Measuring vaccination coverage in a hard to reach minority

Wilhelmina L.M. Ruijs 1,2, Jeannine L.A. Hautvast 1, Wilke J.C. van Ansem 1, Reinier P. Akkermans 1, Kees van’t Spijker 3, Marlies E.J.L. Hulscher 4, Koos van der Velden

1 Radboud University Nijmegen Medical Centre, Department of Primary and Community Care, Nijmegen, The Netherlands
2 Municipal Health Service GGD Rivierenland, Tiel, The Netherlands
3 NPV Dutch Patients’ Association, Veenendaal, The Netherlands
4 Radboud University Nijmegen Medical Centre, Scientific Institute for Quality of Healthcare, Nijmegen, The Netherlands

Correspondence: Wilhelmina L.M. Ruijs, Department of Primary and Community Care, Radboud University Nijmegen Medical Centre, PO Box 9101, 6500 HB Nijmegen, The Netherlands, tel: +31 24 36 55638, fax: +31 24 36 19561, e-mail: h.ruijs@elg.umcn.nl

Background: Although childhood vaccination programmes have been very successful, there are some hard to reach minority groups that object to vaccination. The Netherlands has experienced several epidemics of vaccine-preventable diseases, confined to the orthodox Protestant minority. However, vaccination coverage in this minority is still unknown and this hampers prevention and control of epidemics. Methods: We estimated vaccination coverage among the orthodox Protestant minority and its various subgroups (denominations), using two sub-studies with different design and study population. For both sub-studies separately, we determined overall vaccination coverage and vaccination coverage per denomination. The results were compared and discussed. Results: An online survey was filled out by 1778 orthodox Protestant youngsters, invited via orthodox Protestant media using a snowball method. Next to that, results of a national sample study on vaccination were used, of which only orthodox Protestant respondents were included in our analyses (N = 2129). Overall vaccination coverage among orthodox Protestants in The Netherlands was estimated to be at minimum 60%. Moreover, in both sub-studies three clusters of denominations could be identified, with high (>85%), intermediate (50–75%) and low (<25%) vaccination coverage. Conclusion: The integration of both sub-studies, with their own specific strengths and weaknesses, added to our insight in the vaccination coverage in this minority. Based on these results, we recommend to focus prevention and control of vaccine-preventable diseases on the orthodox Protestant subgroups with intermediate and low vaccination coverage.

Introduction

Childhood vaccination programmes have been very successful in controlling infectious diseases. However, even in affluent societies like in Western Europe, there are minority groups with low vaccination coverage. 1 Some marginalized groups are not sufficiently reached by vaccination programmes 2–4 and an increasing number of parents refuse vaccination because of philosophical objections and safety concerns. 5 Social clustering of unvaccinated children may lead to outbreaks of vaccine-preventable diseases. 6 The last decades The Netherlands has experienced epidemics of poliomyelitis, measles, rubella and mumps, all largely confined to an orthodox Protestant minority with religious objections to vaccination. 7–10 These objections find their origin in the trust in Divine providence. God has predestined health and disease and
man should completely rely on God as He knows what is best for someone in his or her specific situation. Other orthodox Protestants come to a different conclusion: the availability of vaccines is a gift from God, and man should use whatever means God gives us to remain healthy.\textsuperscript{11} The vaccination coverage among the orthodox Protestant minority is unknown. Information on vaccination coverage is, however, necessary for adequate prevention and control of vaccine-preventable diseases in this group.

Like other minority groups, the orthodox Protestants form a hard to reach population.

About 1.5\% of the Dutch population belongs to this minority of an estimated 250,000 persons. Moreover, the orthodox Protestant minority is subdivided into various denominations, each having its own interpretation of the confession and its own position towards vaccination.\textsuperscript{12}

Vaccination is a sensitive subject among orthodox Protestants. The decision whether or not to vaccinate one’s children might be an inner struggle. The general public does not understand the refusal of vaccination while an epidemic is going on. During the polio epidemics the media reacted aggressively, depicting the orthodox Protestants as backward and accusing them of child abuse.\textsuperscript{13} Negative reactions from the general public add to the tendency of orthodox Protestants to focus on their own cultural group.\textsuperscript{14} The willingness to participate in research on such a sensitive subject as vaccination is therefore low.

