most frequently
among the Dutch population (Surinam, Netherlands Antilles/Aruba,
Turkey and Morocco; source: Statistics Netherlands). Only for the
descriptive analysis of SES (low SES: status score ≥1, low average
SES: 0 ≤ status score < 1, high average SES: -1 ≤ status score < 0 and
high SES: status score < -1) and religious objection to vaccination
(0–4% SGP voters, 5–9% SGP voters, 10–14% SGP voters and ≥15%
SGP voters), we stratified the population into four different
subgroups.

A hierarchical, or multilevel, logistic regression model was used to quantify associations between vaccination status (dichotomous variable: fully vaccinated children received the score of 1, and children who were not or only partially vaccinated received the score of 0, individual level) and the proxy variables for ethnic back-
ground (categorical variable, individual level), SES (continuous
variable, 4-digit postcode level) and religious objection to vaccin-
ation (continuous variable, municipal level). This model was chosen
to take the hierarchical structure of the data into account (both
individual as well as aggregated data). In this model, variables that
are not available at individual level become so-called group-level
predictors.7

We first investigated a possible non-linear relation between vac-
cination status and SES or religious objection to vaccination by
plotting the log odds of fully vaccinated children against a large
number of categories of these variables. The graph for SES (from
low SES to high SES) showed a non-monotonic increasing relation.
The graph for the logarithm of percentage SGP voters showed a
monotonic decreasing relation. We applied a log transformation
because this variable was highly skewed.

All analyses were performed in R.8 The model was fitted using
the lme4 package.9 Results are presented as odds ratios (ORs) with
95% confidence intervals. The reference group for ethnic
background was formulated as children whose both parents were
born in The Netherlands. A status score of 0 for SES and 0% SGP
voters for religious objection to vaccination were appointed as
reference value.

Additionally, we calculated the standard deviation (log odds) of the
estimated coefficients, which is a measure for the relative con-
tribution of a variable to the variation within the outcome variable.7

Results

Among children whose at least one parent was not born in The
Netherlands, the ‘partial’ uptake was relatively high (3.7–8.0%)
compared with children whose both parents were born in The
Netherlands (3.1%; table 2). However, among children whose both
parents were born in The Netherlands, the percentage that was not
vaccinated at all was the highest (2.0%). In postcode areas with a low
SES, the ‘partial’ uptake was also relatively high (5.5%) compared
with other SES groups (3.3–3.6%), and the ‘full’ uptake was
somewhat lower (93.7%; table 2). The most striking differences
were seen for religious objection to vaccination: in municipalities
with at least 15% SGP voters, ‘full’ uptake was only 79.1% compared
with 95.3% in municipalities with 0–4% SGP voters (table 2).

Results for each of the single vaccines are included in the
Supplementary Appendix (table A1).

The results of the multilevel logistic regression model showed
that, in general, ‘full’ uptake was lower among children whose

– one or both parents were born in another (non-)Western
country than The Netherlands [OW–OW: OR = 0.5 (0.4–0.6),
ONW–ONW: OR = 0.5 (0.5–0.6), NL–OW: OR = 0.8 (0.7–0.9),
NL–ONW: OR = 0.8 (0.7–0.96), OW–ONW: OR = 0.6 (0.5–0.8)],

– both parents were born in Turkey [TR–TR: OR = 0.7 (0.6–0.8)],

– both parents were born in Morocco [MA–MA: OR = 0.8
(0.7–0.9)],

– the country of birth was unknown for at least one parent
[Unknown: OR = 0.5 (0.5–0.6)] (figure 1).

