

Determining Accurate Vaccination Coverage Rates for Adolescents: The National Immunization Survey-Teen 2006

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SYNOPSIS

Since 1994, the Centers for Disease Control and Prevention has funded the National Immunization Survey (NIS), a large telephone survey used to estimate vaccination coverage of U.S. children aged 19–35 months. The NIS is a two-phase survey that obtains vaccination receipt information from a random-digit-dialed survey, designed to identify households with eligible children, followed by a provider record check, which obtains provider-reported vaccination histories for eligible children. In 2006, the survey was expanded for the first time to include a national sample of adolescents aged 13–17 years, called the NIS-Teen. This article summarizes the methodology used in the NIS-Teen. In 2008, the NIS-Teen was expanded to collect state-specific and national-level data to determine vaccination coverage estimates. This survey provides valuable information to guide immunization programs for adolescents.

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The Centers for Disease Control and Prevention (CDC) and its contractor, the National Opinion Research Center, developed and conducted the National Immunization Survey-Teen (NIS-Teen) for the first time in 2006 as an expansion of the National Immunization Survey (NIS). The NIS was established as part of the Childhood Immunization Initiative (CII)¹ and, since 1994, it has been used to estimate vaccination coverage of 19- to 35-month-old children. The NIS conducts quarterly surveys in 56 areas that receive Section 317 immunization grant funding and five other urban areas, as well as other selected large city/county areas. With this sampling frame, the NIS produces vaccination coverage levels that are comparable over time. In 2006, the NIS was expanded to include a national sample of households with adolescents aged 13–17 years.

Studies show that adolescents do not access health care regularly despite recommendations from professional organizations for annual preventive health-care visits.² Objectives established by Healthy People 2010 (specifically, objectives 14–27) call for 90% vaccination coverage among adolescents aged 13–15 years with ≥ 3 doses of hepatitis B (HepB) vaccine, ≥ 2 doses of measles, mumps, and rubella (MMR) vaccine, ≥ 1 dose of tetanus-diphtheria (Td) boosters, and ≥ 1 dose of varicella (VAR) vaccine among those without previous history of varicella disease.³ In addition, three new vaccines specifically targeted to adolescents have been licensed and recommended in the U.S. since 2005. At the time of the survey, recommendations were: meningococcal conjugate vaccine (MCV4) for 11- to 12- and 15-year-olds (2005); and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine for 11- to 12-year-olds (2006). Recommendations for human papillomavirus (HPV) vaccine for girls 11–12 years of age were published in 2007. Adolescents who did not receive Tdap or HPV at ages 11–12 years should receive the vaccines between 13 and 18 years of age.⁴

In the past, vaccination coverage estimates for adolescents were based on parents reporting vaccinations either from immunization cards or by recalling from memory whether their child had received vaccinations. The National Health Interview Survey (NHIS), a door-to-door household survey of the noninstitutionalized U.S. population, has collected immunization information from parents on children ≤ 17 years of age. Between 1997 and 2003, the NHIS ascertained that only 15% to 20% of households had personal immunization cards available.⁵ Additionally, large differences in vaccination coverage rates existed among parents reporting from immunization cards and parents reporting from recall. Parental recall of children's vaccinations has been shown to be inaccurate compared with using

information from immunization cards.⁶ Other methods that have been used to estimate vaccination coverage include local telephone surveys, registry data analyses, and middle school vaccination assessments.^{7–9}

In 2004, CDC conducted a pilot NIS for adolescents aged 13–17 years. Approximately 1,000 parents or guardians were interviewed, where 26% of households had immunization cards and 81% gave consent to contact vaccination providers to obtain immunization records. Adequate provider data were obtained for 51% of adolescents (Unpublished data, CDC, 2005). In 2006, a larger sample was used for the NIS-Teen to provide information to assess progress toward the Healthy People 2010 objectives, monitor uptake of the new adolescent vaccines, and identify gaps in vaccination coverage. This article describes the methods used in the NIS-Teen, presents key operational findings, and indicates future plans.

