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# Using Electronic Health Records to Conduct Children's Health Insurance Surveillance

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## Abstract

**OBJECTIVE—**Health insurance options are changing. Electronic health record (EHR) databases present new opportunities for providers to track the insurance coverage status of their patients. This study demonstrates the use of EHR data for this purpose.

**METHODS—**Using EHR data from the OCHIN Network of community health centers, we conducted a retrospective cohort study of data from children presenting to a community health center in 2010–2011 ($N = 185\,959$). We described coverage patterns for children, used generalized estimating equation logistic regression to compare uninsured children with those with insurance, and assessed insurance status at subsequent visits.

**RESULTS—**At their first visit during the study period, 21% of children had no insurance. Among children uninsured at a first visit, 30% were uninsured at all subsequent visits. In multivariable analyses (including gender, age, race, ethnicity, language, income, location, and type of clinic), we observed significant differences in the characteristics of children who were uninsured as compared with those with insurance coverage. For example, compared with white, non-Hispanic children, nonwhite and/or Hispanic children had lower odds of being uninsured than having Medicaid/Medicare (adjusted odds ratio, 0.73; 95% confidence interval: 0.71–0.75) but had higher odds of being uninsured than having commercial insurance (adjusted odds ratio, 1.50; 95% confidence interval: 1.44–1.56).

**CONCLUSIONS—**Nearly one-third of children uninsured at their first visit remained uninsured at all subsequent visits, which suggests a need for clinics to conduct insurance

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Dr Hatch conducted all analyses and wrote the first draft; Ms Angier assisted with analysis planning and contributed substantial edits; Dr Marino oversaw the statistical analyses and contributed substantial edits; Drs Heintzman and Nelson contributed substantial edits; Dr Gold helped conceive of the study and contributed substantial edits; Ms Vakarcs pulled the data set from the electronic health record; Dr DeVoe conceived of the study, assisted with analysis planning, and contributed substantial edits; and all authors approved the final manuscript as submitted.
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surveillance and develop mechanisms to assist patients with obtaining coverage. EHRs can facilitate insurance surveillance and inform interventions aimed at helping patients obtain and retain coverage.

**Keywords**

electronic health records; insurance; health; children

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Stable health insurance coverage facilitates access to health care.[–] Policies implemented under the Children's Health Insurance Program (CHIP) expanded coverage options for children in the United States,[–] yet millions of US children remain uninsured or experience frequent gaps in coverage.[–] Parents report barriers to accessing public insurance programs for their children, including uncertainty about a child's coverage eligibility and status.[,] The same barriers may be faced by other populations who become eligible for new coverage under the 2009 Patient Protection and Affordable Care Act, known as the Affordable Care Act (ACA). Thus, it will be important to track coverage for these populations and to identify new data sources that can provide the information needed for tracking insurance status and coverage patterns. Many persons who will be affected by CHIP and ACA insurance expansions are patients of community health centers (CHCs).[,] In this article, we demonstrate secondary usage of electronic health records (EHRs) as an emerging data source for health insurance surveillance by CHCs and other primary care providers to track patients' insurance coverage status and to identify patients most likely to benefit from outreach and support to obtain and maintain coverage.

We conducted a retrospective cohort study to describe the population of children served by 44 CHCs in 7 states during a 2-year period (January 1, 2010–December 31, 2011), and to assess characteristics associated with children presenting to a CHC with no insurance. We then used a nested cohort design to identify trends in insurance status over time for children with more than 1 visit during the study period.

# METHODS

## Data Source

In 2001, a group of Oregon CHCs partnered to form a member-based, nonprofit collaborative. This unique organization, originally called the Oregon Community Health Information Network (renamed "OCHIN" as other states joined), was created to facilitate the implementation of EHRs in CHCs. OCHIN now has CHC members in 13 states with >300 primary care clinics, and >3300 clinicians caring for >1 500 000 patients. All member clinics share OCHIN's fully integrated EHR, which is built on EpicCare Systems software (Epic, Verona,Wisconsin), with a practice management data system (claims, billing, scheduling) and a full electronic medical record.

