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Statistical Methodology of the National Immunization Survey, 1994–2002

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Statistical Methodology of the National Immunization Survey, 1994–2002

Data Evaluation and Methods Research

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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National Center for Health Statistics

Hyattsville, Maryland
March 2005
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Abstract

Objectives

Since 1994 the National Immunization Survey (NIS) has monitored progress toward the Healthy People 2000 and 2010 vaccination goals. The NIS collects data in two phases: first, a random-digit-dialing (RDD) telephone survey to identify households with children 19–35 months old and, second, a mail survey to vaccination providers to obtain vaccination histories used to estimate vaccination coverage rates. This report reviews the methodologies used in the 1994–2002 NIS to obtain official estimates of vaccination coverage and describes the methodology used for the first three topical modules of the NIS.

Methods

From 1994 to 1997 the NIS used a variation of a two-phase estimator to compensate for missing provider-reported vaccination histories. Between 1998 and 2001 a weighting-class estimator was used. In 2002 and thereafter the weighting-class approach was refined to account for households that do not have telephones and for unvaccinated children.

To collect data on immunization-related topics, the NIS sample was randomized among three topical modules: health insurance and ability to pay for vaccinations (HIM); parental knowledge and experiences about vaccinations (PKM); and daycare attendance, breastfeeding practices, and participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (DCM).

Results

In 2001 among children with completed RDD interviews, 0.3 percent were entirely unvaccinated. Together, the new nontelephone adjustment and the refinement for unvaccinated children yielded revised estimates that were within 1.5 percentage points of the original estimates obtained using the 1998–2001 methodology. Over the six quarters during which the first three topical modules were fielded (from mid-2001 through 2002), 21,163 children were randomized to the HIM, 3,576 to the PKM, and 3,511 to the DCM.

Keywords: *Missing at random • nontelephone adjustment • random-digit dialing • split sampling*

Statistical Methodology of the National Immunization Survey, 1994–2002

by Philip J. Smith, Ph.D., Centers for Disease Control and Prevention; David C. Hoaglin, Ph.D., and Michael P. Battaglia, M.A., Abt Associates Inc.; Meena Khare, M.S., National Center for Health Statistics; and Lawrence E. Barker, Ph.D., Centers for Disease Control and Prevention

Introduction

In 1994 the Childhood Immunization Initiative (CII) was established to:

- Improve the delivery of vaccines to children.
- Reduce the cost of vaccines for parents.
- Enhance awareness, partnerships, and community participation.
- Improve vaccinations and their use.
- Monitor vaccination coverage and occurrences of disease (1).

Subsequently, the Healthy People 2000 and 2010 objectives established the goal of having at least 90 percent of 2-year-old children fully vaccinated with the recommended schedule of vaccines (2,3). To fulfill the CII mandate of monitoring vaccination coverage and marking progress toward achieving the Healthy People 2000 and 2010 goals, the National Immunization Survey (NIS) has been implemented by the National Immunization Program (NIP) and the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention (CDC). The data collection contractor has been Abt Associates Inc.

The target population is children between 19 and 35 months of age living in households in the United States at the time of the interview. Official NIS coverage estimates give rates of being up-to-date (UTD) with respect to the recommended numbers of doses of seven vaccines: diphtheria and tetanus toxoids and pertussis vaccine (DTP or DTaP, where aP refers to acellular pertussis vaccine), 4 doses; *Haemophilus influenzae* type b vaccine (Hib), 3 doses; poliovirus vaccine (polio), 3 doses; measles-containing vaccine (MCV), 1 dose; hepatitis B vaccine (Hep B), 3 doses; varicella vaccine (VRC), 1 dose; and pneumococcal conjugate vaccine (PCV), 3 doses (4). (In October 2000 the Advisory Committee on Immunization Practices recommended that all children 2–23 months of age receive 4 doses of pneumococcal vaccine. The pneumococcal vaccine is relatively new; there was a supply problem, and a catch-up schedule provided for some children to be fully compliant despite having received fewer than 4 doses. On February 13, 2004, CDC recommended that health care providers temporarily suspend routine use of the fourth dose of 7-valent pneumococcal conjugate vaccine (PCV7) when immunizing healthy children (5).)

The authors gratefully acknowledge the assistance of the following members of the NCHS Information Design and Publishing Staff, Office of Information Services: Kathy J. Sedgwick, for her careful review and editing of the final report; Zung T. N. Le, who typeset the report; and Jarmila Gail Ogburn, who prepared the graphics.

Vaccination coverage estimates are published for each calendar year. The time lag between the end of a reporting period and publication of official estimates is approximately 6 months.

Beginning with the second quarter of 1994 (Q2/1994), the NIS has conducted quarterly surveys in 78 Immunization Action Plan (IAP) areas, consisting of the 50 States, the District of Columbia, and 27 other large urban areas (table 1). This design has made it possible to produce annualized estimates of vaccination coverage levels within each of the 78 IAP areas with an acceptable degree of precision. Further, by using the same data collection methodology and survey questionnaires in all IAP areas, the NIS produces estimates that are comparable among IAP areas and over time.

In addition to providing vaccination data from which coverage rates may be monitored, the objectives of the NIS are to assist CDC in allocating resources to States for the purpose of increasing coverage rates, to identify subpopulations and/or geographic areas in which rates are low, and to provide a database for epidemiologic research.

Background and Outline

Since its inception in 1994 the NIS methodology has undergone several noteworthy revisions. This report documents these revisions as they were implemented between 1994 and 2002. As a foundation for subsequent sections, ''Sampling Design, Questionnaires, and Response Rates'' presents a synopsis of the NIS sampling design, describes the content of the survey questionnaires used in 2002, and reviews response rates and key monitoring statistics.

''Estimation Methodology'' describes how the NIS methodology for estimating vaccination coverage rates changed between 1994 and 2002. The original methodology, used between 1994 and 1997, was based on a modification of the two-phase sampling estimator. The methodology introduced in 1998 uses a weighting-class estimator, and modifications introduced in 2002 account more accurately for children living in households with no telephones and for children who have had no vaccinations.

''The First Three Topical Modules, 2001'' describes the objectives and design of the first three topical modules, incorporated in the NIS to collect additional information for improving vaccination coverage. These modules focused on the relationship between vaccination status and families' ability to pay for vaccinations; on parental knowledge about vaccinations; and on daycare attendance, participation in the U.S. Department of Agriculture's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and breastfeeding practices. The split-sampling design for the modules is described, along with the statistical methodology used to obtain sampling weights for children who completed the household interview, completed a topical module, and had a sufficiently detailed vaccination history reported by their vaccination providers to evaluate their vaccination status.

''Public-Use Files'' gives a brief description of the NIS public-use data files and supporting documentation.

Sampling Design, Questionnaires, and Response Rates

The NIS Sampling Design

The NIS uses two phases of data collection to obtain vaccination information for a large national probability sample of young children: a random-digit-dialing (RDD) survey designed to identify households with children between 19 and 35 months of age, followed by the NIS Provider Record Check (PRC) survey, which obtains provider-reported vaccination histories for these children. Data from the PRC yield each child's number of doses for each of the seven vaccines. These counts are then compared with the number of doses recommended by the vaccination schedule to determine whether the child is UTD. These data, along with sampling weights and NIS survey design information, are used to obtain estimated vaccination coverage rates.

This section summarizes these two phases of data collection. Other descriptions of the sample design are given by Smith et al., Ezzati-Rice et al., and Zell et al. (6–8).

The 2002 RDD Sample

The RDD sampling phase uses independent quarterly samples of telephone numbers in each of the 78 IAP areas. Table 1 lists the 78 IAP areas and shows the number of children 19–35 months of age in each IAP area and State in 2002. A total of 31,693 households completed the RDD interview for children between 19 and 35 months of age in 2002, an average of 406 per IAP area. The procedures for managing the quarterly RDD samples ensure that the interviews in each IAP area are spread evenly across the year.

The main goals of the RDD sampling phase are to:

- Select a probability sample of telephone numbers for each IAP area.
- Ensure that the desired sample size of children with completed interviews is achieved in each IAP area.
- Minimize in a cost-effective manner the number of age-eligible children excluded from the sampling frame.
- Maintain an up-to-date sampling frame of telephone numbers.

To accomplish these goals the NIS uses the list-assisted method of RDD (9). This method selects a random sample of telephone numbers from banks of 100 consecutive telephone numbers (e.g., 617–495–0000 to 617–495–0099) that contain one or more directory-listed residential telephone numbers (the 1+ working banks). The sampling frame of telephone numbers is updated each quarter to include new banks. Although the number of cellular telephone users in the United States has increased rapidly, most households continue to maintain wire line telephone service. Also, most cellular telephone users pay for incoming calls. Therefore, cellular telephone exchanges are currently excluded from the NIS sampling frame.

Within each IAP area the RDD sample is randomly segmented into replicates to allow for carefully controlled release of the sample. Some RDD surveys give all sampled telephone numbers to interviewers for dialing. Because over one-half of selected numbers are business or unassigned, the NIS uses an automated screening procedure to remove a portion of these unproductive telephone numbers from the sample before interviewer dialing begins.

The NIS Provider Record Check Survey

At the end of the RDD interview, consent to contact the child's vaccination providers is requested from the parent or guardian. When verbal consent is obtained, those providers are mailed an immunization history questionnaire (IHQ), which asks them to record the child's vaccination history. The data from these IHQs are entered, cleaned, edited, and merged to produce a child-level record.

The 2002 RDD Survey

The computer-assisted telephone interview (CATI) questionnaire used in the RDD portion of data collection includes a screening section to identify households with children in the age range 19–35 months and a vaccination interview based on the Immunization Supplement of the National Health Interview Survey (NHIS) (10). The NIS CATI questionnaire has been translated into Spanish, and Language Line Services (formerly part of AT&T) is used for real-time translation of the interview into many other languages (11,12). People who are deaf, hard of hearing, or speech-impaired are included in NIS interviews by using text telephone (TTY). When a number is dialed and the TTY tone is encountered, the number is put in a separate queue for handling by a specialist with access to the TTY equipment needed to communicate with the household. Table A summarizes the content of each section of the 2002 NIS household interview questionnaire.

Table A. Content of the household interview questionnaire: National Immunization Survey, 2002

Section	Content
S	Screening questions to determine eligibility, roster of eligible children, availability of shot records
MR	Most-knowledgeable-respondent callback questions
A	Vaccination history, asked if shot records are available
B	Vaccination history, asked if shot records are not available
C	Demographic and socioeconomic questions
D	Provider information and request for consent to contact the eligible child's vaccination providers

In "Section S" the reason for the telephone call and the purpose of the survey are explained to the respondent, and the household is screened to determine whether it contains any children between 19 and 35 months of age. In 2002 TTY was used to complete "Section S" for 23 households.

In "Section MR," if the household has an eligible child, the respondent is asked whether he or she is the most knowledgeable person about the child's vaccination history. If the respondent indicates that another person in the household is the most knowledgeable and that person is unavailable, a callback is scheduled to interview the most knowledgeable person at a later date.

When information from the child's vaccination record (shot card) is available during the interview, the respondent is asked to provide that information in "Section A." When shot card information is not available, the respondent is asked to recall from memory information about the child's vaccination history in "Section B."

"Section C" obtains information that includes the relationship of the respondent to the child, Hispanic ethnicity of the child, the race of the child, Hispanic ethnicity of the mother, the race of the mother, information about household income and educational attainment of the mother, and other information on the socioeconomic characteristics of the household and its eligible children.

At the conclusion of the RDD interview (in "Section D"), consent is requested to contact the child's vaccination providers. If verbal consent is obtained, identifying information (name, address, and telephone number) on the vaccination provider(s) is requested. When verbal consent and sufficient identifying information are obtained, the IHQ is mailed to the child's vaccination provider(s), along with a copy of a form documenting the household's consent.

The protocol for the 2002 RDD survey used the following primary rules for discontinuing call attempts to sample telephone numbers:

- A maximum of 10 call attempts were made to ring-no-answer numbers.
- A maximum of 15 call attempts were made to numbers that resulted in a residential or potentially residential answering-machine message.
- A maximum of 25 call attempts were made to likely and known households.
- Hostile refusals received no additional call attempts.
- Requests to be placed on the "do not call list" received no additional call attempts.
- A verbal refusal on two call attempts resulted in no further attempt.
- A hangup during the introduction on three call attempts resulted in no further attempts.

Major changes from 1994 to 2002 in the protocol of the RDD survey include:

- Discontinuing after 1996 the practice of calling local telephone company business offices in an effort to determine whether unresolved telephone numbers were residential numbers.

- Introducing in 1996 a provider name and address database to allow interviewers to determine the complete address of a provider identified by a respondent.
- Reducing in 1999 call attempts for ring-no-answer telephone numbers from 24 to 15.
- Introducing in 2000 an improved method of prescreening the sample to remove a portion of the nonworking and business telephone numbers.
- Introducing in 2000 a more comprehensive database for advance letter mailing.
- Reducing in 2000 call attempts for numbers that resulted in a residential or potentially residential answering-machine message from 24 to 15.
- Introducing in 2001 a provider database that allowed interviewers to view all providers in a ZIP Code area.
- Eliminating in 2001 callbacks to households that did not have their shot card available at the time of the interview. (The interview was completed using respondent recall.)
- Reducing in 2002 call attempts for ring-no-answer numbers from 15 to 10.
- Sending refusal conversion letters in 2002 to respondents who refused to give consent for contacting vaccination providers.

The 2002 Immunization History Questionnaire (IHQ) and Provider Survey

The IHQ is designed to be simple and brief, to minimize burden on the providers, and to encourage participation in the survey. Between 1994 and Q2/2002, a 2-page IHQ was used. During Q3/2002, a new, 4-page IHQ (see ''Appendix I'') was introduced. The first page includes space for a label that contains identifying information about the child (child's name and birth date and the full name of the parent). It also asks questions about the facility to which the IHQ was mailed: the types of care the facility provides; whether it is a federally qualified health center, a hospital-based clinic, a private practice, a public health department-operated clinic, a military health care facility, or a clinic associated with the WIC program; whether the facility is a Vaccines for Children (VFC) provider; and whether the facility reported any of the child's immunizations to a community or State immunization registry.

The second page of the IHQ provides instructions for completing the shot grid on the third page, which asks for the date on which each vaccination was administered as well as additional information about combinations of vaccines that were administered. The fourth page lists sources of further information about the NIP and vaccine recommendations and sources of data and statistics from previous years of the NIS. The page also gives a telephone number and an e-mail address and warns against sending confidential information about the child via e-mail.

The data collection process aims to maximize response. Each provider may receive up to three separate mailings and a telephone call. The initial mailing consists of a cover letter from the NIP Director briefly describing the study and its goals, a copy of a *Morbidity and Mortality Weekly Report* article supplying national estimates from the NIS, a signed consent form, an IHQ, and a business reply envelope.

Two weeks later postcards are sent to providers regardless of whether they have responded. The postcards serve to thank those who have responded and to remind those who have not.

Five weeks after the initial mailing reminder mailings are sent to non-responding providers. The reminder mailing includes: a cover letter asking the provider to complete the immunization information for the child listed on the questionnaire, an IHQ, and a business reply envelope.

Seven weeks after the original mailing the remaining nonrespondents are prompted by telephone. Generally, these prompting calls serve to remind providers to return the completed questionnaires and include an offer to mail or fax new materials to those providers who request them. In some cases the questionnaire is completed by telephone.

This approach emphasizes prompting providers as inexpensively and easily as possible at each stage. The most expensive and labor-intensive steps are reserved for the least responsive providers.

IHQs that arrive by approximately 3 weeks after the last prompting are included in that quarter's data file and in the data file for the 4-quarter period ending with that quarter. Any IHQs that arrive after this 3-week cutoff are included in the next 4-quarter file.

The effort to collect vaccination histories has three main limitations. First, if the household respondent refuses to give consent to contact the child's providers, the approved protocol allows only one attempt at refusal conversion. Second, some providers have indicated that they will not comply with any requests from the NIS and, therefore, are no longer sent any IHQs. Third, the field period for provider data collection must be limited to allow for timely release of vaccination coverage estimates. This constraint precludes additional reminder calls to nonresponding providers.

Response Rates and Key Monitoring Statistics, 1994–2002

The NIS is one of the largest federally-sponsored telephone surveys. Among large national telephone surveys, it has a high response rate. This section describes the statistics and response rates that are monitored regularly to maintain a high level of response.

Response Rates and Key Monitoring Statistics for 2002

Several indicators of survey progress and data quality are routinely produced for each IAP area and at the national level. Statistics such as survey response rates also reflect data quality. Table 2 presents the key national monitoring indicators for NIS data collection from 1994 through 2002.

The size and growth of the NIS are evidenced by the numbers listed in table 2. In 2002 2,055,371 telephone numbers (row 3) were called to meet the objective of obtaining estimates of vaccination coverage with predefined accuracy within each IAP area. Among the identified households 986,203 (row 8) did not contain an age-eligible child, and 34,201 (3.4 percent, row 9) contained one or more age-eligible children. Among the households containing one or more age-eligible children, 30,974 (90.6 percent, row 10) completed the household RDD interview. A standard approach for measuring response in RDD surveys, known as the CASRO response rate, has been defined by the Council of American Survey Research Organizations (13). In 2002 the CASRO (household) response rate (row 11) was 74.2 percent. The CASRO response rate can be calculated as the product of the resolution rate (84.8 percent, row 5), the screening completion rate (96.6 percent, row 7), and the interview completion rate among eligible households (90.6 percent, row 10). The resolution rate is the percentage of the total telephone numbers called that were classifiable as either nonworking, nonresidential, or residential. The screening completion rate is the percentage of known households that are successfully screened for the presence of age-eligible children. The interview completion rate is the percentage of households with one or more age-eligible children that complete the RDD interview. Alternative response rates that take into account both nonresponse and noncoverage are also used to monitor the NIS (8,14).

Row 12 of table 2 shows that 31,693 age-eligible children had completed RDD interviews in 2002. Rows 13–16 list monitoring indicators for the PRC phase. Specifically, row 13 gives the rate of obtaining consent from household respondents to contact their children's vaccination providers, 86.7 percent in 2002. The number of IHQs that were mailed to vaccination providers was 34,444 (row 14). This number exceeds the number of children with consent because some children had more than one vaccination provider (on average, 1.37 per child). In 2002 among the children with completed NIS household RDD interviews, 21,410 (67.6 percent, row 16) had adequate vaccination histories returned by their vaccination provider(s). (As discussed in "Adjustment for Partial Nonresponse," as of 2002 this total included children who have received no vaccinations.)

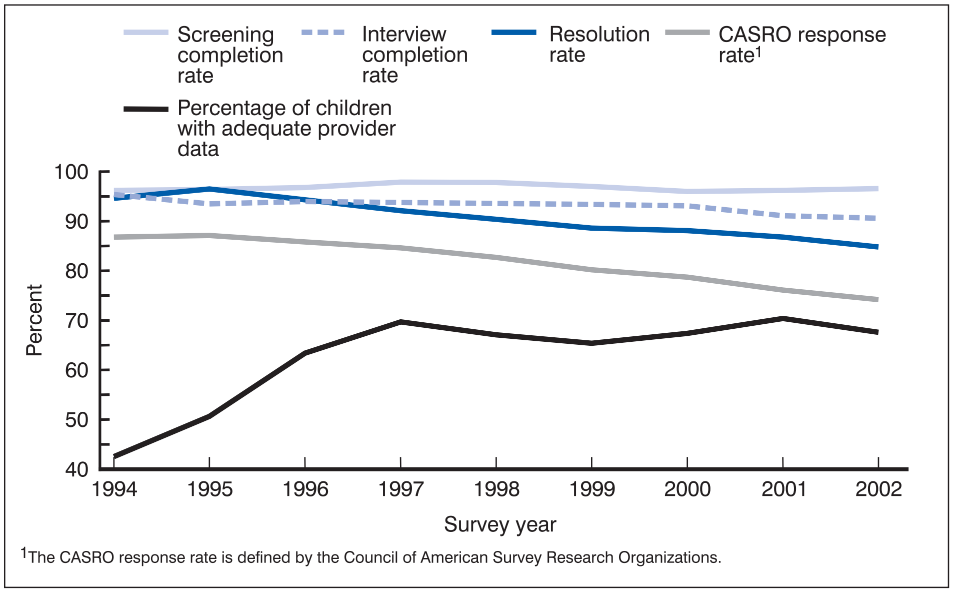


Figure 1. Trends in key indicators from household and provider data collection: National Immunization Survey, 1994–2002

Trends in Response Rates and Key Monitoring Statistics, 1994–2002

Trends in the CASRO response rate—Figure 1 displays the key response-rate indicators over the 9-year period from 1994 through 2002. For the first 3 years the CASRO response rate (row 11 of table 2) was at 85.8 percent or higher. From 1997 to 2002 it declined from 84.6 percent to 74.2 percent (12.6 percentage points lower than in 1994). To understand the slow decline in the CASRO response rate, it is necessary to examine trends in the three component rates that make up the CASRO rate: the resolution rate, the screening completion rate, and the interview completion rate.

The resolution rate (row 5) has shown a substantial decline over time and accounts for much of the decline in the CASRO response rate. The resolution rate was 94.3 percent or higher in the first 3 years of the NIS. These very high rates were due in part to the practice of calling local telephone company business offices in an effort to determine whether the unresolved telephone numbers (e.g., noncontact numbers) were residential numbers. This practice was discontinued after 1996 because it did not yield a sufficient number of interviews with eligible households to make it cost-effective. From 1997 to 1999 the resolution rate declined from 92.1 percent to 88.6 percent. The resolution rate held at 88.1 percent in 2000. This was due to the introduction of an improved method of prescreening the RDD sample to remove a portion of the nonworking and business telephone numbers (row 2). In 2001 the resolution rate declined to 86.8 percent, and in 2002 it was 84.8 percent. The decline in the resolution rate is consistent with the experience of other RDD surveys; more sample telephone numbers end up as unresolved (e.g., ring-no-answer to all call attempts).

The screening completion rate (row 7) remained almost unchanged over the 9-year period. The lowest rate was 96.0 percent in 2000, and the highest rate was 97.9 percent in 1997. The high rate reflects the ability of the interviewers to complete the eligibility screening questions with households identified in the RDD sample.

The interview completion rate (row 10) declined by 4.8 percentage points over the 9-year period. The rate in 1994 was 95.4 percent. The rate declined gradually from 94.0 percent in 1996 to

93.1 percent in 2000, 91.1 percent in 2001, and 90.6 percent in 2002. The high interview completion rate reflects the interviewers' continued success at completing the interview once an eligible household is identified.

Trends in the number of advance letters mailed—The NIS mails advance letters to sample telephone numbers for which it can obtain addresses using a reverse-match procedure. Through 1999 about 33 percent of the sample telephone numbers called were sent an advance letter; in 2000 a more comprehensive database increased the match rate to around 60 percent (row 4). The use of an advance letter has been shown to increase the overall response rate in the NIS (15), and greater use of the advance letter likely contributed to maintaining the high interview and screener completion rates that the NIS has continued to experience.

Trends in the percentage of children with adequate provider data—The conduct of the provider survey has changed in important ways, as reflected in the percentage of children with adequate provider data (row 16). In 1995 this was only 50.6 percent. In 1996 the use of follow-up procedures for providers who had not returned their IHQs raised it to 63.4 percent. In 1997 a tracking system for provider surveys was implemented, and the percentage of children with adequate provider data rose to 69.7 percent. From 1998 to 2002 the percentage ranged between 65 percent and 70 percent, and it showed no pattern of decline. Thus, although the CASRO response rate has declined over time, the product of the CASRO response rate and the percentage of children with adequate provider data (a measure of the overall success of the NIS in obtaining vaccination data for age-eligible children) is higher in 2002 than it was in 1995.

Potential limitations of adequate provider data: incompletely ascertained provider-reported vaccination histories—The NIS goes to considerable lengths to identify, for use in estimation, children whose provider-reported vaccination data are sufficient to determine their vaccination status. Even for such children, however, the vaccination history may not be complete. As a result, estimates of vaccination coverage are likely to be lower than the true level of coverage. The paragraphs that follow define the term ''adequate provider data'' and explore factors that may affect the completeness of children's provider-reported vaccination histories.

Children with adequate provider data include those for whom all vaccination providers identified by the household responded to the IHQ. In addition, if some but not all identified providers responded, a set of rules determines whether the child is considered to have adequate provider data. These rules are based on the following primary criteria:

- Whether the responding provider(s) reported the child as UTD on certain key vaccines
- Whether the provider-reported vaccination dates matched the vaccination history reported by the household from a shot card
- Whether the child was UTD on the key vaccines when vaccinations after the date of the household interview were counted
- Whether the responding provider(s) reported at least as many doses of the key vaccines as the household respondent

The rules were developed in 1995, when epidemiologic interest focused on the 4:3:1 vaccination series (4 or more doses of DTP, 3 or more doses of poliovirus vaccine, and 1 or more doses of any MCV). Thus, through 1998 the key vaccines were DTP, polio, and MCV. Since 1999 the key vaccines have been DTP, polio, MCV, Hib, and Hep B, which make up the 4:3:1:3:3 series (4 or more doses of DTP, 3 or more doses of poliovirus vaccine, 1 or more doses of any MCV, 3 or more doses of Hib, and 3 or more doses of Hep B).

By 2002 the scope of the NIS had expanded to include the VRC and PCV vaccines, but the rules for adequate provider data continued to use the 4:3:1:3:3 series because the household questionnaire did not include those two vaccines in each quarter. As a result, in the years when the NIS collected histories on VRC and PCV, a child with adequate provider data may have a vaccination history that is incompletely ascertained for these vaccines.

Among the 31,693 children for whom completed RDD interviews were obtained in 2002, 21,410 children were determined to have adequate provider data. Among these, 15,506 (72.4 percent) were reported by the household respondent as having only 1 vaccination provider. Among the remaining 5,904 sampled children who had 2 or more vaccination providers, 3,127 (53.2 percent) did not have histories reported from all providers.

When a child has two or more vaccination providers, the vaccination history may be scattered in such a way that no single provider has the entire history. A child's vaccination history may be incompletely ascertained for one or more vaccines when not all providers contribute data and the reported information does not show that the child is UTD. Authoritative literature suggests that children with an incompletely ascertained vaccination status may be found to be UTD when their entire vaccination history from all providers is assembled and examined (16,17).

Figure 2 shows the trend in the percentage of children with two or more providers from 1995 to 2002. This percentage stayed reasonably steady, ranging between 27 and 33 percentage points. Figure 2 also shows the trend in the percentage of children with two or more providers who have fewer than all providers reporting. This percentage ranged between 45 and 54 percentage points.

Table 3 summarizes an analysis of factors associated with having two or more vaccination providers among children who had adequate provider data in the 2002 NIS. These results suggest that, compared with children with only one vaccination provider, children with two or more providers were significantly more likely to be Hispanic or non-Hispanic American Indian than non-Hispanic white; to have a mother who was not married than married, had fewer than 12 years of education rather than a college degree, preferred to speak Spanish rather than English during the interview, or who used a shot card; or, to live in a household that had an annual income of less than $75,000, had moved from another State since the child's birth, or did not live in a metropolitan statistical area (MSA).

Table 4 explores factors associated with incomplete ascertainment (response from fewer than all providers) among children with adequate provider data who had two or more providers. These results suggest that children who did not have response from all providers were significantly more likely to be Hispanic or foreign born; or to have a mother who was never married, had less than a high school education, preferred to speak Spanish, or was 20 years old or over; or lived in a household that had an annual income that was below poverty, or lived in the central city of an MSA. After adjusting for these factors among sampled children with two or more providers, incomplete ascertainment remained a significant predictor of 4:3:1:3:3 vaccination coverage ($p<0.05$).

Because of the potential for incomplete ascertainment of some children's vaccination histories, users of NIS data who wish to compare vaccination coverage rates between sub-populations are cautioned to evaluate whether these differences are statistically significant after adjusting for differing rates of incomplete ascertainment between the subpopulations. ''Evaluation of the Effect of Incomplete Ascertainment of Provider-reported Vaccination Histories on Estimates of Vaccination Coverage'' provides a more thorough evaluation of this effect.

Coverage of the Target Population, 2002

NIS coverage of its target population, children 19–35 months of age, varies among the 78 IAP areas. To give a quantitative picture of that variation in 2002, table 5 presents measures of the ability of the NIS to access the target population and to elicit all of the desired data. The following paragraphs describe and discuss each of the numerical columns in table 5 (where the IAP areas are arranged in order of increasing value in column 9).

