National Immunization Survey-Teen (NIS-Teen): Revised definition of adequate provider data

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Morbidity Mortality Weekly Report published the 2014 NIS-Teen vaccination coverage estimates. All coverage estimates are based on provider-reported vaccination histories from adolescents with adequate provider data (APD). **The definition of adequate provider data used for 2014 NIS-Teen estimates changed from previous years. This revised adequate provider data definition affects vaccination coverage estimates.** This report describes the impact of this definition change on vaccination coverage estimates. To measure this impact, the revised adequate provider data definition was applied to 2006-2013 NIS-Teen data. Revised vaccination coverage estimates were calculated and compared to published estimates that used the previous adequate provider data definition.

Main findings of this report:

Starting in 2014, the NIS-Teen defined an adolescent's vaccination record as having adequate provider data if that adolescent had vaccination history data from one or more of the named vaccination providers or if the parent reported that the adolescent was completely unvaccinated. Prior to 2014, the adequate provider data definition had more criteria, and it was based on a comparison of provider report of vaccination history to parental report of vaccination history, either by shot card report or recall.

- A shorter NIS-Teen questionnaire resulted in a revised adequate provider data definition which impacted NIS-Teen vaccination coverage estimates.
- The 2013 NIS-Teen vaccination coverage estimates using the revised adequate provider data definition were different and generally lower than original 2013 NIS-Teen estimates which used the previous definition.
- Coverage estimates for vaccines routinely recommended in childhood (e.g., MMR, hepatitis B vaccines) decreased more than some of the vaccines routinely recommended in adolescence (e.g., HPV vaccine) (**Footnote 1**).
- Some states and local areas had larger percentage point decreases in vaccination coverage estimates than others. However, most of these changes were not significant.
- In general, the change in APD definition does not impact overall vaccination coverage trends.
- Beginning in 2014, NIS-Teen vaccination coverage estimates will use the revised definition and cannot be directly compared to previously published 2006-2013 NIS-Teen survey vaccination coverage estimates.

Introduction

The NIS-Teen was initiated in 2006 to obtain national level vaccination coverage estimates and was expanded in 2008 to provide state and selected local area estimates. The NIS-Teen is a two-phase random digit dial (RDD) survey of landline phones and, beginning in 2011, cell phones (i.e., a dual-frame survey). The first phase consists of a household interview with the adolescent's parent or guardian

during which sociodemographic information and some vaccination history data are collected. During the household interview, the responding parent/guardian is asked for the names of the adolescent's vaccination providers, and for consent to contact these providers. If consent is given, the second phase involves mailing an immunization history questionnaire (IHQ) to all of the adolescent's vaccination providers. The questionnaire is used to collect provider-reported vaccination history data, including names, dates, and types of vaccines administered. All NIS-Teen vaccination coverage estimates are based on this provider-reported data, as parental-reported vaccination status is subject to recall error (1, 2). Estimates reflect weighting adjustments for household and provider non-response and households without phones. Detailed weighting methods have been previously described (3).

Public health surveillance systems are modified to adapt to changes over time in the target populations, measured outcomes, and technology. For instance, in 2011, given the increasing proportion of cell-telephone-only households, NIS-Teen adopted a dual-frame landline and cell phone sampling design (4). Over recent years, RDD telephone surveys such as NIS-Teen have also been faced with declining response rates, which may increase non-response bias. Declining response rates impact survey costs, as more households need to be contacted to complete the target number of interviews. Telephone survey response rates are affected by multiple factors, including the length of the household interview. Respondent burden should be minimized by restricting data collection to information that is important for use in development of survey findings. In 2013, a shortened NIS-Teen household questionnaire was tested and resulted in an increase in the survey response rate and a decrease in the number of required calls (5). Based on these results the shorter NIS-Teen household questionnaire was implemented in 2014. NIS-Teen continued to include questions about influenza vaccination, vaccinations routinely recommended for adolescents (i.e., Tdap, MenACWY and HPV vaccines), and whether or not the adolescent had ever received a vaccine. All other specific questions about routine childhood vaccines such as MMR, varicella, hepatitis A and hepatitis B vaccines were removed from the telephone survey. The questions about these routine childhood vaccines were used primarily in determination of the adequacy of provider-reported vaccination data for the subset of respondents that reported information from parent-held vaccination records during the NIS-Teen household interview.