SAMPLE DESIGN

Household survey

The NIS-Teen is built on the foundations of the infant NIS survey.^{10,11} Similarly, the NIS-Teen is a two-phase survey consisting of (1) a random-digit-dialing (RDD) telephone survey designed to identify households with an age-eligible adolescent followed by (2) a provider record check (PRC), which obtains provider-reported vaccination histories for the selected adolescent. To preserve the infant NIS, households are first screened for children 19–35 months of age; these households are administered the infant NIS survey. The household is then screened for the presence of a second child aged 13–17 years; these households are administered the NIS-Teen regarding that adolescent. If more than one adolescent aged 13–17 years is present, one adolescent is randomly selected to be the subject of the interview. If a household has no eligible children aged 19–35 months but has a child aged 13–17 years, only the NIS-Teen is administered. Consent is obtained before being interviewed for both surveys. The NIS is considered nonexempt research involving human subjects, and approval by the Institutional Review Board at CDC was obtained.

PRC survey

After completing the household interview, consent is requested to contact immunization provider(s) to verify immunization records. This portion of the survey is called the PRC. Names of providers who have given vaccinations to the adolescent are obtained; if the respondent indicates no vaccination providers (zero vaccinations), or says the number of providers

is unknown, s/he is asked to name all providers the adolescent has seen. Immunization history questionnaires (IHQs) are mailed to all named providers, who are asked to record the sampled child's vaccination history from the medical records.

In 2006, 94% of named providers were mailed an IHQ. Of all the packets mailed, 7% were returned as undeliverable. The contractor found addresses for many of these and the packets were resent. The contractor has a team dedicated to locating providers for both the NIS and the NIS-Teen, using a variety of sources including internal and external databases to locate providers with missing or inaccurate address information.

DATA COLLECTION

Content of the NIS-Teen household questionnaire

The NIS-Teen household interview is conducted as a computer-assisted telephone interview by the same interviewers who conduct the infant NIS. Interviews are conducted in English and Spanish and other languages as necessary. In 2006, 538 of the 5,468 interviews were conducted in Spanish (10%) and 79 were collected in another language (>1%). The contents of each section of the NIS-Teen are summarized in the Figure.

In Section S, the purpose of the survey is explained to the respondent. Screening questions are asked to determine all children aged <18 years living in the household. One child aged 13–17 years is randomly selected to be the subject of the interview. The person in the household who knows the vaccination history of the selected child is asked to be the respondent. Inquiries are made about a current immunization card.

If the household has an immunization card, questions from Section A are asked. The respondent is asked if the adolescent has received particular vaccines; s/he

is asked to count the number of doses on the card and give the recorded vaccination dates of the vaccines. If the respondent does not see any specific immunizations on the card, does not know how many doses the adolescent received, or cannot give the dates on the card, s/he is asked to recall if the adolescent received particular vaccinations. Vaccines include the following: MMR, hepatitis A, HepB, influenza, VAR, Td or Tdap, meningococcal, and HPV vaccines. Section B is administered to households without an immunization card to collect vaccine receipt information of the same vaccines by parental recall only.

Section Health asks questions about whether the adolescent has ever had varicella disease and at what age, at what age the adolescent had the most recent checkup, the adolescent's health status, and whether the adolescent has asthma.

Section C collects information on school grade level, number of people living in the household, respondent's relationship to the adolescent, race/ethnicity of the adolescent and mother, household income, educational attainment of the child's mother, information about household location (city, county, state, and zip code), and other socioeconomic information.

Section D obtains information about the adolescent's vaccination providers. If the respondent states the adolescent has had zero vaccination providers or is unsure, the names of all of the health-care providers are collected. If consent is obtained to contact providers, addresses are collected for the IHQ.

Section Health Insurance asks questions about whether the adolescent has any health insurance, including government-funded programs such as Medicaid or the State Children's Health Insurance Program or private insurance. Information is obtained about gaps in health insurance coverage since age 11.