Using EHR data from the OCHIN, we identified a retrospective cohort of all children (ages 0–18 years) who visited an OCHIN site during the 2-year study period. For this cohort, we obtained EHR data from visits occurring during the study period, including the following: (1) self-reported demographic characteristics routinely collected on patient registration forms at most CHCs (age, gender, household income, race, ethnicity, and preferred language); (2) health center information such as location and clinical setting; and (3) patient insurance status. For patient-level variables, we used information from each individual's first visit to a CHC in the OCHIN network during the study period. Because we had visit-level data from each visit at an OCHIN site, we were also able to represent summative total visits, per person, throughout the study period. We created the EHR research data set by using structured query language to extract all relevant data out of EpicCare's Clarity data warehouse. We then imported this aggregate data set into Stata IC 11.0; all analyses were performed by using Stata (Stata Corp, College Station, TX).

## Variables

Health insurance status was the primary dependent variable. Health insurance status was based on information from each visit and categorized as uninsured, Medicaid/Medicare, and "commercial" (non-Medicaid, non-Medicare insurance). If a child had more than 1 payer at a visit, only the primary payer was assessed. Based on the Aday and Andersen behavioral model of health care utilization,[–] we selected the following covariates that were conceptualized as potentially influencing insurance coverage and utilization of CHC services: gender, age, race, ethnicity, language, income, rural/urban health center location, and whether the visit took place at a school-based health center (SBHC).

## Study Population and Inclusion Criteria

There were 185 989 children seen within the OCHIN system during the study period. To maximize inclusion and provide reliable measures of association, our criteria excluded as few children as possible. We excluded 14 children who had >100 visits recorded, another 14 with missing information on gender, and 2 with missing information on health center location. In total, we excluded only 30 children (0.2%) from our analyses (remaining study population $n = 185\ 959$ children). If covariates were missing data for >1% of the population (race/ethnicity, language, and income), we included a "missing data" category in the multivariable analyses.

## Analyses

We described characteristics for all children in the study population and assessed participant-specific data from each child's first visit within the OCHIN system during the study period. We evaluated the distribution and descriptive statistics of the number of CHC visits made by children in the study population during the study period. We analyzed the relationship between insurance status and the covariates of interest by using univariable and multivariable generalized estimating equation logistic regression models to account for the total number of visits nested in the 185 959 children. An exchangeable correlation structure was assumed where visits were clustered within subjects and subjects within clinics. A robust sandwich estimator was applied to account for possible misspecification of the correlation structure. Finally, we examined changes in children's insurance over time by using graphical methods. This study was approved by the institutional review board at our academic institution.

## RESULTS

Table 1 illustrates demographic information for the 185 959 children in the study population, based on data collected at each child's first visit to a health center in the OCHIN Network in the 2-year study period. Children were evenly distributed across age strata. Approximately 71% identified as white, 41% identified as Hispanic, and 31% identified Spanish as their primary language. Over half had household incomes below the federal poverty level. Over three-fourths (78%) were seen in urban areas. Most visits were in community primary care clinics (88%), as compared with SBHCs (12%). More visits occurred among children who were <5 years old, Hispanic, from non-English speaking households, and receiving Medicaid (data not shown). During the 2-year study period, the population had a total of 880 268 visits. The study cohort of children had a median of 3 visits and an interquartile range of 1 to 6 with a negative logarithmic pattern of distribution (Fig 1). Most children (95%) had between 1 and 15 visits over the 2-year period.

As shown in Table 2, uninsured children seen in this network of CHCs were demographically different from children with Medicaid/Medicare and commercial insurance. An estimated 19% of 0 to 14 year olds were uninsured; 29% of children aged 15 to 18 years of age were uninsured. Approximately 18% nonwhite and/or Hispanic children were uninsured, compared with 24% of white, non-Hispanic children; and 17% of children who spoke a language other than English were uninsured, compared with 20% who spoke English.