In 2014, following implementation of the shorter questionnaire, the NIS-Teen CASRO response rate (**Footnote 2**) for landlines was 60.3% and for cellphones was 31.2%, an increase from 51.1% (+9.2 percentage points) for landline sample and from 23.3% (+7.9 percentage points) for cellphone sample as compared with 2013 (5). The average household interview length decreased from 20.5 minutes for respondents using an immunization record and 16.2 minutes for other respondents to approximately 10 minutes for all respondents in 2014. The provider consent rate is defined as: of adolescents with a completed household interview, the proportion for whom consent to contact vaccination providers was given. The provider consent rate decreased from 68.3% in 2013 to 64.4% in 2014 (-3.9 percentage points) for the landline sample, and from 64.9% to 61.2% (-3.7 percentage points) for the cellphone sample.

CDC publishes NIS-Teen vaccination coverage estimates that are based on provider-reported vaccination histories for adolescents for whom the provider-reported data are considered to be adequate. Prior to 2014, to be classified as having APD, an adolescent had to meet at least one of the three criteria. The third criterion differed slightly depending on whether or not the parent/guardian had access to a "shot card" (i.e., documentation of the adolescent's immunization history) during the household interview. The three criteria were:

1) be up-to-date by provider report with ≥1 Td/Tdap, ≥3 hepatitis B, ≥2 MMR and ≥1 varicella vaccines (or parental or provider report of history of varicella disease); or

2) be completely unvaccinated by parental report; or

3) a) if a shot card was used: have no more doses of measles-containing, varicella, hepatitis A, hepatitis B and Td/Tdap vaccines by household report than by provider report; or b) if a shot card was not used: if a parent/guardian indicated that the adolescent had received "all" of his or her vaccinations in any of the measles-containing, varicella, hepatitis A or hepatitis B categories, have at least two unique vaccination dates by provider report.

With implementation of the shortened questionnaire, which eliminated household vaccination questions regarding childhood vaccines, the comparison of household and provider data was no longer possible, and required revision of the APD definition for the 2014 NIS-Teen survey. Beginning in 2014, any adolescent for whom one or more of the named providers report vaccination history data or who by parental report are completely unvaccinated will be classified as having adequate provider data. These adolescents will be included in the NIS-Teen sample and will contribute to vaccination coverage estimates.

The revision of the NIS-Teen APD definition has the potential to impact vaccination coverage estimates. By definition, the NIS-Teen sample will now include additional adolescents who are not up-to-date with ≥2 MMR, ≥1 Td/Tdap, ≥1 varicella, and ≥3 hepatitis B vaccines based on provider-reported vaccination history. Addition of these adolescents to the NIS-Teen sample could lower vaccination coverage estimates for these and other vaccines. CDC used NIS-Teen data to assess the impact of the revised APD definition on vaccination coverage estimates. This report provides an overview of documentation to facilitate public health partners' understanding of the impact of this definition change on vaccination coverage estimates nationally and within their jurisdictions. The differential impact of the definition change by sociodemographic characteristics at a national level will also be presented.

Methods

Several steps were taken to assess the impact of the revised adequate provider data definition on vaccination coverage estimates. The revised definition was applied retrospectively to NIS-Teen data from 2006-2013. Because this resulted in additional adolescents with adequate provider data under the revised definition that did not have adequate provider data by the previous definition, household-phase survey weights were used to assess the effect of the definition change on trends in vaccination coverage estimates across survey years. The conditional adequacy rate is defined as: of adolescents for whom consent to contact providers was given, the proportion for whom adequate provider data were available. Using 2013 NIS-Teen data only, the original conditional adequacy rate was compared to the revised conditional adequacy rate, at the national level overall and stratified by selected sociodemographic characteristics, and overall for states/local areas. For 2013 NIS-Teen data only, new provider-phase weights were created after adding the adolescents who would have APD under the revised APD definition to the analytic sample. This allowed a direct comparison of previously published 2013 vaccination coverage estimates with revised estimates that would have been obtained if the revised APD definition had been applied to the 2013 NIS-Teen data.