Figure. Content of the 2006 National Immunization Survey-Teen 2006 module household interview

Section	Content
Section S	Screening questions to determine eligibility for adolescent survey, consent and confidentiality statements, determination of availability of immunization record, and if it is up-to-date
Section A	Vaccination history obtained from immunization card; if card not up-to-date, then vaccination history obtained from recall
Section B	Immunization card not available, vaccination history obtained only from recall
Section health	History of varicella, history of 11- to 12-year-old health-care visit or last checkup, asthma status, health status
Section C	Demographic and socioeconomic questions
Section D	Provider information and consent to contact providers
Section health insurance	Health insurance status questions

Content of the IHQ for the PRC

The IHQ used in the NIS-Teen is similar to the one used in the infant NIS. The first page collects information about whether the provider has immunization records for the adolescent, the provider’s recorded adolescent date of birth, and the dates of the first and most recent health-care visits. Practice characteristics including the number of physicians and the facility type (e.g., private practice, school clinic) are asked. Providers are asked if their practice orders vaccines from the state or local health department and if they report adolescent immunizations to the state registry. The provider is asked to record the dates and types of vaccinations that the adolescent has received on a shot grid according to the medical records. The provider may mark a box next to a vaccine if it was given by another practice. Information on the following is collected: diphtheria, tetanus, pertussis (DTP); Td or Tdap; HepB; hepatitis A; measles-containing or MMR; VAR; influenza; pneumococcal polysaccharide; meningococcal; and HPV vaccines.

Providers can return the questionnaires by fax or mail; copies of electronic medical records or other kinds of records that contain vaccination data may be sent in place of the IHQ. Records are transcribed by NIS staff. If no response is obtained after two weeks,

a reminder postcard is sent. For the first month, telephone prompting is used to remind and encourage providers to return the forms.

RESULTS FOR THE NIS-TEEN 2006

Household telephone survey

The NIS-Teen conducted household interviews between October 6, 2006, and February 7, 2007. Response rates are summarized in Table 1. To obtain the sample, 199,897 telephone numbers were called to identify 79,085 households from the infant NIS RDD sample. Of these households, 64,387 (81%) households were screened for adolescents aged 13–17 years at the time of the household interview. Of these households, 6,549 (10%) reported at least one age-eligible adolescent and 5,481 (84%) completed interviews. After removing adolescents ineligible due to their birth date, the final sample of adolescents with completed household interviews was 5,468 adolescents. Of these, 4,356 households completed the health insurance module.

Response rates were measured by the methods of the Council of American Survey Research Organizations (CASRO).¹² Details of response rates are shown in Table 1. For the 2006 NIS-Teen, the CASRO rate was 56% (row 11). The CASRO response rate is the

Table 1. Selected operational results of fourth-quarter 2006 NIS-Teen 2006 and NIS 2006 data collection

Row	Key indicator	NIS-Teen N	NIS-Teen Percent	NIS Percent
1	Total selected telephone numbers in released replicates	341,512		
2	Phone numbers resolved before computer-assisted telephone interviewing (row 2/row 1)	141,615	41.5	43.3
3	Total phone numbers released to telephone center (row 1/row 2)	199,897	NA	NA
4	Advance letters mailed (row 4/row 3)	118,189	59.1	67.4
5	Resolved phone numbers ^a —resolution rate (row 5/row 1)	281,465	82.4	82.1
6	Households identified—WRN rate (row 6/row 5)	79,085	28.1	28.0
7	Households successfully screened for presence of age-eligible teens or infants—screening completion rate (row 7/row 6)	64,387	81.4	90.9
8	Households with no age-eligible teens or infants (row 8/row 7)	57,838	89.8	96.7
9	Households with age-eligible teens or infants—eligibility rate (row 9/row 7)	6,549	10.2	3.3
10	Households with age-eligible teens or infants with completed household interviews—interview completion rate (row 10/row 9)	5,481	83.7	82.8
11	CASRO response rate (row 5 × row 7 × row 10)	NA	56.2	61.8
12	Households completing health insurance module (row 12/row 10)	4,356	79.7	NA