At their first visit, 21% of children were uninsured, 12% had commercial insurance, and 67% had Medicaid (Table 1, Fig 2). Of the 38 726 children with no insurance at their first visit, 30% were uninsured at all subsequent visits during the study period, 19% gained Medicaid for at least 1 subsequent visit, 4% gained commercial insurance for at least 1 subsequent visit, and 47% had no further visits within the OCHIN system. Of the 124 113 children with Medicaid at their first visit, 72% had insurance (any type) for every subsequent visit, 4% were uninsured for at least 1 subsequent visit, and 24% had no further visits within the OCHIN system. Of the 23 120 children with commercial insurance at their first visit, 53% had insurance (any type) for every subsequent visit, 5% were uninsured at a subsequent visit, and 42% had no further visits within the OCHIN system (Fig 2).

In multivariable analyses (including gender, age, race, ethnicity, language, income, location, and type of clinic), we observed significant differences in the characteristics of children who were uninsured as compared with those with insurance coverage (Table 3). Compared with younger kids, children 15 to 18 years of age had higher odds of being uninsured than having Medicaid/Medicare coverage (adjusted odds ratio [aOR], 1.87; 95% confidence interval [CI]: 1.82–1.92), but they had lower odds of being uninsured than having commercial coverage (aOR, 0.81; 95% CI: 0.78–0.84). Compared with white/non-Hispanic children, those who identified as nonwhite and/or Hispanic had lower odds of being uninsured than having Medicaid/Medicare coverage (aOR, 0.73; 95% CI: 0.71–0.75), but they had higher odds of being uninsured than having commercial insurance (aOR, 1.50; 95% CI: 1.44–1.56). Compared with children from urban areas, those from rural areas had lower odds of being uninsured than having either Medicaid/Medicare coverage (aOR, 0.89; 95% CI: 0.87–0.92) or commercial insurance (aOR, 0.22; 95% CI: 0.21–0.23). Compared with children seen at non-SBHCs, children seen at SBHCs had higher odds of being uninsured than having either Medicaid/Medicare (aOR, 3.39; 95% CI: 3.28–3.50) or commercial insurance (aOR, 1.06; 95% CI: 1.01–1.10).

# DISCUSSION

Health insurance status facilitates or hinders access to care for patients. This study demonstrates how health care systems can use their EHR data to better understand insurance coverage patterns among their patient populations. Certain patient characteristics were significantly associated with whether a child had insurance coverage at a CHC visit. Such information can help CHCs and other clinics providing health care to vulnerable populations better focus their insurance outreach efforts on patients most at risk for uninsurance. Conducting this type of surveillance will become increasingly important as insurance coverage options expand with health care reform legislation, such as the CHIP and the ACA. Further, the Health Information Technology for Economic and Clinical Health Act, which incentivizes increased adoption and use of EHRs in health care systems across the country, will increase the impetus for CHCs to conduct this type of surveillance.

In this study population, several patient characteristics were significantly associated with being uninsured, as compared with having Medicaid/Medicare coverage or commercial insurance, at a given CHC visit. Some of our findings confirm previous research (eg, the higher odds of being uninsured versus publicly insured at a visit among children aged 15 to 18 years, compared with children <15 years). Other findings reported here differed from previous reports; for example, we found racial and ethnic minorities had lower odds of being uninsured at a visit than being publicly insured.[,] This may be due to CHC’s outreach efforts to get minority children public coverage, or because some populations were more likely to access health care services despite being uninsured. Children seeking care in SBHCs also had higher odds of being uninsured than being insured by private or public coverage, compared with those seeking care in other settings. This may reflect the fact that SBHCs provide critical access to uninsured kids, or in some cases, because an insured child or adolescent is considered uninsured for an SBHC visit to maintain confidentiality.