Revised 2013 coverage estimates and 95% confidence intervals (CI) were calculated for the following vaccines and doses at a national and state/local area level: ≥1 Td/Tdap, ≥1 Tdap, ≥1 MenACWY, ≥1 HPV, ≥2 HPV, ≥3 HPV, HPV 3-dose series completion, ≥2 MMR, ≥3 hepatitis B, ≥1 varicella, ≥2 varicella, ≥2 varicella or history of varicella disease, and history of varicella disease (**Footnote 1**). All HPV vaccination coverage estimates were calculated separately for female and male adolescents. Revised 2013 estimates and 95% CI were also calculated at a national level stratified by selected sociodemographic characteristics. Percentage point differences between all revised 2013 estimates and original 2013 estimates (published) were calculated (6). A descriptive analysis of

additional adolescents brought into the 2013 NIS-Teen sample with application of the revised APD definition was conducted, including calculation of estimated vaccination coverage and distribution of selected sociodemographic and provider characteristics among this group. T-tests were used to assess differences in sociodemographic and provider characteristics between the original 2013 NIS-Teen sample and the additional adolescents. Differences were considered statistically significant at $p<0.05$.

To examine the potential impact of the revised adequate provider data definition on vaccination coverage trends, national vaccination coverage estimates from 2006-2013 and state/local area vaccination coverage estimates from 2008-2013, using the revised and previous definitions, were recalculated for all the vaccines listed above using the household-phase weight, which adjusts for household non-response and phoneless households but not provider non-response, as a proxy for the provider-phase weight. Line graphs enabling visualization of trends in recalculated vaccination coverage estimates using revised and previous APD definitions over time by survey year from 2006-2013 were generated at a national level.

Results

Impact of definition change on NIS-Teen 2013 sample size and conditional adequacy rate

Applying the revised adequate provider data definition to NIS-Teen 2013 data led to the inclusion of 684 additional adolescents to the national sample, excluding territories. At a national level, the revised conditional adequacy rate was 88.0%, 3.2 percentage points higher than the original conditional adequacy rate (84.8%). Differences in conditional adequacy rate at the state/local area level ranged from +0.6 percentage points in Rhode Island to +7.9 percentage points in Utah (Table 1). Differences at a national level after stratifying by selected sociodemographic characteristics showed less variability than differences at a state/selected local area level (Table 2). The largest percentage point differences in conditional adequacy rate at a national level were seen among Hispanic adolescents (+3.7 percentage points) and adolescents whose mothers had less than high school (+3.6 percentage points) or some college education (+3.6 percentage points).

Characteristics of additional adolescents brought into the 2013 NIS-Teen sample

Of the 684 additional adolescents brought into the 2013 NIS-Teen sample with the revised APD definition, the weighted proportion who were up-to-date with selected vaccines was low compared with published 2013 NIS-Teen vaccination coverage estimates (6), which were based on adolescents who met the previous adequate provider data definition. For vaccines included in the previous adequate provider data definition criteria, only 31.5% of the 684 additional adolescents received ≥2 MMR doses, 39.3% received ≥3 hepatitis B doses, 58.7% received ≥1 varicella dose, and 51.5% received ≥1 Td/Tdap dose (Table 3). For other vaccines routinely recommended for adolescents, only 44.9% received ≥1 MenACWY dose, 40.9% of females received ≥1 HPV dose and 17.1% of males received ≥1 HPV dose.

Selected sociodemographic and provider response characteristics of the additional 684 adolescents are listed in Table 4. Compared with the original 2013 NIS-Teen sample, a higher proportion of the additional adolescents were Hispanic, from the West census region, had moved from their state of birth or were born in a foreign country, while a lower proportion were from the South or Northeast census regions. In addition, a higher proportion of the additional adolescents had 3 or more named vaccination providers or had multiple providers identified only some of whom returned valid immunization history questionnaires.

Impact of definition change on NIS-Teen 2013 vaccination coverage estimates

Differences between revised and published 2013 national level vaccination coverage estimates varied by vaccine. Differences between revised and published estimates ranged from -0.1 percentage points for HPV 3-dose series completion among males to -2.2 percentage points for ≥2 MMR doses (Table 5). Percentage point differences were larger for vaccines routinely recommended in childhood and included as criteria in the previous adequate provider data definition (e.g., MMR, varicella, hepatitis B vaccines) as compared to vaccines routinely recommended for adolescents (e.g., Tdap, MenACWY, HPV vaccines). At a national level, percentage point differences were greater than the margin of error (95% CI half-width) of the original estimates for ≥1 Td/Tdap, ≥1 Tdap, ≥1 MenACWY, ≥2 MMR, ≥3 hepatitis B, ≥1 varicella and ≥2 varicella; but were within the margin of error for all HPV vaccination coverage estimates. The impact of the revised APD definition was different by sociodemographic characteristics. Larger percentage point differences for most vaccines were seen among Hispanic adolescents, adolescents whose mothers had less than high school or some college education, and adolescents whose household income to poverty ratio was <1.33 or >4.0 (Table 6).