^aTelephone numbers considered to be actual working numbers

NIS = National Immunization Survey

NA = not applicable

WRN = working residential number

CASRO = Council of American Survey Research Organizations

product of the resolution rate (82%, row 5), the screening completion rate (81%, row 7), and the interview completion rate among households with age-eligible adolescents (84%, row 10). The resolution rate is the percentage of the phone numbers released that were determined to be actual telephone numbers; whether they were nonworking, non-residential, or residential numbers. The screening completion rate is the percentage of households in which contacts were made and successfully screened for an age-eligible adolescent. The interview completion rate is the percentage of households with at least one age-eligible adolescent that completed the NIS-Teen household survey.

Response rates for the 2006 NIS for infants were different from rates for the NIS-Teen (Table 1). The percentage of households screened for the presence of an age-eligible infant aged 19–35 months was 91% (vs. 81% in the NIS-Teen). The percentage of households with age-eligible infants was 3% (vs. 10% in the NIS-Teen). The CASRO response rate for the 2006 NIS for infants was 62% (vs. 56% in the NIS-Teen). For another comparison, the NHIS data showed that the overall percentage of households with an age-eligible adolescent aged 13–17 years was 14% in 2006. Among households with a landline telephone, 15% had an adolescent; and among households without a telephone, 9% had an adolescent.

PRC

Indicators for the PRC phase of the NIS-Teen module are shown in Table 2, in rows 13–27. The number of parents or guardians who completed the household survey was 5,468 (row 12); of these 5,468 parents/guardians, 4,192 (77%, row 13) gave consent to contact vaccination providers. Of these, 65% of adolescents had a single identified provider (row 16) and 35% had two or more providers (row 20). Of adolescents with a single provider identified, 96% had a single IHQ mailed to the provider (row 17) and 90% of these adolescents had the provider return the IHQ (row 18). Of adolescents with two or more providers, 87% had an IHQ mailed to all identified providers (row 21) and 77% of these adolescents had all providers return the IHQ (row 22). In summary, of 4,192 adolescents for whom consent was obtained to contact vaccination providers, 3,888 adolescents (93%, row 24) had at least one provider identified and all identified providers were mailed an IHQ. However, of this number, 3,333 adolescents (86%, row 25) had all IHQs returned from the providers. In total, the number of IHQs that were mailed to providers was 5,851 (row 26), with 5,220 (89%, row 27) returned.

Adequate provider data

We received adequate provider data to determine provider-reported vaccination coverage for 53% ($n=2,882$) of adolescents with completed household interviews. This number was lower than the infant NIS (70%). In our sample, 4,192 households gave consent to contact adolescents' immunization providers. Of households consenting, 3,888 (93%) had IHQs mailed to all providers and, of these, 3,333 (86%) had all IHQs returned. Only 82% contained an immunization history, which was lower than the infant NIS, in which 93% of children with at least one IHQ returned had at least one IHQ containing an immunization history.

Returned immunization histories must have met certain criteria to be considered adequate. If an adolescent had more than one provider return an IHQ, multiple IHQs were merged to create a synthesized provider immunization history consisting of an array of consecutive shot dates and subtypes for each vaccine category. We also created an immunization history from the household-reported information and used a process to compare the household-reported information with the synthesized provider immunization history to determine if it was adequate.

In determining the number of adolescents with adequate provider data, we first identified zero-shot adolescents. These are adolescents who either had (1) no household-reported vaccinations or no vaccination providers identified or (2) no household-reported vaccinations, one or more providers identified, all the identified providers responded, and no provider-reported vaccinations. In our sample, we identified 16 respondents as zero-shot adolescents.