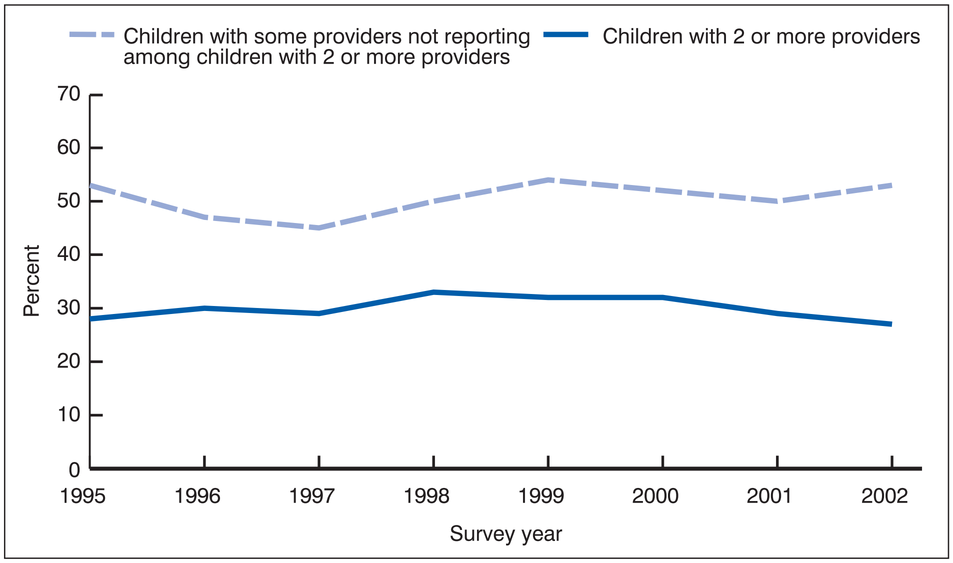


Figure 2. Percentage of sampled children with two or more providers and with some providers not reporting among children with two or more providers: National Immunization Survey, 1995–2002

Column 1: Percentage of children 19–35 months in telephone households—For the United States as a whole in 2000, a high percentage (92.8 percent) of age-eligible children reside in telephone households and, thus, are accessible to the RDD survey. California–Santa Clara County, at 96.5 percent, had the highest percentage among IAP areas; however, 12 IAP areas were below 90 percent (the lowest were 86.7 percent in Arkansas, 86.3 percent in Michigan–City of Detroit, and 85.3 percent in Mississippi).

Column 2: Household eligibility rate (HER)—''Section S'' of the NIS RDD interview (''The 2002 RDD Survey'' and table A) yields information to determine whether a household contains any children 19–35 months of age. The HER is the percentage of telephone households that have children 19–35 months of age. The HER for IAP areas ranged from 2.3 percent (District of Columbia) to 5.9 percent (Utah), with a median of 3.4 percent.

Column 3: Eligibility benchmark (EB)—From sources external to the NIS it is possible to estimate the percentage of telephone households that have an age-eligible child, as a benchmark for the observed household eligibility rate. The public-use microdata samples from Census 2000 yielded a value of this eligibility benchmark for each IAP area and for the United States in 2000. For 2002 the national eligibility benchmark from 2000 was updated by a scaling factor that reflected changes in the number of children 19–35 months of age (from unpublished NCHS natality data) and in the number of households (from U.S. Census Bureau projections). That scaling factor was then applied to the eligibility benchmark for each IAP area. The EB values for 2002 were consistently higher than the HER. The EB ranged from 3.4 percent (District of Columbia) to 8.1 percent (Utah), with a median of 4.7 percent.

Column 4: Ratio of HER to EB—The ratio of HER to EB ranged from 0.55 (Shelby County, TN) to 0.85 (South Dakota), with a median of 0.72. One plausible explanation for this relation, which the NIS has observed each year, is that a substantial number of households conceal age-eligible children.

Column 5: Access rate—The access rate was the percentage of age-eligible children who live in a household with a residential telephone and are acknowledged in ''Section S'' of the NIS RDD interview. This rate is the product of columns 1 and 4. The access rate ranged from 50.3 percent (Shelby County, TN) to 79.1 percent (South Dakota), with a median rate of 62.2 percent.

Column 6: Interview completion rate—The interview completion rate was generally high among households that reported an age-eligible child. The interview completion rate ranged from 85.1 percent (MD–City of Baltimore) to 94.8 percent (Alaska), with a median rate of 90.6 percent.

Column 7: Access rate × completion rate—This product approximates the percentage of children with a completed NIS RDD interview, among age-eligible children in the entire U.S. population. This rate ranged from 44.6 percent (Shelby County, TN) to 73.3 percent (Wyoming), with a median rate of 59.7 percent.

Column 8: Percentage of children with adequate provider data—For estimation of vaccination coverage the key ingredient is children who have adequate provider data. For the IAP areas in 2002 the percentage of children with adequate provider data (among children with a completed household interview) ranged from 50.6 percent (TX–City of Houston) to 79.8 percent (Vermont), with a median of 68.2 percent. Only 8 IAP areas were below 60 percent, with TX–City of Houston (50.6 percent), NY–New York City (51.2 percent), and LA–Orleans Parish (54.2 percent) noticeably lower.

Column 9: Access rate × completion rate × adequate provider data rate—This product summarizes the percentage of children with adequate provider data among age-eligible children who live in a household with a residential telephone, are acknowledged in ''Section S'' of the NIS RDD interview, and have a completed NIS RDD interview. This rate ranged from 27.8 percent (LA–Orleans Parish) to 56.6 percent (Vermont), with a median of 40.2 percent.

Column 10: Percentage of children with complete provider response—''Trends in Response Rates and Key Monitoring Statistics, 1994–2002'' mentioned the challenge of incomplete ascertainment. Table 5 shows the percentage of children with complete provider response (i.e., all providers named by the household respondent supplied immunization information) among those with adequate provider data. This rate ranged from 70.5 percent (TX–City of Houston) to 92.4 percent (OH–Franklin County), with a median of 86.1 percent.

Column 11: Access rate × completion rate × adequate provider data rate × complete provider rate—This product summarizes the percentage of children with complete provider response among age-eligible children who live in a household with a residential telephone, are acknowledged in ''Section S'' of the NIS RDD interview, have a completed NIS RDD interview, and have adequate provider data. This rate ranged from 21.5 percent (TX–City of Houston) to 50.6 percent (Vermont), with a median of 34.2 percent.

The product of the interview completion rate and the percentage of children with adequate provider data summarizes how representative the sample is among NIS age-eligible children living in households with a residential telephone and acknowledged by the NIS RDD respondent as living in the household. This rate ranges from 46.7 percent (TX–City of Houston) to 73.9 percent (Vermont), with a median of 61.5 percent.

In each of these rate calculations the factors contributing toward diminishing the rates are the ratio of HER to EB (column 4: 0.70 percent nationally) and the percentage of children with adequate provider data (column 8: 67.3 percent nationally). The factors contributing least toward diminishing the rates are the percentage of children 19–35 months old living in households with telephones (column 1: 92.8 percent nationally) and the percentage of children with complete provider response (column 10: 84.7 percent nationally).

Characteristics of Children in the NIS Sample, 2002

As shown in table 2 (row 12), in the 2002 NIS 31,693 children had completed RDD interviews, and 21,410 children (67.6 percent) had adequate provider data (defined in ''The 2002 RDD Sample'' and including 93 children who had received no vaccination doses). (See ''Adjustment for Partial Nonresponse—Accounting for Children with No Vaccinations.'') Table 6 shows the unweighted sample sizes and weighted percentage distributions of these two groups of children by a variety of child, maternal, and household characteristics. For each characteristic the percentage distribution of the subset of children with adequate provider data is closely similar to that for the children with a completed RDD interview. Thus, with the weights assigned by the 2002 NIS estimation methodology (see ''Adjustment for Partial Nonresponse—Accounting for Children with No Vaccinations''), the children with adequate provider data effectively represent the full RDD sample (weighted with the RDD-phase sampling weights). (See ''The RDD-phase Sampling Weight'' and ''Nontelephone Adjustments to the RDD Weights.'')

Estimation Methodology

In preparation for calculating the estimates of vaccination coverage, the NIS assigns sampling weights to children who have a completed household interview, adjusts those weights (for reasons that include multiple residential telephone numbers, unit nonresponse, and noncoverage of nontelephone households), and incorporates data from providers (for children who have adequate provider data). Research led to major changes in the estimation methodology in 1998 and 2002 as well as a variety of smaller improvements. This section describes these developments, with emphasis on the methodology as it stood in 2002.

1994–97 Estimation Methodology

For each year from 1994 to 1997 the NIS used a variant of the two-phase sampling estimator to obtain estimates of vaccination coverage for each of the 78 IAP areas. This method required survey weights for children whose parent or guardian completed the RDD interview. This report refers to this sampling weight as the ''RDD-phase sampling weight'' or, more compactly, the ''RDD weight.'' This section describes the adjustments that define the RDD weight and the two-phase sampling estimator.

The RDD-phase Sampling Weight

Between 1994 and 2001 the process of obtaining the RDD-phase sampling weight involved seven steps. The following paragraphs describe each of these steps and its purpose.

Step 1: Base sampling weight—Each child sampled by the NIS receives a base sampling weight that is equal to the reciprocal of the probability of selecting the household's telephone number into the sample. Specifically, this weight is the ratio of two totals for that IAP area: the number of telephone numbers in the 1+ working banks and the number of telephone numbers drawn from those banks and released for use.

Step 2: Base sampling weight trimming adjustment—Some children actually reside in an IAP area adjacent to the one for which their household's telephone number was sampled. Because a large range in the base weights can substantially increase the variance of estimates, the base weight for such a child is trimmed to no more than three times the base weight for the IAP area in which the child resides.

Step 3: Multiple residential telephones adjustment—A household with two or more residential telephone numbers has a proportionally higher probability of being selected into the RDD sample. To preserve the relationship between the base sampling weight and this probability, an adjustment divides the trimmed base sampling weight by the number of nonbusiness voice-use telephone numbers reported in the household.

Step 4: Multiple residential telephone weight trimming adjustment—Division of a household's trimmed base sampling weight by the number of nonbusiness voice-use telephone numbers (Step 3) can introduce considerable variation in the adjusted weights. To reduce variation, the reported number of these telephones is trimmed to no more than three. This adjustment incurs a small amount of bias.

Step 5: Household unit nonresponse adjustment—Unit nonresponse occurs because some of the sample telephone numbers with age-eligible children are never determined to be residential telephone numbers despite multiple call attempts; or they are determined to be a residence but cannot be determined to have age-eligible children; or they are residences with age-eligible children for whom the RDD interview is not completed. To account for these three types of unit nonresponse, the sampling weights of children with a completed RDD interview are adjusted for the estimated number of age-eligible children in households that are never determined to be residential telephone numbers, the estimated number of age-eligible children in households that fail to complete the screening interview, and the number of children in identified age-eligible households for whom the RDD interview is not completed. Each adjustment is tailored to account for variation of these factors within IAP areas related to the socioeconomic characteristics of children in the sample and the corresponding composition of the population in sampled telephone exchanges. That is, unit nonresponse adjustments are made within cells formed using telephone-exchange characteristics. These cells are defined by cross-classifying the residential directory-listed status of the sample telephone number by at least one of four telephone-exchange-level variables: MSA status, percentage of households that are owner-occupied, percentage of the adult population that are college graduates, and percentage of the population that is non-Hispanic white.

Step 6: Nontelephone coverage adjustment—RDD yields a sample of children in households that have telephones, but the NIS aims to measure vaccination rates for *all* children 19–35 months of age. Data from the NHIS indicated that vaccination levels are generally lower among nontelephone children than among telephone children. In some IAP areas a substantial proportion of age-eligible children reside in nontelephone households. To compensate for such potential noncoverage bias, the NIS employs a weight-adjustment procedure described in ''Nontelephone Adjustments to the RDD Weights'' and by Battaglia et al. (18).

Step 7: Poststratification adjustment—Poststratification separates the actual sample into cells defined by characteristics that are related to noncoverage and to vaccination status: education of the mother, race/ethnicity of the mother, and age group of the child (discussed further in ''Nontelephone Adjustments to the RDD Weights''). Then, the weighted distribution of completed interviews over the cells is brought into agreement with a corresponding set of population totals of these birth cohorts derived from NCHS natality data. This adjustment reduces bias incurred by obtaining samples whose weighted totals do not agree with known population totals of variables that are believed to be associated with being vaccinated. In RDD surveys these differences often arise from differential nonresponse.

The Two-phase Sampling Estimator

In surveys like the NIS that have two phases of data collection, two-phase sampling estimators (described by Cochran) often have been used to adjust for nonresponse at the second phase (19). This section describes how the NIS implemented this methodology to obtain vaccination coverage rates between 1994 and 1997.

A child is said to be ''4:3:1:3 UTD'' provided he or she has received 4 or more doses of DTP or DTaP, 3 or more doses of polio, 1 or more doses of MCV, and 3 or more doses of Hib. Within an IAP area, each child with a completed interview was categorized into one of five strata according to whether the household respondent reported that the child was 4:3:1:3 UTD and whether a shot card was used during the household interview. These strata are described below.

Stratum 1: Household respondent had a shot card during the RDD interview and reported the eligible child as being 4:3:1:3 UTD.

Stratum 2: Household respondent had a shot card during the RDD interview and reported the eligible child as not being 4:3:1:3 UTD.

Stratum 3: Household respondent did not have a shot card during the RDD interview and reported from recall the eligible child as being 4:3:1:3 UTD.

Stratum 4: Household respondent did not have a shot card during the RDD interview and reported from recall the eligible child as not being 4:3:1:3 UTD.

Stratum 5: Information was missing on 4:3:1:3 UTD status and/or shot card use.

Table B shows the percentage distribution of children over these five strata in 1997, along with the percentage whose providers reported they were 4:3:1:3 UTD (among children who had adequate provider data). The provider data indicate substantial response biases in the household reports, in both directions. In Stratum 1 and Stratum 3, though the household respondent reported the child UTD, only 87.6 percent and 77.2 percent, respectively, were reported as UTD by their providers. Conversely, in Stratum 2 and Stratum 4, though the household reported the child not UTD (NUTD), 68.6 percent and 70.8 percent, respectively, were reported as actually UTD by their providers.

Children in Stratum 1 were said to belong to the ''top row.'' These children were 4:3:1:3 UTD according to their shot card. Of the NIS children with completed household interviews in 1997, 28.4 percent belonged to the top row. As described below, the two-phase estimator in the NIS handled the top row in a special way.

Using the RDD weights, let $\hat{p}_{1,ij}$ denote in IAP area i the estimated weighted proportion of children who belong to Stratum j, $j = 1,...,5$. Also, let $\hat{p}_{2,ij}$ denote the estimated weighted proportion of children in IAP area i belonging to Stratum j who are determined to be 4:3:1:3 UTD from data obtained from the providers in the second phase of sampling. Then, the two-phase sampling estimator for the 4:3:1:3 vaccination coverage rate in IAP area i is

Table B. Strata based on household's report of child's 4:3:1:3 up-to-date status and household's use of shot card, percentage distribution of children by stratum, and percentage of children in each stratum who are 4:3:1:3 up to date in providers' reports: National Immunization Survey, 1997

Stratum	Percent distribution (unweighted)	Percent UTD from providers' reports (weighted)[1]
Shot card, 4:3:1:3 up-to-date	28.4	87.6
Shot card, not 4:3:1:3 up-to-date	20.7	68.6
No shot card, 4:3:1:3 up-to-date	16.7	77.2
No shot card, not 4:3:1:3 up-to-date	15.4	70.8
Shot card or 4:3:1:3 status missing	18.8	72.9

[1]UTD is up-to-date.

NOTE: 4:3:1:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), and 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib).

$$\hat{\pi}_i = \sum_{j=1}^{5} \hat{p}_{1,ij}\, \hat{p}_{2,ij} \qquad [1]$$

The NIS implementation involved a special modification of this two-phase sampling estimator. Specifically, weighted data from the entire national sample of children belonging to Stratum 1 (i.e., the top row) with adequate provider data were used to estimate $\hat{p}_{2,i1}$ for every IAP area. Parallel to the definition for the 4:3:1:3 series given previously, each vaccine or series had its own $\hat{p}_{2,ij}$. In addition, for estimation of Hep B coverage, the definitions of the five strata were based on the household's report of the child's UTD status on Hep B rather than on 4:3:1:3. The resulting provider-adjusted top-row estimator was used in the NIS before 1998. It reduced the impact of IAP areas where a substantial proportion of top-row children were not 4:3:1:3 UTD in their provider data. This situation was thought to be caused primarily by incomplete provider records. A further description of the NIS estimation methodology used before 1998 can be found in Zell et al. (8).

One disadvantage of the provider-adjusted estimator is that it tends to produce a slightly biased estimate of IAP area vaccination coverage rates. Using national data to estimate $\hat{p}_{2,i1}$ tends to bias coverage estimates for IAP areas toward the national figure.

An additional disadvantage is that few methods are tailored for statistical analyses of data from two-phase sampling designs when the analysis calls for more-complicated models. For example, epidemiologic analyses of complex survey data routinely require logistic regression. However, no standard statistical methods for logistic regression that account for a two-phase sampling design have been developed and made accessible to analysts through commonly available commercial software. So, although weighted estimates reflecting both phases of sampling can be produced, limitations exist for more-complex epidemiologic analysis and for release of data on public-use files.

Because of these disadvantages, a different statistical estimation methodology was implemented in 1998 (6). The next section describes this methodology.

1998–2001 Estimation Methodology

As discussed previously, the NIS has two phases of data collection. The first phase collects demographic and other descriptive data from households using list-assisted RDD sampling. The RDD weights then account for the probability of being selected from the sampling frame, nonsampling error resulting from unit nonresponse and/or failure to complete the first phase, and other adjustments such as post-stratification. At the end of the first phase of data collection, respondents are asked for consent to allow survey staff to contact their children's medical providers. With consent, the second phase asks the medical providers to report on aspects of the children's vaccination histories.

In the remainder of this report the term ''partial response'' refers to the response pattern in which data are obtained from respondents in the first phase of the survey but provider data are not obtained in the second phase. The term ''complete response'' refers to response patterns in which data are obtained in both phases.

When complete responders and partial responders have very different characteristics and the proportion of partial responders is at least moderately large, survey estimates may be severely biased. This partial-nonresponse bias can arise when the estimates are based only on data from complete responders, without adjusting for differences between complete and partial responders.

Brick and Kalton indicate that the most common method of adjusting for partial-nonresponse bias in health surveys is by using weighting classes, also called adjustment cells (20). This method assigns each complete responder and each partial responder to an adjustment cell within which sampled persons are comparable. Within the cell the adjustment redistributes the first-phase sample weights of the partial responders equally among the complete responders so that (with their adjusted first-phase sample weights) the complete responders represent the population in the cell.

The purpose of the weighting-class method is to compensate for potential bias in estimation that would result if the factors associated with partial response were ignored and estimates were prepared without accounting for differences between complete and partial responders. Weighting classes are defined by factors believed to be associated with these differences. Within each adjustment cell it is assumed that partial responders' provider data are missing at random (21,22). This assumption implies that, within a cell, complete and partial responders are comparable, and any estimate that uses data only from the complete responders (along with their adjusted first-phase sample weights) should have little bias attributable to differences between complete and partial responders. Suitably aggregating the estimates from all weighting classes yields a population-level estimate that has reduced bias attributable to such differences.

The NIS estimation methodology used between 1998 and 2001 was based on weighting classes; it yielded survey weights for complete responders that were used, along with their vaccination history data, to obtain estimates of vaccination coverage rates. This report refers to these survey weights as ''partial-nonresponse-adjusted sampling weights.'' The specific steps in the process consisted of adjusting the RDD weights of complete responders using weighting classes and then raking the adjusted weights so that their sums for specific demographic cells corresponded to known or estimated totals. The next two subsections describe these two steps.

Adjustment of Complete Responders' RDD Weights

To adjust the RDD weights so that coverage estimates could be based on data only from complete responders, weighting classes were formed using response propensities obtained from a logistic regression model whose response variable indicated whether a child was a complete responder. Within each IAP area, sampled children can be grouped into weighting classes according to the similarity of their response propensities to be a complete responder. Children with similar response propensities have similar probabilities of having adequate provider data. A group of children who have similar response propensities will also be similar with respect to characteristics that are strongly associated with the probability of having adequate provider data. In this important respect, children within each weighting class are comparable; thus, all of the sampled children in the class may be represented by the complete responders. In particular, by dividing the RDD weights of children with adequate provider data by the weighted response rate for the class, these children's weights are adjusted to represent all of the children belonging to the class. Thus, the bias in estimated vaccination coverage rates attributable to differences between sampled children who have and do not have provider-reported immunization histories is reduced. Within each weighting class, children without adequate provider data are represented by children who have similar response propensities and other associated characteristics.

To obtain the response propensities, a national model was developed using logistic regression. Within each IAP area the RDD weights were first rescaled so that their sum equaled the IAP-area-specific sample size. Inclusion of these rescaled weights as prior weights in the logistic regression ensured that the regression coefficients would have the property that, as the sample size increases to the finite population size, the estimated coefficients converge to the true finite-population values, provided the logistic model and its linear predictors correctly depict why provider vaccination histories are missing.

The candidates for predictors in the response propensity model were variables that have been found to be associated with immunization status in other research conducted by CDC (23). Table C lists variables used as candidates for the model in 2002. Forward stepwise logistic regression was used to select predictors among these candidates. SPlus 2000 was used for all calculations (24).

At each step of the stepwise selection process, the logistic regression model examined the main effects of each predictor. Also, at each step after adding regressors to the model, the model-selection method re-examined each regressor in the model to determine whether any predictor that entered at a previous step could be dropped. Akaike's Information Criterion (AIC) guided the choice of the optimal set of candidate regressors at each step (25). AIC provides a measure of goodness of fit of a model, corrected for the number of parameters in the model. Within this framework a model with minimum AIC provides the best fit to the data. Also, deviance provides a related measure of goodness of fit measured on the scale of –2 times log likelihood. The asymptotic

Table C. Variables used in the model selection for the response propensity model: National Immunization Survey, 2002

Variable name	Description and levels
agegrp	Child's age:
1	19–24 months[1]
2	25–29 months
3	30–35 months
c5	Relationship of the household respondent to the child:
1	Mother (step, foster, adoptive) or female guardian[1]
2	Father (step, foster, adoptive) or male guardian
3	Other
4	Unknown
childnm	Number of children under 18 years of age living in the household:
1	1 child[1]
2	2–3 children
3	4 or more children
educ1	Educational status of the mother:
1	Less than 12 years[1]
2	12 years
3	More than 12 years, not college graduate
4	College graduate
frstbrn	Firstborn status of child:
1	Not firstborn[1]
2	Firstborn
incpov1	Annual income and poverty status:
1	Above poverty, $75,000 or more[1]
2	Above poverty, less than $75,000
3	Below poverty
4	Unknown
m.agegrp	Maternal age group:
1	19 years or under[1]
2	20–29 years
3	30 years or over
marital	Marital status of the mother (or deceased)
1	Widowed/divorced/separated/deceased[1]
2	Never married
3	Married
mobil	Mobility status
1	Moved from different State[1]
2	Did not move from a different State
msa	Household MSA status[2]:
1	MSA, central city[1]
2	MSA, not in central city
3	Not MSA
racekid	Race/ethnicity of the child:
1	Hispanic[1]
2	Non-Hispanic white and other races
3	Non-Hispanic black
4	Non-Hispanic American Indian
5	Non-Hispanic Asian
sex	Sex of the child:
1	Male[1]
2	Female
shot card	Household reported immunization status using a shot card:
1	Shot card used during RDD interview[1,3]
2	Shot card not used during RDD interview

[1]This is the reference level for this variable.
[2]MSA is metropolitan statistical area.
[3]RDD is random-digit-dialed.

distribution of the difference of deviances for two nested models is a chi-squared distribution with degrees of freedom equal to the difference in the number of parameters indexing the two models. McCullagh and Nelder discuss the use of the deviance as a way of evaluating the statistical significance of predictors in a model (26). For the 2002 NIS the eight predictor variables (in order of entry, after the constant term) in the response-propensity model for whether a child has adequate provider data are poverty status; relationship of the household respondent to the child; household-reported immunization status using a shot card; household within central city of MSA, suburban, or nonmetro area; educational status of the mother; mobility status; race/ethnicity of the child; and number of children in the household.

The final model obtained from the variable-selection process yielded a predicted response propensity for each sampled child. Within each IAP area five weighting classes were formed, with boundaries defined by quintiles of the distribution of the response propensities. Each sampled child belonged to one of these weighting classes. Within each weighting class the complete responders' RDD weights were divided by the weighted response rate in the class. In this way, the RDD weight for all children in a class was proportionally redistributed among the complete responders in that class, producing adjusted RDD weights.

Raking the Adjusted Sampling Weights of Complete Responders

Within an IAP area the sums of adjusted sampling weights of complete responders for the various levels of important demographic variables (such as race/ethnicity) may not be equal to corresponding population totals. To reduce bias attributable to these differences, iterative ratio adjustment was used to rake the adjusted weights to match poststratification totals (27). Table D lists the variables used for raking in 2002. Control totals for these variables were estimated using the

Table D. Variables used for raking the response-propensity-adjusted sampling weights of children with provider data: National Immunization Survey, 2002

Variable name	Variable description
educ[1]	Educational status of the mother
racekid[1]	Race/ethnicity of the child
agegrp[1]	Age group of the child
sex	Sex of the child
frstbrn	Firstborn status of the child
adj.cell	Adjustment cell to which each child belongs within each immunization action plan area

[1]This variable was also used to provide a poststratification adjustment to the random-digit-dialed weights. Mother's race/ethnicity was used for poststratification.

weighted totals from the first-phase sample.

For a particular stratum, let n denote the number of complete responders, and let $W_1^{(0)},...,W_n^{(0)}$ denote their partial-nonresponse-adjusted sampling weights (before any raking). Also, let L_v denote the number of levels for the v-th demographic raking variable, and let X_{vlc}=1 if the c-th complete responder belongs to the l-th level of the v-th demographic raking variable and 0 otherwise, v=1,...,V, l=1,2,...,L_v. Finally, let T_{vl} denote the population total in the stratum for the v-th raking variable at its l-th level. Each iteration of the raking process takes one variable in turn (v=1,...,V) and makes a multiplicative adjustment for each level of that variable (l=1,...,L_v). At the i-th iteration, (i=1,2,...), the partial-nonresponse-adjusted sampling weights from the (i–1)-th iteration, $\{W_c^{(i-1)}\}$, for complete responders belonging to the l-th level of the current variable (v^*) are raked to yield

$$W_c^{(i)} = W_c^{(i-1)} \frac{T_{v^*l}}{\sum_{c=1}^{n} W_c^{(i-1)} X_{v^*lc}}$$

l=1,2,...,L_{v^*}. If v^*=V and $|T_{vl} - \sum_{c=1}^{n} W_c^{(i)} X_{vlc}| < 1$ for all l=1,2,...,L_v and all v=1,...,V, iteration stops. Otherwise, at the next iteration the process rakes each level of the (v^*+1)-th variable (or the first variable, if v^*=V). To maintain the effect of the partial-nonresponse adjustment, adjustment-cell membership is included among the raking variables. Deville et al. discuss more-general raking procedures (28).

The Ratio Estimator of Vaccination Coverage

Estimates of vaccination coverage in the NIS are weighted proportions of children who are UTD, often in some domain of interest. Formally, those proportions are ratio estimators, either within a stratum (i.e., an IAP area) or combining the data from the strata. In this section, let L denote the number of strata, and let

N_h = the number of primary sampling units (PSUs, or households in the NIS) in stratum h;

n_h = the number of PSUs sampled in stratum h, h=1,...,L;

M_{hi} = the number of subjects in PSU i of stratum h belonging to the target population;

m_{hi} = the number of subjects in PSU i of stratum h who were sampled in the survey;

W_{hij} = the overall sampling weight for subject j sampled in PSU i of stratum h, accounting for all sampling and nonsampling adjustments;

Y_{hij} = 0 when subject j in PSU i of stratum h is NUTD on a specific vaccination, and Y_{hij} = 1 when the child is UTD;

δ_{hij} = 1 when subject j in PSU i of stratum h belongs to the domain of interest, and δ_{hij}=0, otherwise;

Y'_{hij} = 0 when the j-th sampled subject in the i-th sampled PSU of stratum h is NUTD on a specific vaccination, and Y'_{hij}=1 when the child is UTD; and

δ'_{hij} = 1 when the j-th sampled subject in the i-th sampled PSU of stratum h belongs to the domain of interest, and δ'_{hij}=0, otherwise.

Letting

$$Y_h = \sum_{i=1}^{N_h} \sum_{j=1}^{M_{hi}} \delta_{hij} Y_{hij}$$

and

$$T_h = \sum_{i=1}^{N_h} \sum_{j=1}^{M_{hi}} \delta_{hij}$$

the true but unknown vaccination rate for the domain is

$$\theta = \frac{\sum_{h=1}^{L} Y_h}{\sum_{h=1}^{L} T_h}$$

Let

$$\hat{Y}_h = \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} \delta'_{hij} W_{hij} Y'_{hij}$$

and

$$\hat{T}_h = \sum_{i=1}^{n_h} \sum_{j=1}^{m_{hi}} \delta'_{hij} W_{hij}$$

Then the combined ratio estimator of the vaccination rate for the domain of interest is

$$\hat{\theta} = \frac{\sum_{h=1}^{L} \hat{Y}_h}{\sum_{h=1}^{L} \hat{T}_h} \qquad [2]$$

The Taylor-series Estimate of Variance

Letting

$$Z_{hij} = \Big(\sum_{h=1}^{L} \hat{T}_h\Big)^{-1} [\delta'_{hij} W_{hij} (Y'_{hij} - \hat{\theta})]$$

denote the linearized value of the ratio estimator [2] and letting

$$Z_{hi} = \sum_{j=1}^{m_{hi}} Z_{hij} \text{ and } \bar{Z}_h = (n_h)^{-1} \sum_{i=1}^{n_h} Z_{hi}$$

the Taylor-series estimate of the variance of $\hat{\theta}$ is (neglecting higher-order terms)

$$\hat{V}_T(\hat{\theta}) = \sum_{h=1}^{L} \frac{n_h}{n_h-1} \sum_{i=1}^{n_h} (Z_{hi} - \bar{Z}_h)^2 \qquad [3]$$

2002 Estimation Methodology

In 2002 a different approach to adjusting the RDD weights produced a more accurate accounting within each IAP area for households that do not have telephones. Also, the procedure for obtaining partial-nonresponse-adjusted sampling weights of children with adequate provider data was revised to account for children who have had no vaccinations. This section details the procedures used before 2002, describes the changes for 2002, and examines the effect of the two modifications.