Differences between 2013 revised and original state/local area level vaccination coverage estimates varied by state/local area (Table 5). Median percentage point differences were slightly larger for vaccines routinely recommended in childhood (e.g., -1.5 for ≥2 MMR and -1.6 for ≥3 hepatitis B doses) compared to vaccines routinely recommended for adolescents (e.g., -0.8 for ≥1 MenACWY and ≥1 HPV dose in females and -0.9 for ≥1 Tdap) (Table 5). However, for vaccines routinely recommended for adolescents, some state/local areas were outliers with large absolute differences between revised and original estimates. These tended to be the same jurisdictions that had large absolute differences for childhood vaccines. In 2013, percentage point differences between revised and original estimates at a state/local area level ranged from 0.0 to -4.9 for ≥1 Tdap dose, +0.7 to -5.2 for ≥1 MenACWY dose, +1.6 to -4.2 for ≥1 HPV dose in females, +1.2 to -3.0 for ≥3 HPV doses in females, +1.7 to -4.2 for ≥1 HPV dose in males, +0.6 to -1.7 for ≥3 HPV doses in males, +0.1 to -5.1 for ≥2 MMR doses, 0.0 to -4.7 for ≥3 hepatitis B doses, and +0.5 to -4.6 for ≥2 varicella doses (Table 5). For ≥1 Tdap, ≥1 MenACWY, ≥2 varicella and all HPV vaccination coverage estimates, differences observed at a state/local area level were within the margin of error of the original estimates. However, a small number of states/local areas did see differences greater than the margin of error for ≥2 MMR, ≥3 hepatitis B and ≥1 varicella vaccination coverage estimates.

Impact of adequate provider data definition change on trends in vaccination coverage estimates

In evaluating temporal trends in recalculated national vaccination coverage estimates using the revised adequate provider data definition compared with the previous definition from 2006-2013, levels for recalculated estimates using the revised adequate provider data definition were lower than estimates based upon the previous definition, but the slope of the trend lines did not differ substantively from estimates using the previous adequate provider data definition. Trends for selected vaccines and doses are presented in Figures 1 through 17.

Conclusions

Results from this assessment demonstrate that the revised NIS-Teen adequate provider data definition will impact the level of vaccination coverage estimates, leading to a decrease in estimates for most vaccines nationally and at a state/local level. A larger impact was seen in particular states/local areas, among certain sociodemographic groups and for vaccines routinely recommended in childhood and included as criteria in the previous definition as compared with vaccines routinely recommended for adolescents. At a national level, differences between revised and original 2013 estimates were greater than the margin of error for the original estimates for Td/Tdap, MenACWY, MMR, hepatitis B and varicella vaccines while HPV vaccination coverage estimates were not as affected. Only a few states had

differences for MMR, hepatitis B and varicella vaccination coverage estimates greater than the margin of error for the original estimates, however, due to smaller sample size state/local-level margins of error are larger than for national level estimates. Despite differences in vaccination coverage estimates, trends over time in vaccination coverage were similar. Vaccination coverage estimates decreased because of the inclusion of additional adolescents who as a group were less likely to be up-to-date with most vaccines by provider report than adolescents previously included in the NIS-Teen sample. These adolescents could have incompletely ascertained provider-reported vaccination histories, or might truly be under-vaccinated.

Vaccination record scattering can occur when an individual has more than one vaccination provider, each of which may have only partial vaccination history for that individual. Previous analyses of NIS data have shown that factors associated with record scattering among providers, which could lead to a greater likelihood of under-ascertainment of vaccination history, overlap with factors associated with lower childhood vaccination coverage, such as child's race/ethnicity and household income (7). The impact of record scattering on vaccination coverage estimates among adolescents has not been previously explored. However, record scattering is likely to be larger among adolescents than among children, particularly for vaccines administered in childhood. With more years having elapsed since receipt of childhood vaccines, adolescents may move to new vaccination providers due to family relocation, closure of provider practices, change in insurance, or other factors; or parents may have difficulty recalling the names and contact information of remote historical providers. This may increase the potential for loss of vaccination records. In recent years, inclusion of childhood immunization data in immunization information systems (IIS) has grown (8). These population-based computerized databases record all immunization doses given by participating providers to individuals within a specific jurisdiction. Over time, use of IIS may mitigate some of this potential vaccination record loss. However, IIS vary by state/local area in their maturity, population coverage, and provider participation (8). In a recent analysis of 2012 NIS-Teen data, 51.5% of adolescents had one or more providers obtain vaccination information from IIS (9). Further exploration of record scattering in NIS-Teen, and differential reporting to, or use of IIS information in completion of the IHQ by providers may improve our understanding of this impact.