Second, we used criteria to compare the household-reported immunization histories to the synthesized provider immunization histories for each adolescent. If an adolescent had a synthesized provider immunization history in which s/he had completed the 1:3:2:1 vaccine series (≥ 1 dose of Td or Tdap after age 7 years, ≥ 3 doses of HepB, ≥ 2 doses of MMR, and ≥ 1 dose of VAR), we considered her/him to have adequate provider data, regardless of the household-reported immunization history. Even if s/he had received additional immunizations by the household report that did not appear in the synthesized provider immunization history, these additional immunizations would not change the adolescent's status of having adequate provider data.

Additionally, if the synthesized provider immunization history showed that the adolescent had not completed the 1:3:2:1 vaccine series, we still considered him/her to have adequate provider data as long

Table 2. Indicators for the provider phase of fourth-quarter 2006 NIS-Teen 2006 and NIS 2006 data collection

Row	Key indicator	NIS-Teen N	NIS-Teen Percent	NIS Percent
12	Total households (with adolescents) completing household survey	5,468		
13	Households with adolescents and infants with consent to contact vaccination providers (row 13/row 12)	4,192	76.7	81.0
14	Households with adolescents and infants with consent and ≥ 1 IHQ mailed (row 14/row 13)	4,062	96.9	97.9
15	Households with adolescents and infants with consent and no IHQ mailed (row 15/row 13)	130	3.1	2.1
16	Households with adolescents and infants with single provider identified (row 16/row 13)	2,706	64.6	75.8
17	Households with adolescents and infants with single IHQ mailed to single provider identified (row 17/row 16)	2,607	96.3	97.7
18	Households with adolescents and infants with single provider identified who returned the IHQ (row 18/row 17)	2,352	90.2	95.1
19	Households with adolescents and infants with single provider identified who did not return the IHQ (row 19/row 17)	255	9.8	4.9
20	Households with adolescents and infants with ≥ 2 providers identified (row 20/row 13)	1,480	35.3	24.0
21	Households with adolescents and infants with ≥ 2 providers and IHQs mailed to all providers (row 21/row 20)	1,281	86.6	93.6
22	Households with adolescents and infants with ≥ 2 providers, IHQs mailed to all providers, and all IHQs returned from all providers (row 22/row 21)	981	76.6	87.3
23	Households with adolescents and infants with multiple providers identified and not all returned valid IHQ (row 23/row 21)	300	23.4	12.7
24	Households with adolescents and infants with ≥ 1 provider, IHQs mailed to all providers identified (row 24/row 13)	3,888	92.8	96.4
25	Households with adolescents and infants with ≥ 1 providers, IHQs mailed to all providers and all IHQs returned (row 25/row 24)	3,333	85.7	90.0
26	IHQs mailed to providers	5,851	NA	NA
27	IHQs returned from providers for NIS-Teen and NIS (row 27/row 26)	5,220	89.2	94.5

NIS = National Immunization Survey

IHQ = immunization history questionnaire

NA = not available

as the household-reported immunization history did not contain more immunizations than the synthesized provider immunization history. This could occur if (1) an immunization card was used by the household and the number of shots in the synthesized provider immunization history was less than the number of shots reported from the immunization card for any of the following vaccine categories: diphtheria-tetanus-pertussis (DTP), hepatitis B-containing (HEPB), hepatitis A-containing (HEPA), measles-containing (MCV), and varicella-containing (VRC) (213 adolescents met this criteria) or (2) an immunization card was not used by the household, but the household reported that the adolescent had received all recommended vaccines in any of the vaccine categories (DTP, HEPB, HEPA, MCV,

and VRC) and the synthesized provider history contained less than two unique shot dates (19 adolescents met this criteria). Subtracting these 232 cases from our sample of 3,098 adolescents with at least one IHQ returned containing an immunization history left 2,866 adolescents with immunization histories and adequate provider data. Adding the 16 zero-shot adolescents to this number gave the final sample of 2,882 adolescents with adequate provider data.