Nontelephone Adjustments to the RDD Weights

Background

The NIS relies on RDD to obtain a sample of children 19–35 months of age in each IAP area. A key disadvantage of the RDD sampling approach is that it gives children residing in nontelephone households a zero probability of selection. Although one can use an RDD sample to generalize to the population of age-eligible children in telephone households in a straightforward manner, the objective of the NIS is to generalize to the entire population of age-eligible children residing in households in each IAP area.

The accuracy of estimates obtained from the NIS will be affected by the proportion of age-eligible children residing in nontelephone households and by the difference in vaccination rates between telephone and nontelephone children. Although an estimated 90 percent of 2-year-old children in the United States resided in a household with a telephone in 1996–97, the percentage for IAP areas (table 7) ranged from 76 percent (Arkansas) to 97 percent (Pennsylvania–Rest of State). Table 7 also shows the corresponding percentage in 2000 from lowest to highest, based on the 2000 census and information from the March 2000 Current Population Survey (CPS). Many IAP areas had higher telephone coverage in 2000. The Federal Communications Commission (FCC) has also reported an increase in the percentage of U.S. households with telephone service: 93.9 percent in March 1997, 94.6 percent in March 2000, and 95.5 percent in March 2002 (29). Although telephone coverage has increased over recent years, the number of telephone lines has decreased since 2000. The FCC attributes this to the recession, elimination of second telephone lines when households move from dial-up Internet service to broadband or cable-modem service, and substitution of wireless service for wireline service.

Data on vaccination coverage and household telephone status have been collected by the NHIS (in its Immunization Supplement) and by the National Immunization Provider Record Check Study (NHIS/NIPRCS), which collected provider-reported vaccination histories of children sampled in the Immunization Supplement (30). Those data indicated that vaccination coverage rates for 19–35-month-old children differ considerably between telephone and nontelephone households. The sizable percentages of nontelephone households in many IAP areas and the large differences in vaccination coverage between telephone and nontelephone children suggest that vaccination coverage estimates that use only telephone households could have considerable bias. Thus, NIS estimation methods attempt to adjust for differences between telephone and nontelephone children.

Initial evidence on approaches to adjustment for noncoverage in the NIS came from an analysis of the 1992 NHIS sample of children 19–35 months of age. An initial hypothesis in the NIS was that demographic and socio-economic characteristics could account for the relationship between having a telephone in the household and being UTD on vaccinations. A positive finding would suggest that poststratifying the NIS sample of telephone children on those demographic and socioeconomic characteristics could reduce noncoverage bias. To test this hypothesis, logistic regression models related indicators of UTD vaccination coverage to a set of demographic and socioeconomic predictors, both individual-level and county-level variables. Adding an indicator for the presence of a telephone produced a statistically significant improvement in each model. This result indicated that, for the 1992 NHIS, the demographic and socioeconomic variables could not adequately account for the effect of telephone ownership on vaccination coverage.

The process of developing alternative estimation techniques to adjust for noncoverage of children in nontelephone households began with a review of past research. In a comprehensive review of weighting procedures for RDD samples, Massey and Botman discuss adjustments to the base sampling weight to account for households without telephones (31). In a specific example, they multiply the base sampling weight by the ratio of the estimated total population to the estimated telephone population within a set of cells defined by geographic region and race. They also suggest poststratification as a way to reduce noncoverage bias. In their evaluation of an RDD survey on smoking behavior, a comparison with the NHIS sample seems to indicate that the weighting adjustments were partially successful in accounting for telephone coverage bias. A National Center for Education Statistics study examining schooling variables in the CPS found that poststratifying the sample of telephone individuals was not always successful in reducing noncoverage bias (32,33). The investigators found that multiplying the base sampling weight by the ratio of total population to telephone population for three categories of school-enrollment status within each poststratification cell before carrying out the usual post-stratification adjustment sometimes led to a greater reduction in noncoverage bias than poststratification alone. The general conclusion from reviewing the literature was that a single estimation procedure may not always be the most successful in reducing noncoverage bias in an RDD sample.

Further work on NIS estimation procedures (described below) focused on poststratification. Simple poststratification served as a starting point and as a basis for assessing the further reduction in noncoverage bias that could be achieved by modified poststratification, which used estimates from the NHIS/NIPRCS on the ratio of vaccination coverage rates for nontelephone children to the corresponding rates for telephone children.

Simple Poststratification

A widely-used estimation technique for an RDD sample poststratifies the nonresponse-adjusted base sampling weight. That is, the weighted distribution of the completed interviews is brought into agreement with the population control totals for a set of poststratification cells. This method is called ''simple poststratification.'' For example, a sample that is poststratified on the combination of three age categories and two gender categories would have six poststratification cells. The NIS can obtain population control totals from unpublished NCHS natality data files. The general idea is to select variables that are related to unit nonresponse and/or noncoverage and are associated with the key subject-matter variables. NCHS natality data include variables such as date of birth, race of mother, Hispanic origin of mother, and education of mother. These variables, as demonstrated in the analysis of the 1992 NHIS, are related to noncoverage and vaccination status.

One major drawback is that simple poststratification assumes that the percentage vaccinated within each poststratification cell is the same for both telephone and nontelephone children. Most of the estimates of vaccination coverage produced by the NIS can be characterized as UTD estimates. That is, a child is considered UTD if he or she has received at least a specified number of vaccinations. One of the primary estimates is the percentage of children who were UTD on DTP, polio, and MCV (i.e., 4 or more DTP, 3 or more polio, and 1 or more MCV). The analysis of the 1992 NHIS indicated that the percentage of 19–35-month-old children who were UTD on DTP, polio, and MCV was lower for nontelephone children than for telephone children within the categories of the potential poststratifiers. This result suggests that simple post-stratification will be only partially successful in eliminating noncoverage bias. It does, however, provide a frame-work for modified poststratification.

Simple poststratification in the NIS serves primarily to adjust for noncoverage of nontelephone households and secondarily to compensate for unit nonresponse. The population control totals must correspond to variables that are collected for respondents. The NIS questionnaire obtains State and county of residence, race of child, Hispanic origin of child, age of child in months, race of mother, Hispanic origin of mother, and education of mother. NCHS natality data are the only source for IAP-area-specific population control totals based on children's age in months during a 4-quarter period (34). Specifically, the population control totals for a 4-quarter period are based on birth records for children born 19–35 months prior to the midpoint of that period. The natality data file contains all the above variables as well as month and year of birth, age of mother, education of father, and MSA identification codes as of June 30, 1990. (Subsequently the MSA codes were updated, effective with 1996 data, to reflect the results of the 1990 census.) For a small percentage of birth records, Hispanic origin of mother and/or education of mother was missing. A hot-deck procedure, basing imputation cells on State and race, was used to fill in those missing data.

Formation of Poststratification Cells

The natality data files yield population control totals for each of the 78 IAP areas. In developing this process the first step was to prepare a cross-tabulation for each IAP area, showing the distribution of live births for education of mother by race of mother by Hispanic origin of mother by MSA status of residence county. Tabulations that included age of child were also developed.

These cross-tabulations were analyzed, and rules were developed for collapsing cells of the cross-tabulation into a set of poststratification cells for each IAP area. This analysis aimed to create a reasonable number of poststratification cells from a potentially large number of cross-classification cells. The poststratification for Q2 and Q3 of 1994 used three cells within each IAP area: mother's education less than 12 years; mother's education 12 years or more and child 19–25 months old; and mother's education 12 years or more and child 26–35 months old.

For the combined data from Q2, Q3, and Q4 of 1994 (and for data from four consecutive quarters), the process introduced race/ethnicity as an additional poststratification variable and constructed poststratification cells separately for each IAP area. The hierarchical process for constructing the cells used race/ethnicity as the first variable (with three categories: Hispanic, non-Hispanic black, and non-Hispanic white or other), mother's education as the second variable (two categories: 12 years or less and more than 12 years), and age of child as the third variable (two categories: 19–25 months and 26–35 months). To remain separate, a category had to contain enough children with completed interviews to satisfy the following minimum sample size requirements:

- 25 for a category of race/ethnicity
- 30 for a category of mother's education
- 30 for a category of child's age

If either the Hispanic category or the non-Hispanic black category had fewer than 25 children with completed interviews, it was first combined with the other minority category to see whether the resulting sample size exceeded 25. After comparing the weighted age distribution of the NIS sample against that in the natality file, the minimum sample size for an age category was reduced to 25 in nine IAP areas.

To illustrate the construction of poststratification cells, table 8 shows the initial data and the result for the Massachusetts–City of Boston IAP area. In the cross-classification of sample children by race/ethnicity, education of mother, and age of child, all three race/ethnicity categories exceed the minimum sample size requirement of 25 children.

Education of mother is then examined. For Hispanic children the more than 12 years category for education of mother contains fewer than 30, but each of the other two race/ethnicity categories has more than 30 children in both education-of-mother categories. Therefore, non-Hispanic black and non-Hispanic white or other children are split into the two education-of-mother cells, and no education split is made for Hispanic children.

Age of child is examined next. Hispanic children cannot be split on age because the 19–25-month age category contains fewer than 30 children. Non-Hispanic black children whose mothers have 12 or less years of education cannot be split on age of child. The same holds for non-Hispanic black children whose mothers have more than 12 years of education. For non-Hispanic white or other children the lower-education cell has 23 children in the 19–25-month age category, and therefore no split on age is made. The higher-education cell has more than 30 children in both age categories, however, and these children are split on age. As shown in the second panel of table 8, the process yields a total of six poststratification cells for the Massachusetts–City of Boston IAP area.

After reviewing the results for Q2–Q4/1994, it was decided to use the same set of poststratification cells in each IAP area for each subsequent 4-quarter period of the NIS. However, if one of those cells contained fewer than 20 children, it was combined with an adjacent cell.

The Natality Data

The NCHS natality file provides a universe of live births in the United States. Using these data to form the required population control totals of 19–35 months of age for the NIS requires adjustments for infant mortality, immigration into the United States, and emigration from State to State. To adjust for infant mortality in the native-born U.S. population, State-specific rates of infant mortality by race group (obtained from NCHS) are applied.

Next, an adjustment to the mortality-corrected NCHS natality counts is made to account for children who immigrate into the United States before reaching the age of 19–35 months. This immigration adjustment increases the population of children. The public-use microdata samples (PUMS) from the 1990 census were used to estimate the number of 2-year-olds in each State who were born outside the United States.

Lastly, the mortality-and-immigration-adjusted NCHS natality counts used for NIS control totals are adjusted for emigration from State to State. The average annual interstate migration rate for children 1–4 years of age is 3.6 percent. To examine this issue in more detail, 1990 census data were used to estimate the percentage of 2-year-old children who had been born outside their State of residence. A different State of birth would indicate migration over the 2-year period or that the child was born in a hospital outside the State of residence (e.g., the State of residence was Maryland, but the child was born in a hospital in the District of Columbia). In general, a nontrivial percentage of 2-year-old children were born in a different State than their State of residence. Thus, inter-IAP-area migration might reduce or inflate the population control totals for a given IAP area. The 1990 census data, however, permitted estimation of net migration only for States, not for individual IAP areas. Given the limitations of the data, a simple State-by-State adjustment for net migration was made.

The ratio of the adjusted count to the original count yields a weight factor that is applied to a State-level IAP area or to the individual IAP areas in a State that contains multiple IAP areas. Using this adjustment factor, the weighted distribution of births for education of mother (12 years or less, more than 12 years) by age of child (19–25 months, 26–35 months) by race/ethnicity of mother (Hispanic, non-Hispanic black, non-Hispanic white or other) is tabulated for each IAP area. These weighted counts provide the post-stratification control totals for the 4-quarter period.

The Nontelephone Adjustment Used Between 1994 and 2001: Modified Poststratification

The analysis of the 1992 NHIS (described previously) indicated that the relationship between telephone ownership and the various UTD vaccination coverage variables cannot completely be accounted for by individual-level demographic and socioeconomic variables or by county-level demographic, socio-economic, and health-care-related variables. This result, in turn, indicated that, within the poststratification cells developed from the natality data file, the UTD vaccination rates differ between telephone and nontelephone children. It was, therefore, likely that simple poststratification would be only partially successful in reducing noncoverage bias. The poststratification framework, however, offered a way to achieve additional bias reduction. At a national level the NHIS Immunization Supplement or NHIS/NIPRCS provided estimates of vaccination rates for telephone and nontelephone children for the various poststratification cells. This information was used to split each poststratification cell into two subcells: one representing UTD children and the other representing children who were NUTD. Poststratification then was used to adjust the weights of the NIS children within these subcells. The definition of ‘‘up to date’’ for the subcells was based on the 4:3:1 series from 1994 through Q3/1997–Q2/1998 and on the 4:3:1:3 series from Q4/1997 through Q3/1998 onward.

To describe how the poststratification totals were obtained for the two subcells of poststratification cell g in a given IAP area, let N_g denote the total number of children in the cell, and let P_g denote the proportion of children in the cell residing in households with telephones, as determined from the most recent U.S. census. Then

$$N_{Tg} = N_g P_g$$

denotes the number of children in telephone households, and

$$N_{\bar{T}g} = N_g - N_{Tg}$$

denotes the number of children in nontelephone households. Let r_g denote the weighted proportion of NIS children in poststratification cell g who are UTD (using the nonresponse-adjusted base sampling weight). Also, let ρ_{Tg} and $\rho_{\bar{T}g}$ denote the *national* 4:3:1 (later, 4:3:1:3) vaccination coverage rates, as estimated from recent NHIS/NIPRCS data, among children in telephone and nontelephone households whose maternal race/ethnicity is the same as in poststratification cell g of the IAP area. Then, the estimated number of children who are UTD in poststratification cell g of the IAP area is

$$\hat{N}_g^{(\mathrm{UTD})} = N_{Tg}\, r_g + N_{\bar{T}g}\, (\rho_{\bar{T}g} / \rho_{Tg})\, r_g$$

and $\hat{N}_g^{(\mathrm{NUTD})} = N_g - \hat{N}_g^{(\mathrm{UTD})}$ is the estimated number of children who are NUTD. $\hat{N}_g^{(\mathrm{UTD})}$ and $\hat{N}_g^{(\mathrm{NUTD})}$ are then used as control totals for the UTD and NUTD subcells of poststratification cell g of the IAP area. Battaglia et al. discuss modified poststratification in more detail (18).

The modified-poststratification approach allows direct use of the weights to form vaccination coverage proportions and totals for each IAP area. It has some limitations, however. First, to avoid complications, it uses only one NHIS vaccination variable: the 4:3:1 series (replaced by 4:3:1:3 starting with Q4/1997–Q3/1998). This approach assumes that other measures, such as Hep B and VRC, exhibit a strong positive correlation with 4:3:1 (or 4:3:1:3). Second, the modified-poststratification technique applies national NHIS rates (by maternal race/ethnicity) to each individual IAP area. Thus, in using the ratio of the national UTD rates for nontelephone to telephone children, it implicitly assumes that the actual ratio is close to this value in all IAP areas. Third, poststratification is based on the assumption that the population control totals are subject to little, if any, sampling variability. Fourth, the adjustment relies on a separate independent survey, NHIS/NIPRCS, which ended in 2000. For all of these reasons a new adjustment for noncoverage of households without telephones was implemented in 2002.

The 2002 Revision

To adjust for potential bias in estimated coverage rates that may be incurred by sampling only households with telephones, the 2002 revised method uses data that are specific to the IAP area instead of using the same adjustment for every IAP area (based on recent national data from the NHIS). It builds on empirical evidence suggesting that households that have experienced a recent interruption in telephone service are similar to households that do not have telephones (35). Using NHIS data, Srinath et al. found that persons residing in households that have experienced a recent interruption in telephone service are generally more similar to persons in households that do not have telephones than are persons in telephone households that have had no interruption, with respect to insurance status, self-reported health status, Medicaid eligibility, and not receiving health care because of its cost (36). Table 9 shows how these four health-related variables are related to the combination of telephone status and interruption status in nine large States. When combined, telephone status and interruption status form four groups of households (and persons): those without telephone service at the time of the survey that had had telephone service during the previous 12 months, those without telephone service at the time of the survey that had not had telephone service any time during the previous 12 months, those with telephone service at the time of the survey that had had an interruption lasting 1 week or longer during the previous 12 months, and those with telephone service at the time of the survey and throughout the previous 12 months. For the majority of the 36 combinations of health-related variable and State, the prevalence estimate for persons in telephone households with interruptions was closer to the estimates for the two nontelephone groups than was the estimate for persons in telephone households without interruptions.

Questions on whether the household experienced an interruption in telephone service of 1 week or longer in the past 12 months were added to the RDD interview. The responses make it possible to classify children who have a completed household interview according to whether their household experienced an interruption in telephone service.

The notation in table E gives the result of cross-classifying the target population by telephone status and interruption status. The adjustment uses two population control totals derived from the number of age-eligible children in telephone households (N_{T+}), the number of such children in nontelephone households ($N_{\bar{T}+}$), and the estimated number of children from households with interruptions in telephone service ($\hat{N}_{TI}$). The weights of all sample children in households without interruptions are adjusted so that their sum equals $N_{T+} - \hat{N}_{TI}$. Similarly, the weights of the children in households with interruptions are made to sum to $N_{\bar{T}+} + \hat{N}_{TI}$.

Similar to modified poststratification (described above), N_{T+} and $N_{\bar{T}+}$ arise from allocating the total number of age-eligible children in the IAP area (derived from NCHS natality data) according to the proportion of children 1–3 years of age in the IAP area who reside in telephone households. The estimates of that proportion for the IAP areas came from an analysis that combined the 24 monthly samples from the CPS's Basic Monthly Survey (http://ferret.bls.census.gov) for 1996 and 1997. Table F gives instructions for downloading those files. (For each State

Table E. Notation for numbers in the target population at the time of the telephone survey by the combination of telephone status and interruption status

Telephone status	Interruption status: Interruption (I)	Interruption status: No interruption ($\bar{I}$)	Total
Telephone (T)	N_{TI}	$N_{T\bar{I}}$	N_{T+}
No telephone ($\bar{T}$)	$N_{\bar{T}I}$	$N_{\bar{T}\bar{I}}$	$N_{\bar{T}+}$
Total	N_{+I}	$N_{+\bar{I}}$	N_{++}

Table F. Instructions for downloading Current Population Survey monthly survey data files

Step	Action
1	Visit the Bureau of Labor Statistics Web site at http://ferret.bls.census.gov.
2	Click on Get Ferrett Data.
3	Download the install file for the latest application version of DataFerrett.
4	After installation is complete, double-click on the DataFerrett application to start the program.
5	Enter your e-mail address.
6	Select CPS Basic.
7	Indicate the month and year of the data file to be downloaded.
8	List the variables to include in the download of the data.[1]
9	Specify the creation of an ASCII file for downloading.
10	Select a record format.
11	Download the data file.

[1]For the analysis of telephone coverage, the chosen variables were GESTFIPS (FIPS State code), GTCO (FIPS county code), GTMSA (Metropolitan Statistical Area code), HETELHHD (household telephone in living quarters), PRTAGE (age in years), and PWSSWGT (weight: second-stage weight).

and for four urban IAP areas the combined CPS sample was large enough to support a separate estimate. For the other urban IAP areas the estimate was derived from a combination of MSA-level and State-level samples.) The NIS sample for the IAP area yields the weighted proportion of children from households with interruptions, and $\hat{N}_{TI}$ equals the product of that proportion and N_{T+}.

When the adjustment factor for the weights of children in households with interruptions (in an IAP area) would exceed 3.0 times the adjustment factor for the weights of children in households without interruptions, that ratio is truncated to 3.0. The resulting adjusted weights are then poststratified, using the control totals for the same cells as in simple poststratification. Table 10 illustrates the calculations for the interruption-based adjustment in the Georgia–Rest of State IAP area.

Using data from the 1997 NHIS, Frankel et al. found that, for 12 health-related variables correlated with telephone status, the interruption-based adjustment eliminated 76 percent of the nontelephone bias that simple poststratification was unable to remove (35). Using 1997–99 NHIS data for nine large States, Srinath et al. found that, for four health-related variables, the interruption-based adjustment eliminated 60 percent of that bias (36).

It is reasonable to expect similar reductions in the bias in the NIS. The interruption-based approach makes a separate adjustment in each IAP area. By relying on data on interruptions in telephone service, it is less direct than modified poststratification, which uses ratios (from NHIS/NIPRCS) of vaccination coverage among nontelephone children to vaccination coverage among telephone children. Those ratios, however, were available only at the national level, and the end of NHIS/NIPRCS in 2000 meant that they would become increasingly out of date.

Adjustment for Partial Nonresponse—Accounting for Children with No Vaccinations

The 1998–2001 Method for Partial Nonresponders

Once the RDD weights are adjusted for nontelephone households, they are adjusted further to account for differences between complete responders and partial responders. This process, based on a weighting-class methodology, involves four steps:

Step 1: Estimate response propensities. As in ''Adjustment of Complete Responders' RDD Weights,'' for every sampled child with a completed RDD interview, the national-level logistic regression model yields a response propensity for having adequate provider data.

Step 2: Assign children to weighting classes. Within each IAP area the response propensity of each sampled child with a completed RDD interview places the child in one of five weighting classes, defined by the quintiles of the response propensities in that IAP area.

Step 3: Adjust the nontelephone-adjusted RDD weights. Within each weighting class the RDD weights of partial responders are distributed proportionally among the complete responders (by dividing the RDD weights of complete respondents by the weighted response rate).

Step 4: Rake.The nontelephone-adjusted RDD weights, as adjusted for partial nonresponse in Step 3, are subsequently raked (as described in ''Raking the Adjusted Sampling Weights of Complete Responders'').

The validity of the current weighting-class method depends upon whether, within each weighting class, missing data from partial respondents are missing at random and observed data from complete responders are observed at random (21,22,37). Research is currently underway by the first author to evaluate the plausibility of this assumption and to learn how vaccination coverage rates might change if partial respondents' missing data were imputed using a model that accounts for selection bias.

Adjustment for Children Who Had No Vaccinations—Implemented in 2002

Smith et al. have described the epidemiologic importance of children who have not received any vaccine doses, how their characteristics tend to be distinctly different from those of other undervaccinated children, and where they tend to reside in the United States (38). In the NIS children are said to be unvaccinated if the household respondent reported that the child received no vaccinations and the child had no vaccination providers, or if all providers identified by the household reported administering no vaccinations to the child. In the NIS sampled children with no vaccine doses are few (totaling only 111 in 2001), and they pose a special challenge in accounting for their vaccination status among the children whose data are included in the estimation of vaccination coverage rates. These children's provider-reported vaccination histories are not missing at random. Specifically, those vaccination histories are missing either because the children had no medical providers and received no vaccinations or because all their medical providers reported administering no vaccinations. The weighting-class methodology implemented in the 1998 NIS (''1998–2001 Estimation Methodology'') treated children with no vaccinations as if their vaccination status were missing at random, rather than recognizing that they were NUTD on any vaccine.

That weighting-class methodology is valid only for children whose vaccination histories are either missing at random or observed at random. Because the vaccination histories of children with no vaccinations are not missing at random, it is not valid to overlook their vaccination status, treat them as if they did not have a provider-reported vaccination history, and allow them to be represented by complete responders, who are more likely to be UTD. Also, because the vaccination histories of children with no vaccinations are not observed at random, it is not valid for these children to represent partial responders, who are more likely to be UTD. Modifications of the 1998–2001 weighting-class methodology allowed children with no vaccinations to play a proper role in accounting for partial nonresponse.

The revised weighting-class methodology accounts for the fact that the vaccination status of children with no vaccinations is neither missing at random nor observed at random. The unvaccinated children are set aside in the following steps: estimating response propensities, assigning children to weighting classes, adjusting the weights of children with adequate provider data, and raking the resulting revised weights. The revised method involves four steps:

Step 1: Revised approach to estimating response propensities—Sampled children with no vaccinations are set aside (for use in Step 4 below), and a national-level logistic regression model is developed. That model then yields estimated response propensities for all vaccinated children in the sample.

Step 2: Assignment to a weighting class—Within each IAP area each vaccinated sampled child is assigned to a weighting class according to the quintiles of the estimated response propensities in the IAP area. Children with no vaccinations are not assigned to a weighting class.

Step 3: Adjusting the nontelephone-adjusted RDD weights—Within each weighting class the RDD weights of the partial responders are distributed proportionally among the vaccinated complete responders.

Step 4: Raking the revised weights of complete responders—Children with no vaccinations are assigned a weight equal to their nontelephone-adjusted RDD weight. Within each IAP area the revised survey weights of complete responders from Step 3 are raked to match IAP-area-specific control totals, minus the weights of children with no vaccinations. This ensures that the totals of the raked revised weights of the complete responders and the nontelephone-adjusted RDD weights of the children with no vaccinations match IAP area control totals. These sampling weights are called ''the partial-nonresponse-adjusted sampling weights that account for the children with no vaccinations.''

Evaluation of the Effect of the Two Modifications

Table 11 lists estimated 2001 coverage rates for each State, revised to account for children with no vaccinations and incorporating the revised nontelephone adjustment to show the combined effect of the two modifications. Δ denotes the difference between the revised coverage rate and the coverage rate that does not account for children with zero vaccinations or incorporate the new nontelephone adjustment. The differences, Δ, are generally small: 90 percent of them are between –1.8 and +1.2 percentage points, with a median difference of –0.3 percentage point. These statistics suggest that the combined effect of the new nontelephone adjustment and the revised weighting-class method yielded vaccination coverage rates that were close to the 1998–2001 estimation methodology, which had neither of these modifications.

Explanation of Unexpected Consequences

Estimated vaccination coverage rates might be expected to decrease as a result of adjusting more accurately for nontelephone households and for children with no vaccinations. One reason for this is the expectation that children living in nontelephone households are less likely to be UTD, and they are represented by children living in households that experienced an interruption in telephone service. A further reason is the expectation that all children with no vaccinations are NUTD, and including them in the calculations for estimated vaccination coverage should decrease rates. However, these expectations are not borne out for all estimated vaccination coverage rates—33 percent of the revised coverage estimates in table 11 are greater than the estimates from the 1998–2001 methodology. The reasons why the revised estimates sometimes exceed the original estimates (albeit by a very small amount) can be traced to unfulfilled assumptions underlying the two expectations listed above and the number and complexity of the adjustments to the survey weights in the NIS.

Empirical research on data from the NHIS has shown that, at a national level, children living in nontelephone households have characteristics that are similar to those of children in households experiencing an interruption in telephone service and that these characteristics are associated with being NUTD. Among the complete responders living in a household with an interruption in telephone service, 70 percent are 4:3:1:3 UTD. This percentage varies from State to State and can be higher than the 4:3:1:3 UTD rate for children in households that did not experience an interruption in telephone service. Therefore, the impact of the revised nontelephone adjustment also varies, and it can yield estimated rates that are higher than the original estimates.

As an example of unexpected results arising from the complexity of the NIS methods, in 5 of the 50 States and the District of Columbia all sampled children had vaccinations (n_0=0), and estimated vaccination coverage rates increased slightly as a result of using the revised methodology. *This can occur because the data of children with no vaccinations are not used in the national response propensity model.* However, children with no vaccinations were used in estimating the model between 1998 and 2001, and they were considered to have had missing provider data. As a consequence, Steps 1 through 4 also change. These changes can increase estimated coverage rates when the estimates obtained from the 2002 estimation methodology are compared with those obtained from the 1998–2001 estimation methodology.

In States that have sampled children with no vaccinations (n_0>0), estimates of vaccination coverage also can increase slightly. Such children are more likely to be white, live in families with 4 or more children under 18 years of age, and have moved from a different State. Sampled children with these characteristics have lower response propensities for having adequate provider data and would belong to a lower-propensity weighting-class in the original weighting-class methodology. It is important to recognize that sampled children belonging to the low-response-propensity weighting classes tend to be less likely to be UTD.

When the children with no vaccinations are removed from the response propensity and weighting-class methodology, the resulting weighted response rate for low-propensity cells *increases*, compared with what the rate would be if unvaccinated children remained in the cell and were assumed to have no provider data. As a result, the adjusted weights are *smaller* within the low-propensity cells. Also, children with no vaccinations are retained in the data set, and their adjusted weights are relatively small because these weights are never divided by a weighted response rate. As a result, children who are NUTD can have smaller adjusted sampling weights, compared with the weights they would receive in the 1998–2001 methodology. This can tend to increase estimated coverage rates.

Separating the Contributions of the Two Modifications

Further studies examined the separate contributions of the new nontelephone adjustment and accounting for children with no vaccinations to the differences in estimates of vaccination coverage for 2001. The first two columns of table 12 show the State estimate of 4:3:1:3 vaccination coverage and its standard error based on the 1998–2001 estimation methodology, which uses modified poststratification and does not account for children with no vaccinations. Subsequent columns show the difference in the estimate associated with using only the new nontelephone adjustment, only accounting for children with no vaccinations, accounting for children with no vaccinations after making the new nontelephone adjustment, and combining the two modifications. The results are summarized as follows:

(a) Differences between the 4:3:1:3 estimate that incorporates the new nontelephone adjustment but does not account for children with no vaccinations and the estimate based on the 1998–2001 methodology ranged from 2.2 to –2.9 percentage points, with an interquartile range of 1.0 percentage point. Thirty of the 51 differences were negative.
(b) Differences between the 4:3:1:3 estimate that accounts for children with no vaccinations but does not incorporate the new nontelephone adjustment and the estimate based on the 1998–2001 methodology ranged from 1.4 to –1.1 percentage points, with an interquartile range of 0.6 percentage point. Twenty-nine of the differences were negative.
(c) Overall differences between the 4:3:1:3 estimate that incorporates the new nontelephone adjustment and accounts for children with no vaccinations and the estimate based on the 1998–2001 methodology ranged from 1.5 to –3.6 percentage points, with an interquartile range of 1.1 percentage points. Thirty-one of the differences were negative.
(d) The nontelephone adjustment is made before the children with no vaccinations are incorporated into the weight calculations. Differences between the 4:3:1:3 estimate that incorporates the new nontelephone adjustment and accounts for children with no vaccinations and the estimate based on the new nontelephone adjustment but not accounting for children with no vaccinations ranged from 1.9 to –1.0 percentage points, with an interquartile range of 0.7 percentage point. Twenty-nine of the differences are negative.