Results per single vaccine are included in the Supplementary
Appendix (figure A1). In general, ‘full’ uptake for ‘single’ vaccines
was lower among children whose

– both parents were born in another Western country than The
Netherlands (OW–OW),

– both parents were born in another (non-)Western country than
The Netherlands (OW–ONW),

– both parents were born in another country than The Nether-
lands (ONW–ONW),

– both parents were born in Turkey (TR–TR),

– both parents were born in Morocco (MA–MA),

– the country of birth was unknown for at least one parent
(Unknown),

– one or both parents were born in another (non-)Western
country than The Netherlands (OW–OW: OR = 0.5 (0.4–0.6),
ONW–ONW: OR = 0.5 (0.5–0.6), NL–OW: OR = 0.8 (0.7–0.9),
NL–ONW: OR = 0.8 (0.7–0.96), OW–ONW: OR = 0.6 (0.5–0.8)),

– both parents were born in Turkey (TR–TR: OR = 0.7 (0.6–0.8)),

– both parents were born in Morocco (MA–MA: OR = 0.8
(0.7–0.9)),

– the country of birth was unknown for at least one parent
(Unknown: OR = 0.5 (0.5–0.6)) (figure 1).
### Table 2 Vaccine uptake (%) by determinants

<table>
<thead>
<tr>
<th>Country of birth of parents (individual level), proxy for ethnic background</th>
<th>N</th>
<th>Combined uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands–The Netherlands [NL–NL]</td>
<td>135982</td>
<td>94.9 3.1 2.0</td>
</tr>
<tr>
<td>The Netherlands–other country</td>
<td>18732</td>
<td>94.5 4.6 0.9</td>
</tr>
<tr>
<td>The Netherlands–Surinam [SR–SR]</td>
<td>1712</td>
<td>95.0 4.8 0.2</td>
</tr>
<tr>
<td>The Netherlands–Netherlands Antilles/Aruba [AN/AW–AN/AW]</td>
<td>901</td>
<td>95.9 4.0 0.1</td>
</tr>
<tr>
<td>The Netherlands–Turkey [TR–TR]</td>
<td>2256</td>
<td>94.8 4.9 0.3</td>
</tr>
<tr>
<td>The Netherlands–Morocco [NL–MA]</td>
<td>1637</td>
<td>94.8 4.9 0.3</td>
</tr>
<tr>
<td>The Netherlands–other Western [NL–OW]</td>
<td>7915</td>
<td>94.2 4.3 1.5</td>
</tr>
<tr>
<td>The Netherlands–other non-Western [NL–ONW]</td>
<td>4311</td>
<td>94.5 4.8 0.7</td>
</tr>
<tr>
<td>Other country–other country</td>
<td>18909</td>
<td>92.9 6.8 0.4</td>
</tr>
<tr>
<td>Surinam–Surinam [SR–SR]</td>
<td>1187</td>
<td>94.8 5.1 0.2</td>
</tr>
<tr>
<td>Netherlands Antilles/Aruba–Netherlands Antilles/Aruba [AN/AW–AN/AW]</td>
<td>296</td>
<td>95.9 3.7 0.3</td>
</tr>
<tr>
<td>Turkey–Turkey [TR–TR]</td>
<td>3592</td>
<td>93.6 6.2 0.2</td>
</tr>
<tr>
<td>Morocco–Morocco [MA–MA]</td>
<td>5910</td>
<td>93.7 6.2 0.2</td>
</tr>
<tr>
<td>Other Western–other Western [OW–OW]</td>
<td>1607</td>
<td>91.4 7.7 0.9</td>
</tr>
<tr>
<td>Other non-Western–other non-Western [ONW–ONW]</td>
<td>5467</td>
<td>91.5 8.0 0.5</td>
</tr>
<tr>
<td>Other Western–other non-Western [OW–ONW]</td>
<td>850</td>
<td>92.1 7.4 0.5</td>
</tr>
<tr>
<td>Unknown (for at least one parent) [Unknown]</td>
<td>6833</td>
<td>90.9 7.5 1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status score (4-digit postcode level), proxy for socio-economic status (SES)</th>
<th>N</th>
<th>Combined uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low SES (status score ≥1)</td>
<td>29783</td>
<td>93.7 5.5 0.8</td>
</tr>
<tr>
<td>Low average SES (0 ≤ status score &lt; 1)</td>
<td>57506</td>
<td>94.2 3.6 2.2</td>
</tr>
<tr>
<td>High average SES (−1 ≤ status score &lt; 0)</td>
<td>68590</td>
<td>94.7 3.3 2.0</td>
</tr>
<tr>
<td>High SES (status score &lt; −1)</td>
<td>24301</td>
<td>95.6 3.6 0.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage SGP voters (municipal level), proxy for religious objection to vaccination</th>
<th>N</th>
<th>Combined uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4%</td>
<td>163054</td>
<td>95.3 3.9 0.8</td>
</tr>
<tr>
<td>5–9%</td>
<td>8329</td>
<td>91.1 2.9 5.9</td>
</tr>
<tr>
<td>10–14%</td>
<td>4401</td>
<td>87.8 2.2 9.9</td>
</tr>
<tr>
<td>≥15%</td>
<td>4672</td>
<td>79.1 3.5 17.4</td>
</tr>
<tr>
<td>Total</td>
<td>180456</td>
<td>94.5 3.8 1.7</td>
</tr>
</tbody>
</table>