The differences in the strength and direction of associations with being uninsured compared with having public versus commercial coverage highlight the benefits of public health insurance programs. This might suggest that public insurance programs help reduce health insurance disparities for racial/ethnic minorities and low-income families. In contrast, these disparities persist in private programs.

## Policy and Practice Implications

As the first study of this scale, this article demonstrates a novel methodology: using EHR data to conduct health insurance surveillance in CHCs. These methods could be used in primary care clinics to inform system-level interventions seeking to facilitate health insurance enrollment and retention for patients, especially those who become eligible for new insurance programs through the ACA. These methods could also be used by policy makers wishing to partner with CHCs and other health care systems to better understand patterns of insurance among certain populations or geographic communities. Importantly, our longitudinal assessment of children over a 2-year time period demonstrates a methodology for using EHR data to track how a patient's insurance status changes (or does not change) over time. Notably, we found that nearly one-third of the children uninsured at their first visit remained uninsured at all subsequent visits. This speaks to the need for clinics to conduct insurance surveillance and develop mechanisms to intervene and assist patients with obtaining coverage that may be available to them.

This article also demonstrates the need to develop better systems for capturing the data needed for conducting such analyses in the future. For example, we were missing information on race/ethnicity, language, and/or income for a moderate percentage of the children in the study population (7%–29%); even without complete data, we demonstrated that these demographic characteristics are associated with different patterns of insurance coverage. Further, these social determinants of health have been reported in multiple studies to be associated with patients' ability to access health care services, comprehend health care advice, and improve health status and outcomes.– Thus, it is imperative that information on patients' social determinants of health be included in EHR data. This could be accomplished through policies requiring that EHRs facilitate the collection of these data, and that health care systems develop workflows to collect related data.

## Limitations

The method for monitoring insurance status employed here requires regular health care visits. We may have under-estimated the percentage of patients without health insurance, as it is likely that some uninsured children in the communities served by these CHCs did not come in for a visit during the study period. Further, children insured at a first visit may not have returned to the clinics if they lost coverage subsequent to the first visit. We also acknowledge the potential for misclassification of insurance status, especially in settings where there may be concerns about confidentiality (eg, SBHCs). We used missing data categories in our statistical analyses to minimize exclusions, which may have limited our understanding of the true relationship between the study covariates and their effect on insurance outcomes. For example, some of the missing demographic categories were associated with higher or lower odds of being uninsured (Table 2). Imputation methods were considered to address this "missingness"; however, the use of such methods with EHR data needs further development and evaluation. Finally, our EHR data set did not allow for identification of siblings, so we could not account for clustering within families. We did, however, adjust for number of visits and clinic variation in our multivariable analyses to account for the fact that visits were clustered within subjects and subjects within clinics.

## Conclusions

EHRs provide new opportunities for identifying uninsured populations and tracking insurance coverage in populations at risk for discontinuous coverage. EHRs can facilitate insurance surveillance and inform clinic-based interventions aimed at helping patients obtain and retain insurance coverage.

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## ABBREVIATIONS

| | |
|---|---|
| **aOR** | adjusted odds ratio |
| **ACA** | Affordable Care Act |
| **CHC** | community health center |
| **CHIP** | Children’s Health Insurance Program |
| **CI** | confidence interval |
| **EHR** | electronic health record |
| **SBHC** | school-based health center |

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### WHAT'S KNOWN ON THIS SUBJECT

Stable health insurance coverage facilitates access to health care. Despite expanded coverage options for children, parents report barriers to accessing insurance programs for their children, including uncertainty about a child's coverage status and eligibility.

### WHAT THIS STUDY ADDS

Electronic health records can be used as an emerging data source for conducting health insurance surveillance to track trends in patients' insurance coverage status, and to identify patients who may benefit from outreach and support to obtain and maintain coverage.