The overall differences in item (c) above are equal to the sum of the differences in items (a) and (d). For 34 States the new nontelephone adjustment had a larger impact than did accounting for the children with no vaccinations. Almost all of the differences in table 12 are smaller than the standard errors of the estimates based on the 1998–2001 methodology, and many of the differences are quite small relative to the standard errors.

A Further Evaluation of the Effect of Accounting for Children with No Doses on Vaccination Coverage Estimates

To assess the effect of accounting for children with no vaccine doses (without, at the same time, changing the method of compensating for households with no telephones), a modification of the 1998–2001 estimation methodology incorporated only that change. For the 1995–2002 survey years, table G lists the national rates of 4:3:1:3 coverage estimated by the 1998–2001 estimation methodology and by the modification. On the national level, accounting for children with no vaccine doses had very little effect on the 4:3:1:3 vaccination coverage rates. Within IAP areas the two coverage estimates also differed little. The largest difference (in either direction) was commonly 1 to 2 percentage points (with the isolated exception of single IAP areas in 1995 and 2002). Differences of that magnitude are small compared with the half-widths of the confidence intervals.

The NIS estimates published between 1995 and 2001 did not account for children with no vaccine doses. Also, NIS public-use files for survey years from 1995 through 2001 did not include survey weights that accounted for the effect of these children (39). Although accounting for unvaccinated children has a small effect on estimated 4:3:1:3 vaccination coverage rates, analysts who use the public-use files for survey years 1995–2002 to evaluate State-level and IAP-area-level trends are

Table G. Effect on estimated 4:3:1:3 coverage of a modification of the 1998–2001 estimation methodology that only accounted for children with no vaccine doses: National Immunization Survey, 1995–2002

Survey year	National estimate					IAP area differences[1]	
	Accounting for children with no doses		Not accounting for children with no doses				
	Percent	CI[2]	Percent	CI[2]	Difference	Minimum	Maximum
1995	74.2	(±1.2)	73.7	(±1.2)	0.5	–2.0	7.2
1996	76.2	(±1.0)	76.4	(±1.0)	–0.2	–1.7	1.6
1997	76.0	(±0.9)	76.2	(±0.9)	–0.2	–0.9	1.1
1998	79.1	(±0.9)	79.1	(±0.9)	0.0	–1.1	1.0
1999	78.5	(±0.9)	78.4	(±0.9)	0.1	–0.6	1.2
2000	76.0	(±0.9)	76.2	(±0.9)	–0.2	–1.2	1.0
2001	77.1	(±0.9)	77.2	(±0.9)	–0.1	–1.1	1.4
2002	77.8	(±0.9)	77.6	(±0.9)	0.2	–1.4	3.2

[1]IAP is immunization action plan.

[2]CI is half-width of 95-percent confidence interval.

NOTE: 4:3:1:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), and 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib).

Table H. Estimated 4:3:1:3 coverage by provider-reported ascertainment status, among children with adequate provider data and two or more providers: National Immunization Survey, 1995–2002

Survey year	4:3:1:3 status			
	Completely ascertained children		Incompletely ascertained children	
	Percent	CI[1]	Percent	CI[1]
1995	83.5	(±1.8)	65.3	(±3.0)
1996	80.6	(±4.4)	65.3	(±2.2)
1997	83.2	(±1.7)	64.2	(±3.0)
1998	85.4	(±1.4)	69.8	(±3.1)
1999	83.1	(±1.6)	70.5	(±3.1)
2000	78.8	(±3.4)	66.7	(±3.5)
2001	83.3	(±1.8)	68.7	(±2.4)
2002	81.0	(±5.1)	70.2	(±2.7)

[1]CI is half-width of 95-percent confidence interval.

NOTE: 4:3:1:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), and 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib).

advised to interpret the results with caution.

Conclusions

In 19 of the 50 States and the District of Columbia vaccination coverage rates increase slightly as a result of using the revised weighting-class methodology, which accounts appropriately for children with no vaccinations. Generally, the effect of the revised methodology is small, yielding estimated vaccination coverage rates that are within 1.5 percentage points of the original weighting-class estimates. Using 2001 data IAP-area differences of 4:3:1:3 coverage between the estimates from the 2002 and the estimates from the 1998–2001 methodology ranged from –3.6 percentage points to +1.5 percentage points, with a median difference of –0.2 percentage point.

Evaluation of the Effect of Incomplete Ascertainment of Provider-reported Vaccination Histories on Estimates of Vaccination Coverage

Background

''Trends in Response Rates and Key Monitoring Statistics, 1994–2002'' discusses potential limitations of the NIS data. One limitation arises from children with adequate provider data who had two or more vaccination providers, some of whom did not respond with at least a portion of the child's vaccination history. These children have ''incompletely ascertained provider-reported vaccination histories.'' Children who had ''completely ascertained provider-reported vaccination histories'' are defined as those who had two or more vaccination providers, all of whom responded to the PRC with at least a portion of the child's vaccination history.

In 2002, 27.5 percent of the 21,317 children with adequate provider data had two or more providers (figure 2). Among these 53.1 percent were incompletely ascertained. Table H lists estimated 4:3:1:3 coverage rates by whether a child's provider-reported vaccination history was completely ascertained, among children with adequate provider data and two or more providers. Between 1995 and 2002 the national estimated vaccination coverage rates for the incompletely ascertained children were consistently lower than those of the completely ascertained children. These differences may be attributed to the underestimation of national vaccination coverage rates for incompletely ascertained children. These children may appear to have fewer doses than are required to be UTD because a fragment of their vaccination history documenting the missing doses was not reported by providers who did not respond to the PRC.

Table 13 lists the percentage of sampled children with adequate provider data who were incompletely ascertained by race/ethnicity and survey year. For Hispanic, non-Hispanic white, and non-Hispanic black children, this table shows that the percentage of sampled children who were incompletely ascertained remained stable between 1995 and 2002. Over this period the change in the percentage of incompletely ascertained children did not differ between Hispanic and non-Hispanic white children (p=0.17), or between non-Hispanic black and non-Hispanic white children (p=0.88), and it did not increase or decrease significantly for any of these three groups (p=0.07). Over this period the percentage of incompletely ascertained non-Hispanic black children did not differ significantly from that of non-Hispanic whites (p=0.23). However, the percentage of incompletely ascertained Hispanic children was significantly greater than that of non-Hispanic white children (p<0.05), by approximately 4 percentage points on average.

Methods

To evaluate the effect of incomplete ascertainment on estimates of 4:3:1:3:3 vaccination coverage, the 2002 estimation and weighting methodology (described in ''Adjustment for Partial Nonresponse—Accounting for Children with No Vaccinations'') is compared with three alternative estimation methodologies. The three alternative methodologies differ according to how they classify incompletely ascertained children as having a sufficiently well-ascertained provider-reported vaccination history to merit including those histories in the estimation of vaccination coverage rates.

For alternative methodology #1 none of the incompletely ascertained children were counted as having a sufficiently well-ascertained history. For alternative methodology #2 incompletely ascertained children who were 4:3:1:3:3 UTD according to their provider-reported histories were counted as being sufficiently well-ascertained. Alternative methodology #3 counted those incompletely ascertained children who were either 4:3:1:3:3 UTD according to their provider-reported histories or who had a shot card that recorded the same number of doses as on their available provider reports for each of the DTP, polio, MCV, Hib, Hep B, and VRC vaccines. To estimate vaccination coverage rates, each of the three alternative estimation methodologies used data from children with no vaccine doses, children who had only one provider, children with two or more providers and a completely ascertained vaccination history, and children with a sufficiently well-ascertained vaccination history.

Across all survey years, having more vaccination providers is positively and significantly correlated with higher vaccination coverage rates among complete responders who either had one provider or who were completely ascertained (p<0.01). Therefore, each of the three alternative methodologies was designed to redistribute the partial-nonresponse-adjusted sampling weights (described in ''Adjustment for Partial Nonresponse—Accounting for Children with No Vaccinations'') of children with two or more vaccination providers and an incomplete and insufficiently well-ascertained provider-reported vaccination history among children who are most similar to them with respect to their number of providers. Specifically, these sampling weights are redistributed to children with two or more providers who had either a completely ascertained or a sufficiently well-ascertained provider-reported vaccination history.

To adjust the partial-nonresponse-adjusted sampling weights for incomplete ascertainment, each of the three alternative methodologies follows a four-step approach. This approach is similar to the weighting-class methodology described in ''Adjustment for Partial Nnonresponse—Accounting for Children with No Vaccinations'' that yielded partial-nonresponse-adjusted sampling weights and accounted for the children with no vaccination doses. The four steps are:

Step 1: Estimate predictive probabilities—Sampled children with one provider or with no vaccinations are set aside (for use in Step 4 below). From the data of the remaining children (those with two or more vaccination providers), a national-level logistic regression model is developed. The binary dependent variable indicates which children are sufficiently well-ascertained. Using the predictors in table C and the variable selection procedure described in ''Adjustment of Complete Responders' RDD Weights,'' the model yields an estimated predictive probability of having a sufficiently well ascertained provider-reported vaccination history for each vaccinated child with two or more providers.

Step 2: Assign children to weighting classes—Within each IAP area each sampled child with two or more providers is assigned to one of two weighting classes. These weighting classes are defined by the median of the estimated predictive probabilities in the IAP area. Children with only one provider or no vaccinations are not assigned to a weighting class.

Step 3: Adjust the weights—Within each weighting class the sampling weights of the children with insufficiently well-ascertained histories are distributed proportionally among the children with a sufficiently well-ascertained history. The median and inter-quartile range of the adjusted weights are determined, along with a limit equal to the median plus 4 times the inter-quartile range. Adjusted weights that exceed the limit are trimmed to equal the limit.

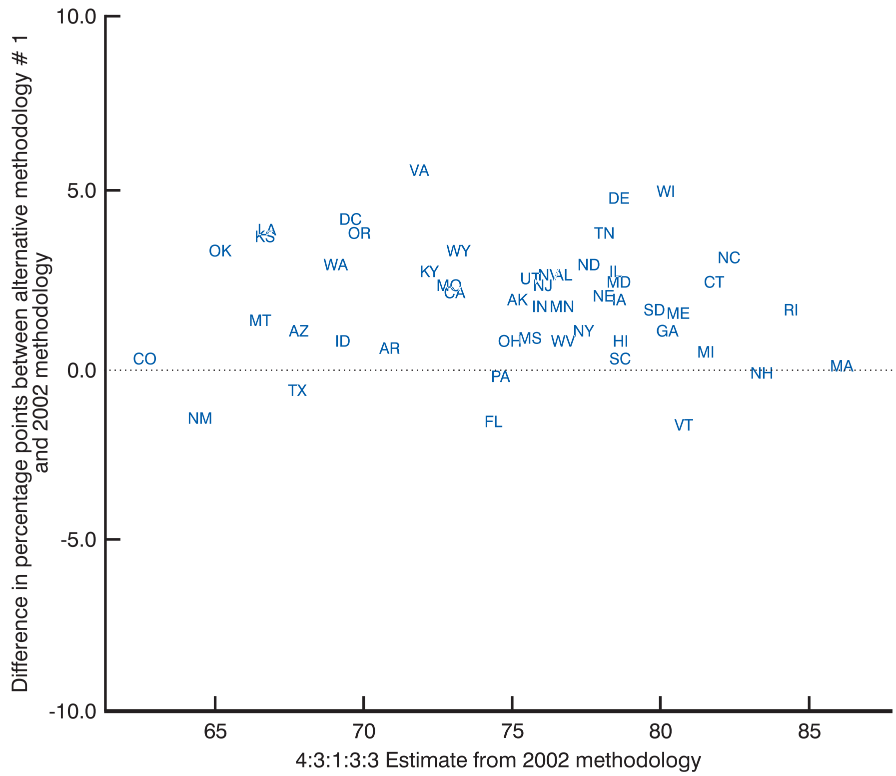
Step 4: Rake the revised weights of the children with a sufficiently well-ascertained provider-reported vaccination history—Children who were complete responders with one provider and children with no vaccinations retain their partial-nonresponse-adjusted sampling weights. Within each IAP area the sampling weights from Step 3 of children with a sufficiently well-ascertained vaccination history are raked using the variables in table D to match IAP-area-specific control totals, minus the weights of children who were complete responders with one provider and the weights of children with no vaccinations. This process ensures that the raked sampling weights of the sufficiently well-ascertained children, the sampling weights of complete responders with one provider, and the sampling weights of children with no vaccination history match the IAP-area-specific control totals for the variables in table D.

When raking failed to converge, the raking variable in table D with the largest discrepancy between the last iteration and the next-to-last iteration (excluding the adjustment cell, adj.cell) was removed from the list of raking variables. Raking was then restarted, and the procedure was repeated until raking converged.

Results

Using data from the 2002 NIS table 14 lists the 4:3:1:3:3 coverage estimate for each State and the District of Columbia using the 2002 methodology and the three alternative methodologies, along with the difference between the estimates from each of the three alternative methodologies and the estimate from the 2002 methodology. These differences suggest that the 2002 national 4:3:1:3:3 vaccination coverage rate may be underestimated between 1.6 percentage points and 4.3 percentage points because of incompletely ascertained provider-reported vaccination histories.

Figures 3–5 plot the difference between each alternative methodology's 4:3:1:3:3 estimate and the 2002 estimation methodology's estimate, versus the 2002 estimation methodology's estimate. On the State level, adjustment for under-ascertainment may result in an increase in the estimated 4:3:1:3:3 coverage rate by as much as 10.3 percentage points or a decrease by as much as 1.6 percentage points across the three alternative methodologies. Further, the potential bias attributable to underascertainment does not depend on the estimate obtained using the 2002 estimation and weighting methodology.

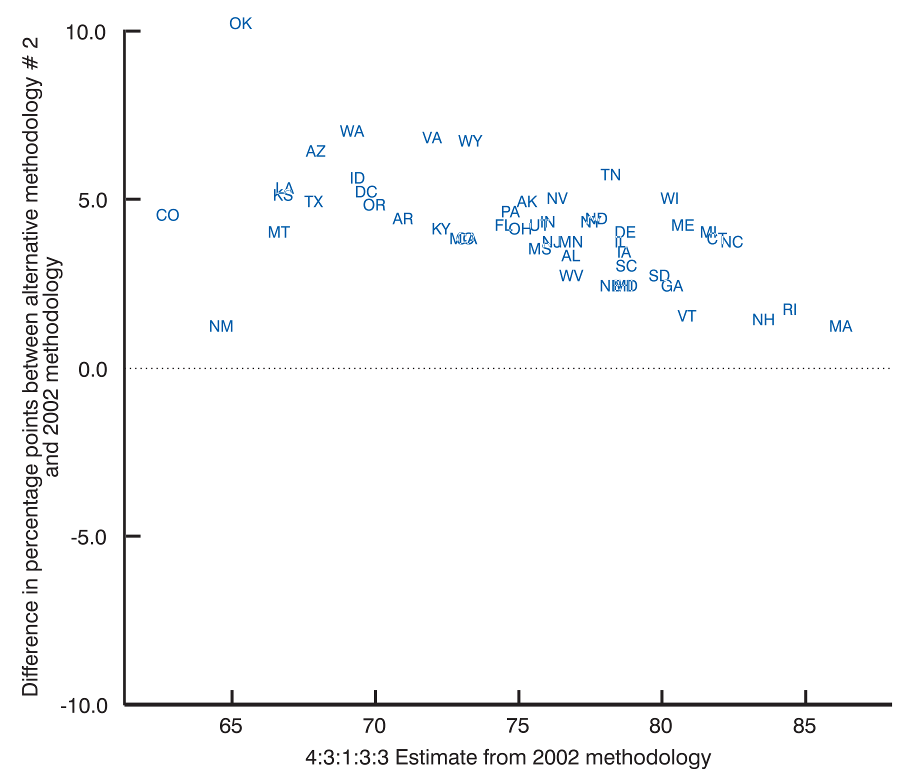


NOTE: 4:3:1:3:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib), and 3 or more doses of hepatitis B vaccine (Hep B).

Figure 3. Plot of estimated difference in vaccination coverage between alternative methodology #1 and the 2002 estimation methodology versus the 4:3:1:3:3 estimates obtained from the 2002 estimation methodology: National Immunization Survey, 2002

Discussion

The alternative methodologies described in ''Methods'' are based on adjusting the NIS partial-nonresponse-adjusted sampling weights (that account for the children with no vaccinations) of children who have two or more vaccination providers. Within each IAP area sampled children with two or more providers who have an insufficiently well-ascertained vaccination history are treated as if they have a missing vaccination history. Their partial-nonresponse-adjusted sampling weights are redistributed among other sampled children who have two or more vaccination providers and a sufficiently well-ascertained provider-reported vaccination history. Furthermore, the sampling weights of children with an insufficiently well-ascertained provider-reported vaccination history are redistributed among children who have a sufficiently well-ascertained provider-reported vaccination history and are similar to them with respect to their estimated probability of having a sufficiently well-ascertained provider-reported vaccination history. No portion of these survey weights is distributed to complete responders who either have one vaccination provider or have had no vaccinations. The latter two groups of children have zero probability of being incompletely ascertained and, thus, are not comparable in this important respect to any children with two or more providers, all of whom had a positive probability of being incompletely ascertained. Further, because the number of providers is known to be positively correlated with a greater chance of being UTD, both the bias and variance of vaccination coverage estimates will be reduced by redistributing these survey weights among other children who have the same important predictors of vaccination coverage.



NOTE: 4:3:1:3:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib), and 3 or more doses of hepatitis B vaccine (Hep B).

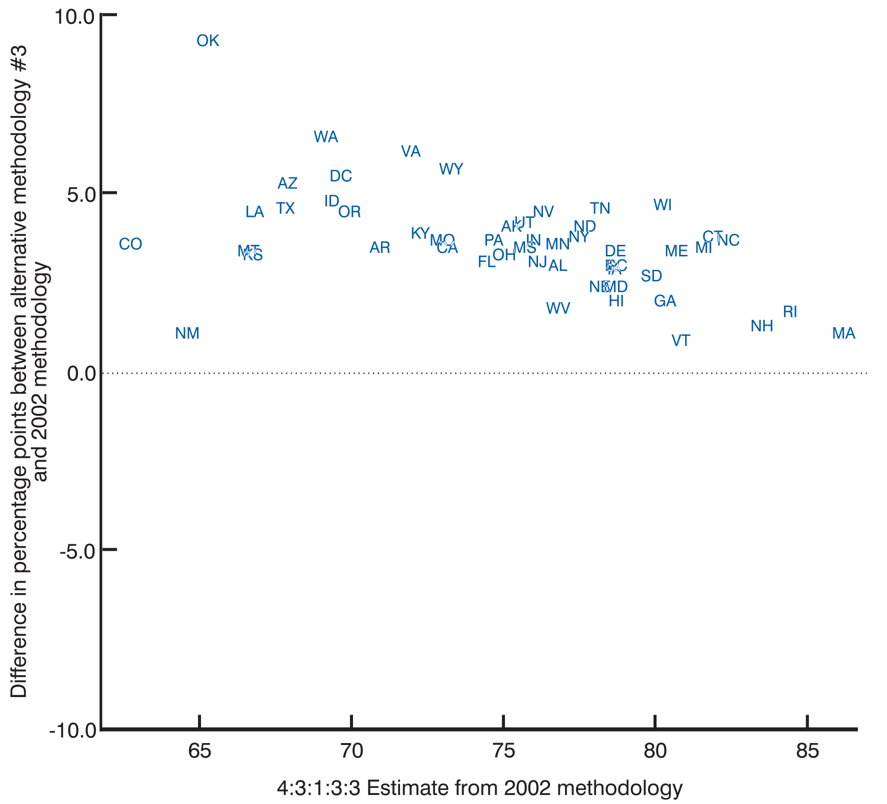
Figure 4. Plot of estimated difference in vaccination coverage between alternative methodology #2 and the 2002 estimation methodology versus the 4:3:1:3:3 estimates obtained from the 2002 method: National Immunization Survey, 2002

If, within each weighting class, the missing portions of incompletely ascertained provider-reported vaccination histories are missing at random, then vaccination coverage estimates obtained from alternative methodology #1 would nearly eliminate bias attributable to incomplete provider-reported vaccination histories. Results from alternative methodology #1 suggest that the official estimate of the national 4:3:1:3:3 vaccination coverage rate for 2002 may be low by as much as 5.7 percentage points (table 14). An important disadvantage of this alternative methodology is that, in 2002, incompletely ascertained provider-reported vaccination histories from 3,106 sampled children are discarded. This corresponds to 14.6 percent of the sample of complete responders. Incompletely ascertained children are more likely to be Hispanic than non-Hispanic white, or to have other characteristics traditionally associated with being NUTD (table 4). Because of this it may be more appealing to use one of the other alternative methodologies, which retain more of these children in the sample.

Alternative methodology #2 retained 2,120 additional cases because they were 4:3:1:3:3 UTD according to available provider reports. Using this method the correction for the bias that may be attributed to incomplete provider-reported vaccination histories is 4.3 percentage points. This alternative methodology may lack credibility and may be easily criticized as being biased because it includes only UTD cases among those with an incompletely ascertained vaccination history. This methodology may be perceived as an attempt to slant the data to achieve higher estimates of vaccination coverage.

Alternative methodology #3 balances the UTD cases included by alternative #2 by including NUTD children who have an incompletely ascertained provider-reported vaccination history but whose provider-reported history was validated as being complete from a household-maintained record of the child's history. As a result, the correction for the bias that may be attributed to incomplete provider-reported vaccination histories is more modest: 3.8 percentage points. However, 71.8 percent of the sampled children discarded by alternative methodology #1 are retained. These children are more likely to belong to a racial and/or ethnic minority (table 4) or have other characteristics that are important in other epidemiologic analyses. Although the percentage of incompletely ascertained children whose household reported vaccination histories using a shot card varied greatly from State to State (figure 6), the correction in ascertainment bias from alternative methodology #3 did not depend on this percentage (figure 7). Thus, the extent of the bias correction using alternative methodology #3 did not vary from State to State in a manner that depended on an important predictor of being UTD. Further, use of the shot card in alternative methodology #3 tends to decrease this method's estimate of vaccination coverage—children whose data are included in the estimation of vaccination coverage as a result of validating existing reports with a shot card are NUTD. Thus, alternative methodology #3 may be viewed as an attempt to include more data from the sample in the vaccination coverage estimate, at the expense of obtaining a somewhat more conservative correction to potential ascertainment bias than is obtained from alternative #2.

Among children with two or more providers national coverage estimates for incompletely ascertained children were consistently lower between 1995 and 2002 than for completely ascertained children. These differences may be attributed to the underestimation of national vaccination coverage rates for incompletely ascertained children, who appear to have fewer doses than required to be UTD, because a fragment of their vaccination history documenting the missing doses was not reported by some of their providers who did not respond to the PRC. On the national level all three alternative estimation



NOTE: 4:3:1:3:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib), and 3 or more doses of hepatitis B vaccine (Hep B).

Figure 5. Plot of estimated difference in vaccination coverage between alternative methodology #3 and the 2002 estimation methodology versus the 4:3:1:3:3 estimates obtained from the 2002 method: National Immunization Survey, 2002

methodologies yielded a higher estimate of the national 4:3:1:3:3 coverage rate, and, thus, provided a correction to the underestimation of vaccination coverage resulting from incomplete ascertainment. However, on the State level alternative method #1 may produce an estimate that is lower than the estimate obtained using the 2002 weighting and estimation methodology. This can happen because characteristics associated with being incompletely ascertained (table 4) are similar to the characteristics that are known to be associated with being NUTD. States with larger proportions of children who have characteristics associated with being NUTD have more children who are incompletely ascertained and are represented in the weighting class by completely ascertained children who are less likely to be UTD. Using the weighting-class methodology described in ‘‘Methods,’’ the partial-nonresponse-adjusted sampling weights of sufficiently well-ascertained children in this weighting class will be increased and may lead to an adjusted estimate that is lower than the unadjusted estimate. None of the three alternative methodologies were used in 2002 to adjust official estimates for incomplete ascertainment.

The First Three Topical Modules, 2001

The NIS was undertaken to monitor vaccination coverage on an ongoing basis. Besides estimated coverage rates for IAP areas, additional information would assist the NIP in improving vaccination coverage rates. Specific topics include health insurance and parents’ ability to pay for vaccinations; parental knowledge and experiences about immunization; and daycare arrangements, breastfeeding practices, and WIC participation. Data on these important topics were collected and are being analyzed to improve understanding of vaccination in the United States This information could contribute to further increases in vaccination rates.

The need to collect information on these topics was carefully balanced with the burden that respondents bear in participating in the RDD interview. Approximately 85 percent of respondents are mothers with at least one child between 19 and 35 months of age. Also, the average length for the household interview is approximately 24 minutes for households with an age-eligible child. Although the need for information on additional topics is great, if all respondents were asked additional questions, the NIS interview would become considerably longer and more burdensome.

To control respondent burden, a split-sampling design is used. Each household with an age-eligible child is randomly assigned to receive a module of questions pertaining to only one of the three topics (a topical module). The overall goal of the split-sampling design is to control interview time with respondents and yet enhance the NIS interview by collecting additional analytically important information.

To make room for the new topical-module questions and ensure that the overall household burden does not increase unduly, several questions that had been administered to all respondents were dropped. Specifically, detailed questions on participation in the WIC program and the age of the child during WIC participation were no longer asked of all respondents. Also dropped were two questions on the parent or guardian’s perception of whether their child is UTD on recommended vaccinations and identifying who took the child for most of his or her vaccinations.

The first three modules were introduced into the NIS in Q3/2001 and were originally scheduled to be asked for four consecutive quarters (Q3/2001–

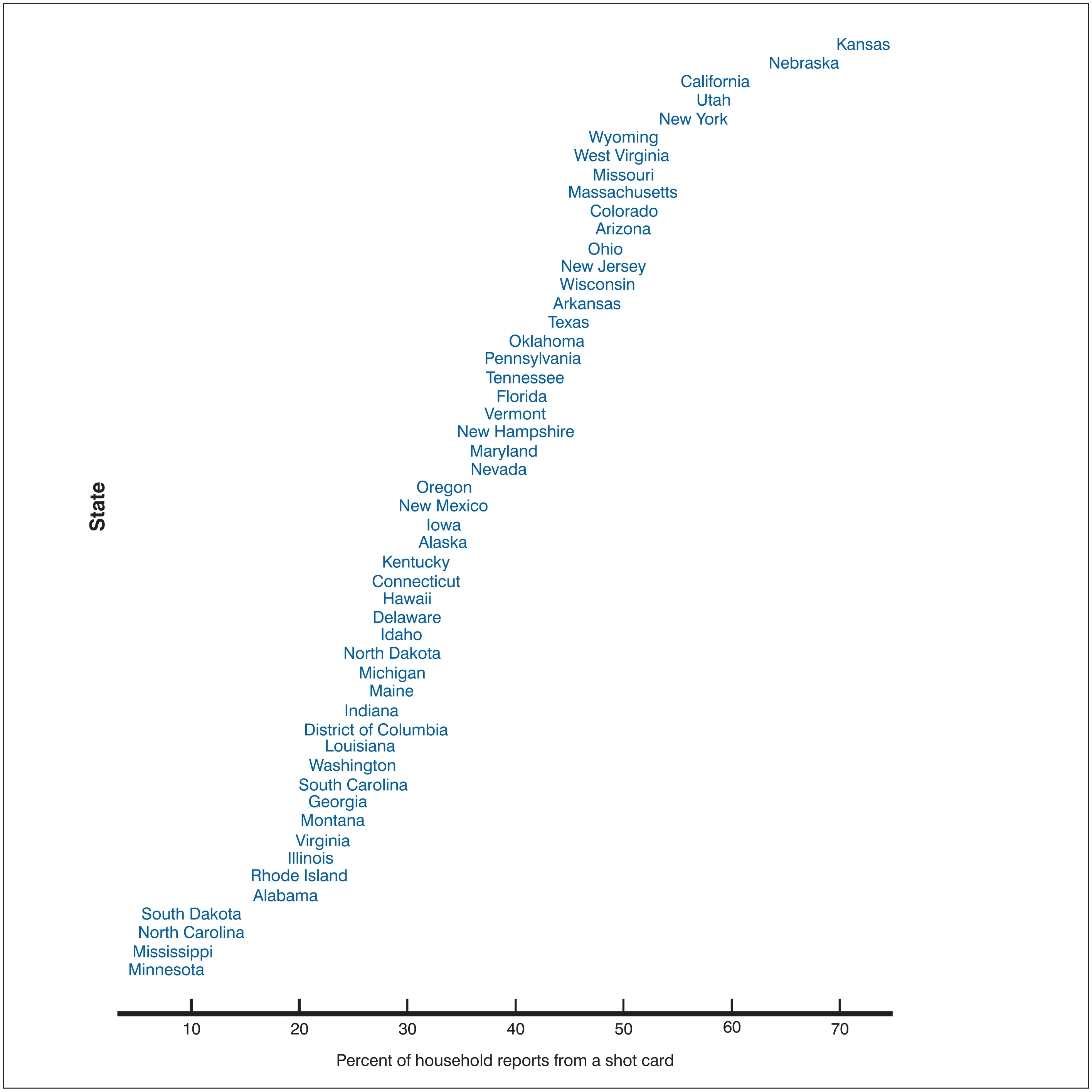


Figure 6. Percentage of incompletely ascertained children whose parent reported vaccination histories using a shot card by State: National Immunization Survey, 2002

Q2/2002). (Ultimately, they were continued for two additional quarters, Q3–Q4/2002.) These modules may be repeated, or they may be replaced with other modules as new topics are proposed for study. The rapid availability of quarterly data on a national level and 4-quarter data at the IAP-area level makes the NIS unique among national health surveys. Adding topical modules to the NIS makes information on current events rapidly available and increases the pool of data on behavioral, social, demographic, and economic correlates of vaccination practices. Smith et al. provide further details on the objectives and design of the first three topical modules (40).