The few scientific publications on vaccination in orthodox Protestant groups show that refusal of vaccination is not complete.\textsuperscript{15–17} Our recent ecological study on the influence of orthodox Protestant subgroups on municipal vaccination coverage showed that two very conservative denominations (the Reformed Congregations in The Netherlands and the Old Reformed Congregations) had a strongly negative influence on municipal vaccination coverage, while the negative influence of two larger denominations (the Restored Reformed Church and the Reformed Congregations) was moderate, and the other denominations hardly had any influence.\textsuperscript{18} This suggests that the orthodox Protestant denominations might be classified in three clusters with low, intermediate and high vaccination coverage.

Historically the orthodox Protestants live geographically clustered in a rural area stretching from the southwest to the northeast of The Netherlands, the so-called Bible belt.\textsuperscript{19} However, even within the Bible belt the various denominations are not equally dispersed, members of one denomination clustering in one village and members of another denomination clustering in another. Because of the division in subgroups and geographical clustering it is not only hard to obtain the cooperation of the orthodox Protestants but hard to obtain a representative sample of this minority as well.

The aim of the present study is to achieve a reliable estimation of the vaccination coverage within this hard to reach minority, and its various denominations, using two sub-studies varying in design.

\section*{Methods}

We used data from two sub-studies to assess vaccination coverage in the orthodox Protestant minority and compared the results.

\subsection*{Source population of study populations}

The orthodox Protestant minority in The Netherlands consists of an estimated 250,000 persons and is divided in denominations. The largest orthodox Protestant denominations are the Restored Reformed Church (55,000 members), the Reformed Congregations (103,000 members), the Reformed Congregations in The Netherlands (23,000 members) and the Old Reformed Congregations (18,000 members). Orthodox branches of some other protestant denominations are reckoned to the orthodox Protestant minority as well. For example, within the Christian Reformed Churches (75,000 members), there is an orthodox branch of an estimated 18,000 followers, while within the Protestant Church in The Netherlands (estimated membership number 1.8 million), there is an orthodox branch ‘the Reformed Bond’ and another small branch is orthodox without following the Reformed Bond.

\subsection*{Internet survey on vaccination coverage among orthodox Protestant youngsters}

\textbf{Design and study population}

In a cross-sectional design, orthodox Protestant youngsters in the age of 16- to 23-years old were invited to take part in an online survey. The survey was carried out in 2008, in cooperation with the NPV, a patients association on Christian basis, representing among others the orthodox Protestants. The NPV approached all her youth members (N = 550) by e-mail, inviting them to take part in the study. Moreover, they asked them to forward the e-mail invitation to their friends (snowball method). Furthermore orthodox Protestant youth were approached via banners on specific websites for this group and via an orthodox Protestant newspaper.

\textbf{Data collection}

Participants were asked to fill out an easily accessible online questionnaire. Questions focused on participation in the National Vaccination Programme specifically DTPP and MMR vaccinations, denomination, education and need for information on vaccination.

\textbf{Inclusion criteria}

In our analyses, all respondents with known orthodox Protestant denomination and known vaccination status were included.

\subsection*{National sample study on the immunity of the Dutch population to vaccine-preventable diseases}

\textbf{Design and study population}

In 2006–07, a population-based cross-sectional national survey was conducted by the RIVM in order to assess immunity to infectious diseases, especially vaccine-preventable diseases.\textsuperscript{20–22}

In this study, a representative sample of 40 Dutch municipalities was taken. Within each municipality about 400 people in the age of 0–79 years were randomly selected for participation. An extra sample was taken in eight municipalities with low vaccination coverage in the Bible belt area. In total, 17,223 individuals were invited in the regular sample and 4,366 individuals were invited in the low vaccination coverage municipalities.

\textbf{Data collection}

Participants were invited to come to a location within the municipality to donate a blood sample for serological testing and to fill out a questionnaire on present and past health status, vaccination status, denomination, education, occupation and travel history. Persons who did not comply to blood donation were asked to fill out only the questionnaire.

\textbf{Inclusion criteria}

In our analyses, all respondents with known orthodox Protestant denomination and known vaccination status in the age of 0–55 years were included, from the regular sample as well as from the low vaccination coverage municipalities (Respondents >55 years old were excluded as they were born before the start of the National Vaccination Programme in The Netherlands).

\subsection*{Variables}

In both studies for every respondent, the following variables were selected: age (in years), sex (male/female), educational level, denomination and vaccination status.

Denomination was classified according to the above mentioned denominations.

Vaccination status was classified in vaccinated and not vaccinated. As religious objections concern vaccination in general, we did not distinguish vaccination status for the various vaccinations. Thus a child
vaccinated against DTP, but not vaccinated against MMR is in this study considered as vaccinated.