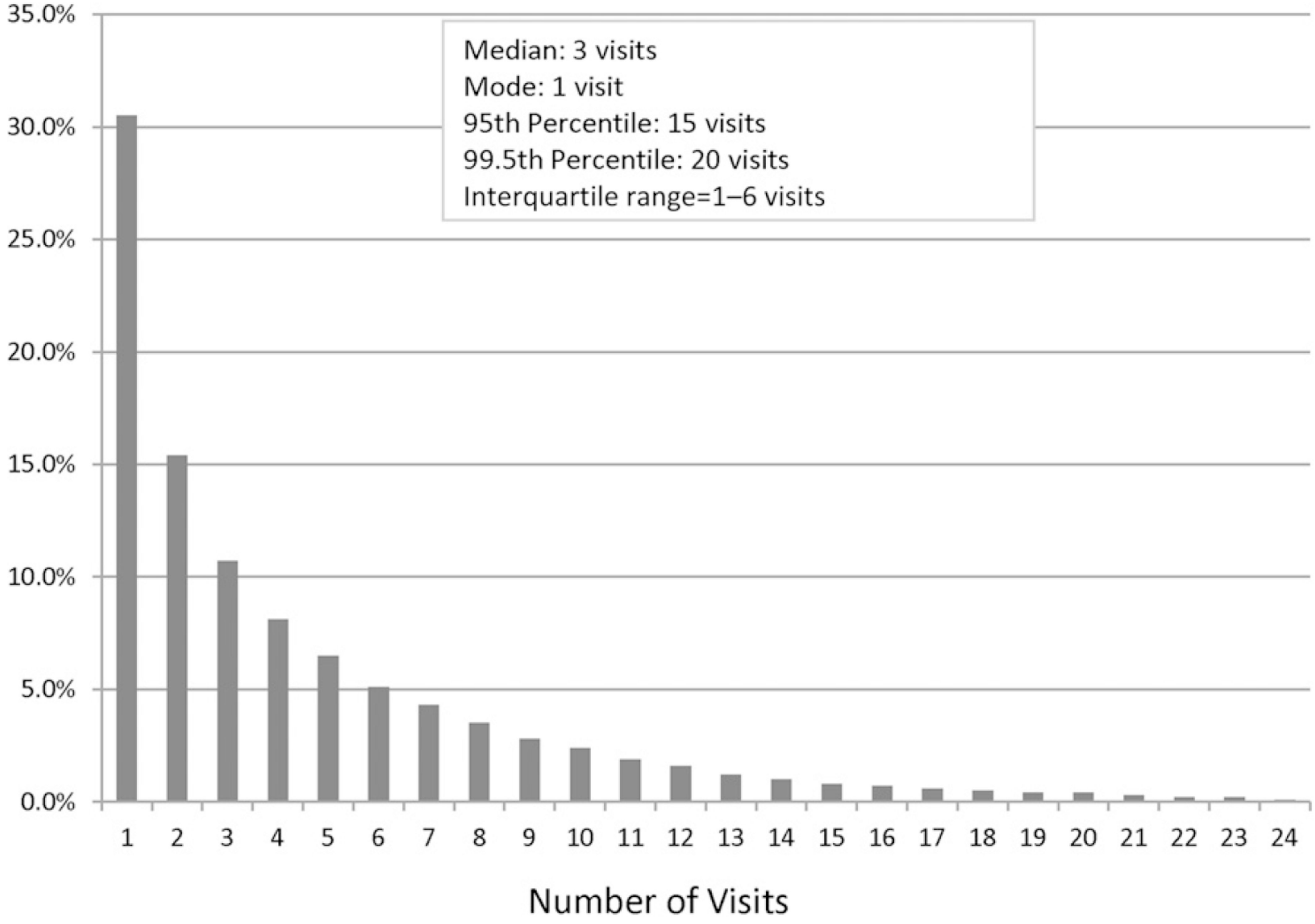

**FIGURE 1.**

Number of visits, per child, to a CHC clinic in the OCHIN Network during the study period (January 1, 2010–December 31, 2011). Total number of visits for study population = 880 268.