STATISTICAL METHODS

We weighted NIS-Teen data using similar procedures to the infant NIS.¹¹ We computed the base sampling weights within each NIS sampling area as defined in

the fourth quarter of 2006. We made adjustments step-by-step to produce a final weight. We made adjustments for (1) non-resolution of released telephone numbers, (2) nonresponse to age-eligibility screener questions, (3) subsampling of one age-eligible child per household, (4) interview nonresponse, and (5) presence of multiple telephone lines in the household. After these five steps produced a weight, we made post-stratification adjustments for noncoverage of non-landline telephone households and for differential telephone coverage rates, taking into account (1) race/ethnicity of the child's mother (Hispanic, non-Hispanic black only, all other), (2) educational attainment of the child's mother (<grade 12, grade 12, >grade 12 non-college graduate, and college graduate), and (3) age of child (13–14 years and 15–17 years).

We conducted raking adjustments on each variable using a proportional adjustment to the current weights of the adolescents from each stratum. Raking adjusts the final weights to the control totals to ensure national representativeness. Variables used in raking in the NIS-Teen included the child's race/ethnicity (Hispanic, non-Hispanic black only, all other), education of the adolescent's mother (<grade 12, grade 12, >grade 12), age category (13–14 years and 15–17 years), gender (male and female), true state of residence (true state), and telephone status. We produced a household-phase weight (RDD-weight) after this first raking. We further adjusted the household-phase weights for missing provider data followed by a final raking adjustment to produce the provider-phase weights (provider weight). Because provider-reported vaccinations are used to determine coverage estimates, we estimated coverage rates using provider-phase weights only. Further details can be found in previously published articles about the NIS methodology.¹²

ASSESSING REPRESENTATIVENESS OF THE NIS-TEEN: COMPARING HOUSEHOLDS WITH AND WITHOUT ADEQUATE PROVIDER DATA

Because we used only data for adolescents who had adequate provider data to determine vaccination coverage estimates, we compared households with adequate provider data to households not consenting to contact vaccination providers, households without adequate provider data, and all households to ensure the representativeness of the survey. In Table 3, non-consenting households did not differ significantly from consenting households that had adequate provider data. However, consenting households without adequate provider data compared with consenting households with adequate provider data were more likely to have a foreign-born

adolescent, have a mother with less than a high school education, have a never-married mother, live below the Federal Poverty Level, live in an urban area (metropolitan statistical area), live in the West as opposed to the Northeast, and have no health insurance or no private health insurance.

Because of the differences between households with and without adequate provider data, and to ensure representativeness of the survey, we weighted results with the provider-phase weights as described previously to adjust the percentages of adolescents with adequate provider data closer to the overall sample with completed household records. This adjustment is shown in Table 3.

DISCUSSION

In 2006, CDC conducted the first NIS-Teen, a survey designed to monitor national health status indicators and vaccination coverage estimates for adolescents aged 13–17 years. The NIS-Teen collected provider-reported vaccination histories to determine vaccination coverage estimates, a method that is more accurate than parental report of vaccinations either by reporting from immunization cards or by parental recall. Additionally, by collecting dates of vaccination from provider immunization histories, age of vaccine receipt can be determined, which can give information to immunization programs to monitor their progress in promoting vaccination among adolescents. The NIS-Teen also collected household information such as family income level, family size, and health insurance status, which can be used to estimate the population eligible for Vaccines for Children, an entitlement program for children 0–18 years of age.¹³

The infant NIS has been conducted since 1994, and its methodology has been well-established in determining vaccination coverage estimates for children aged 19–35 months. In developing the NIS-Teen, we used a similar methodology to ensure the representativeness of the survey with the national population. Efforts to validate data from the NIS include comparing it with other immunization data sources. For example, most states have immunization information systems (IISs), which also collect vaccination information from providers. In 2006, it was reported that 47 grantees (84%) maintained vaccination data in their IIS for people aged 11–18 years. Approximately 22.3 million adolescents (66%) had two or more vaccinations recorded. Additionally, participation in the IIS is not complete in some states.¹⁴ The quality and completeness of the registry data must be improved and must be comparable across all states before consideration can be given to