**Analysis**

For both studies separately, the characteristics of the respondents were described and the overall vaccination coverage and the vaccination coverage per denomination were determined. The results were compared and an explanation was sought for any differences between the results of both studies.

**Results**

**Characteristics of the respondents of the sub-studies**

**Internet survey**

As the Internet survey was performed in a population of which the total number was not known, we cannot calculate the response ratio. Among the NPV members, who were initially approached, the response ratio was 28% (N = 152). The online questionnaire was eventually filled out by 1778 respondents, 9% of them were directly recruited via the NPV, 51% via orthodox Protestant media and 40% via the snowball method. A total of 1713 respondents adhered to our inclusion criteria.

Almost half of the respondents were members of the Reformed Congregations, see table 1. Respondents came from all over the country. Most of the respondents were women, the mean age was about 19 years old and they were middle–high educated.

**National sample study**

The overall response in the national sample study was 47% in the regular sample and 54% in the low vaccination coverage municipalities. In all, 2129 persons adhered to the criteria for inclusion in our analysis, 968 from the regular sample and 1161 from the low vaccination coverage municipalities. Almost half of the respondents belonged to the Protestant Church in The Netherlands, see table 2. Especially among members of smaller denominations, there was municipal clustering: 60% of the respondents of the Reformed Congregations from another municipality. There was a large diversity in age, with an overrepresentation of children <5 years old (33%).

**Vaccination coverage**

Overall vaccination coverage in the Internet study was 64.3% (95% CI 62.0–66.6%), whereas overall vaccination coverage in the national sample study was 77.3% (95% CI 75.5–79.1%). These results vary considerably; however, the composition of both study populations according to denomination varied considerably as well.

As almost half of the respondents of the national sample study belonged to the Protestant Church in The Netherlands, and only few members of this church are orthodox, we also calculated vaccination coverage without this denomination. Among the remaining, 1145 respondents of the national sample study vaccination coverage was 61.0% (95% CI 58.2–63.8%), among the remaining 1528 respondents of the Internet survey this was 60.9% (95% CI 58.5–63.3%).

The vaccination coverage per denomination ranged from <15% to >95%, see table 3. However, within each sub-study, the denominations could—according to the results of our previous ecological study—be classified in a high, intermediate and low vaccination coverage cluster, without any overlap in the confidence intervals of the vaccination coverage between the clusters. The high vaccination coverage cluster consists of the Protestant Church in The Netherlands, the Reformed Bond within the Protestant Church in The Netherlands and the Christian Reformed Churches. Vaccination coverage in this cluster is >85%. The intermediate vaccination coverage cluster consists of the Reformed Reformed Church and the Reformed Congregations with vaccination coverage of ~50–75%. And the low vaccination coverage cluster consists of the Reformed Congregations in The Netherlands and the Old Reformed Congregations, with vaccination coverage of <25%.

**Discussion**

Based on the two sub-studies, with different designs and study populations, we estimated vaccination coverage among the orthodox Protestant minority in The Netherlands and its various denominations. Although there were some differences in results between the sub-studies, overall vaccination coverage among orthodox Protestants was estimated to be at minimum 60%.

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**Table 1** Characteristics respondents Internet survey

<table>
<thead>
<tr>
<th>Denomination</th>
<th>N total = 1713</th>
<th>(%)</th>
<th>% men</th>
<th>Age (in years), mean (SD)</th>
<th>Middle–high educated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protestant Church in The Netherlands (without Reformed Bond)</td>
<td>185</td>
<td>(10.8)</td>
<td>31.4</td>
<td>18.7 (2.6)</td>
<td>95.7</td>
</tr>
<tr>
<td>Reformed Bond</td>
<td>92</td>
<td>(5.4)</td>
<td>28.6</td>
<td>19.4 (2.4)</td>
<td>96.7</td>
</tr>
<tr>
<td>Christian Reformed Churches</td>
<td>120</td>
<td>(7.0)</td>
<td>30.0</td>
<td>18.9 (2.5)</td>
<td>94.2</td>
</tr>
<tr>
<td>Restored Reformed Church</td>
<td>257</td>
<td>(14.9)</td>
<td>23.0</td>
<td>18.8 (2.5)</td>
<td>92.6</td>
</tr>
<tr>
<td>Reformed Congregations</td>
<td>772</td>
<td>(45.1)</td>
<td>25.9</td>
<td>19.0 (2.5)</td>
<td>94.2</td>
</tr>
<tr>
<td>Reformed Congregations in The Netherlands</td>
<td>190</td>
<td>(11.1)</td>
<td>21.3</td>
<td>18.9 (2.4)</td>
<td>89.5</td>
</tr>
<tr>
<td>Old Reformed Congregations</td>
<td>97</td>
<td>(5.7)</td>
<td>24.0</td>
<td>18.9 (2.5)</td>
<td>90.7</td>
</tr>
</tbody>
</table>