This section describes:

- The primary analytic purpose of each topical module.
- Methodological issues for topical modules.
- The design used to ensure that the statistics obtained from each module will be suitably precise for the module's primary analytic purpose.

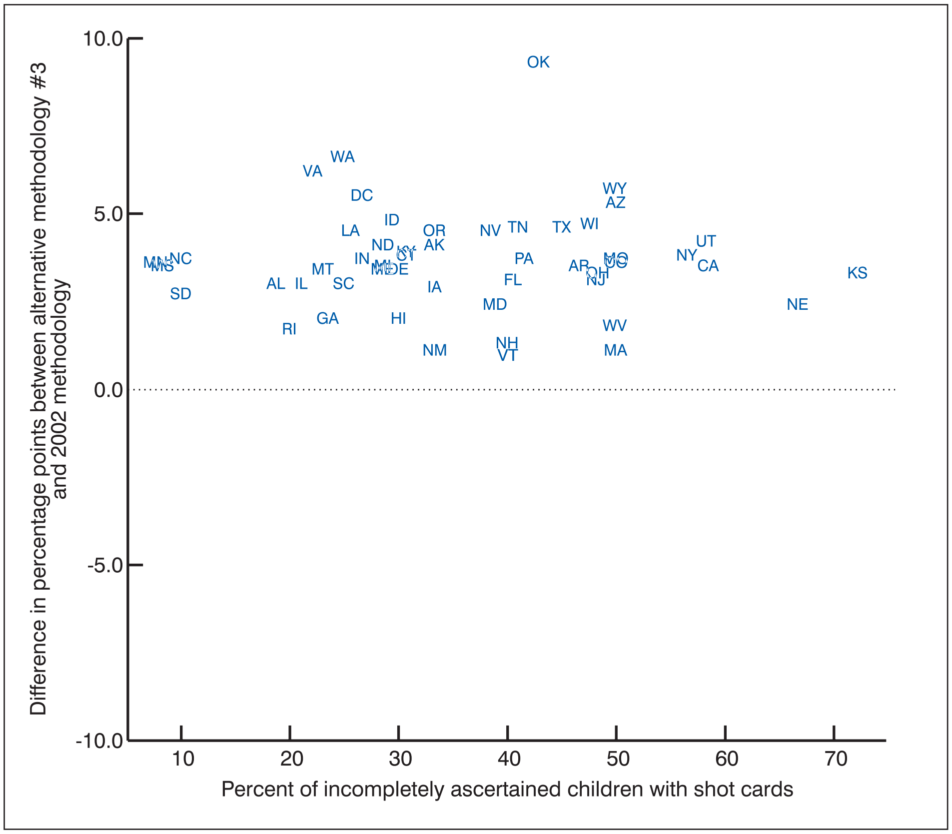


Figure 7. Difference between the 2002 methodology and estimation method #3 versus the percentage of incompletely ascertained children in the sample who had a shot card from which household-reported vaccination histories were obtained during the National Immunization Survey random-digit-dialed interview: National Immunization Survey, 2002

Analytic Objectives

This section describes the objectives of the first three modules.

Health Insurance and Ability to Pay for Vaccinations

This module is referred to as the HIM.

Costs to parents and providers are a known barrier to vaccination. Specifically, administration of vaccines by private providers depends on insurance reimbursement rates, the availability of publicly purchased vaccines, and other possible costs to providers. Referral of children needing vaccinations away from a child's medical home to a health department clinic also depends on insurance coverage and out-of-pocket costs to parents. These referrals cause missed opportunities and delays in timely vaccinations. Data from this topical module provide information on these economic and health insurance-related barriers to vaccination and their impact on vaccination coverage levels.

VFC is a federal entitlement program that provides publicly-purchased vaccines for four groups of children: uninsured children, underinsured children if they go to a federally qualified health center, Medicaid-eligible children, and American Indian or Alaska Native children. Nationally approximately 32 percent of preschool children are eligible for VFC. To correctly distribute the VFC funds to the States, CDC needs to know the proportion of a State's preschool children who are entitled to VFC vaccine. This module yields State-by-State estimates of this proportion, and these estimates can be combined with State program information to distribute funds.

Although VFC is a federal program, it is operated at the State level. Each State enrolls providers in the program, and these providers administer VFC vaccine to eligible children. Because the NIS provider survey asks whether the provider is enrolled in VFC, this module allows each State to determine the proportion of VFC-eligible children who receive their vaccines from VFC-enrolled providers. This information will help guide States' provider-enrollment efforts.

In 2001 health departments purchased vaccines using one of five policies:

- Universal—all recommended vaccines were purchased for all children.
- Universal select—selected vaccines were purchased for all children.
- VFC and underinsured—all recommended vaccines were purchased for VFC-eligible and underinsured children.
- VFC and underinsured select—selected vaccines were purchased for VFC-eligible and underinsured children.
- VFC only—selected vaccines were purchased only for VFC-eligible children.

This module can show whether the likelihood of referral to health department clinics is associated with vaccine purchase policy.

As mentioned above, an important group of children are eligible for VFC by virtue of being eligible for Medicaid. The eligibility of these children is based on their income-to-poverty ratio, in which the numerator is the family income (in the past calendar year) and the denominator is the U.S. Census Bureau poverty threshold (for that calendar year) for the size of the family and the number of children under 18 years old in the household who are related to the child. For children in the NIS the family income, family size, and number of related children come from the RDD interview.

Parental Knowledge and Experiences

This module is referred to as the PKM.

Factors that are believed to influence a child's UTD vaccination status include:

- Parental perception of vaccine safety.
- Perception of vaccine efficacy.

- Awareness of the recommended vaccination schedule.
- Perception of the need for vaccines (i.e., the severity and probability of exposure to vaccine-preventable diseases).

Also, important influences (e.g., doctors, vaccination campaigns directed toward families) may affect parental decisions to seek or avoid vaccines. Understanding these influences is important in developing new initiatives and in improving current vaccination programs.

The questions in this topical module aim to assess the parent or guardian's perceptions about vaccine safety and influences to seek vaccines. The relationship between these perceptions and a child's timely receipt of vaccines also will be evaluated. A better understanding of these factors will enable the NIP to address concerns and improve education, with the overall goal of increasing timely vaccination coverage among young children in the United States.

Daycare, Breastfeeding, and WIC

This module is referred to as the DCM.

Young children in daycare facilities are at greater risk of disease because of the increased chance of exposure to vaccine-preventable diseases. Thus, some States require that children attending licensed daycare facilities receive vaccinations. Parents of young children in daycare may be informed by their daycare facility about the importance of immunization, even if vaccines are not mandatory for enrollment.

One goal of the Healthy People 2010 is to increase UTD vaccination rates among children attending daycare (3). Questions in this module allow NIP to evaluate the extent of attendance in daycare and to analyze vaccination coverage as it relates to attendance.

Breastfeeding is believed to give children antibodies and other factors that help protect against invasive forms of some diseases, such as *Haemophilus influenzae* type b. However, some parents may think breastfeeding lessens the need for timely vaccinations. Knowledge of the prevalence of breastfeeding in the United States and whether it is linked to vaccination status is important for maternal and child health programs to plan and improve campaigns to increase this healthful practice while maintaining high age-appropriate vaccination coverage.

The NIP routinely assesses whether the WIC program encourages mothers to adequately vaccinate their children. The WIC program was established to provide education and access to nutritious diets to low-income children and pregnant and lactating women at high risk for inadequate diets. This program serves about 5.5 million infants and children. Almost one-half of the babies born in the United States qualify for WIC. In 1997 the WIC program began an initiative to promote breastfeeding. Despite its efforts and relative success in increasing breastfeeding, WIC supplies formula to mothers and may be creating an unintentional disincentive to breastfeeding. Analysis of data on daycare, breastfeeding, and WIC participation from the same sample of children allows the study of potentially complex relationships among UTD vaccination status and daycare attendance, WIC participation, and breastfeeding practices.

The Design for the First Three Topical Modules

The split-sampling design for the initial four quarters (Q3/2001–Q2/2002) randomized each completed RDD interview to receive only one of the three topical modules: health insurance and ability to pay for vaccinations (HIM); parental knowledge and experiences (PKM); or daycare arrangements, breastfeeding practices, and WIC (DCM). To obtain suitably precise estimates for the primary analytic objectives of each topical module, the design allocated approximately 74.6 percent of the sample to HIM, 12.7 percent to PKM, and 12.7 percent to DCM. The sample for each module was allocated equally to the 78 IAP areas. The following subsections give further details about the sample design. ''Weighting Methodology for Topical Modules'' reports on the numbers of children who were randomized to a module and whose household completed the module interview.

The Daycare, Breastfeeding Practices, and WIC Module

The estimated sample size for this module was based on the objective of producing suitably accurate national coverage estimates for population subdomains that make up at least 50 percent of the entire population. These subdomains include children enrolled in daycare (~54 percent), children who were breastfed (~60 percent), and children who ever participated in the WIC program (~51 percent). For these purposes the term ''suitably accurate'' refers to estimates that are within 2.5 percentage points of the true but unknown national coverage with a probability of 0.95 when the true coverage is 80 percent within a subdomain that makes up 50 percent of the target population.

Among the roughly 34,000 completed interviews expected over the initial 4-quarter period, approximately 4,300 (12.7 percent) were allocated to DCM. Adequate provider data are obtained for approximately 67 percent of children who complete the RDD survey. The number of children with adequate provider data for DCM was, therefore, expected to be around 2,900 over the 4-quarter period. For a subdomain that makes up 50 percent of the target population, this sample would yield approximately 1,450 children with provider-reported vaccination histories. Using these specifications and the average expected design effect of 1.52 for estimated national vaccination rates in the NIS, the effective sample size was approximately 950 children in the subdomain of interest (40). Table J shows that, with these design specifications, the expected half-width of the 95-percent confidence interval would be approximately 2.5 percentage points.

The Parental Knowledge and Experiences Module

Among the 34,000 completed interviews expected over the initial 4-quarter period, approximately 4,300 (12.7 percent) completed household interviews were allocated to PKM. Subdomains for this module were expected to range from 5 percent to 50 percent of sample households. Table J shows the expected 95-percent confidence interval half-widths for estimated national vaccination rates for such subdomains.

Table J. Expected 95-percent confidence interval half-widths for topical modules designed to yield national coverage estimates within subdomains of specified size

Subdomain size in percent	Expected half-width of 95% confidence interval in percentage points
5	8.0
10	5.7
20	4.0
30	3.3
40	2.8
50	2.5

The Health Insurance and Ability to Pay Module

The estimated sample size for this module was based on the assumption that accurate State-level statistics are important. The 25,400 completed interviews expected for this module represent about 74.6 percent of the 34,000 expected completed interviews annually. At the State level the sample size was expected to range from 325 to 1,625 completed interviews, according to the number of IAP areas in the State (table K). A key estimate from HIM was the percentage of children who were eligible for the VFC program. About 32 percent of the children 19–35 months of age in a State were expected to be eligible for VFC. As a consequence, confidence-interval half-widths were expected to be in the range of 3.3 to 5.5 percentage points (table K). Further, if the true percentage of VFC-eligible children who are UTD on immunizations is 80 percent, the half-width of the corresponding 95-percent confidence interval was expected to range from 6.7 to 10.6 percentage points (table K).

Table K. State sample sizes and expected 95-percent confidence interval half-widths for the health insurance module

		Expected half-width of 95% confidence interval for—	
Number of IAP areas in State[1]	Number of completed interviews over four quarters	Percent of children eligible for VFC program[2]	Vaccination rate for VFC-eligible children[2]
1	325	5.5	10.6
2	650	4.6	8.6
3	975	4.3	8.1
4	1,300	3.5	6.8
5	1,625	3.3	6.7

[1]IAP is immunization action plan.
[2]VFC is Vaccines for Children, a federal entitlement program that provides publicly-purchased vaccines for certain groups of children.

Weighting Methodology for Topical Modules (Q3/2001–Q2/2002)

As discussed above, the topical modules were implemented in the first four quarters by taking all age-eligible households that reached the end of the NIS interview and randomly assigning them to one of the three modules. If a household contained two or more age-eligible children, all were assigned to the same module. The only exception to this procedure was for PKM, where only the youngest age-eligible child in the household was assigned. The random assignment was implemented separately in each of the 78 IAP areas.

The children with a completed topical-module interview received a topical-interview weight that incorporates adjustments for interview nonresponse. The subset of children with completed module interviews who have adequate provider data have a second weight that incorporates adjustments for provider nonresponse.

Survey Weights for Children with Completed Module Interviews

The Q3/2001–Q2/2002 NIS completed interviews for 32,587 children 19–35 months of age. Each of these children has an RDD weight that reflects adjustments for nonresponse in the RDD survey, poststratification to population control totals, and an adjustment to compensate for the exclusion of children residing in nontelephone households. Of the 32,587 children, 28,250 (86.7 percent) were randomized to one of the three modules. The remaining 4,337 children did not reach module randomization. Table L traces the children through the stages of data collection on the topical modules.

The first step in the weighting methodology involved adjusting the RDD weights of the 28,250 randomized children to account for the children who were not randomized. A list of demographic and socioeconomic categorical variables was assembled, and two-variable tables of each variable by whether the child was randomized to a topical module were examined. Also, PROC LOGLINK in SUDAAN was used to identify variables that were statistically significant at the 0.05 level (41). Those variables were offered in a forward stepwise logistic regression using randomization to a topical module as the dichotomous outcome variable. The Schwarz criterion was used to determine the stopping point for the stepwise model (42). Table M lists the variables offered in the model and the

Table L. Key indicators for the topical modules: National Immunization Survey, third quarter of 2001 through second quarter of 2002

Indicator	Total	HIM[1]	DCM[2]	PKM[3]
Number of children with NIS interviews	32,587	. . .	. . .	. . .
Number of children randomized to topical module	28,250	21,163	3,511	3,576
Number of module interviews completed	27,843	20,952	3,488	3,403
Topical module completion rate	98.6%	99.0%	99.3%	95.2%
Topical module response rate[4]	64.3%	64.5%	64.7%	62.1%
Number of children with adequate provider data[5]	22,541	16,980	2,797	2,764
Percent of children with adequate provider data	81.0%	81.0%	80.2%	81.2%

. . . Category not applicable.

[1]HIM refers to the health insurance module.

[2]DCM refers to the daycare arrangements, breastfeeding practices, and WIC participation module. WIC is the Special Supplemental Nutrition Program for Women, Infants, and Children.

[3]PKM refers to the parental knowledge and experiences about vaccinations module.

[4]The topical module response rate equals the product of the topical module completion rate, the percentage of children randomized to a topical module (86.7%), and the CASRO (Council of American Survey Research Organizations) response rate for the National Immunization Survey as a whole (75.2%). See ''Response Rates and Key Monitoring Statistics for 2002.''

[5]Number of children with adequate provider data includes 77 unvaccinated children (58 for HIM, 11 for DCM, and 8 for PKM).

variables retained in the final model (in the order that they entered the model).

The final logistic regression model was used to assign each of the 32,587 children a predicted probability of being randomized to a topical module. As described in ''Adjustment of Complete Responsers' RDD Weights,'' the predicted probabilities were ordered from lowest to highest value within each IAP area, and five approximately equal-sized nonresponse weighting classes were formed. Within each weighting class the RDD weight was used to calculate the weighted proportion of children randomized to a module. The RDD weights of children in a given cell who were randomized to a module were divided by the weighted proportion for that cell to obtain the module randomization nonresponse-adjusted weight.

Among the 28,250 children assigned to a module 21,163 received HIM, 3,511 received DCM, and 3,576 received PKM (table L). The second step in the weighting methodology divided the weight calculated in the first step by the module subsampling rate: 0.746 for HIM, 0.127 for DCM, and 0.127 for PKM. Also at the second step, the success of the randomization algorithm was examined by testing for independence between each demographic and socioeconomic variable and the module to which the child was randomized. The results indicated that the module assignment operated in a random fashion.

For a small percentage of the children assigned to a module, the module interview was not completed. Table J shows the completion rates. The third step in the weighting process entailed raking the weights of children who completed a module to weighted control totals obtained from the Q3/2001–Q2/2002 NIS.

The DCM and PKM rakings were carried out at the national level and included the following variables:

- Education of mother
- Race/ethnicity of the child
- Age group of the child
- Census region
- Whether the household experienced an interruption in telephone service of 1 week or longer
- The five nonresponse weighting classes

The first three demographic variables were used to ensure that the weighted module distribution was the same as the NIS distribution. Census region was used to ensure that the weighted geographic distribution for the module matched the distribution of NIS children among the four regions. The interruption-in-telephone-service variable was used to maintain the nontelephone adjustment in the final module interview weights. Finally, the five nonresponse weighting classes were included in the raking to maintain the nonresponse

Table M. Logistic regression predictors for randomization to a topical module: National Immunization Survey, third quarter of 2001 through second quarter of 2002

Variable description	Variable included in final logistic regression model[1]
Income-to-poverty ratio	1
Shot card used during NIS interview	2
State of residence at birth differs from current State of residence	3
Mother's education	4
Relationship of respondent to child	5
CATI language queue[2]	6
Maternal age group	[3]NI
Race/ethnicity of mother	[3]NI
Number of children in household	[3]NI
Race/ethnicity of child	[3]NI
MSA residence[4]	[3]NI
4:3:1:3 up to date according to household report[5]	[3]NI
Poverty status	[3]NI
Age group of child	[3]NI
Firstborn status of child	[3]NI

[1]Variables are listed in order of entry.

[2]CATI is computer-assisted telephone interview.

[3]NI indicates this variable was not included in the final model.

[4]MSA is metropolitan statistical area.

[5]4:3:1:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), and 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib).

Table N. Logistic regression models for predicting presence of adequate provider data: National Immunization Survey, third quarter of 2001 through second quarter of 2002

Variable description[1]	DCM[2]	HIM[3]	PKM[4]
Race/ethnicity of the child	1	[5]NI	1
Mother's education	2	[5]NI	4
MSA residence[6]	3	4	[5]NI
State of residence at birth differs from current State of residence	4	2	2
Poverty status	[5]NI	5	[5]NI
Race/ethnicity of the mother	[5]NI	1	[5]NI
Relationship of respondent to the child	5	3	3
Household report of 4:3:1:3 up-to-date status	[5]NI	7	[5]NI
Survey quarter	[5]NI	6	[5]NI
Age group of the mother	[5]NI	[5]NI	[5]NI
Marital status of the mother	[5]NI	[5]NI	[5]NI
Income-to-poverty ratio categories	[5]NI	[5]NI	[5]NI
CATI language queue[7]	[5]NI	[5]NI	[5]NI
Number of children in the household	NI	NI	NI

[1]Variables are listed in order of entry for each topical module.
[2]DCM refers to the daycare arrangements, breastfeeding practices, and WIC participation module. WIC is the Special Supplemental Nutrition Program for Women, Infants, and Children.
[3]HIM refers to the health insurance module.
[4]PKM refers to the parental knowledge and experiences about vaccinations module.
[5]This variable was not included in the final model.
[6]MSA is metropolitan statistical area.
[7]CATI is computer-assisted telephone interview.

adjustment for children not randomized to a module.

The HIM raking was carried out at the State level. The above six variables were used in the raking, along with a variable to indicate IAP area within State for those States containing two or more IAP areas.

Survey Weights for Children with Adequate Provider Data

Among the 27,843 children with a completed module interview 22,464 (80.7 percent) had adequate provider data (table L). Another 77 children (58 for HIM, 11 for DCM, and 8 for PKM) were unvaccinated. Following the procedure for 2002 described in ''Adjustment for Partial Nonresponse—Accounting for Children with No Vaccinations,'' the 77 unvaccinated children were temporarily set aside. For the remaining 27,766 children an outcome variable indicated whether the child had adequate provider data. PROC LOGLINK in SUDAAN was used to identify demographic and socioeconomic variables that were statistically significant at the 0.05 level.

For each topical module those variables were offered in a forward stepwise regression to identify the predictors to include in the final logistic regression model for that topical module. The Schwartz criterion was used to choose the final model. Table N lists the predictors offered and identifies the predictors in the final model for each module, with order of entry indicated. The fitting of separate models to the three topical modules is equivalent to fitting a single model that offers the main effects of the demographic and socioeconomic predictor variables and the two-factor interactions of each predictor variable and a topical-module indicator variable.

For the sake of parsimony, it was decided to use the race/ethnicity of the child in the final model for HIM, instead of race/ethnicity of the mother. Of the 16,922 children with completed HIM interviews who had adequate provider data, 93.9 percent were reported to have the same race/ethnicity as their mother.

The predicted probability of having adequate provider data was calculated for each child. For DCM and PKM the predicted probabilities were ordered from lowest to highest, and five approximately equal-sized nonresponse weighting classes were formed at the national level. Within each module the topical-module interview weights were used to calculate the weighted proportion of children with adequate provider data. The module interview weights of the children with adequate provider data in each adjustment cell were divided by the weighted proportion for that cell to obtain the provider-nonresponse-adjusted weights.

The final logistic regression model for HIM was also used to calculate the predicted probability of having adequate provider data. Within each IAP area the children with a completed HIM were ordered from lowest to highest predicted probability and then divided into three approximately equal-sized groups. For each of these weighting classes the weighted proportion of children with adequate provider data was calculated. The HIM module interview weights of children with adequate provider data in an adjustment cell were divided by the weighted proportion for that cell to obtain the provider-nonresponse-adjusted HIM weight.

The next step involved raking the weights from the prior step to control totals from the Q3/2001–Q2/2002 NIS. The DCM and PKM rakings were conducted at the national level. The raking variables for these two modules included maternal education, age group of child, race/ethnicity of the child, census region, whether the household experienced an interruption in telephone service of 1 week or longer, the five nonresponse weighting classes, and the provider-reported 4:3:1:3 UTD status of the child. In addition the DCM raking included a variable from the DCM survey indicating whether the child attended a daycare center. For the PKM raking the additional variable was derived from a question rating the safety of childhood vaccines.

The HIM rakings were conducted at the State level. The raking variables for this module included maternal education, age group of child, race/ethnicity of the child, whether the household experienced an interruption in telephone service of 1 week or longer, the three nonresponse weighting classes, the provider-reported 4:3:1:3 UTD status of the child, and an IAP area indicator variable for those States with two or more IAP areas. For the HIM the additional raking variable measured whether the child was eligible for the VFC program.

The demographic variables used in the raking ensured that the weighted distribution of the children with adequate provider data for each module was the same as in the Q3/2001–Q2/2002 NIS. The interruption variable was included to ensure that the nontelephone adjustment was carried through to the final weights. The inclusion of the provider-nonresponse weighting classes ensured that this nonresponse adjustment was maintained. The 4:3:1:3 UTD variable was included to ensure that the estimate of 4:3:1:3 UTD vaccination coverage from a topical module would be the same as that obtained from the Q3/2001–Q2/2002 NIS. Finally, a key subject-matter variable from each module was included in the raking to ensure that the weighted distribution of children with adequate provider data on that subject-matter variable was the same as the distribution for all children who completed that module.

In the final step the unvaccinated children who completed a module were brought back into the weight-calculation process. It was necessary to ratio-adjust their module interview weights so that the sum of their weights equaled the total weighted count of unvaccinated children in the Q3/2001–Q2/2002 NIS (15,262).

Two Additional Quarters of Topical Modules

The successful implementation of the topical modules prompted their continuation for two additional quarters of data collection (Q3–Q4/2002). The design, however, was modified for those two quarters: 13.3 percent of age-eligible households were randomly assigned to DCM, 13.3 percent were randomized only to PKM, 36.7 percent were randomized only to HIM, and 36.7 percent were randomized to PKM and HIM (with the order of administration randomly rotated). Thus, 50.0 percent of households were randomized to PKM, and 73.4 percent were randomized to HIM. For the six quarters combined, table O traces the children through the stages of data collection (parallel to table L).

The weighting methodology for the six quarters of topical modules data collection followed the 4-quarter approach. The only notable differences were the use of 10 nonresponse weighting classes instead of 5 for the PKM provider-nonresponse adjustment and the use of the 9 census divisions rather than the 4 census regions in the PKM raking. These modifications were introduced because the PKM sample size after six quarters increased by around 6,500 interviews.

Future Topical Modules

The introduction of the three topical modules is expected to be the beginning of a long-term approach to enhance the programmatic value of the NIS and use its rapid turnaround capabilities to address current questions related to vaccination and the health of young children. In 2003 two new topical modules were administered: vaccine shortage and vaccine safety. Both of these have been administered again in 2004, and those who receive the vaccine shortage module also receive a module on influenza.

Public-Use Files

NIS public-use data files for 1995–2002 are available at http://www.cdc.gov/nis/datafiles.htm and on CD–ROM from NCHS. Each annual public-use file is in ASCII file format and is accompanied by a data user's guide, a code book, and SAS input statements for reading the ASCII file. Estimates of vaccination coverage at the national, State, and IAP

Table O. Key indicators for the topical modules: National Immunization Survey, third quarter of 2001 through fourth quarter of 2002

Indicator	Total	HIM[1]	DCM[2]	PKM[3]
Number of children with NIS interviews	48,529	...	...	...
Number of children randomized to topical module[4]	41,937	31,250	5,310	10,393
Number of children with completed module interviews[5]	41,231	30,741	5,273	9,908
Topical module completion rate	98.3%	98.4%	99.3%	95.3%
Topical module response rate[6]	63.4%	63.5%	64.1%	61.5%
Number of children with adequate provider data[7]	32,936	24,596	4,179	7,810
Percent of children with adequate provider data	79.9%	80.0%	79.3%	78.8%

. . . Category not applicable.

[1]HIM refers to the health insurance module.

[2]DCM refers to the daycare arrangements, breastfeeding practices, and WIC participation module. WIC is the Special Supplemental Nutrition Program for Women, Infants, and Children.

[3]PKM refers to the parental knowledge and experiences about vaccinations module.

[4]In the third and fourth quarters of 2002, 5,016 children were randomized to HIM and PKM.

[5]In the third and fourth quarters of 2002, 4,691 children had completed interviews for HIM and PKM.

[6]The topical module response rate equals the product of the topical module completion rate, the percentage of children randomized to a topical module (86.4%) and the CASRO (Council of American Survey Research Organizations) response rate for the National Immunization Survey as a whole (74.7%). See "Response Rates and Key Monitoring Statistics for 2002."

[7]Number of children with adequate provider data includes unvaccinated children (82 for HIM, 17 for DCM, and 25 for PKM). In the third and fourth quarters of 2002, 3,649 children with completed HIM and PKM interviews had adequate provider data.

area levels are routinely released on the Web site (http://www.cdc.gov/nip/coverage) and in the CDC's *Morbidity and Mortality Weekly Report (MMWR)*.

To ensure the highest quality of the NIS data, the survey staff uses a wide range of quality control procedures at every stage of data collection. Khare et al. and the *National Immunization Survey: Guide to Quality Control Procedures* discuss the quality assurance procedures used in the NIS (43–45). All information collected in the NIS is covered by strict assurances of confidentiality and may be used only for research purposes. Prior to release the contents of each public-use file undergo extensive review by the NCHS Disclosure Review Board to protect the confidentiality of participants and data (46).

An additional resource is the NIS Web site at http://www.cdc.gov/nis/reports.htm. The site includes a selected bibliography of technical reports developed since the inception of the survey.

Summary

Since it began in 1994 the NIS has monitored the performance of its methods and investigated potential improvements. This report documents the changes in sample design and estimation methodology adopted through 2002, and it describes those aspects of the NIS as of 2002. It also discusses the addition, in 2001, of modules of questions on specific topics, following the basic household interview, and the split-sampling design for allocating households among those modules.

The sample design, in which each of the 78 IAP areas is a stratum, has undergone one major change. From 1994 through 1998 it aimed to produce an equal number of children with completed household interviews in all IAP areas. Since 1999 the target has been an approximately equal number of children with adequate provider data in all IAP areas.

The estimation methodology is oriented primarily toward assigning the proper sampling weight to each child with adequate provider data, as a basis for calculating estimates of vaccination coverage and estimating their variances. The estimation methodology underwent one substantial change in 1998 and another in 2002. From 1994 through 1997 each child with a completed household interview received a sampling weight that included adjustments for multiple telephone lines, unit nonresponse, and noncoverage of nontelephone households. The latter adjustment used a modified form of poststratification that took into account NHIS estimates of a ratio of vaccination coverage among nontelephone households to vaccination coverage among telephone households. A two-phase sampling estimator then used the resulting RDD weights to estimate vaccination coverage for each vaccine and series. Within each of five categories it calculated the weighted proportion of children with provider data who were UTD according to their providers. Then it combined those proportions according to the weighted distribution, over the five categories, of children with a completed household interview.

