Rural Childhood Immunization
Rates and Demographic Characteristics

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BACKGROUND. Childhood immunization rates are suboptimal, especially in high-risk populations. Rural residents could constitute a population at high risk for childhood underimmunization; little is known about demographic factors associated with childhood underimmunization. This study compared the immunization rates of urban and rural 2-year-olds and examined the association between demographic factors and underimmunization for rural 2-year-olds.

METHODS. We analyzed two nationally representative surveys: the 1991 National Maternal and Infant Health Survey (NMIHS) and the 1993 National Health Interview Survey (NHIS). The study population consisted of children in non-metropolitan statistical areas who were 24 to 36 months of age in the NMIHS and 19 months to 5 years of age in the NHIS. The NMIHS sample contained 4425 children (966 in rural areas) and the NHIS sample contained 2505 children (566 in rural areas).

RESULTS. There were no significant differences in immunization rates between rural and urban children. In urban areas, immunization rates were 63.3% (NMIHS) and 65.5% (NHIS) compared with 63.0% (NMIHS) and 67.8% (NHIS) in rural areas. Low income, low family education, nonwhite race, unemployment, and being a female child were associated with underimmunization in one or both data sets. These relationships were not modified by residence in a universal purchase state, where the state purchases and distributes vaccine for all children to reduce the cost and thereby improve access to immunization services.

CONCLUSIONS. Approximately one third of children in urban and rural areas were underimmunized. The demographic characteristics of underimmunized children were similar in urban and rural areas; however, the special characteristics of rural areas may require that interventions be tailored to rural needs.

KEY WORDS. Children; vaccination; immunization; rural population. *(J Fam Pract 1998; 47:221-225)*

Immunization levels for children in this country remain below the *Healthy People 2000* goal of 90% immunization coverage of 2-year-olds by the year 2000.[1] Immunization coverage of 2-year-olds was approximately 78% nationally in 1997 and remained substantially lower in high-risk subpopulations, such as low-income families and racial minorities.[2-4]

Identification of groups at high risk for underimmunization is a starting point for effective intervention strategies to increase childhood immunization rates. The literature concerning rural and urban differences in health care and demographics suggests that rural residence could be a risk factor for underimmunization. Rural residents tend to be poorer and less educated than urban residents, and are more likely to lack health insurance.[5-8] These demographic factors have been associated with lower immunization rates.[9-11] The differences in the organization of rural and urban medical practices could also influence the delivery of immunization services. Rural primary care physicians are more likely to see more patients during office hours than are urban and suburban physicians, and to spend less time on each patient visit.[12] These characteristics might lead to less emphasis on the delivery of preventive services. Differences in access to and continuity of primary care have been noted between urban and rural children, with rural children having less physician contact.[8] Some studies show that rural primary care physicians are reducing their provision of childhood immunizations,[13] requiring rural children to obtain immunizations at public health departments.[14,15] Although these differences in demographic characteristics and health care delivery systems suggest that immunization rates in rural areas might be lower than immunization rates in urban areas, some studies show that rural children have higher immunization rates than their urban counterparts.[3,11,16-18]

In addition to place of residence, other demographic characteristics have been used to identify populations at high risk for underimmunization. Young maternal age, less parental education, larger families, lower family

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income, and being of a minority race have all been associated with underimmunization.[4,9,10,19-31] Most of these studies have been in urban populations or in populations containing few rural residents. Studies examining the association of demographic characteristics with underimmunization in rural residents were limited to one state[19-21] or to patients in one hospital.[10]

In this study we used two national surveys, the 1991 National Maternal and Infant Health Survey (NMIHS) and the 1993 National Health Interview Survey (NHIS), to compare immunization rates among 2-year-olds in rural and urban areas, and to identify demographic characteristics associated with underimmunization in rural areas. We hypothesized that rural immunization rates would be comparable to those for urban children and that low income, fewer years of education, single parenthood, large family size, young maternal age, being a member of a racial minority, and unemployment would be associated with underimmunization in rural children. We also examined whether the predicted associations of demographic factors would be modified by residence in a state with a universal purchase program. In such a program, the state purchases and distributes vaccine for all children to reduce the cost and thereby improve access to immunization services.

METHODS

The NMIHS was a stratified, systematic survey of pregnant women in the 48 contiguous United States, begun in 1988, conducted to describe factors related to poor pregnancy outcomes. In the 1991 NMIHS Follow-Up used in this study, mothers were asked about their child's health status, including immunizations. Of the approximately 13,400 mothers who were mailed questionnaires in 1988, approximately 74% completed the survey. Approximately 88% (n=8252) of the eligible mothers participated in the 1991 NMIHS Follow-Up. The primary mode of data collection for the follow-up was a telephone interview, with approximately 22% of the respondents completing face-to-face interviews.

The NHIS is a continuous, multistage household survey of the civilian noninstitutionalized population of the United States. Details of the sampling methodology and statistical design can be found elsewhere.[32] In the 1993 NHIS, information on childhood immunizations was collected through a face-to-face interview with an adult respondent (often the mother) for a child younger than 6 years of age. The response rate for the 1993 childhood immunization supplement to the NHIS was 92.7%, resulting in 7323 records. Children in the NHIS sample were born between 1987 and 1992.

The population for our study consisted of children 19 months to 5 years of age at the time of either survey and for whom immunization status at or before 36 months of age could be determined. The final NMIHS sample had 4425 children (966 from rural areas) and the final NHIS sample had 2505 children (566 from rural areas). The only rural designator available in the two surveys was nonresidence in a metropolitan statistical area (MSA). An MSA is defined as a county or multicounty area that contains an urban population center of 50,000 or more people.[33] For the purposes of this study, rural was defined as all areas not in an MSA.