**Table 2** Characteristics respondents national sample study

<table>
<thead>
<tr>
<th>Denomination</th>
<th>N total = 2129</th>
<th>(%)</th>
<th>% men</th>
<th>Age (in years), mean (SD)</th>
<th>Middle–high educated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protestant Church in The Netherlands (without Reformed Bond)</td>
<td>984</td>
<td>(46.2)</td>
<td>45.3</td>
<td>21.1 (17.7)</td>
<td>68.9</td>
</tr>
<tr>
<td>Reformed Bond</td>
<td>260</td>
<td>(12.2)</td>
<td>49.6</td>
<td>19.6 (16.7)</td>
<td>61.5</td>
</tr>
<tr>
<td>Christian Reformed Churches</td>
<td>79</td>
<td>(3.7)</td>
<td>44.3</td>
<td>20.6 (16.3)</td>
<td>75.6</td>
</tr>
<tr>
<td>Restored Reformed Church</td>
<td>220</td>
<td>(10.3)</td>
<td>42.3</td>
<td>16.6 (15.5)</td>
<td>55.9</td>
</tr>
<tr>
<td>Reformed Congregations</td>
<td>394</td>
<td>(18.5)</td>
<td>54.1</td>
<td>16.5 (15.8)</td>
<td>49.5</td>
</tr>
<tr>
<td>Reformed Congregations in The Netherlands</td>
<td>136</td>
<td>(6.4)</td>
<td>47.8</td>
<td>13.9 (14.5)</td>
<td>44.1</td>
</tr>
<tr>
<td>Old Reformed Congregations</td>
<td>56</td>
<td>(2.6)</td>
<td>55.4</td>
<td>18.1 (16.7)</td>
<td>32.3</td>
</tr>
</tbody>
</table>

a: For children up to 15 years educational level of the mother was registered
In the Internet survey, overall vaccination coverage was 64%, whereas in the national sample study this was 77%. However, leaving out the members of the Protestant Church in The Netherlands, whose members were overrepresented in the national sample study, resulted in an overall vaccination coverage of 61% in both sub-studies.

Within the orthodox Protestant minority three clusters of denominations could be distinguished with high (>85%), intermediate (50–75%) and low (<25%) vaccination coverage. The differences in the results between the sub-studies and between the denominations show the importance of a robust study design.

Both sub-studies have their specific strengths and weaknesses.

### Internet survey

As our study population is hard to reach and since our study concerns a sensitive subject, we choose an Internet design for one sub-study. Internet is easily accessible from all over the country and guarantees a high degree of anonymity. Although orthodox Protestants object to television and recreational use of Internet, Internet is widely used for educational purposes and mutual contact as is confirmed by the existence of specific orthodox Protestant websites.

Recruitment of participants via orthodox Protestant channels implies that in denominations with a small orthodox Protestant branch, like the Protestant Church in The Netherlands and the Christian Reformed Churches, only this orthodox branch is addressed. And as vaccination coverage in this branch is likely to be lower than in the non-orthodox majority of these denominations, this recruitment method may explain the difference in vaccination coverage between the sub-studies for these denominations.

The number of participants in the Internet survey was unexpectedly high. However, according to the Dutch population, women and middle- to highly educated persons were overrepresented. As among orthodox Protestants a higher educational level is associated with higher vaccination coverage, the overrepresentation of middle- to highly educated respondents may have influenced the results.

Compared with their membership numbers, the Reformed Congregations and the Reformed Congregations in The Netherlands (that seceded from the former in 1953) provided a relatively high proportion of respondents. Rev. Kersten, the founder of the Reformed Congregations, was also the founder of the SGP, the orthodox Protestant political party in The Netherlands. The increased social and political awareness in these denominations—as compared with other orthodox Protestant denominations—may explain the higher willingness to participate in the survey.

Finally, the participants of the Internet survey were not randomly recruited. As in this hard to reach minority a more reliable sampling method was not available, we used all possible ways of recruitment, including a snow ball method. The recruitment procedures may be difficult to reproduce and the representativeness of the respondents and the generalization of the results remain questionable.