Certain states/local areas had larger increases in the conditional adequacy rate with application of the revised adequate provider data definition. These jurisdictions also tended to have larger percentage point differences between revised and previous 2013 NIS-Teen vaccination coverage estimates. The differential impact of the definition change across states/local areas may be due in part to random variation but may also be due to various factors known to be associated with vaccination coverage. Differences in sociodemographic characteristics of the state/local area population could lead to a higher proportion of adolescents being under-vaccinated, or be more likely to have immunization record scattering and provider under-reporting. There also may have been differential provider non-response by state/local area. Population mobility, particularly if adolescents have moved from their state or country of birth, could also lead to under-ascertainment of provider immunization records. At a national level, additional adolescents brought into the sample using the revised adequate provider data definition were more likely to have moved from their birth state, be foreign-born, or have 3 or more vaccination providers than adolescents in the original sample.

This analysis has at least two limitations. First, recalculated vaccination coverage estimates using the household-phase weight for 2006-2013 trend analyses were not adjusted for provider non-response, so may be biased. Second, small sample size precluded calculation of revised 2013 estimates stratified by sociodemographic characteristics and analysis of vaccination coverage or sociodemographic characteristics of the additional adolescents added to the 2013 NIS-Teen sample with the revised adequate provider data definition at a state/local area level.

In summary, beginning with 2014 NIS-Teen, published vaccination coverage estimates will use the revised adequate provider data definition. Given the potential differences described above, immunization programs and other public health partners should be aware that 2014 NIS-Teen vaccination coverage estimates, using the revised definition, and those previously published for 2006-2013 NIS-Teen survey years, which used the previous adequate provider data definition, are not directly comparable. The difference between 2013 revised and published estimates described in this report demonstrates the impact of the definition change on vaccination coverage estimates. Changes in vaccination coverage between the 2013 and 2014 NIS-Teen will be best measured by comparing revised 2013 and 2014 estimates, both which use the revised adequate provider data definition.

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Footnotes

Footnote 1: Vaccine abbreviations used in this report are: Td = Tetanus, reduced diphtheria toxoid; Tdap = Tetanus, acellular pertussis and reduced diphtheria toxoid; MenACWY = meningococcal conjugate; HPV = human papillomavirus; MMR = measles, mumps, rubella. Vaccination coverage

estimates with the following vaccines and doses are abbreviated as follows: ≥1 Td/Tdap = ≥1 dose Td or Tdap vaccine at or after age 10 years; ≥1 Tdap = ≥1 dose Tdap vaccine at or after age 10 years; ≥1 MenACWY = ≥1 dose MenACWY or meningococcal-unknown type vaccine; ≥1, ≥2 or ≥3 HPV = ≥1, ≥2 or ≥3 HPV vaccine doses, either quadrivalent or bivalent; HPV 3-dose series completion = of those adolescents receiving ≥1 HPV doses, the percentage that had ≥24 weeks between first HPV vaccine dose and NIS-Teen interview (i.e., had enough time to complete the vaccine series) and received ≥3 HPV vaccine doses; ≥2 MMR = ≥2 doses MMR or measles-containing vaccine; ≥3 hepatitis B = ≥3 hepatitis B vaccine doses; ≥1 varicella = ≥1 varicella vaccine dose among adolescents with no varicella disease history by parental/provider report; ≥2 varicella = ≥2 varicella vaccine doses among adolescents with no varicella disease history.

Footnote 2: The CASRO response rate is the product of three other rates: 1) the resolution rate (the proportion of telephone numbers that can be identified as either for business or residence), 2) the screening rate (the proportion of qualified households that complete the screening process), and 3) the cooperation rate (the proportion of contacted eligible households for which a completed interview is obtained).