Table 3. Comparison of households with and without consent and with and without adequate provider data, by certain characteristics, National Immunization Survey-Teen 2006

Characteristic	Households without consent Percent (SE) n=1,276	Households with consent, but without adequate provider data Percent (SE) n=1,314	Households with consent and adequate provider data Percent (SE) n=2,882	All households Percent (SE) n=5,468	Households with consent and adequate provider data-weighted ^a Percent (SE) n=2,882
Parental report of receipt of vaccine: ^b					
≥3 doses of hepatitis B	69.5 (±1.6)	70.2 (±1.6)	72.4 (±1.0)	71.2 (±0.8)	72.3 (±1.1)
≥2 doses of MMR	90.4 (±1.0)	89.3 (±1.1)	92.6 (±0.6)	91.3 (±0.5)	92.8 (±0.6)
≥1 dose of Td or Tdap	61.6 (±1.7)	62.2 (±1.7)	65.2 (±1.1)	63.7 (±0.8)	65.1 (±1.2)
1 dose of MCV4	8.8 (±1.0)	8.9 (±1.0)	10.4 (±0.7)	9.7 (±0.5)	10.6 (±0.7)
Adolescent born in U.S.					
Yes	95.0 (±0.8)	90.9 (±1.0)	96.2 (±0.5)	94.6 (±0.4)	95.5 (±0.5)
No	5.0 (±0.8)	9.1 (±1.0) ^c	3.8 (±0.5) ^d	5.4 (±0.4)	4.5 (±0.5)
Mother's marital status					
Married	72.9 (±1.6)	68.8 (±1.7)	72.6 (±1.1)	71.7 (±0.8)	71.6 (±1.1)
Widowed/separated/divorced	19.8 (±1.4)	20.6 (±1.5)	20.7 (±1.0)	20.5 (±0.7)	21.1 (±1.0)
Never married	7.3 (±1.0)	10.5 (±1.2) ^c	6.8 (±0.7) ^d	7.8 (±0.5)	7.4 (±0.7)
Mother's education status					
<High school	12.2 (±1.2)	24.7 (±1.6) ^c	13.8 (±0.9) ^d	16.2 (±0.7)	15.2 (±1.0)
≥High school	87.8 (±1.2)	75.3 (±1.6)	86.2 (±0.9)	83.8 (±0.7)	84.8 (±1.0)
Income/poverty ratio					
Above poverty/≥\$75,000	31.8 (±1.7)	25.4 (±1.4)	32.9 (±1.1)	30.8 (±0.8)	32.0 (±1.1)
Above poverty/<\$75,000	53.3 (±1.9)	51.3 (±1.8)	49.9 (±1.2)	51.0 (±0.9)	49.6 (±1.2)
Below poverty	14.9 (±1.5)	23.3 (±1.7) ^c	17.2 (±1.0) ^d	18.3 (±0.7)	18.4 (±1.1)
MSA					
Central city	36.1 (±1.6)	44.1 (±1.7) ^c	36.3 (±1.1) ^d	38.2 (±0.8)	38.0 (±1.1)
Non-central city	50.1 (±1.7)	41.3 (±1.7)	44.5 (±1.1)	44.9 (±0.8)	45.1 (±1.1)
Non-MSA	13.8 (±1.2)	14.7 (±1.2)	19.2 (±0.9)	16.9 (±0.6)	16.8 (±0.8)
Region					
Northeast	20.9 (±1.3)	12.9 (±1.2) ^d	18.8 (±0.7) ^c	17.8 (±0.4)	17.8 (±0.5)
Midwest	21.7 (±1.3)	20.2 (±1.3)	23.7 (±0.8)	22.4 (±0.4)	22.3 (±0.5)
South	35.7 (±1.5)	37.8 (±1.5)	35.4 (±0.9)	36.1 (±0.4)	36.1 (±0.5)
West	21.6 (±1.3)	29.2 (±1.4) ^c	22.1 (±0.8) ^d	23.8 (±0.4)	23.7 (±0.5)
Health insurance status ^e					
Private	73.3 (±4.0)	54.9 (±1.8) ^c	66.2 (±1.1) ^c	63.0 (±0.9)	64.0 (±1.2)
Public	19.1 (±3.7)	31.5 (±1.7)	26.9 (±1.1)	28.0 (±0.9)	28.4 (±1.1)
Uninsured	7.6 (±2.1)	13.8 (±1.3) ^c	6.9 (±0.6) ^d	9.0 (±0.6)	7.6 (±0.7)