Full, fully vaccinated for DTaP-IPV, Hib, MMR and Men C (vaccination status = 1); Part, fully vaccinated for some but not for all vaccines (vaccination status = 0); Not, for none of the vaccines fully vaccinated (vaccination status = 0).

- both parents were born in a non-Western country other than Surinam, Netherlands Antilles/Aruba, Turkey or Morocco (ONW–ONW), with the exception of MMR vaccination,
- one parent was born in The Netherlands and the other parent in another Western country (NL–OW),
- the country of birth was unknown for at least one parent.

Postcode areas with a lower SES were associated with a lower ‘full’ vaccine uptake, and postcode areas with a higher SES were associated with a higher ‘full’ vaccine uptake. Furthermore, municipalities with more religious objection to vaccination were associated with a lower ‘full’ vaccine uptake. The same trend for SES and religious objection to vaccination was seen for each of the ‘single’ vaccines; results per single vaccine are included in the Supplementary Appendix (figure A2 and A3).

Based on the standard deviation (log odds) of the estimated coefficients, ethnic background and religious objection to vaccination had the greatest relative contribution to the variation within the vaccine uptake; the influence of SES was less outspoken (figure 2).

**Discussion**

In general, the vaccine uptake for the NIP in The Netherlands is high. However, even if the national uptake is high, it is always important to investigate whether there are specific groups where the uptake is lower and improvement might be achievable. The introduction of the electronic registration system Præventis in The Netherlands easier. The possibility of combining existing data sets with vaccination coverage data could be interesting for other countries as well, especially for those countries with a relatively low vaccination coverage, but even in The Netherlands, we were able to identify risk groups.

This study showed that in The Netherlands, ethnic background and religious objection to vaccination had the greatest relative contribution to the variation within the vaccine uptake; the influence of SES was less outspoken. The effect of religious objection to vaccination is known in The Netherlands since long time. The full vaccine uptake was considerably lower in municipalities with a high percentage of SGP voters (this region is called the Bible belt), which was used as a proxy for religious objection to vaccination. Owing to the limited number of people with religious objection to vaccination (approximately 1.3% of the Dutch population is a member of one of the orthodox reformed denominations), the effect on the national vaccine uptake is small. However, the low uptake among this group regularly results in epidemics (i.e. poliomyelitis in 1992/1993, measles in 1999/2000, rubella in 2004/2005 and mumps in 2007/2008).