The change in 1998 introduced an additional sampling weight for children with adequate provider data (the complete responders). A national model was developed using logistic regression to estimate each child's propensity to be a complete responder. Within each IAP area the quintiles of the distribution of these response propensities served to define five weighting classes, as a basis for adjustment for partial nonresponse. A further step produced final weights by raking on five demographic variables and the weighting classes. This approach yields vaccination coverage rates as weighted percentages of the complete responders.

The change in 2002 accounted more accurately for nontelephone households and for unvaccinated children. The adjustment for nontelephone households built on empirical evidence that households that have experienced a recent interruption in telephone service are often similar to households that do not have telephones. It classified RDD children according to whether their household had had an interruption in telephone service and then poststratified their weights to two control totals (for each IAP area), one for children in households without interruptions and the other for the sum of children in households with interruptions and children in nontelephone households.

Prior to 2002 children who had not received any vaccinations were included among the partial responders (i.e., their provider data were treated as missing at random). The 1998 method of adjusting for partial nonresponse was modified for 2002 by setting aside the unvaccinated children until the final step and then including them with their RDD weights. That is, the data of the unvaccinated children were not used in estimating response propensities, assigning children to weighting classes, adjusting the weights of complete responders, or raking the resulting revised weights.

An evaluation of the 2002 changes applied them to the data from the 2001 NIS. The differences in the vaccination coverage rates for the various vaccines and series were generally small. The new methods of accounting for nontelephone households and unvaccinated children yielded vaccination coverage rates that were close to those produced by the 1998–2001 methodology.

By shortening the main household questionnaire in 2001 the NIS made room for additional questions on important topics. To cover more than one topic at a time, a split-sampling design allocated households with completed interviews (in each IAP area) among the topical modules; random assignment to a module took place after completion of the main interview. The first three topical modules were introduced in Q3/2001 and continued through Q4/2002: health insurance and ability to pay for vaccinations; parental knowledge and experiences; and daycare arrangements, breastfeeding practices, and WIC. The additional data collection went well. Over the six quarters 86 percent of children with a household (NIS) interview were assigned to a topical module, and 98 percent of those module interviews were completed.

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Table 1. Number of children 19–35 months of age, by State and immunization action plan area: United States, 2002

State or IAP area[1]	Population in thousands
Total United States	5,845
Alabama	92
Rest of State	78
Jefferson County	14
Alaska	14
Arizona	119
Rest of State	43
Maricopa County	76
Arkansas	54
California	774
Rest of State	438
Los Angeles County	231
Santa Clara County	40
San Diego County	66
Colorado	90
Connecticut	63
Delaware	15
District of Columbia	10
Florida	309
Rest of State	241
Duval County	19
Miami-Dade County	49
Georgia	191
Rest of State	155
Fulton/DeKalb Counties	36
Hawaii	25
Idaho	29
Illinois	267
Rest of State	193
City of Chicago	73
Indiana	126
Rest of State	105
Marion County	21
Iowa	54
Kansas	58
Kentucky	79
Louisiana	93
Rest of State	82
Orleans Parish	10
Maine	21
Maryland	115
Rest of State	99
Baltimore City	17
Massachusetts	116
Rest of State	104
City of Boston	12
Michigan	195
Rest of State	172
City of Detroit	23
Minnesota	100
Mississippi	62
Missouri	108
Montana	15
Nebraska	34
Nevada	48
New Hampshire	21
New Jersey	171
Rest of State	164
City of Newark	7
New Mexico	39
New York	367
Rest of State	194
New York City	173
North Carolina	173
North Dakota	10
Ohio	220
Rest of State	169
Cuyahoga County	27
Franklin County	25
Oklahoma	72
Oregon	67
Pennsylvania	209
Rest of State	178
Philadelphia County	31
Rhode Island	18
South Carolina	83
South Dakota	15
Tennessee	110
Rest of State	77
Shelby County	21
Davidson County	12
Texas	513
Rest of State	335
Dallas County	60
El Paso County	20
City of Houston	64
Bexar County	34
Utah	63
Vermont	10
Virginia	148
Washington	120
Rest of State	87
King County	33
West Virginia	29
Wisconsin	101
Rest of State	79
Milwaukee County	22
Wyoming	9

[1]IAP is immunization action plan.

SOURCE: Data were derived from an unpublished natality file for August 2000–December 2001, provided by the Centers for Disease Control and Prevention, National Center for Health Statistics.

Table 2. Response rates and key monitoring statistics: National Immunization Survey, 1994–2002

Row	Key indicator	1994 (2nd–4th quarter)	1995	1996	1997	1998	1999	2000	2001	2002
	Random-digit-dialed phase									
1	Total selected telephone numbers in released replicates	1,453,000	1,917,474	2,021,133	2,118,796	2,239,721	2,533,608	2,662,722	3,042,911	3,361,396
2	Phone numbers resolved before CATI[1]	275,860	407,259	397,276	395,488	407,496	483,903	671,215	1,055,376	1,306,025
	(row 2/row 1)	19.0%	21.2%	19.7%	18.7%	18.2%	19.1%	25.2%	34.7%	38.9%
3	Total phone numbers called	1,177,140	1,510,215	1,623,857	1,723,308	1,832,225	2,049,705	1,991,507	1,987,535	2,055,371
4	Advance letters mailed	- - -	565,194	537,322	573,748	589,944	746,824	1,146,845	1,191,713	1,285,751
	(row 4/row 3)	- - -	37.4%	33.1%	33.3%	32.2%	36.4%	57.6%	60.0%	62.6%
5	Resolved phone numbers[2]	1,374,480	1,851,274	1,905,956	1,950,500	2,024,343	2,243,904	2,345,183	2,641,723	2,849,329
	Resolution rate (row 5/row 1)	94.6%	96.5%	94.3%	92.1%	90.4%	88.6%	88.1%	86.8%	84.8%
6	Households identified	668,972	885,069	929,066	943,834	945,122	1,009,543	1,014,714	1,054,561	1,056,429
	(row 6/row 5)	48.7%	47.8%	48.7%	48.4%	46.7%	45.0%	43.3%	39.9%	37.1%
7	Households successfully screened for presence of age-eligible children	643,328	853,536	899,549	924,328	923,970	979,606	973,784	1,014,363	1,020,404
	Screening completion rate (row 7/row 6)	96.2%	96.4%	96.8%	97.9%	97.8%	97.0%	96.0%	96.2%	96.6%
8	Households with no age-eligible children	617,113	819,825	864,528	889,758	889,489	943,268	937,824	978,378	986,203
	(row 8/row 7)	95.9%	96.1%	96.1%	96.3%	96.3%	96.3%	96.3%	96.5%	96.6%
9	Households with age-eligible children	26,215	33,711	35,021	34,570	34,481	36,338	35,960	35,985	34,201
	Eligibility rate (row 9/row 7)	4.1%	3.9%	3.9%	3.7%	3.7%	3.7%	3.7%	3.5%	3.4%
10	Households with age-eligible children with completed RDD interviews[3]	25,017	31,520	32,911	32,434	32,271	33,932	33,477	32,796	30,974
	Interview completion rate (row 10/row 9)	95.4%	93.5%	94.0%	93.8%	93.6%	93.4%	93.1%	91.1%	90.6%
11	CASRO response rate (row 5*row 7*row 10)[4]	86.8%	87.1%	85.8%	84.6%	82.7%	80.3%	78.7%	76.1%	74.2%
12	Age-eligible children with completed RDD interviews[3]	25,247	31,997	33,305	32,742	32,511	34,442	34,087	33,437	31,693
	Provider record check phase									
13	Children with consent obtained to contact vaccination providers	- - -	- - -	- - -	27,169	26,884	28,936	28,402	[5]28,770	[5]27,489
	(row 13/row 12)	- - -	[6]84.0%	[6]85.0%	83.0%	82.7%	84.0%	83.3%	86.0%	86.7%
14	IHQs mailed to providers[7]	- - -	- - -	- - -	34,848	35,429	37,373	37,885	[5]37,268	[5]34,444
15	IHQs returned from providers[7]	- - -	- - -	- - -	28,389	33,748	35,517	35,971	[5]32,939	[5]29,579
	(row 15/row 14)	- - -	[6]61.0%	[6]76.0%	81.5%	95.3%	95.0%	94.9%	88.4%	85.9%
16	Children with adequate provider data	7,862	16,183	21,099	22,806	21,827	22,521	22,958	23,531	[8]21,410
	(row 16/row 12)	[9]42.5%	50.6%	63.4%	69.7%	67.1%	65.4%	67.4%	70.4%	67.3%

- - - Data not available.

[1]CATI is computer-assisted telephone interview.

[2]Resolved phone numbers include phone numbers resolved before CATI (row 2).

[3]RDD is random-digit-dialed.

[4]CASRO is the Council of American Survey Research Organizations.

[5]The provider record check reports from which these numbers were drawn were redefined and revised in 2001.

[6]These data were not available from the National Immunization Survey provider management database prior to 1997; figures shown are estimated from other sources.

[7]IHQ is immunization history questionnaire.

[8]In 2002 the definition of children with adequate provider data was revised to include unvaccinated children.

[9]Some 6,768 shot card children who were 4:3:1:3 up to date in the household survey were not eligible for provider followup.

Table 3. Factors associated with having two or more vaccination providers, among sampled children with adequate provider data: National Immunization Survey, 2002

Factor and level	Number of children	Percent at each factor level (CI[1])	Percent with two or more providers (CI[1])	Relative risk (RR): two or more providers (CI[2])
Survey quarter				
1	5,442	25.4 (±0.6)	27.3 (±1.2)	0.9 (0.9, 1.0)
2	5,458	25.5 (±0.6)	26.9 (±1.2)	0.9 (0.9, 1.0)
3	5,223	24.4 (±0.6)	26.4 (±1.2)	0.9 (0.8, 1.0)
4	5,287	24.7 (±0.6)	29.3 (±1.2)	([3])
Child's characteristics				
Race/ethnicity:				
Hispanic	4,194	19.6 (±0.5)	32.2 (±1.4)	1.2 (1.2, 1.3)
Non-Hispanic white	12,940	60.4 (±0.6)	26.5 (±0.8)	([3])
Non-Hispanic black	2,992	14.0 (±0.4)	25.3 (±1.6)	1.0 (0.9, 1.0)
Non-Hispanic American Indian	324	1.5 (±0.2)	38.0 (±5.4)	1.4 (1.2, 1.7)
Non-Hispanic Asian	956	4.5 (±0.3)	22.4 (±2.7)	0.8 (0.7, 1.0)
Non-Hispanic other	4	0.0 (±0.0)	25.0 (±42.4)	0.9 (0.2, 5.2)
Sex:				
Male	11,024	51.5 (±0.7)	27.3 (±0.8)	([3])
Female	10,386	48.5 (±0.7)	27.6 (±0.9)	1.0 (1.0, 1.1)
Age:				
19–24 months	7,766	36.3 (±0.7)	27.2 (±1.0)	([3])
25–29 months	6,340	29.6 (±0.6)	27.2 (±1.1)	1.0 (0.9, 1.1)
30–35 months	7,304	34.1 (±0.6)	27.9 (±1.0)	1.0 (1.0, 1.1)
Foreign-born:				
Yes	198	0.9 (±0.1)	38.4 (±6.8)	1.4 (1.2, 1.7)
No	21,212	99.1 (±0.1)	27.3 (±0.6)	([3])
Mother's characteristics				
Marital status (or deceased):				
Widowed/divorced/separated	1,567	7.3 (±0.4)	31.8 (±2.3)	1.2 (1.1, 1.3)
Never married	4,070	19.0 (±0.5)	29.1 (±1.4)	1.1 (1.0, 1.2)
Married	15,759	73.6 (±0.6)	26.6 (±0.7)	([3])
Deceased	14	0.1 (±0.0)	28.6 (±23.7)	1.1 (0.5, 2.5)
Educational attainment:				
Less than 12 years	2,626	12.3 (±0.4)	32.2 (±1.8)	1.1 (1.0, 1.2)
12 years	6,103	28.5 (±0.6)	28.1 (±1.1)	1.0 (0.9, 1.0)
More than 12 years, not college graduate	3,986	18.6 (±0.5)	29.2 (±1.4)	([3])
College graduate	8,695	40.6 (±0.7)	24.7 (±0.9)	0.8 (0.8, 0.9)
Preferred language:				
English	19,080	89.1 (±0.4)	26.8 (±0.6)	([3])
Spanish	1,995	9.3 (±0.4)	34.7 (±2.1)	1.3 (1.2, 1.4)
Other	335	1.6 (±0.2)	18.8 (±4.2)	0.7 (0.6, 0.9)
Age:				
19 years or under	548	2.6 (±0.2)	32.3 (±4.0)	1.4 (1.2, 1.6)
20–29 years	8,833	41.3 (±0.7)	33.2 (±1.0)	1.4 (1.4, 1.5)
30 years or over	12,029	56.2 (±0.7)	23.0 (±0.8)	([3])
Shot card:				
Yes	9,607	44.9 (±0.7)	32.3 (±0.9)	([3])
No	11,803	55.1 (±0.7)	23.5 (±0.8)	0.7 (0.7, 0.8)
Household characteristics				
Annual income and poverty status:				
Above $75,000/year	4,372	20.4 (±0.5)	21.4 (±1.2)	([3])
Above poverty, $75,000/year or less	11,218	52.4 (±0.7)	29.0 (±0.9)	1.4 (1.3, 1.4)
Below poverty	3,864	18.0 (±0.5)	31.3 (±1.5)	1.5 (1.4, 1.6)
Unknown	1,956	9.1 (±0.4)	24.2 (±1.9)	1.1 (1.0, 1.2)
Number of children under 18 years of age living in the household:				
1	5,991	28.0 (±0.6)	28.8 (±1.1)	([3])
2–3	12,791	59.7 (±0.7)	26.9 (±0.8)	0.9 (0.9, 1.0)
4 or more	2,628	12.3 (±0.5)	26.9 (±1.8)	0.9 (0.9, 1.0)
Moved from another State since child's birth:				
Moved	1,733	8.1 (±0.4)	58.6 (±2.4)	2.4 (2.3, 2.5)
Did not move	19,607	91.9 (±0.4)	24.7 (±0.6)	([3])
MSA:[4]				
MSA, central city	9,259	43.2 (±0.6)	26.9 (±0.9)	([3])
MSA, not in central city	7,641	35.7 (±0.6)	26.5 (±1.0)	1.0 (0.9, 1.0)
Non-MSA	4,510	21.1 (±0.5)	30.0 (±1.4)	1.1 (1.1, 1.2)

[1]CI is half-width of 95-percent confidence interval. [2]CI is 95-percent confidence interval. [3]This is the reference level for this variable. [4]MSA is metropolitan statistical area.

Table 4. Characteristics associated with incomplete ascertainment, among sampled children with two or more vaccination providers and adequate provider data: National Immunization Survey, 2002

Characteristic	Estimated percentage at each level of the characteristic: Completely ascertained children (CI[1])	Estimated percentage at each level of the characteristic: Incompletely ascertained children (CI[1])	*p*-Value for the difference
Child			
Race/ethnicity:			
Hispanic	23.3 (±1.1)	30.7 (±2.8)	<0.01
Non-Hispanic white	56.6 (±1.2)	50.6 (±2.9)	<0.01
Non-Hispanic black	14.6 (±0.9)	13.8 (±2.1)	0.49
Non-Hispanic American Indian	1.1 (±0.3)	1.6 (±0.6)	0.12
Non-Hispanic Asian	4.5 (±0.5)	3.3 (±1.1)	0.05
Non-Hispanic other	0.0 (±0.0)	0.0 (±0.0)	0.80
Sex:			
Male	51.4 (±1.2)	52.0 (±2.8)	0.68
Female	48.6 (±1.2)	48.0 (±2.8)	0.68
Age:			
19–24 months	36.4 (±1.2)	35.0 (±2.7)	0.35
25–29 months	29.3 (±1.1)	28.2 (±2.5)	0.41
30–35 months	34.2 (±1.1)	36.8 (±2.9)	0.10
Foreign-born:			
Yes	0.8 (±0.2)	2.5 (±1.0)	<0.01
No	99.2 (±0.2)	97.5 (±1.0)	<0.10
Mother			
Marital status (or deceased):			
Widowed/divorced/separated	7.3 (±0.6)	8.9 (±1.7)	0.08
Never married	21.3 (±1.1)	24.1 (±2.5)	0.04
Married	71.3 (±1.2)	66.9 (±2.8)	<0.01
Deceased	0.1 (±0.1)	0.0 (±0.0)	0.16
Educational attainment:			
Less than 12 years	16.8 (±1.1)	20.8 (±2.6)	0.01
12 years	35.2 (±1.2)	36.1 (±2.8)	0.55
More than 12 years, not college graduate	15.5 (±0.8)	16.1 (±1.9)	0.56
College graduate	32.6 (±1.0)	27.1 (±2.3)	<0.01
Preferred language:			
English	86.0 (±0.9)	81.2 (±2.6)	<0.01
Spanish	12.1 (±0.9)	17.3 (±2.5)	<0.01
Other	1.9 (±0.3)	1.5 (±0.7)	0.32
Age:			
19 years or under	3.1 (±0.5)	4.5 (±1.3)	0.07
20–29 years	43.1 (±1.2)	53.9 (±2.8)	<0.01
30 years or over	53.7 (±1.2)	41.6 (±2.8)	<0.01
Shot card:			
Yes	43.2 (±1.2)	50.5 (±2.9)	<0.01
No	56.8 (±1.2)	49.5 (±2.9)	<0.01
Household			
Annual income and poverty status:			
Above $75,000/year	18.0 (±0.8)	12.6 (±1.6)	<0.01
Above poverty, $75,000/year or less	49.2 (±1.2)	50.3 (±2.9)	0.46
Below poverty	20.6 (±1.1)	24.7 (±2.5)	<0.01
Unknown	12.2 (±0.9)	12.4 (±2.3)	0.90
Number of children under 18 years of age living in the household:			
1	27.1 (±1.1)	27.7 (±2.6)	0.66
2–3	59.9 (±1.2)	59.0 (±2.8)	0.56
4 or more	13.0 (±0.9)	13.3 (±1.9)	0.78
MSA:[2]			
MSA, central city	34.6 (±1.1)	37.7 (±2.8)	0.04
MSA, not in central city	46.9 (±1.2)	45.4 (±2.9)	0.33
Non-MSA	18.6 (±0.9)	16.9 (±1.9)	0.12

See footnotes at end of table.

Table 4. Characteristics associated with incomplete ascertainment, among sampled children with two or more vaccination providers and adequate provider data: National Immunization Survey, 2002—Con.

Characteristic	Estimated percentage at each level of the characteristic		*p*-Value for the difference
	Completely ascertained children (CI[1])	Incompletely ascertained children (CI[1])	
Household—Continued			
Facility type(s) of vaccination provider(s):			
All public	62.3 (±1.2)	55.6 (±2.9)	<0.01
All private	8.7 (±0.7)	14.2 (±2.1)	<0.01
All hospital	14.1 (±0.9)	14.1 (±2.0)	0.99
All FQHC[3]	5.7 (±0.6)	6.6 (±1.5)	0.28
Other	9.1 (±0.7)	9.4 (±1.7)	0.75
Moved from another State since child's birth:			
Moved	6.3 (±0.6)	20.0 (±2.4)	<0.01
Did not move	93.3 (±0.6)	80.0 (±2.4)	<0.01
Unknown	0.4 (±0.1)	0.0 (±0.0)	. . .

0.0 Quantity more than zero but less than 0.05.

. . . Category not applicable.

[1]CI is half-width of 95-percent confidence interval.

[2]MSA is metropolitan statistical area.

[3]FQHC is federally qualified health center.

Table 5. Response at successive stages of data collection: National Immunization Survey, 2002

Immunization action plan area	Percentage of children 19–35 months old in telephone households (1)	Household eligibility rate (HER) (2)	Eligibility benchmark (EB) (3)	Ratio of HER to EB (HER/EB) (4)	Access rate (column 1 × column 4) (5)	Interview completion rate (6)	Access rate × completion rate (7)	Percentage of children with adequate provider data (8)	Access rate × completion rate × adequate provider data rate (9)	Percentage of children with complete provider response (10)	Access rate × completion rate × adequate provider data rate × complete provider data rate (11)
United States total	92.8	3.4	4.8	0.7	64.5	90.1	59.9	67.3	39.9	85.4	33.6
LA–Orleans Parish	91.5	2.8	4.4	0.6	58.0	88.5	51.3	54.2	27.8	86.2	24.0
NY–New York City	93.5	3.0	4.7	0.6	59.5	91.6	54.5	51.2	27.9	81.3	22.7
TN–Shelby County	91.9	3.0	5.6	0.6	50.3	88.6	44.6	62.9	28.1	84.0	23.6
MI–City of Detroit	86.3	3.7	5.8	0.6	54.9	89.7	49.3	58.2	28.7	80.2	23.0
CA–Los Angeles County	94.3	3.5	6.1	0.6	54.0	89.6	48.4	59.7	28.9	82.1	23.7
NJ–City of Newark	88.5	3.8	6.2	0.6	54.1	88.3	47.8	60.9	29.1	81.5	23.7
IL–City of Chicago	88.3	3.4	5.3	0.7	57.1	87.8	50.1	60.6	30.4	86.4	26.2
TX–City of Houston	90.1	4.3	5.9	0.7	65.5	92.2	60.4	50.6	30.5	70.5	21.5
PA–Philadelphia County	92.6	2.9	4.4	0.7	61.3	87.1	53.4	58.3	31.1	92.3	28.7
FL–Miami-Dade County	93.5	3.0	5.1	0.6	55.8	87.3	48.7	64.6	31.5	83.0	26.1
District of Columbia	90.6	2.3	3.4	0.7	63.3	86.3	54.6	58.4	31.9	87.2	27.8
MD–Baltimore City	89.2	2.8	4.3	0.6	57.1	85.1	48.6	66.2	32.2	87.8	28.3
MA–City of Boston	94.9	2.4	3.9	0.6	58.5	90.0	52.7	66.2	34.9	89.6	31.2
NV	94.2	3.5	5.4	0.7	62.2	90.4	56.2	62.1	34.9	77.8	27.2
CA–San Diego County	95.4	3.3	5.3	0.6	59.6	91.5	54.5	64.2	35.0	84.5	29.6
OH–Cuyahoga County	94.1	2.8	4.2	0.7	62.7	88.8	55.7	63.5	35.4	87.2	30.8
AL–Jefferson County	93.2	2.9	4.8	0.6	57.2	87.7	50.2	72.3	36.3	89.5	32.5
FL–Duval County	91.5	3.3	5.1	0.6	58.9	89.6	52.7	68.8	36.3	84.7	30.7
LA–Rest of State	89.3	3.5	5.0	0.7	62.8	89.5	56.2	64.7	36.4	86.7	31.5
TN–Davidson County	93.1	2.8	4.5	0.6	58.4	90.4	52.8	69.4	36.6	87.8	32.2
NJ–Rest of State	94.4	3.2	4.9	0.7	61.3	91.3	55.9	65.6	36.7	89.7	32.9
WV	87.5	2.5	3.6	0.7	61.9	90.0	55.7	66.2	36.9	83.1	30.6
TX–Rest of State	90.6	4.2	5.6	0.8	68.5	91.2	62.5	59.3	37.1	76.3	28.3
HI	94.7	3.7	5.3	0.7	66.6	89.7	59.7	62.3	37.2	87.7	32.6
GA–Rest of State	90.6	3.5	5.3	0.7	58.8	93.2	54.8	68.8	37.7	86.9	32.8
AZ–Rest of State	87.4	3.3	4.7	0.7	60.4	93.0	56.2	67.3	37.8	84.9	32.1
CA–Rest of State	94.9	3.7	5.5	0.7	63.7	93.2	59.3	63.9	37.9	84.8	32.2
TX–Dallas County	91.4	4.3	6.0	0.7	65.9	89.3	58.8	64.4	37.9	85.1	32.2
TX–Bexar County	92.1	4.1	5.9	0.7	64.8	89.3	57.9	65.4	37.9	83.8	31.7
AZ–Maricopa County	93.8	4.0	5.7	0.7	66.8	91.1	60.9	62.6	38.1	77.2	29.4
IL–Rest of State	93.3	3.2	5.0	0.7	60.6	91.1	55.2	69.4	38.3	89.3	34.2
CA–Santa Clara County	96.5	3.7	5.7	0.6	62.1	92.8	57.7	66.6	38.4	85.6	32.9
GA–Fulton/DeKalb Counties	93.3	3.6	5.1	0.7	66.3	89.7	59.5	64.6	38.4	88.4	34.0
DE	92.3	3.2	4.7	0.7	63.3	92.3	58.4	66.6	38.9	83.7	32.6
MD–Rest of State	94.4	3.5	4.9	0.7	67.6	89.2	60.3	64.6	38.9	85.0	33.1
NY–Rest of State	95.0	3.2	4.6	0.7	64.4	88.8	57.1	69.3	39.6	89.3	35.4
RI	94.2	2.8	4.2	0.7	62.4	91.3	57.0	69.5	39.6	90.7	35.9
AL–Rest of State	88.3	3.1	4.4	0.7	61.5	90.9	55.9	71.1	39.8	87.6	34.8
WA–Rest of State	95.2	3.5	5.1	0.7	64.6	90.6	58.5	68.5	40.1	82.5	33.1
NM	94.5	3.5	5.1	0.7	65.9	93.1	61.3	65.6	40.2	89.3	35.9
FL–Rest of State	91.8	3.0	3.7	0.8	74.9	87.9	65.8	61.2	40.3	84.0	33.8
MS	85.3	3.7	5.0	0.8	64.2	89.4	57.4	70.5	40.5	84.6	34.2
VA	92.6	3.4	4.7	0.7	68.4	91.5	62.5	64.7	40.5	88.2	35.7
NC	91.0	3.3	4.6	0.7	66.3	90.8	60.2	67.4	40.6	84.9	34.5
OK	88.4	3.4	4.6	0.7	65.0	91.4	59.4	69.1	41.0	76.9	31.6

Table 5. Response at successive stages of data collection: National Immunization Survey, 2002—Con.

Immunization action plan area	Percentage of children 19–35 months old in telephone households (1)	Household eligibility rate (HER) (2)	Eligibility benchmark (EB) (3)	Ratio of HER to EB (HER/EB) (4)	Access rate (column 1 × column 4) (5)	Interview completion rate (6)	Access rate × completion rate (7)	Percentage of children with adequate provider data (8)	Access rate × completion rate × adequate provider data rate (9)	Percentage of children with complete provider response (10)	Access rate × completion rate × adequate provider data rate × complete provider data rate (11)
WI–Milwaukee County	90.5	3.4	4.5	0.7	67.4	89.5	60.3	69.6	42.0	87.6	36.8
PA–Rest of State	94.7	3.0	4.0	0.8	70.7	89.2	63.0	67.0	42.2	84.0	35.5
CT	94.6	3.3	4.6	0.7	68.7	87.3	59.9	70.5	42.3	86.2	36.4
MI–Rest of State	93.9	3.4	4.6	0.8	70.3	89.5	62.9	67.3	42.3	79.9	33.8
TX–El Paso County	91.9	5.6	7.6	0.7	67.2	92.2	61.9	68.8	42.6	83.8	35.7
MO	92.8	3.3	4.4	0.8	69.8	92.6	64.6	66.3	42.9	87.1	37.3
SC	90.2	3.3	4.5	0.7	66.2	90.4	59.8	72.4	43.3	85.8	37.2
UT	95.6	5.9	8.1	0.7	69.9	90.6	63.3	70.3	44.5	79.6	35.4
AR	86.7	3.3	4.6	0.7	62.8	92.1	57.9	77.1	44.6	82.9	37.0
CO	95.1	3.7	4.8	0.8	73.4	90.6	66.5	67.0	44.6	82.1	36.6
TN–Rest of State	90.7	3.1	4.2	0.7	66.8	88.4	59.1	75.4	44.6	86.1	38.4
KY	88.2	3.4	4.5	0.8	66.3	90.6	60.1	74.7	44.9	86.4	38.8
MT	93.4	2.9	4.1	0.7	66.5	94.3	62.7	71.7	45.0	88.4	39.8
OH–Franklin County	94.4	3.7	4.7	0.8	73.5	90.2	66.3	68.2	45.2	92.4	41.8
IN–Rest of State	91.6	3.6	4.7	0.8	70.8	90.0	63.7	71.3	45.4	85.6	38.9
MA–Rest of State	95.6	3.2	4.5	0.7	67.7	92.0	62.3	72.8	45.4	87.1	39.5
IN–Marion County	93.4	3.7	4.6	0.8	75.3	88.1	66.3	69.4	46.0	84.4	38.8
OH–Rest of State	93.5	3.4	4.5	0.8	71.9	89.8	64.6	71.8	46.4	88.1	40.8
WA–King County	96.4	2.9	3.9	0.7	71.4	91.8	65.6	72.0	47.2	82.7	39.0
ME	95.1	2.7	3.7	0.7	70.7	90.9	64.2	74.1	47.6	86.8	41.3
ND	96.1	3.0	4.2	0.7	68.8	93.0	64.0	75.3	48.2	88.8	42.8
OR	95.1	3.4	4.5	0.8	71.4	93.7	66.9	72.1	48.3	87.9	42.4
AK	95.0	4.6	5.8	0.8	75.3	94.8	71.4	68.2	48.7	82.1	40.0
NE	94.6	3.8	4.8	0.8	74.7	92.1	68.8	70.9	48.8	91.4	44.6
WI–Rest of State	94.8	3.3	4.4	0.8	71.8	91.9	65.9	74.7	49.3	88.8	43.7
IA	95.0	3.4	4.4	0.8	74.4	92.0	68.5	72.4	49.6	90.5	44.9
KS	93.2	3.9	4.8	0.8	77.1	94.1	72.6	71.4	51.8	82.4	42.7
NH	95.6	3.2	4.2	0.8	72.3	94.0	68.0	76.2	51.8	84.2	43.6
ID	95.3	4.3	5.8	0.7	70.8	93.5	66.2	79.2	52.4	81.6	42.8
WY	92.8	3.7	4.4	0.8	77.5	94.6	73.3	71.5	52.4	87.1	45.6
SD	93.0	3.9	4.6	0.9	79.1	91.1	72.1	73.6	53.1	87.9	46.6
MN	95.8	3.7	4.6	0.8	77.1	91.1	70.3	77.8	54.7	90.0	49.2
VT	95.1	2.9	3.6	0.8	76.6	92.6	70.9	79.8	56.6	89.4	50.6

NOTE: Immunization action plan areas are listed in ascending order of their value in column 9.