^aUsing weights based on provider response (provider phase weights)

^bParental report of vaccine receipt based on immunization card information and parental recall of vaccination

^cSignificantly greater than the percentage of households with consent and adequate provider data column in this characteristic group by Chi-square or t-test

^dSignificantly less than the percentage of households with consent, but without adequate provider data in this characteristic group by Chi-square or t-test

^eUsing health insurance module weights, as only 4,356 households completed the health insurance module

SE = standard error

MMR = measles-mumps-rubella vaccine

Td = tetanus toxoid-diphtheria vaccine

Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine

MCV4 = meningococcal conjugate and meningococcal-unknown type vaccine

MSA = metropolitan statistical area

supplement or replace provider-reported data in the NIS.¹⁵ The NHIS is another data source of vaccination information, and further research is being conducted comparing the NIS-Teen with this face-to-face household survey.^{16,17}

Limitations

The NIS-Teen has limitations in its design. Because it is a telephone survey, nonresponse can occur from households that choose not to participate and noncoverage can occur with households that use only cellular telephones. Data from the NHIS show that cellular-only households differ slightly from landline households.^{18,19} Further research is needed to understand what bias this contributes to the NIS-Teen. Plans to conduct a PRC on a sample from the NHIS and adding a cellular-phone sampling frame to the NIS are being considered.

The number of adolescents who had adequate provider records was low and reflects that adolescents typically have more than one vaccination provider. Some parents may not have remembered all providers or some providers were unreachable or did not have the adolescents' complete immunization records. In particular, vaccinations administered at nontraditional sites, such as teen clinics or sexually transmitted disease clinics, may have been missed if they were not recorded in the providers' records, underestimating coverage levels. Lastly, compared with data collection in the infant NIS, the NIS-Teen had lower rates of obtaining consent to contact vaccination providers. This issue will need to be addressed in future surveys.

CONCLUSION

In 2007, the NIS-Teen was repeated with enhanced questions. To better capture all vaccination providers adolescents may have visited, parents and guardians were asked to recall all providers and locations whereby the adolescent may have received vaccinations and were specifically asked if the adolescent had received Td, Tdap, or influenza vaccines at nontraditional sites. Parents were also asked if a provider had recommended the new vaccines—Tdap, MCV4, and HPV vaccines—for their adolescent. In 2008, the NIS-Teen was expanded to collect data in all 50 states and six urban area grantee level estimates. The NIS-Teen will be conducted annually and additional modules may be added, such as a parental concerns module regarding vaccine safety or a socioeconomic status module regarding additional factors related to poverty.

The 2008 NIS-Teen guided states in developing and implementing their adolescent vaccination programs with state- and local-level vaccination coverage estimates

that build upon the previously released national coverage estimates.^{20,21} Additionally, the larger sample size provided with the 2008 data can be used to determine vaccination uptake by race/ethnicity, socioeconomic status, and specific geographic area. Monitoring adolescent vaccination coverage is important to follow progress in vaccinating adolescents as more programs are being developed for adolescent vaccinations, state laws are being proposed for middle school entry, and interest in preventing vaccine-preventable diseases among adolescents increases. Because states do not have a reliable data source for vaccination information, the NIS-Teen is filling that need during this rapidly changing time of adolescent vaccination.

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