With regard to ethnic background, the results of the study showed that in some groups (OW–OW, ONW–ONW, NL–OW, NL–ONW, OW–ONW, TR–TR, MA–MA, Unknown), the ‘full’ vaccine uptake was lower. The impact of ethnic background is not so well known in The Netherlands. Although the differences between subgroups by ethnic background are not as outspoken as for religious objection to vaccination, these subgroups concern a considerable part (approximately one-fifth) of the population and are therefore not negligible. Strikingly, almost all subgroups had a higher ‘partial’ uptake but less conscientious refusers than the group with both parents born in The Netherlands. Mikolajczyk et al. also concluded that lower acculturation was associated with higher risk of incomplete vaccination but lower risk of lacking vaccination than in the indigenous population. It seems that migrant groups are willing to vaccinate, but are less likely to complete the NIP fully and in time compared with children with both parents born in The Netherlands. So, improvement of the full vaccine uptake among migrant groups might be achievable.
The outreach of the child health services (responsible for administering the NIP vaccinations at local level) in The Netherlands is high, also among migrant groups. However, the contact frequency among immigrants in Amsterdam was lower, which might be a reason for the relatively high 'partial' participation of migrant groups in the NIP. A possible explanation could be that foreigners (persons with at least one parent born abroad) in The Netherlands are known to change their residence more often. If these movements are not reported (in time) to the municipality (and incorporated into Præventis), the parents will not receive the invitation letter with the call for the next vaccination of their child (in time). Furthermore, children within migrant groups are more often born abroad. Children born abroad are more often vaccinated according to an adapted immunization schedule and miss the intensive contact with the child health services in the first year of life, in which a lot of information on vaccination is provided. However, in our study, we only included children born in The Netherlands. Other factors that could play a role are the language barrier, unfamiliarity with the health care system, through which the (information) service might not be sufficient for these groups, or a different opinion regarding specific vaccinations. Further research is needed to reveal the reasons behind these differences by ethnic background to be able to come up with suitable and effective interventions. For the organizations involved in administering vaccinations, it is important to be aware of these differences by ethnic background in their communication with parents.

In general, postcode areas with a lower SES had a lower full vaccine uptake, whereas postcode areas with a higher SES had a higher full vaccine uptake. However, the influence of SES was less

Figure 1 Adjusted odds ratio (OR; hierarchical logistic regression model) for vaccination status by country of birth of parents (proxy for ethnic background, individual level; reference: NL–NL), status score (proxy for socio-economic status (SES), postcode level; reference: SES = 0), percentage SGP voters (proxy for religious objection to vaccination, municipal level; reference: % SGP voters = 0). The reference is always indicated by a dotted line at OR = 1. *A high status score reflects a low SES, whereas a low status score reflects a high SES. To make graphs for SES more easy to interpret, we choose to display the axis going from low SES (a high status score) on the left to high SES (a low status score) on the right.

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In general, postcode areas with a lower SES had a lower full vaccine uptake, whereas postcode areas with a higher SES had a higher full vaccine uptake. However, the influence of SES was less
outspoken than for ethnic background and religious objection to vaccination. Van der Wal et al. also found that the influence of socio-economic differences on vaccination coverage is limited.\(^\text{18}\)

In postcode areas with a low SES, the ‘partial’ uptake was relatively high. So, this might also be a group where future improvement of the vaccine uptake might be achievable if there is more information about the reasons behind partial participation.