### National sample study

Strength of the national sample study is that the participants were randomly selected. However, to recruit enough orthodox Protestants in the study there was an oversampling of eight municipalities with the lowest vaccination coverage in the Bible belt. As the various orthodox Protestant denominations are not equally dispersed in the Bible belt, this oversampling introduces clustering of respondents of specific denominations in these municipalities. The effect on the measuring of vaccination coverage is illustrated by a study on tetanus protection in which vaccination coverage among orthodox Protestants—based on these eight municipalities—was estimated to be only 32%. In addition to this, vaccination coverage among members of an orthodox Protestant denomination in a specific village may deviate from the overall vaccination coverage within that denomination, due to local processes and local interaction.

Another possible weakness is that respondents were invited for blood donation—which may have been a threshold for participation—and that they were invited at a location in the village, so participation was publically visible. The response in the national sample study was in general mediocre; however, the response in the low vaccination coverage sample was not worse than in the regular sample and comparable to another study in this population.

### Vaccination data

Vaccination status was assessed anamnestically. Several reports indicate that parental recall of vaccination is inaccurate; however, this inaccuracy concerns mostly the number of injections and timeliness. Overall community surveys based on parent held cards and recall data provide reasonable estimates of vaccination coverage for public health purposes. Since vaccination is a sensitive subject among orthodox Protestants that certainly will be remembered, we expect our respondents will recall this information accurately, providing reliable data. Serological analyses, based on the national sample study, showed that protection against tetanus and pertussis were indeed lower among unvaccinated orthodox Protestants than in the general population.

### Vaccination coverage for specific vaccines

In this study, vaccination coverage was not specified for specific vaccines. Religious objections to vaccination concern vaccination as a preventive measure, interfering with Divine providence; thus religious objections concern all vaccines regardless of the disease that is vaccinated against. However, orthodox Protestants who do not have any religious objections to vaccination as a preventive measure, may have other objections to specific vaccines e.g. because of (assumed) side effects. The results of the Internet survey showed that 55% of the respondents was vaccinated against both DTPP and MMR, 9% was partially vaccinated (in most cases vaccinated against DTPP but not against MMR) and 35% was not vaccinated at all. Thus, vaccination coverage for specific vaccines may be lower than the general vaccination coverage reported here. However, regarding the spread of epidemics, social clustering seems more
important than actual vaccination coverage. The epidemics of measles (1999–2000), mumps (2007–08) and rubella (2004–05) hardly spread beyond the orthodox Protestant groups, while a measles outbreak in the anthroposophic community (2008) did not spread to the orthodox Protestant minority.29

Future research
This study focused on measuring the actual vaccination coverage in the orthodox Protestant minority. More, qualitative, research is planned on decisions on vaccination in this community. As hard to reach minorities in Europe may vary in their social position and motives for refusing vaccination, we consider knowledge of the specific characteristics of these minorities as a prerequisite for adequate measures to prevent and control vaccine-preventable diseases. Collaboration with community-based organizations—like in our case the NPV—increases insight in the needs of the specific minority.30

Conclusion
We assessed vaccination coverage among the hard to reach orthodox Protestant minority in The Netherlands, comparing two sub-studies with a different design and study population. While both studies have their specific strengths and weaknesses, the integration of the results adds to our insight in the vaccination coverage among the orthodox Protestants. Overall vaccination coverage in this minority is estimated to be at minimum 60%; however, three clusters of denominations could be distinguished with high (>85%), intermediate (50–75%) and low (<25%) vaccination coverage.

As the orthodox Protestant community consists of only 1.5% of the Dutch population and more than half of their members are vaccinated, the low vaccination coverage in this minority does hardly influence national vaccination coverage. Nevertheless, because of social clustering of susceptible persons, the members of denominations with low and intermediate vaccination coverage have an increased risk of contracting vaccine-preventable diseases, as was confirmed by the epidemics in the past decades. Therefore, we recommend to focus prevention and control of vaccine-preventable diseases in the orthodox Protestant minority on these subgroups.

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Conflicts of interest: None declared.

Key points
- In many countries, there are hard to reach minority groups who object to vaccination.
- We estimated vaccination coverage among the orthodox Protestant minority in The Netherlands, using two sub-studies with different design and study population.
- Both sub-studies showed that within the orthodox Protestant minority three sub-groups could be identified with high (>85%), intermediate (50–75%) and low (25%) vaccination coverage.
- Based on these results, we recommend to focus prevention and control of vaccine-preventable diseases on the subgroups with intermediate and low vaccination coverage.