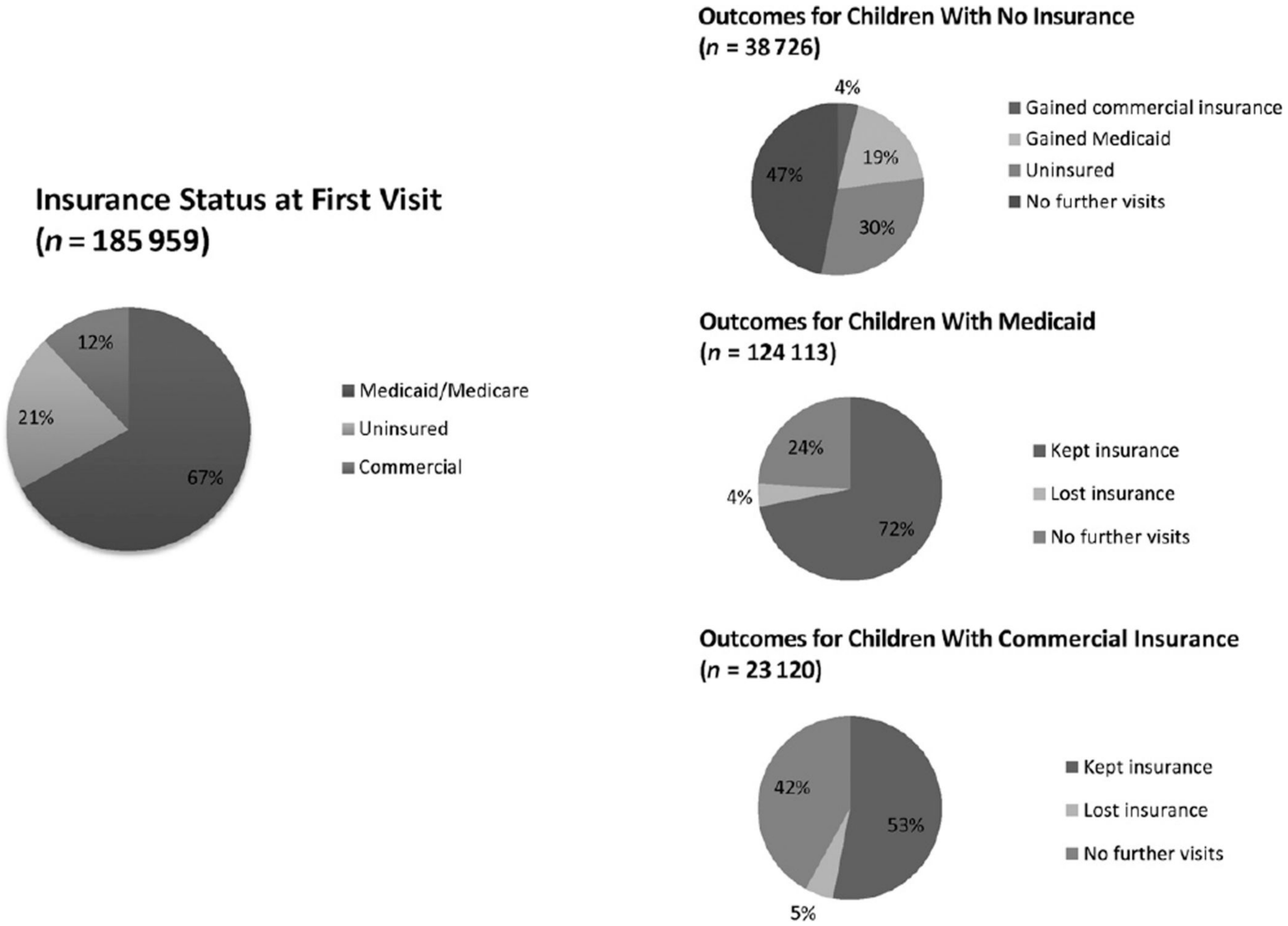

**FIGURE 2.**

Longitudinal assessment of insurance status over time, among children seen in CHCs in the OCHIN Network.