This study concerned a descriptive research based on existing data on background characteristics for a large group of children. We have to keep in mind that associations between determinants and vaccination status were quantified by a hierarchical logistic regression model. Therefore, associations at aggregated levels do not directly apply to individuals, but to the group of individuals within a given geographic area. The presented analyses give information on determinants of vaccine uptake in The Netherlands but did not reveal in much detail the reasons behind partial or no participation in the NIP. In general, lower vaccine uptake is known to be linked with different factors. Most evidence is available for the following seven factors: vaccine factors, health care system and/or government, information needs, disease factors, parenting/social context, practicalities and demographics. Vaccine factors include general side effects/safety concerns or lower perceived vaccine effectiveness and importance. Health care system and/or government issues concern lower trust in the health care system and/or government or dissatisfaction with the communication with health professionals. Information needs indicate perceived inadequacy of information or knowledge. Disease factors include lower perceived disease severity, lower perceived likelihood of catching the disease or preference for natural immunity. Parenting/social context involves disinclination to vaccine for the benefit of wider society, valuing parents’ right to choose to vaccinate, lack of peer support for decision and engagement in personal research. Practicalities could be having missed or declined vaccinations previously, planning to give vaccinations in the future, perceived contraindications on the appointment day, difficulty finding time (and childcare for other children) for the immunization appointment and for pre-decisional research, parents’ own phobias and anticipated guilt, problems with getting to the clinic or poor facilities within the clinic and uncertainty about who was to arrange the appointment. Related demographics are lower parental income, lower parental education and the child in question not being firstborn.\(^\text{19}\) Besides efforts to remove practical barriers, one of the implications for policy and practice as mentioned by Brown et al. is that personal advice of health professionals should include reinforcing and discussing points that are already addressed in generic information material provided routinely to parents. Furthermore, multifactorial interventions could aim to identify factors on which parents are not polarized and improve attitudes towards these. Additionally, training for health professionals could focus more on improving parents’ satisfaction with vaccination consultations and fostering trusting relationships with parents with regard to immunization.\(^\text{19}\) An important point mentioned by parents of unvaccinated children is that not enough time was allocated for questions and discussions regarding vaccination.\(^\text{20}\) If we want to provide parents with tailored information, address myths about vaccination, give facts about safety and share success stories, as suggested by Kassianos,\(^\text{21}\) it is even clearer that additional time might be needed for vaccination consultations. Qualitative research is needed to shed more light on the specific reasons behind the lower vaccine uptake among certain groups within the Dutch situation. Recently, qualitative research has been started in The Netherlands as preparation on the development of a vaccination monitor. With these tools, we hope to find ways to adapt communication strategies and invitation policy to further maximize the vaccine uptake of the NIP in The Netherlands in the future.

Conclusions

Despite the high vaccine uptake in The Netherlands, there is a responsibility for non-participants and for keeping up the vaccination coverage on a high level. By combining existing data on background characteristics with data from the national immunization register Præventis, we were able to indentify determinants of vaccine uptake. This research might be an example for other countries.

The impact of ethnic background and SES is not as well known in The Netherlands as the effect of religious objection to vaccination, and deserves more attention. Future research should focus on reasons behind these determinants to find out whether the uptake of certain groups could be improved in the future by changing communication strategies and invitation policy. It is especially important to get more insight into the reasons behind ‘partial’ participation in the NIP, as these parents do not reject vaccination in general and optimization of vaccination coverage might be achievable.

Supplementary Data

Supplementary data are available at EURPUB online.

Acknowledgements

The authors would like to thank Petra Oomen [RIVM–Regional Coordination of Programmes/Purchase, Storage and Distribution (RCP/IOD)] for providing the individual data from the national immunization register Præventis. Preliminary results were presented through a poster presentation at the 29th Annual Meeting of the European Society for Paediatric Infectious Diseases (ESPID) in the Hague, The Netherlands, 7–11 June 2011. A.v.L. drafted the manuscript, and J.v.d.K. performed the multilevel logistic regression model analysis and drafted the manuscript regarding this
component. P.d.H., I.D. and H.d.M. critically revised the manuscript. All authors read and approved the final manuscript.

Conflicts of interest: None declared.

Key points
- Availability of a national immunization register enables a country to identify determinants of (incomplete) vaccination.
- The impact of ethnic background and SES is not as well known in The Netherlands as the effect of religious objection to vaccination, and deserves more attention.
- It is especially important to get more insight into the reasons behind ‘partial’ participation in the NIP, as these parents do not reject vaccination in general and optimization of vaccination coverage might be achievable.

References