Table 6. Child, maternal, and household characteristics of children with a completed random-digit-dialed interview and children who had adequate provider data: National Immunization Survey, 2002

Characteristic	Children with completed RDD interview[1]		Children with adequate provider data	
	Unweighted sample size	Weighted percent[2]	Unweighted sample size	Weighted percent[3]
Total sample size or percent	31,693	100.0	21,410	100.0
Child				
Race/ethnicity:				
Hispanic	6,517	24.4	4,194	24.4
Non-Hispanic white	18,138	55.6	12,944	55.7
Non-Hispanic black	5,094	14.5	2,992	14.5
Non-Hispanic American Indian	455	1.2	324	1.2
Non-Hispanic Asian	1,489	4.4	956	4.3
Sex:				
Male	16,299	51.5	11,024	51.5
Female	15,394	48.5	10,386	48.5
Age:				
19–24 months	11,408	35.8	7,766	36.2
25–29 months	9,421	29.6	6,340	29.1
30–35 months	10,864	34.6	7,304	34.6
Foreign born:				
Yes	429	1.4	198	1.1
No	31,264	98.6	21,212	98.9
Mother				
Marital status (or deceased):				
Widowed/divorced/separated/deceased	2,449	8.2	1,581	7.7
Never married	6,329	21	4,070	21.7
Married	22,915	70.8	15,759	70.6
Educational attainment:				
Less than 12 years	4,069	17.3	2,626	17.4
12 years	9,115	35.4	6,103	35.3
More than 12, not college graduate	5,920	15.3	3,986	15.6
College graduate	12,589	32	8,695	31.7
Preferred language:				
English	28,010	85.4	19,080	85.3
Spanish	3,105	12.7	1,995	12.9
Other	578	1.9	335	1.8
Age:				
19 years or under	862	3.1	548	3.3
20–29 years	13,406	45.1	8,833	44.8
30 years or over	17,425	51.7	12,029	51.8
Household				
Annual income and poverty status:				
Above $75,000/year	6,025	16.9	4,372	17.2
Above poverty, $75,000/year or less	15,981	48.9	11,218	49.4
Below poverty	5,696	21.1	3,864	21.2
Unknown	3,991	13.2	1,956	12.2
Number of children under 18 years of age living in the household:				
1	9,102	27.4	5,991	27.2
2–3	18,626	59.5	12,791	59.7
4 or more	3,965	13.1	2,628	13.1
Moved from another State since child's birth:				
Moved	2,868	8.6	1,733	8.5
Did not move	28,360	90	19,607	91.2
Unknown	465	1.4	70	0.4
MSA:[4]				
MSA, central city	14,255	34.7	9,259	35.1
MSA, not in central city	11,255	46.5	7,641	46.6
Non-MSA	6,183	18.8	4,510	18.3

[1]RDD is random-digit-dialed.

[2]Figures in this column are based on the RDD-phase sampling weights.

[3]Figures in this column are based on the 2002 weighting methodology, which accounts for partial nonresponse, children who have received no vaccinations, and the 2002 revision of the nontelephone adjustment.

[4]MSA is metropolitan statistical area.

Table 7. Estimated percentage of children 2 years of age residing in telephone households by immunization action plan area: United States, 1996–97 and 2000

IAP area[1]	Percent with a telephone		IAP area[1]	Percent with a telephone	
	1996–97	2000		1996–97	2000
Mississippi	81.7	85.3	IN–Marion County	89.9	93.4
MI–Detroit	90.7	86.3	Montana	89.0	93.4
Arkansas	75.9	86.7	FL–Miami–Dade County	89.4	93.5
AZ–Rest of State	90.1	87.4	NY–New York City	89.6	93.5
West Virginia	87.9	87.5	OH–Rest of State	92.9	93.5
Kentucky	86.7	88.2	AZ–Maricopa County	86.6	93.8
AL–Rest of State	87.7	88.3	MI–Rest of State	91.4	93.9
IL–City of Chicago	87.2	88.3	OH–Cuyahoga County	84.9	94.1
Oklahoma	82.1	88.4	Nevada	94.6	94.2
NJ–City of Newark	92.1	88.5	Rhode Island	93.0	94.2
MD–Baltimore City	93.3	89.2	CA–Los Angeles County	89.2	94.3
LA–Rest of State	82.8	89.3	MD–Rest of State	93.3	94.4
TX–City of Houston	84.9	90.1	NJ–Rest of State	92.1	94.4
South Carolina	80.9	90.2	OH–Franklin County	92.9	94.4
WI–Milwaukee County	93.9	90.5	New Mexico	85.7	94.5
District of Columbia	81.0	90.6	Connecticut	96.4	94.6
GA–Rest of State	79.7	90.6	Nebraska	95.1	94.6
TX–Rest of State	84.3	90.6	Hawaii	94.3	94.7
TN–Rest of State	86.4	90.7	PA–Rest of State	97.1	94.7
North Carolina	87.8	91.0	WI–Rest of State	93.9	94.8
TX–Dallas County	92.1	91.4	CA–Rest of State	92.8	94.9
FL–Duval County	89.4	91.5	MA–City of Boston	94.5	94.9
LA–Orleans Parish	82.8	91.5	Alaska	93.9	95.0
IN–Rest of State	89.9	91.6	Iowa	94.1	95.0
FL–Rest of State	89.4	91.8	NY–Rest of State	95.2	95.0
TN–Shelby County	86.4	91.9	Colorado	95.8	95.1
TX–El Paso County	84.3	91.9	Maine	95.9	95.1
TX–Bexar County	84.3	92.1	Oregon	94.3	95.1
Delaware	93.0	92.3	Vermont	95.5	95.1
PA–Philadelphia County	94.7	92.6	WA–Rest of State	95.6	95.2
Virginia	93.0	92.6	Idaho	91.7	95.3
Missouri	89.4	92.8	CA–San Diego County	92.8	95.4
Wyoming	89.6	92.8	MA–Rest of State	92.8	95.6
South Dakota	84.9	93.0	New Hampshire	92.1	95.6
TN–Davidson County	86.4	93.1	Utah	96.3	95.6
AL–Jefferson County	87.7	93.2	Minnesota	97.0	95.8
Kansas	89.1	93.2	North Dakota	96.7	96.1
GA–Fulton/DeKalb Counties	94.3	93.3	WA–King County	95.6	96.4
IL–Rest of State	84.0	93.3	CA–Santa Clara County	92.8	96.5

[1]IAP is immunization action plan.

NOTE: IAP areas are listed in order of the estimated percentage for 2000. The 2000 estimate for an IAP area equals the product of the estimate from the 2000 census and an adjustment factor for the corresponding census region that aligns the 2000 census estimate for the region with the region's estimate from the March 2000 Current Population Survey.

SOURCE: U.S. Census Bureau, Current Population Surveys, 1996–97 and March 2000; and Census 2000.

Table 8. Number of sample children by each combination of the three characteristics that define poststratification cells, with poststratification cells produced by the collapsing procedure: Massachusetts—City of Boston, second, third, and fourth quarters of 1994

Race/ethnicity	Education of mother: 12 years or less, Age of child: 19–25 months	12 years or less, 26–35 months	More than 12 years, 19–25 months	More than 12 years, 26–35 months
Hispanic	13	24	9	12
Non-Hispanic black	23	36	14	24
Non-Hispanic white or other	23	30	39	52

Poststratification cell	Number of children
Hispanic	58
Non-Hispanic black, education 12 years or less	59
Non-Hispanic black, education more than 12 years	38
Non-Hispanic white or other, education 12 years or less	53
Non-Hispanic white or other, education more than 12 years, age 19–25 months	39
Non-Hispanic white or other, education more than 12 years, age 26–35 months	52

Table 9. Prevalence of selected characteristics by the combination of household telephone status at the time of the survey and interruption in telephone service: Nine large States, 1997–99

State and characteristic	No phone with interruption	No phone, no interruption	Phone with interruption	Phone and no interruption
California				
No insurance	37.60	38.65	31.72	18.27
Self-reported fair/poor health	10.97	14.62	10.23	8.19
Medicaid eligibility	38.24	35.91	31.21	11.24
No health care–cost barrier[1]	8.35	8.92	10.25	3.78
Texas				
No insurance	55.16	52.09	39.08	20.87
Self-reported fair/poor health	12.73	13.87	9.89	8.58
Medicaid eligibility	16.66	21.52	19.14	6.11
No health care–cost barrier[1]	8.17	10.42	10.82	4.19
Florida				
No insurance	51.90	51.68	27.61	18.13
Self-reported fair/poor health	13.22	14.26	12.78	9.55
Medicaid eligibility	22.38	16.39	20.68	5.92
No health care–cost barrier[1]	17.15	14.20	9.90	5.18
Michigan				
No insurance	39.35	22.39	25.81	8.72
Self-reported fair/poor health	9.93	14.46	14.36	7.22
Medicaid eligibility	28.65	40.95	32.69	7.80
No health care–cost barrier[1]	9.84	8.83	10.26	3.49
Illinois				
No insurance	32.30	36.56	24.93	9.99
Self-reported fair/poor health	7.77	14.74	7.50	7.04
Medicaid eligibility	45.60	33.94	22.67	5.21
No health care–cost barrier[1]	11.14	10.04	6.54	2.59
New Jersey				
No insurance	23.04	35.83	19.91	12.60
Self-reported fair/poor health	2.87	13.17	9.83	7.20
Medicaid eligibility	52.24	32.81	17.14	4.81
No health care–cost barrier[1]	4.63	11.85	7.94	2.95
New York				
No insurance	24.02	29.08	24.76	13.30
Self-reported fair/poor health	10.33	22.00	12.63	8.32
Medicaid eligibility	50.00	48.78	29.51	10.51
No health care–cost barrier[1]	4.76	8.63	10.24	3.38
Ohio				
No insurance	37.37	28.21	19.43	9.83
Self-reported fair/poor health	10.51	18.33	14.17	8.88
Medicaid eligibility	19.32	25.89	21.33	5.39
No health care–cost barrier[1]	10.13	9.89	18.45	3.90
Pennsylvania				
No insurance	22.27	31.35	19.18	7.90
Self-reported fair/poor health	15.27	16.76	6.69	8.43
Medicaid eligibility	51.29	26.54	18.12	6.15
No health care–cost barrier[1]	8.97	16.71	5.91	3.04

[1]The respondent reported not receiving health care because of cost barriers.

NOTE: The National Health Interview Survey is currently not designed to yield State-level estimates. These nine States had a sufficiently large sample to yield reliable estimates for the four categories defining the columns of the table.

SOURCE: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey, 1997–99.

Table 10. Calculations for applying the interruption-based adjustment: Georgia—Rest of State immunization action plan area, 2001

Step number	Description	Calculation
1	Population number of children	$N_{++} = 148{,}344$
2	Estimated proportion of children (2 years of age) in telephone households	[1]0.79687
3	Number of children in telephone households	$N_{T+} = 148{,}344 \times 0.79687 = 118{,}211$
4	Number of children in nontelephone households	$N_{\bar{T}+} = N_{++} - N_{T+} = 148{,}344 - 118{,}211 = 30{,}133$
5	Weighted proportion of children in telephone households with an interruption in telephone service	[2]0.07611
6	Estimated number of children from telephone households with interruptions	$\hat{N}_{TI} = N_{T+} \times 0.07611 = 118{,}211 \times 0.07611 = 8{,}998$
7	Control total for children from telephone households without interruptions	$N_{T+} - \hat{N}_{TI} = 118{,}211 - 8{,}998 = 109{,}213$
8	Control total for children from telephone households with interruptions	$N_{\bar{T}+} + \hat{N}_{TI} = 30{,}133 + 8{,}998 = 39{,}131$
9	Adjustment factor for children from telephone households without interruptions	[3]109,213/95,799 = 1.140
10	Adjustment factor for children from telephone households with interruptions	[4]39,131/7,892 = 4.958
11	Ratio of the adjustment factors	[5]4.958/1.140 = 4.349
12	Truncate the adjustment factor for children from telephone households with interruptions	$1.140 \times 3.0 = 3.420$
13	For each child from a telephone household without an interruption, multiply the nonresponse-adjusted base sampling weight by 1.140	
14	For each child from a telephone household with an interruption, multiply the nonresponse-adjusted base sampling weight by 3.420	
15	Poststratify the sample of children to the population control totals for the poststratification cells	

[1]This figure is from the 1996–97 Current Population Survey. See table 7 of this report.
[2]This figure is from the National Immunization Survey sample, with the nonresponse-adjusted base sampling weight.
[3]95,799 is the sum of the nonresponse-adjusted base sampling weights for such children.
[4]7,892 is the sum of the nonresponse-adjusted base sampling weights for such children.
[5]The ratio of the adjustment factors exceeds 3.0.

Table 11. Vaccination coverage rates revised to account for children with no vaccinations and incorporating new nontelephone adjustment by State: National Immunization Survey, 2001

State	n_{NIT}	n_{IT}	n_{1+}	n_0	DTP4[1]		DTP3[2]		POL[3]		MMR[4]		MCV[5]		HIB[6]		HEP[7]		VRC[8]		4:3:1[9]		3:3:1[10]		4:3:1:3[11]		4:3:1:3:3[12]	
					%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ
United States total	22,057	1,585	23,531	111	81.8	–0.3	93.9	–0.4	89.0	–0.4	91.1	–0.3	91.3	–0.3	92.8	–0.2	88.8	–0.1	76.5	0.2	78.2	–0.4	84.0	–0.4	76.9	–0.3	73.4	–0.3
Alabama	543	49	591	1	86.8	0.0	97.4	–0.9	92.3	–0.4	94.4	0.4	94.7	0.4	97.2	0.0	92.0	0.8	89.3	1.2	83.9	–0.6	89.3	–0.6	82.4	–0.3	78.8	–0.3
Alaska	273	19	289	3	76.6	–0.4	89.4	–0.4	84.4	–0.5	87.8	0.0	88.1	–0.1	87.7	–0.6	84.4	0.0	61.1	0.0	74.2	–0.3	80.7	–0.3	73.9	–0.2	70.8	–0.4
Arizona	553	39	590	2	78.9	1.0	93.6	0.7	85.9	0.0	88.7	0.0	88.8	0.0	91.2	0.0	85.5	0.5	74.9	0.4	74.1	0.3	81.0	0.0	73.2	0.3	68.0	–0.1
Arkansas	346	46	391	1	75.2	–2.0	94.8	0.6	88.4	–0.5	89.1	–1.2	89.2	–1.2	92.5	–0.7	86.1	–0.5	82.5	–0.6	72.5	–1.6	83.0	–0.8	72.5	–1.6	68.1	–1.0
California	1,200	66	1,261	5	79.1	–0.7	93.4	–0.3	88.0	–0.8	90.8	–0.5	91.0	–0.6	92.1	–0.2	89.2	0.4	82.1	–0.9	76.1	–0.4	83.1	–0.9	74.6	–0.3	72.3	–0.3
Colorado	346	26	368	4	80.1	–1.6	94.4	–1.2	89.1	–1.2	91.3	–0.8	91.5	–0.8	90.7	–1.6	86.8	–0.8	78.6	–0.4	75.5	–1.7	83.9	–0.9	73.6	–1.8	69.9	–1.6
Connecticut	274	12	285	1	90.1	0.2	94.8	–0.2	93.9	–0.3	93.8	–0.1	93.8	–0.1	94.4	–0.1	89.6	0.6	83.9	–0.4	86.0	0.1	87.7	0.0	84.3	0.2	79.1	0.7
Delaware	259	22	281	0	87.7	0.8	93.6	–0.2	91.6	1.0	93.4	–0.2	93.6	–0.3	93.8	0.6	90.7	0.8	81.0	0.4	81.8	0.8	84.2	0.2	79.5	0.9	75.8	0.9
District of Columbia	284	28	311	1	79.8	–0.6	91.7	0.1	88.4	–0.2	92.5	0.6	92.9	0.7	91.4	–0.2	84.7	–2.2	85.5	–1.1	75.6	0.1	84.2	0.5	74.1	–0.1	67.5	–1.4
Florida	756	56	811	1	83.8	–0.4	94.1	0.1	90.5	0.6	91.2	–0.2	91.3	–0.2	92.5	–0.4	87.7	–1.0	73.2	1.2	79.3	–0.1	83.1	–0.1	76.8	–0.1	72.1	–0.9
Georgia	558	40	598	0	84.5	0.3	94.7	0.0	93.1	0.0	90.9	0.8	91.3	0.7	93.6	0.3	92.7	0.3	88.3	1.2	81.8	0.5	87.5	0.9	80.7	0.7	79.3	0.8
Hawaii	263	16	278	1	77.9	0.7	91.2	0.8	84.8	1.2	90.7	0.1	91.0	0.0	90.7	0.8	87.7	1.1	81.1	0.4	74.6	1.2	79.6	1.4	74.1	1.3	72.0	1.2
Idaho	310	19	327	2	75.2	–1.2	91.3	–0.5	84.3	–0.8	87.2	–1.4	87.2	–1.4	90.4	–1.1	86.1	–0.3	56.3	0.5	73.9	–1.1	80.4	–1.1	73.3	–0.8	69.3	–0.9
Illinois	566	39	602	3	81.8	0.6	93.0	0.5	86.5	1.0	89.3	0.3	89.7	0.1	92.6	0.7	88.8	0.7	58.2	1.2	76.7	0.3	81.8	0.7	76.1	0.5	73.3	0.6
Indiana	516	46	559	3	78.9	0.5	92.8	0.1	89.6	0.2	91.3	0.2	91.3	0.2	93.3	0.6	89.7	0.9	61.0	2.1	75.6	0.1	82.1	0.0	74.0	0.4	71.7	0.6
Iowa	284	10	292	2	85.1	1.1	94.0	0.0	89.7	0.6	89.4	0.2	89.4	0.2	93.5	0.2	92.5	0.4	63.5	1.1	81.2	1.1	83.8	0.8	80.3	0.9	79.6	1.0
Kansas	253	18	269	2	82.6	0.1	93.9	1.8	91.0	2.5	91.6	1.2	91.6	1.2	94.1	1.6	90.3	1.5	65.8	1.7	78.0	1.3	84.7	2.8	77.2	1.5	74.4	1.6
Kentucky	282	24	305	1	83.0	1.4	95.5	0.5	92.5	0.3	91.7	0.1	92.3	–0.1	94.0	0.7	91.6	1.3	79.5	2.0	80.9	0.7	87.1	0.2	79.5	1.0	77.2	1.3
Louisiana	532	45	572	5	73.3	–0.8	88.5	–0.7	80.1	–1.3	83.4	–1.3	83.4	–1.3	89.5	–0.6	85.7	0.1	70.9	–2.1	69.7	–0.2	73.6	–0.6	69.0	0.1	65.5	1.4
Maine	301	14	310	5	89.5	–0.9	96.7	–1.1	92.0	–1.0	93.2	–1.0	93.5	–1.0	94.0	–1.1	86.3	–1.3	62.2	0.1	82.4	–0.9	87.6	–0.9	81.2	–1.0	74.0	–1.1
Maryland	610	25	632	3	82.6	–0.7	93.4	–0.2	89.8	–1.1	92.9	0.0	92.9	0.0	93.6	0.0	89.7	–0.1	88.0	0.2	79.1	–0.6	84.9	–1.0	77.3	–0.6	72.9	–0.5
Massachusetts	569	31	599	1	85.6	–0.1	95.6	–0.4	92.7	–0.2	91.8	–1.0	91.8	–1.0	97.9	0.0	92.9	0.4	83.2	0.4	81.3	–0.6	84.9	–0.9	80.2	–0.4	76.5	–0.1
Michigan	536	68	601	3	76.3	–1.4	93.2	–1.8	87.1	–1.2	87.6	–1.0	87.9	–1.0	91.8	–1.3	86.9	0.5	77.6	1.0	73.4	–1.3	82.7	–0.4	72.7	–1.2	69.7	–0.3
Minnesota	303	5	306	2	86.2	–0.1	97.0	–0.3	91.3	–0.3	91.2	0.4	91.2	0.4	93.5	0.1	92.2	–0.3	74.5	0.8	81.1	–0.2	85.9	–0.2	79.1	0.1	75.9	–0.4
Mississippi	254	32	286	0	89.0	1.5	97.1	0.7	93.6	0.8	93.5	0.2	93.5	0.2	94.0	0.7	92.9	1.6	63.1	1.6	86.1	1.6	90.3	1.0	84.8	0.9	81.7	1.5
Missouri	252	17	267	2	83.1	–0.7	95.3	–0.6	87.8	–1.9	89.8	–0.2	90.2	–0.3	92.5	–1.2	89.5	–1.6	69.4	0.7	78.1	–0.9	83.4	–1.2	76.9	–0.9	74.9	–0.6
Montana	275	20	290	5	83.7	–1.8	96.1	–1.0	88.3	–1.3	94.1	–0.6	94.1	–0.6	94.5	–0.6	90.2	–1.1	66.8	–0.4	81.6	–1.4	86.3	–0.9	80.5	–1.2	76.7	–1.2
Nebraska	289	12	301	0	84.1	–1.3	93.8	–0.4	88.5	–0.4	90.9	0.0	90.9	0.0	92.3	0.3	90.7	–0.5	68.4	–0.7	80.2	–1.3	82.7	–1.2	79.0	–1.4	77.7	–1.2
Nevada	275	23	297	1	76.2	0.4	89.6	–0.6	86.3	0.3	87.1	1.1	87.4	1.1	88.8	–0.8	84.8	–0.7	68.3	1.3	74.7	0.8	80.7	0.7	72.4	0.2	68.2	0.1
New Hampshire	312	7	318	1	87.0	–1.8	98.1	–0.1	93.1	–1.3	93.0	–1.3	93.2	–1.4	97.2	–0.2	90.5	0.5	73.3	0.0	83.1	–1.8	89.0	–1.4	82.1	–1.8	76.4	–1.2
New Jersey	589	51	636	4	78.9	–2.4	90.2	–2.2	85.3	–3.1	90.9	–0.2	91.8	–0.3	89.6	–2.8	82.0	–3.8	74.4	–1.1	75.0	–2.9	80.9	–2.5	72.6	–3.6	69.7	–3.4
New Mexico	308	30	338	0	76.0	–0.1	92.0	–0.5	84.3	0.0	87.1	–0.6	87.1	–0.6	90.3	0.0	78.9	–0.4	71.9	–0.4	72.7	0.0	79.3	–0.3	71.0	0.0	63.1	–0.1
New York	550	41	589	2	86.2	–1.2	95.3	0.1	88.3	–1.0	92.2	–0.3	92.6	–0.3	94.0	0.6	89.4	–0.3	78.4	–0.6	80.1	–1.8	83.3	–1.4	79.0	–1.5	75.6	–1.5
North Carolina	284	19	301	2	87.9	1.0	97.7	–0.6	93.4	0.3	96.0	–0.4	96.3	–0.4	94.0	0.0	91.7	–0.4	83.6	0.5	86.8	1.1	90.5	0.4	85.9	1.2	81.3	0.9
North Dakota	300	20	318	2	85.7	–0.3	93.6	–0.5	92.2	–0.4	92.3	–0.2	92.3	–0.2	93.5	–1.0	89.2	–0.5	68.4	–0.8	83.3	–0.2	89.2	–0.2	82.1	–0.4	78.1	–0.6
Ohio	887	36	920	3	78.0	–0.5	92.8	–0.6	88.8	–1.2	91.6	–0.2	91.6	–0.3	92.5	–0.7	89.6	–0.7	70.8	–1.3	75.9	–0.4	82.8	–0.5	74.3	–0.4	71.1	–0.1
Oklahoma	280	37	315	2	79.2	–0.9	91.9	–1.7	84.9	–1.8	93.0	–0.8	93.0	–0.8	89.9	–1.0	84.0	–0.6	83.0	0.5	76.7	–0.4	82.5	–1.3	76.2	0.0	70.3	0.3
Oregon	273	15	286	2	78.3	0.1	94.5	–0.3	87.2	–1.3	88.2	–1.2	88.5	–1.2	90.7	–0.7	87.8	–1.2	73.3	–0.9	74.8	–0.5	81.7	–1.0	72.7	–0.3	68.2	–0.3
Pennsylvania	537	31	564	4	87.0	–0.1	96.8	–0.4	91.7	–0.4	95.3	–0.2	95.5	–0.3	93.7	–0.4	91.3	–0.2	80.7	0.6	84.4	–0.2	89.4	–0.2	81.9	–0.1	78.7	–0.1
Rhode Island	338	27	364	1	89.1	–0.8	95.9	–1.2	94.9	0.0	95.3	0.5	95.8	0.4	96.5	–0.3	94.9	–0.9	89.0	–0.9	84.4	–0.4	88.6	–0.5	83.3	–0.4	80.9	–0.8
South Carolina	270	26	296	0	82.4	–0.3	95.6	–0.4	93.6	0.9	95.4	0.7	95.7	0.7	96.0	0.2	93.1	0.8	79.2	–1.0	80.9	–0.3	90.2	0.6	80.5	–0.3	78.7	0.0
South Dakota	252	18	265	5	81.8	–1.4	93.6	–1.8	89.9	–1.3	93.0	–0.7	93.0	–0.7	93.2	–1.7	90.0	–0.5	53.7	0.9	79.5	–1.0	86.8	–0.7	77.9	–1.2	75.9	–0.6
Tennessee	856	61	916	1	85.5	–0.8	95.8	0.7	93.8	0.3	94.2	0.0	94.2	0.0	96.5	0.5	91.9	0.4	80.2	0.1	84.0	–0.6	89.0	0.3	83.2	–0.7	79.3	–0.4
Texas	1,454	142	1,594	2	78.8	0.2	93.2	–0.1	87.9	0.3	90.1	–0.3	90.1	–0.3	91.4	0.3	86.8	–0.1	83.3	–0.2	75.6	0.7	83.1	0.0	74.4	0.7	69.9	0.2
Utah	290	15	302	3	80.0	0.6	91.5	–0.5	88.1	–0.3	89.2	0.1	89.2	0.1	91.0	–0.9	83.0	0.3	69.3	1.2	75.7	0.6	82.9	0.0	74.2	0.1	66.4	0.3

See footnotes at end of table.

Table 11. Vaccination coverage rates revised to account for children with no vaccinations and incorporating new nontelephone adjustment by State: National Immunization Survey, 2001—Con.

State	n_{NIT}	n_{IT}	n_{1+}	n_0	DTP4[1]		DTP3[2]		POL[3]		MMR[4]		MCV[5]		HIB[6]		HEP[7]		VRC[8]		4:3:1[9]		3:3:1[10]		4:3:1:3[11]		4:3:1:3:3[12]	
					%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ	%	Δ
Vermont	324	10	331	3	91.3	–0.4	97.1	–0.5	94.7	–0.5	95.1	–0.5	95.1	–0.5	96.5	–0.5	86.1	–1.2	61.2	–0.7	88.9	–0.3	92.3	–0.5	87.8	–0.2	79.4	–0.9
Virginia	239	4	243	0	82.9	–0.4	94.8	0.3	88.7	0.1	91.3	0.3	91.3	0.3	95.7	0.6	89.5	0.0	82.0	–1.1	77.9	–0.5	83.0	0.0	77.4	–0.6	73.6	–1.3
Washington	563	37	592	8	78.3	–1.6	89.2	–1.6	87.2	–1.3	87.6	–1.7	87.7	–1.8	89.3	–1.3	85.1	–0.9	57.0	0.0	75.1	–1.6	80.0	–1.9	73.9	–1.6	69.5	–1.7
West Virginia	264	24	287	1	87.9	–0.3	96.5	–0.4	91.1	–0.1	93.4	–0.4	93.4	–0.4	97.6	–0.6	91.1	–0.8	75.2	2.2	82.7	0.6	86.9	0.6	81.2	0.2	77.7	–0.4
Wisconsin	568	37	601	4	86.6	–0.6	94.8	–0.3	90.5	–0.3	91.4	–0.9	91.6	–1.1	93.1	–0.1	91.1	–0.1	67.6	0.4	83.1	–0.7	86.5	–0.9	81.9	–0.6	79.3	–0.2
Wyoming	257	30	286	1	81.5	–2.2	92.4	–2.3	87.9	–1.3	88.8	–2.8	89.0	–2.8	93.9	–1.4	85.6	–1.2	57.5	–3.4	78.9	–2.0	83.1	–2.6	78.6	–2.0	72.1	–2.2

[1]Percent up to date for 4+ DTP (4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine).