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Representativeness of participants in a cross-sectional health survey by time of day and day of week of data collection

Jennifer Mindell¹, Maria Aresu¹, Laia Bécares¹, Hanna Tolonen²

¹ Health and Social Surveys Research Group, Department of Epidemiology and Public Health, University College London, London, UK
² Chronic Disease Epidemiology and Prevention Unit, Department of Chronic Disease Prevention, National Institute for Health and Welfare (THL), Helsinki, Finland

Correspondence: Dr Jennifer Mindell, HSSRG, Department Epidemiology and Public Health, University College London, 1-19 Torrington Place, London WC1E 6BT, UK, tel: +44 (0)20 7679 1269, fax: +44 (0)20 7813 0242, e-mail: j.mindell@ucl.ac.uk

Background: General population health examination surveys (HESs) provide a reliable source of information to monitor the health of populations. A number of countries across Europe are currently planning their first HES, or the first after a significant gap, and some of these intend offering appointments only during office hours and/or weekdays, raising concerns about representativeness of survey participants. It is important to ascertain whether personal characteristics of participants vary by time of day and day of week of data collection, in order to determine the association between time and day of interview and physical examination on the results of data collected in HES.

Methods: Multivariable regression models were applied to national HES in England to examine socio-demographic and health variations in three combined day–time periods of interview and physical examination: weekday daytime; weekday evening; and weekend. Results: The characteristics of participants interviewed or visited by a nurse varied by both time of day and day of the week for age, ethnicity, marital status, income, socio-economic group, economic activity and deprivation. People seen during weekday working hours had higher rates of poor self-reported health, limiting longstanding illness and obesity, and higher alcohol consumption, BMI and systolic blood pressure; adjustment for socio-demographic characteristics eliminated or substantially reduced these differences. Conclusion: People responsible for planning surveys should be aware of participant preference for the timing of data collection and ensure flexibility and choice in times and days offered to optimise participation rates and representativeness.

Introduction

Population-level information about health and health-related risk factors in different population groups are needed to plan and target health promotion activities and health care. The only reliable source of such information is to conduct a general population health examination survey (HES), a population study in which randomly selected people answer a number of questionnaire items, have physical examinations and provide biological samples. In England, this type of survey has been conducted annually since 1991.

The representativeness of the results obtained depends on the participation rate: survey participants differ from those who do not participate.¹⁻⁴ Non-participants tend to have worse health behaviours and excess mortality⁵⁻⁷ than participants. Therefore, low participation rates give biased results that do not provide a true picture about the population’s health. Where participants and non-participants do not differ from each other, the participation rate should ideally be around 70%;⁸⁻⁹ where non-participation is not random, higher participation rates are needed for accurate estimates.¹⁰ In recent national HESs in Europe, the participation rate varied from 21% to 85%.¹¹ Globally, participation rates in population surveys has been declining,¹²⁻¹⁳ diminishing the representativeness of the results.

For the working age population, it may be difficult to take part in a survey during the day (working hours). Previous American studies showed that people are best contacted at home in the evenings after 17:00 and during the day at weekends.¹⁴⁻¹⁵ At the weekend, potential participants were most likely to be at home during the morning and afternoon hours on Saturday and in the evening hours on Sunday.¹⁴ However, previous studies were based on telephone interviews, while HESs require face-to-face contact and reported information only for the population as a whole: findings may differ by socio-demographic group or health status.

Until recently, few HESs have been conducted at a national scale.¹¹ Several countries across Europe are currently planning their first general population HES or the first after a significant gap. Some intend offering appointments only during office hours and/or only on weekdays. Given international concern about falling response rates¹¹⁻¹³ and under-representativeness of survey participants,¹²⁻¹⁷ we have used data from a well-established general population HES in England to examine representativeness of respondents by time and day of data collection. First, this article considers whether, and how, personal demographic and socio-economic characteristics of participants vary by time of day and day of week of data collection. Second, we have ascertained the effect of this variation on the results of subjective and objective health and risk factor data collected at personal household visits.

Method

Participants and data collection

The Health Survey for England (HSE) is an annual, cross-sectional, general population HES. Each year, a new nationally representative random probability sample is selected using a two-stage process. The sampling frame is the small area Postcode Address File, which lists all non-commercial addresses in the country. The primary sampling unit, postcode sectors (each containing around 3000 addresses, except in rural