## TABLE 1

Characteristics of Children at Their First Visit to a CHC in the OCHIN Network During the Study Period (January 1, 2010–December 31, 2011)

| | **No. (*n* = 185 959)** | **Percentage** |
|---|---|---|
| Gender | | |
| Boy | 90 227 | 48.52 |
| Girl | 95 732 | 51.48 |
| Age | | |
| <1 | 24 593 | 13.22 |
| 1–4 | 40 426 | 21.74 |
| 5–9 | 39 690 | 21.34 |
| 10–14 | 41 412 | 22.27 |
| 15–18 | 39 838 | 21.42 |
| Race | | |
| White | 132 778 | 71.40 |
| Black/African American | 12 358 | 6.65 |
| Asian/Pacific Islander/Hawaiian Native | 6554 | 3.52 |
| Native American/Alaska Native | 1548 | 0.83 |
| More than 1 race | 2644 | 1.42 |
| Missing | 30 077 | 16.17 |
| Ethnicity | | |
| Hispanic | 76 871 | 41.34 |
| Non-Hispanic | 108 708 | 58.46 |
| Missing | 380 | 0.20 |
| Language | | |
| English | 108 807 | 58.51 |
| Spanish | 56 721 | 30.50 |
| Other | 7008 | 3.77 |
| Missing | 13 423 | 7.22 |
| Income | | |
| <100% federal poverty level | 96 015 | 51.63 |
| 101%–150% federal poverty level | 14 074 | 7.57 |
| 151%–200% federal poverty level | 5592 | 3.01 |
| >200% federal poverty level | 16 214 | 8.72 |
| Missing | 54 064 | 29.07 |
| Clinic type | | |
| School-based health center | 22 767 | 12.24 |
| Primary care clinic | 163 192 | 87.76 |
| Health center location | | |
| Rural | 39 993 | 21.51 |
| Urban | 145 966 | 78.49 |
| Insurance status | | |

| | **No. (*n* = 185 959)** | **Percentage** |
|---|---:|---:|
| Uninsured | 38 726 | 20.83 |
| Medicaid/Medicare | 124 113 | 66.74 |
| Commercial | 23 120 | 12.43 |

## TABLE 2

Characteristics of Being Uninsured, Having Medicaid/Medicare, or Commercial Insurance at First Visit for Children Seen at a CHC in the OCHIN Network (January 1, 2010–December 31, 2011)

| **Covariates** | **Characteristics at First Visit, %** | | |
|---|---|---|---|
| | **Uninsured, *n* = 38 726** | **Medicaid/Medicare, *n* = 124 113** | **Commercial, *n* = 23 120** |
| Gender | | | |
| Boy | 20.56 | 67.31 | 12.13 |
| Girl | 21.07 | 66.21 | 12.72 |
| Age, y | | | |
| 0–14 | 18.60 | 70.54 | 10.86 |
| 15–18 | 28.98 | 52.80 | 18.22 |
| Race/ethnicity | | | |
| White, Non-Hispanic | 24.24 | 55.50 | 20.25 |
| Nonwhite and/or Hispanic | 17.90 | 75.91 | 6.18 |
| Missing | 23.09 | 63.83 | 13.08 |
| Language | | | |
| English | 19.94 | 63.63 | 16.44 |
| Other than English | 16.50 | 79.15 | 4.35 |
| Missing | 48.54 | 33.08 | 18.39 |
| Income | | | |
| >100% federal poverty level | 22.27 | 55.44 | 22.30 |
| At or below 100% federal poverty level | 24.27 | 67.91 | 7.82 |
| Missing | 13.74 | 72.17 | 14.09 |
| Location | | | |
| Urban | 22.19 | 70.37 | 7.44 |
| Rural | 15.85 | 53.49 | 30.66 |
| Clinic type | | | |
| Primary care clinic | 17.36 | 71.56 | 11.07 |
| School-based health center | 45.64 | 32.19 | 22.17 |