[2]Percent up to date for 3+ DTP (3 or more doses of diphtheria and tetanus toxoids and pertussis vaccine).

[3]Percent up to date for 3+ polio (3 or more doses of polio vaccine).

[4]Percent up to date for 1+ MMR (1 or more doses of measles, mumps, and rubella vaccine, not including any measles-only shots).

[5]Percent up to date for 1+ MCV (1 or more doses of measles-containing vaccine).

[6]Percent up to date for 3+ Hib (3 or more doses of *Haemophilus influenzae* type b vaccine).

[7]Percent up to date for 3+ Hep B (3 or more doses of hepatitis B vaccine).

[8]Percent up to date for 1+ VRC (1 or more doses of varicella vaccine) at 12 or more months of age.

[9]Percent up to date for 4:3:1 (4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine, 3 or more doses of polio vaccine, and 1 or more doses of measles-containing vaccine).

[10]Percent up to date for 3:3:1 (3 or more doses of diphtheria and tetanus toxoids and pertussis vaccine, 3 or more doses of polio vaccine, and 1 or more doses of measles-containing vaccine).

[11]Percent up to date for 4:3:1:3 (4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine, 3 or more doses of polio vaccine, 1 or more doses of measles-containing vaccine, and 3 or more doses of *Haemophilus influenzae* type b vaccine).

[12]Percent up to date for 4:3:1:3:3 (4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine, 3 or more doses of polio vaccine, 1 or more doses of measles-containing vaccine, 3 or more doses of *Haemophilus influenzae* type b vaccine, and 3 or more doses of hepatitis B vaccine).

NOTE: Among complete responders and children with no vaccinations, n_{NIT} denotes the number of children living in a household that did not experience an interruption in telephone service, n_{IT} denotes the number of children living in a household that did experience an interruption in telephone service, n_{1+} denotes the number of children with one or more vaccinations, n_0 denotes the number of children with no vaccinations, and Δ denotes the difference between the revised coverage rate listed in the table and the coverage rate that does not account for children with zero vaccinations or incorporate the new nontelephone adjustment.

Table 12. Differences in estimates of 4:3:1:3 vaccination coverage produced by using the new nontelephone adjustment and accounting for children with no vaccinations by State: National Immunization Survey, 2001

State	Estimate based on 1998–2001 methodology[1]	Standard error of estimate	Change in estimate caused by— Using only the new nontelephone adjustment[2]	Accounting only for children with no vaccinations[3]	Accounting for children with no vaccinations (after making new nontelephone adjustment)[4]	Using the new nontelephone adjustment and accounting for children with no vaccinations[5]
United States total	77.2	0.4	–0.3	–0.1	0.0	–0.3
Alabama	82.7	2.0	–0.1	–0.1	–0.2	–0.3
Alaska	74.1	2.8	–0.3	0.0	0.1	–0.2
Arizona	72.9	2.1	1.1	–0.5	–0.8	0.3
Arkansas	74.1	2.4	–1.4	0.0	–0.2	–1.6
California	74.9	1.8	–0.5	0.3	0.2	–0.3
Colorado	75.4	2.4	–1	–0.9	–0.8	–1.8
Connecticut	84.1	2.5	–0.1	0.1	0.3	0.2
Delaware	78.6	2.6	0.6	0.1	0.3	0.9
District of Columbia	74.2	2.9	0.2	–0.3	–0.3	–0.1
Florida	76.9	2.2	–0.3	0.1	0.2	–0.1
Georgia	80.0	2.2	0.4	0.3	0.3	0.7
Hawaii	72.8	3.4	0.7	1.3	0.6	1.3
Idaho	74.1	2.7	–1.2	0.2	0.4	–0.8
Illinois	75.6	2.1	0.3	0.4	0.2	0.5
Indiana	73.6	2.4	0.2	0.0	0.2	0.4
Iowa	79.4	2.6	1.2	–0.1	–0.3	0.9
Kansas	75.7	3.5	–0.4	1.4	1.9	1.5
Kentucky	78.5	2.5	1.0	–0.3	0.0	1.0
Louisiana	68.9	2.8	0.8	–0.5	–0.7	0.1
Maine	82.2	2.3	–0.1	–0.9	–0.9	–1
Maryland	77.9	2.1	–0.4	–0.3	–0.2	–0.6
Massachusetts	80.6	2.2	–1	0.4	0.6	–0.4
Michigan	73.9	2.5	–1.3	0.1	0.1	–1.2
Minnesota	79.0	2.6	0.0	0.1	0.1	0.1
Mississippi	83.9	2.5	0.7	0.6	0.2	0.9
Missouri	77.8	2.7	–0.7	–0.2	–0.2	–0.9
Montana	81.7	2.4	–0.2	–1.1	–1	–1.2
Nebraska	80.4	2.4	–0.9	–0.3	–0.5	–1.4
Nevada	72.2	2.9	0.0	0.5	0.2	0.2
New Hampshire	83.9	2.2	–1	–1	–0.8	–1.8
New Jersey	76.2	2.7	–2.9	–0.8	–0.7	–3.6
New Mexico	71.0	2.6	0.3	–0.1	–0.3	0.0
New York	80.5	1.8	–1.2	–0.3	–0.3	–1.5
North Carolina	84.7	2.4	2.2	–0.2	–1	1.2
North Dakota	82.5	2.3	0.1	–0.4	–0.5	–0.4
Ohio	74.7	2.1	–0.4	–0.1	0.0	–0.4
Oklahoma	76.2	2.8	–0.1	0.0	0.1	0.0
Oregon	73.0	3.0	–0.2	0.1	–0.1	–0.3
Pennsylvania	82.0	2.1	0.4	–0.5	–0.5	–0.1
Rhode Island	83.7	2.1	–0.2	0.0	–0.2	–0.4
South Carolina	80.8	2.6	–0.1	0.1	–0.2	–0.3
South Dakota	79.1	2.8	–1	–0.2	–0.2	–1.2
Tennessee	83.9	1.6	–0.7	0.1	0.0	–0.7
Texas	73.7	1.9	0.5	–0.2	0.2	0.7
Utah	74.1	2.8	0.1	–0.4	0.0	0.1
Vermont	88.0	1.9	0.2	–0.6	–0.4	–0.2

See footnotes at end of table.

Table 12. Differences in estimates of 4:3:1:3 vaccination coverage produced by using the new nontelephone adjustment and accounting for children with no vaccinations by State: National Immunization Survey, 2001—Con.

			Change in estimate caused by—			
State	Estimate based on 1998–2001 methodology[1]	Standard error of estimate	Using only the new nontelephone adjustment[2]	Accounting only for children with no vaccinations[3]	Accounting for children with no vaccinations (after making new nontelephone adjustment)[4]	Using the new nontelephone adjustment and accounting for children with no vaccinations[5]
Virginia	78.0	3.1	–0.4	–0.5	–0.2	–0.6
Washington	75.5	2.2	–1.1	–0.7	–0.5	–1.6
West Virginia	81.0	2.6	0.3	–0.2	–0.1	0.2
Wisconsin	82.5	1.8	–0.1	–0.5	–0.5	–0.6
Wyoming	80.6	2.6	–1.3	–0.6	–0.7	–2

[1]The 4:3:1:3 estimate of vaccination coverage based on modified poststratification and not accounting for children with no vaccinations.

[2]Difference between the 4:3:1:3 estimate of vaccination coverage that incorporates the new nontelephone adjustment but does not account for children with no vaccinations and the 4:3:1:3 estimate based on modified poststratification and not accounting for children with no vaccinations.

[3]Difference between the 4:3:1:3 estimate of vaccination coverage that accounts for children with no vaccinations but does not incorporate the new nontelephone adjustment and the 4:3:1:3 estimate based on modified poststratification and not accounting for children with no vaccinations.

[4]Difference between the 4:3:1:3 estimate of vaccination coverage that incorporates the new nontelephone adjustment and accounts for children with no vaccinations and the 4:3:1:3 estimate based on the new nontelephone adjustment but not accounting for children with no vaccinations.

[5]Overall difference between the 4:3:1:3 estimate of vaccination coverage that incorporates the new nontelephone adjustment and accounts for children with no vaccinations and the 4:3:1:3 estimate based on modified poststratification and not accounting for children with no vaccinations. The overall difference equals the sum of columns 4 (using only the new nontelephone adjustment) and 6 (accounting for children with no vaccinations, after making new nontelephone adjustment).

NOTE: 4:3:1:3:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib), and 3 or more doses of hepatitis B vaccine (Hep B).

Table 13. Percentage of sampled children with adequate provider data who were incompletely ascertained by race/ethnicity: National Immunization Survey, 1995–2002

			Non-Hispanic									
	Hispanic		White		Black		American Indian		Asian		Other	
Survey year	Percent	CI[1]	Percent	CI[1]	Percent	CI[1]	Percent	CI[1]	Percent	CI[1]	Percent	CI[1]
1995	18.4	(±4.2)	15.0	(±1.1)	15.5	(±2.6)	12.9	(±7.4)	17.6	(±6.7)	19.5	(±15.6)
1996	17.0	(±1.6)	13.9	(±1.3)	15.8	(±3.0)	11.7	(±4.3)	18.1	(±3.4)	5.6	(±6.9)
1997	16.2	(±3.6)	13.5	(±1.4)	14.6	(±2.4)	15.1	(±6.4)	15.9	(±3.5)	16.0	(±6.1)
1998	18.9	(±1.7)	15.9	(±1.3)	17.3	(±2.3)	19.7	(±12.3)	16.5	(±3.1)	13.6	(±6.0)
1999	22.3	(±2.2)	17.7	(±1.6)	17.2	(±2.2)	25.8	(±12.1)	13.2	(±3.0)	14.9	(±9.2)
2000	21.8	(±2.9)	16.2	(±1.9)	17.0	(±2.6)	18.6	(±5.1)	14.8	(±5.3)	15.2	(±24.0)
2001	19.2	(±2.3)	13.2	(±1.1)	16.6	(±2.5)	10.6	(±5.3)	18.3	(±4.9)	51.4	(±53.0)
2002	19.5	(±2.6)	14.1	(±1.1)	14.8	(±1.8)	21.0	(±8.2)	11.8	(±2.9)	12.1	(±25.2)

[1]CI is half-width of 95-percent confidence interval.

Table 14. State and national estimates of 4:3:1:3:3 vaccination coverage for the 2002 estimation methodology and the three alternative methodologies: National Immunization Survey, 2002

				Cases treated as missing											
	2002 methodology (a)			All underascertained cases (b)			Underascertained cases who are not 4:3:1:3:3 up to date (c)			Underascertained cases who are not 4:3:1:3:3 up to date and incompletely ascertained shot card cases whose records do not agree with their providers' records[3] (d)			Difference in 4:3:1:3:3 coverage		
State	Percent	CI[1]	CV[2]	Percent	CI[1]	CV[2]	Percent	CI[1]	CV[2]	Percent	C1[1]	CV[2]	b–a	c–a	d–a
United States total	74.8	(±1.0)	0.01	76.4	(±1.2)	0.01	79.1	(±1.0)	0.01	78.6	(±1.0)	0.01	1.6	4.3	3.8
Alabama	76.8	(±5.3)	0.04	79.6	(±5.4)	0.03	80.2	(±5.1)	0.03	79.9	(±5.1)	0.03	2.7	3.4	3.1
Alaska	75.3	(±5.7)	0.04	77.3	(±6.2)	0.04	80.3	(±5.3)	0.03	79.5	(±5.4)	0.03	2.0	5.0	4.2
Arizona	67.9	(±4.7)	0.04	69.1	(±6.1)	0.05	74.5	(±4.6)	0.03	73.3	(±4.6)	0.03	1.1	6.5	5.4
Arkansas	71.0	(±5.9)	0.04	71.6	(±6.7)	0.05	75.5	(±5.5)	0.04	74.5	(±5.7)	0.04	0.6	4.5	3.6
California	73.2	(±3.8)	0.03	75.4	(±4.2)	0.03	77.1	(±3.7)	0.02	76.8	(±3.7)	0.02	2.2	3.9	3.6
Colorado	62.7	(±6.5)	0.05	63.0	(±7.8)	0.06	67.3	(±6.5)	0.05	66.5	(±6.5)	0.05	0.3	4.6	3.7
Connecticut	81.9	(±5.2)	0.03	84.4	(±6.2)	0.04	85.8	(±5.0)	0.03	85.8	(±5.0)	0.03	2.5	3.9	3.9
Delaware	78.7	(±5.6)	0.04	83.7	(±5.4)	0.03	82.8	(±5.1)	0.03	82.2	(±5.1)	0.03	4.9	4.1	3.5
District of Columbia	69.7	(±7.5)	0.05	74.0	(±8.3)	0.06	75.0	(±7.4)	0.05	75.3	(±7.3)	0.05	4.3	5.3	5.6
Florida	74.5	(±4.8)	0.03	72.9	(±6.8)	0.05	78.8	(±4.5)	0.03	77.7	(±4.6)	0.03	–1.5	4.3	3.2
Georgia	80.4	(±4.2)	0.03	81.4	(±4.8)	0.03	82.9	(±4.1)	0.02	82.5	(±4.1)	0.03	1.1	2.5	2.1
Hawaii	78.7	(±5.5)	0.04	79.6	(±5.9)	0.04	81.2	(±5.5)	0.03	80.9	(±5.5)	0.03	0.8	2.5	2.1
Idaho	69.4	(±5.9)	0.04	70.2	(±6.8)	0.05	75.0	(±5.6)	0.04	74.3	(±5.6)	0.04	0.8	5.7	4.9
Illinois	78.6	(±4.3)	0.03	81.3	(±4.3)	0.03	82.3	(±3.9)	0.02	81.7	(±4.0)	0.03	2.8	3.8	3.1
Indiana	76.0	(±4.8)	0.03	77.8	(±5.2)	0.03	80.4	(±4.6)	0.03	79.8	(±4.6)	0.03	1.8	4.4	3.8
Iowa	78.7	(±5.5)	0.04	80.7	(±5.8)	0.04	82.1	(±5.3)	0.03	81.7	(±5.4)	0.03	2.0	3.5	3.0
Kansas	66.8	(±6.8)	0.05	70.6	(±7.2)	0.05	72.0	(±6.9)	0.05	70.2	(±6.9)	0.05	3.8	5.2	3.4
Kentucky	72.3	(±6.3)	0.04	75.1	(±6.7)	0.05	76.5	(±6.1)	0.04	76.3	(±6.1)	0.04	2.8	4.2	4.0
Louisiana	66.8	(±5.6)	0.04	70.8	(±5.8)	0.04	72.2	(±5.4)	0.04	71.5	(±5.4)	0.04	4.0	5.4	4.6
Maine	80.7	(±5.1)	0.03	82.3	(±6.5)	0.04	85.1	(±4.9)	0.03	84.3	(±5.0)	0.03	1.6	4.3	3.5
Maryland	78.7	(±5.6)	0.04	81.3	(±5.7)	0.04	81.2	(±5.5)	0.03	81.2	(±5.5)	0.03	2.5	2.5	2.5
Massachusetts	86.2	(±3.8)	0.02	86.3	(±4.4)	0.03	87.5	(±3.9)	0.02	87.4	(±3.9)	0.02	0.1	1.3	1.2
Michigan	81.6	(±4.3)	0.03	82.1	(±5.5)	0.03	85.7	(±3.7)	0.02	85.2	(±3.8)	0.02	0.5	4.1	3.6
Minnesota	76.8	(±6.5)	0.04	78.6	(±7.0)	0.05	80.6	(±6.6)	0.04	80.5	(±6.6)	0.04	1.8	3.8	3.7
Mississippi	75.7	(±6.3)	0.04	76.6	(±7.2)	0.05	79.3	(±6.1)	0.04	79.3	(±6.1)	0.04	0.9	3.6	3.6
Missouri	73.0	(±6.5)	0.05	75.4	(±7.2)	0.05	77.0	(±6.5)	0.04	76.8	(±6.5)	0.04	2.4	3.9	3.8
Montana	66.6	(±6.5)	0.05	68.1	(±7.0)	0.05	70.7	(±6.4)	0.05	70.1	(±6.5)	0.05	1.4	4.1	3.5
Nebraska	78.2	(±5.3)	0.03	80.3	(±5.3)	0.03	80.7	(±5.1)	0.03	80.7	(±5.1)	0.03	2.1	2.5	2.5
Nevada	76.4	(±6.1)	0.04	79.1	(±6.7)	0.04	81.4	(±5.8)	0.04	81.0	(±5.8)	0.04	2.7	5.1	4.6
New Hampshire	83.5	(±5.0)	0.03	83.4	(±5.9)	0.04	85.0	(±4.9)	0.03	85.0	(±4.9)	0.03	–0.1	1.5	1.4
New Jersey	76.1	(±5.4)	0.04	78.5	(±5.6)	0.04	79.9	(±5.1)	0.03	79.4	(±5.1)	0.03	2.4	3.8	3.2
New Mexico	64.6	(±6.8)	0.05	63.2	(±7.5)	0.06	65.9	(±6.8)	0.05	65.9	(±6.8)	0.05	–1.4	1.3	1.2
New York	77.5	(±4.3)	0.03	78.6	(±6.1)	0.04	82.0	(±4.0)	0.03	81.4	(±4.1)	0.03	1.1	4.4	3.9
North Carolina	82.4	(±5.3)	0.03	85.6	(±5.4)	0.03	86.2	(±4.8)	0.03	86.2	(±4.8)	0.03	3.2	3.8	3.8
North Dakota	77.7	(±6.1)	0.04	80.7	(±5.9)	0.04	82.2	(±5.3)	0.03	81.9	(±5.3)	0.03	3.0	4.5	4.2
Ohio	75.0	(±4.4)	0.03	75.9	(±5.8)	0.04	79.2	(±4.2)	0.03	78.5	(±4.3)	0.03	0.8	4.2	3.4
Oklahoma	65.3	(±7.4)	0.06	68.7	(±9.7)	0.07	75.6	(±7.3)	0.05	74.7	(±7.4)	0.05	3.4	10.3	9.4
Oregon	70.0	(±5.8)	0.04	73.9	(±6.2)	0.04	74.9	(±5.8)	0.04	74.5	(±5.8)	0.04	3.9	4.9	4.6
Pennsylvania	74.7	(±5.4)	0.04	74.6	(±8.4)	0.06	79.4	(±5.6)	0.04	78.5	(±5.4)	0.04	–0.2	4.7	3.8
Rhode Island	84.5	(±5.6)	0.03	86.2	(±5.6)	0.03	86.3	(±5.4)	0.03	86.3	(±5.4)	0.03	1.7	1.8	1.8
South Carolina	78.8	(±6.3)	0.04	79.1	(±7.7)	0.05	81.8	(±6.4)	0.04	81.9	(±6.3)	0.04	0.3	3.1	3.1
South Dakota	79.9	(±6.4)	0.04	81.6	(±6.8)	0.04	82.7	(±6.4)	0.04	82.7	(±6.4)	0.04	1.7	2.8	2.8
Tennessee	78.2	(±4.1)	0.03	82.1	(±4.2)	0.03	84.0	(±3.6)	0.02	83.0	(±3.8)	0.02	3.9	5.8	4.7
Texas	67.9	(±5.1)	0.04	67.2	(±6.7)	0.05	72.9	(±5.5)	0.04	72.5	(±5.5)	0.04	–0.6	5.0	4.7
Utah	75.7	(±5.8)	0.04	78.4	(±6.3)	0.04	80.0	(±5.6)	0.04	80.0	(±5.6)	0.04	2.6	4.3	4.3
Vermont	80.9	(±4.8)	0.03	79.3	(±6.0)	0.04	82.4	(±4.6)	0.03	81.9	(±4.7)	0.03	–1.6	1.6	1.0
Virginia	72.0	(±6.1)	0.04	77.7	(±6.1)	0.04	78.9	(±5.8)	0.04	78.3	(±5.8)	0.04	5.7	6.9	6.3
Washington	69.2	(±4.8)	0.04	72.2	(±5.5)	0.04	76.3	(±4.5)	0.03	75.9	(±4.5)	0.03	3.0	7.1	6.7
West Virginia	76.9	(±6.2)	0.04	77.6	(±7.2)	0.05	79.6	(±6.1)	0.04	78.8	(±6.2)	0.04	0.8	2.8	1.9
Wisconsin	80.3	(±4.3)	0.03	85.4	(±3.5)	0.02	85.4	(±3.4)	0.02	85.0	(±3.5)	0.02	5.1	5.1	4.8
Wyoming	73.3	(±6.4)	0.04	76.8	(±7.3)	0.05	80.1	(±5.8)	0.04	79.2	(±5.7)	0.04	3.4	6.8	5.8

[1]CI is half-width of 95-percent confidence interval.

[2]CV is coefficient of variation (standard error/estimate).

[3]Shot cards and provider records do not agree on the number of doses administered for each of the following vaccines: diphtheria, tetanus toxoids, and acellular pertussis (DTaP); polio; measles-mumps-rubella (MMR); *Haemophilus influenzae* type b (Hib); hepatitis B (Hep B); and varicella (VRC).

NOTE: 4:3:1:3:3 refers to 4 or more doses of diphtheria and tetanus toxoids and pertussis vaccine (DTP), 3 or more doses of polio vaccine (polio), 1 or more doses of measles-containing vaccine (MCV), 3 or more doses of *Haemophilus influenzae* type b vaccine (Hib), and 3 or more doses of hepatitis B vaccine (Hep B).

Appendix

National Immunization Survey Immunization History Questionnaire

National Immunization Survey
Immunization History Questionnaire

CENTERS FOR DISEASE CONTROL AND PREVENTION

Confidential Information. If received in error, please call 1-800-886-4993.

START HERE → Please review your records and complete this questionnaire for the child identified on the label to the right, then return the questionnaire in the postage-paid envelope provided or FAX toll-free to (888) 529-1772. These medical records are confidential. If FAXing, please take extra care to dial the correct number.

1. Which of the following best describes your immunization records for this child?

- ☐ You have all or partial immunization records for this child, go to question 2 below.
- ☐ This facility only gives immunizations at birth (hospital), go to question 2 below.
- ☐ Other - Explain
- ☐ You have provided care to this child, but do not have immunization records.
- ☐ You have no record of providing care to this child.

Please complete item 9 and return form as instructed above

2. According to your records, what is this child's date of birth?

Month Day Year ☐ Don't know

3. What was the date of this child's *first* visit, for any reason, to this place of practice?

Month Day Year ☐ Don't know

4. What was the date of this child's *most recent* visit, for any reason, to this place of practice?

Month Day Year ☐ Don't know

5. Which types of care does this facility routinely provide? Check all that apply.

- ☐ Comprehensive well-child care (examination, anticipatory guidance, screening)
- ☐ Acute illness care
- ☐ Follow-up visits
- ☐ After-hours telephone coverage
- ☐ WIC Program/services
- ☐ Other - Explain

6. Which of the following best describes this facility? Check only one box, representing the most specific description.

- ☐ Federally-qualified health center, including community/migrant/rural/Indian health center
- ☐ Hospital-based clinic, including university clinic, or residency teaching practice
- ☐ Private practice, including solo, group practice, or HMO
- ☐ Public health department-operated clinic
- ☐ Military health care facility
- ☐ WIC clinic
- ☐ Other - Explain

7. Is this facility a Vaccines for Children provider?

- ☐ Yes
- ☐ No
- ☐ Don't know

8. Did you or your facility report any of this child's immunizations to your community or state immunization registry?

- ☐ Yes
- ☐ No
- ☐ Not applicable (No registry in my community/state.)
- ☐ Don't know

9. Contact information for the person returning this form.

Name:

☐ Physician ☐ Nurse ☐ Office Manager/Receptionist

☐ Medical Records Administrator/Technician ☐ Other

Phone: ( ) X

FAX: ( ) X

10. Go to the next page →

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Please review the instructions and examples below, then complete the "Shot Grid" on the next page.

Refer to your vaccination records for the child named on the labels on the front cover and next page of this form.

- **Be sure to mark the box for the correct combination vaccine for each dose as shown in the example below. If the combination included both DTaP and Hib, DTP and Hib, or HepB and Hib, be sure to enter the information in both vaccine categories. Note that the same vaccine (a combination DTaP-Hib vaccine) is entered under both DTP and Hib in the example below.**

Vaccine	*Date Given* Month	Day	Year	Given by other practice?	*Type of Vaccine* Mark one box for each vaccine dose				
DTP .. 1	11	20	2000	☐ Yes	☐ DTP	☐ DT	☐ DTaP	☒ DTaP-Hib	☐ DTP-Hib
2	1	18	2001	☒ Yes	☐ DTP	☐ DT	☒ DTaP	☐ DTaP-Hib	☐ DTP-Hib

					Mark one box for each vaccine dose			
Hib ... 1	11	20	2000	☐ Yes	☐ Hib	☐ HepB-Hib	☒ DTaP-Hib	☐ DTP-Hib
2	1	18	2001	☒ Yes	☒ Hib	☐ HepB-Hib	☐ DTaP-Hib	☐ DTP-Hib

- **Be sure to mark the "Yes" box under "Given by other practice" for vaccines given by another practice (see example above).**

- **Be sure to mark the "Yes" box under "Given at birth?" if the first dose of HepB was given at birth. (see example below).**

					Given at birth?	Mark one box for each vaccine dose	
Hepatitis B 1	7	19	2000	☐ Yes	☒ Yes	☐ HepB Only	☒ HepB-Hib
2				☐ Yes		☐ HepB Only	☐ HepB-Hib

- **Use the "Other" space to enter any vaccines not listed on the next page or additional doses of listed vaccines that were given to this child (see example below).**

					Please enter a description of each vaccine dose
Other 1	11	20	2001	☐ Yes	BCG
2				☐ Yes	

- **After completing the "Shot Grid" on the next page, please return this form in the envelope provided.**

(Optional) You may also attach a copy of your immunization history records for this child to this form and send it back to the National Immunization Survey, Centers for Disease Control and Prevention, P.O. Box 5517, Chicago, IL 60680-8817.

Or you may FAX the confidential information to (888) 529-1772. If FAXing this form, cut along fold to separate pages, then FAX pages 1 and 3. Do not FAX this page.

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Vaccine		Date Given: Month	Day	Year	Given by other practice?	Type of Vaccine
						Mark one box for each vaccine dose
DTP	1				☐Yes	☐DTP ☐DT ☐DTaP ☐DTaP-Hib ☐DTP-Hib
	2				☐Yes	☐DTP ☐DT ☐DTaP ☐DTaP-Hib ☐DTP-Hib
	3				☐Yes	☐DTP ☐DT ☐DTaP ☐DTaP-Hib ☐DTP-Hib
	4				☐Yes	☐DTP ☐DT ☐DTaP ☐DTaP-Hib ☐DTP-Hib
	5				☐Yes	☐DTP ☐DT ☐DTaP ☐DTaP-Hib ☐DTP-Hib
						Mark one box for each vaccine dose
Hib	1				☐Yes	☐Hib ☐HepB-Hib ☐DTaP-Hib ☐DTP-Hib
	2				☐Yes	☐Hib ☐HepB-Hib ☐DTaP-Hib ☐DTP-Hib
	3				☐Yes	☐Hib ☐HepB-Hib ☐DTaP-Hib ☐DTP-Hib
	4				☐Yes	☐Hib ☐HepB-Hib ☐DTaP-Hib ☐DTP-Hib
	5				☐Yes	☐Hib ☐HepB-Hib ☐DTaP-Hib ☐DTP-Hib
						Given at birth? / Mark one box for each vaccine dose
Hepatitis B	1				☐Yes	☐Yes ☐HepB Only ☐HepB-Hib
	2				☐Yes	☐HepB Only ☐HepB-Hib
	3				☐Yes	☐HepB Only ☐HepB-Hib
	4				☐Yes	☐HepB Only ☐HepB-Hib
						Mark one box for each vaccine dose
MMR	1				☐Yes	☐MMR ☐Measles only
	2				☐Yes	☐MMR ☐Measles only
						Mark one box for each vaccine dose
Polio	1				☐Yes	☐OPV ☐IPV
	2				☐Yes	☐OPV ☐IPV
	3				☐Yes	☐OPV ☐IPV
	4				☐Yes	☐OPV ☐IPV
Varicella	1				☐Yes	
	2				☐Yes	
						Mark one box for each vaccine dose
Pneumo-coccal	1				☐Yes	☐Conjugate ☐Polysaccharide
	2				☐Yes	☐Conjugate ☐Polysaccharide
	3				☐Yes	☐Conjugate ☐Polysaccharide
	4				☐Yes	☐Conjugate ☐Polysaccharide
Rotavirus	1				☐Yes	
	2				☐Yes	
	3				☐Yes	
Hepatitis A	1				☐Yes	
	2				☐Yes	
Influenza	1				☐Yes	
	2				☐Yes	
						Please enter a description of each vaccine dose
Other	1				☐Yes	
	2				☐Yes	
	3				☐Yes	

Please remember to answer question 9 on page 1.

If you need more space to report vaccines, please attach additional sheets.

Thank You!

CENTERS FOR DISEASE CONTROL AND PREVENTION

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U.S. Department of Health and Human Services

Thank you for your help with this important study!

If you would like more information about the National Immunization Program, including information about vaccine recommendations, or data and statistics from previous years of the National Immunization Survey, please visit the National Immunization Program website at www.cdc.gov/nip/coverage.

If you would like more information about the National Immunization Survey, please visit the National Immunization Survey website at www.cdc.gov/nis. If you have any questions or comments about this study, please call (800) 886-4993 or email nis@cdc.gov.

Note: Do **NOT** send any confidential patient information, such as the patient's name or date of birth, in an email message.

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For answers to questions about this report or for a list of reports published in these series, contact:

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