## TABLE 3

Factors Associated With Being Uninsured Compared With Medicaid/Medicare and Commercial Insurance, Among Children Seen at a CHC in the OCHIN Network (January 1, 2010–December 31, 2011)

| **Covariates** | **Medicaid/Medicare** | | | | **Commercial** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Unadjusted Odds of Being Uninsured** | ***P*** | **Adjusted Odds of Being Uninsured** | ***P*** | **Unadjusted Odds of Being Uninsured** | ***P*** | **Adjusted Odds of Being Uninsured** | ***P*** |
| Gender | | | | | | | | |
| Boy | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| Girl | 1.07 (1.05–1.09) | <.001 | 0.98 (0.96–1.00) | .073 | 0.97 (0.94–1.00) | .088 | 0.98 (0.95–1.01) | .201 |
| Age, y | | | | | | | | |
| 0–14 | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| 15–18 | 2.21 (2.16–2.26) | <.001 | 1.87 (1.82–1.92) | <.001 | 0.82 (0.79–0.84) | <.001 | 0.81 (0.78–0.84) | <.001 |
| Race/ethnicity | | | | | | | | |
| White, Non-Hispanic | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| Nonwhite and/or Hispanic | 0.57 (0.55–0.58) | <.001 | 0.73 (0.71–0.75) | <.001 | 3.00 (2.90–3.09) | <.001 | 1.50 (1.44–1.56) | <.001 |
| Missing | 0.83 (0.79–0.87) | <.001 | 0.84 (0.80–0.89) | <.001 | 1.54 (1.44–1.65) | <.001 | 1.19 (1.11–1.28) | <.001 |
| Language | | | | | | | | |
| English | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| Other than English | 0.66 (0.65–0.68) | <.001 | 0.96 (0.93–0.99) | .003 | 3.75 (3.61–3.90) | <.001 | 1.87 (1.78–1.96) | <.001 |
| Missing | 4.37 (4.20–4.55) | <.001 | 4.04 (3.86–4.22) | <.001 | 1.94 (1.85–2.04) | <.001 | 1.22 (1.16–1.28) | <.001 |
| Income | | | | | | | | |
| >100% federal poverty level | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| At or below 100% federal poverty level | 0.94 (0.92–0.96) | <.001 | 0.87 (0.85–0.89) | <.001 | 1.60 (1.55–1.66) | <.001 | 1.62 (1.56–1.68) | <.001 |
| Missing | 0.69 (0.67–0.71) | <.001 | 0.84 (0.82–0.86) | <.001 | 1.06 (1.02–1.10) | .002 | 1.08 (1.04–1.12) | <.001 |
| Location | | | | | | | | |
| Urban | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| Rural | 0.93 (0.90–0.95) | <.001 | 0.89 (0.87 –0.92) | <.001 | 0.16 (0.16–0.17) | <.001 | 0.22 (0.21–0.23) | <.001 |
| Clinic type | | | | | | | | |
| Primary care clinic | 1.00 | — | 1.00 | — | 1.00 | — | 1.00 | — |
| School-based health center | 3.91 (3.80–4.04) | <.001 | 3.39 (3.28–3.50) | <.001 | 1.23 (1.19–1.29) | <.001 | 1.06 (1.01–1.10) | .011 |

Adjusted odds ratios are based on multivariable generalized estimating equation logistic regression models accounting for visits nested in children and children nested in clinics. Multivariable models were adjusted for gender, age, race, ethnicity, language, income, rural/urban health center location, and clinic type.