The primary outcome measure (up-to-date immunization, or UTD) was based on the Centers for Disease Control Advisory Committee on Immunization Practices recommendations in effect at the time immunization was recommended for the children in the sample. UTD was defined as receipt of four diphtheria, pertussis, and tetanus vaccines (DPT), three oral polio vaccines (OPV), and one measles, mumps, and rubella vaccine (MMR) before 36 months of age. Dates of immunization were not available for the NMIHS, so immunization status could not be determined using the more traditional cutoff of 24 months. Respondents to both surveys were asked to use family records to retrieve immunization information. Almost three quarters (74.3%) of the NHIS sample relied on family records to provide immunization information. The NMIHS did not report the proportion of respondents who relied on family records to provide immunization status. Immunization status was not verified by medical record review for either survey. Respondents with vaccination records were also asked about additional shots that the child may have received, but were not listed on the records. Respondents who were unable to provide records were asked to recall how many shots of each type their child received. Those who did not know the exact number of shots, but stated the child had received "all" of a particular type of vaccination, were counted as being UTD.

Demographic variables examined for the NMIHS included: sex of child; race of child; annual family income; mother's education level (less than high school, high school graduate, or some college); mother's age at the time of the child's birth (19 years or younger, 20 to 29 years, or 30 years or older); number of children in the family (one, two, three, or four or more); whether any family member was employed during the preceding month; and mother's marital status. Demographic variables examined in the NHIS included race of child (white/non-Hispanic or other, including all children of Hispanic origin); sex of child; annual family income; highest education of adult respondent; poverty index (at or above poverty threshold or below it); and size of the family (three or fewer members, four members, or five or more members).

The NHIS was used to examine whether the relationship of demographic variables and immunization status was modified by residence in a universal purchase state. Respondents to the NHIS were classified on the basis of their state of residence at the time of the survey. Universal purchase states were defined as the nine states with a universal purchase program in 1987, the year in which it was recommended that the children in the NHIS sample receive their first immunizations (Alaska, Connecticut,

Maine, Massachusetts, Nevada, Rhode Island, South Dakota, Vermont, and Wyoming).

Both the NHIS and the NMIHS use statistical weights to produce national estimates. In this study, analyses were conducted with SAS software[34] using rescaled weights, where the rescaling factor was the reciprocal of the mean weight for the total sample. Chi-square tests were used to compare urban and rural immunization rates. The bivariate association between each demographic variable and immunization status in rural children was tested with logistic regression. All demographic variables that had a *P* value of .25 or less in bivariate logistic regressions were simultaneously entered into a multivariate logistic regression model for each data set. In addition, the state level variable of residence in a universal purchase state was included in a multivariate logistic regression model for the NHIS. Unadjusted (bivariate) and adjusted odds ratios and 95% confidence limits are presented for each demographic variable that was significantly associated with immunization status.

RESULTS

There were no significant differences in immunization rates between rural and urban areas in either data set. In the NMIHS, the immunization rates in urban areas were 63.3% compared with 63.0% in rural areas ($P = .88$). In the NHIS, immunization rates in urban areas were 65.5% compared with 67.8% in rural areas ($P = .31$).

The Table shows significant results from the bivariate and multivariate models of the relationship between immunization status and demographic variables for rural children in the 1991 NMIHS and the 1993 NHIS, respectively. Complete tables of results from the bivariate and multivariate models are available from the authors by request. In the bivariate analyses of the 1991 NMIHS, black children and children whose race was identified as "other" were significantly less likely to be UTD than white, non-Hispanic children. Race differences were no longer significant when other demographic factors were taken into account, however. Children from low-income families had a lower probability of being UTD than children in higher income homes, even after controlling for other factors. Children living in a household with no employed adult were less likely to be immunized than children in households with at least one employed adult. Finally, children of single mothers were less likely to be immunized than children of married mothers in the bivariate but not the multivariate analysis. In the multivariate analysis, female children were less likely to be UTD than male children. No significant association was found between mother's age, mother's education, or number of children in the family and immunization status.

In the 1993 NHIS, rural children who lived with an adult with less than a high school education were significantly less likely to be UTD than rural children who lived with an

TABLE

Significant Relationships Between Demographic Characteristics and Immunization Status of Two-Year-Old Children in Rural Areas: 1991 National Maternal and Infant Health Survey and 1993 National Health Interview Survey

Variable*	UTD, %†	Bivariate Results OR (95% CI)	Multivariate Results OR (95% CI)
Child's sex‡			
Male	65.1		
Female	60.7	0.8 (0.6, 1.1)	0.7¶ (0.5, 0.9)
Child's race‡			
White, non-Hispanic	66.4		
Black	48.0	0.5‖ (0.3, 0.7)	0.8 (0.5, 1.4)
Other	52.1	0.6‖ (0.3, 0.9)	0.6 (0.3, 1.0)
Family income, $‡			
≥40,000	70.6		
20,000 to 39,999	68.8	0.9 (0.6, 1.4)	1.0 (0.6, 1.5)
<20,000	50.8	0.4‖ (0.3, 0.6)	0.6¶ (0.4, 0.9)
Employment status‡			
Employed	66.0		
Unemployed	37.0	0.3‖ (0.2, 0.5)	0.5¶ (0.3, 0.8)
Marital status of mother‡			
Married	66.8		
Single	47.0	0.4‖ (0.3, 0.6)	0.8 (0.5, 1.2)
Education§			
Some college	72.9		
High school graduate	68.4	0.8 (0.5, 1.2)	0.8 (0.5, 1.2)
<High school graduate	43.3	0.3‖ (0.2, 0.5)	0.3‖ (0.1, 0.5)

*Variables with a *P* value < .25 were included in the multivariate models. The 1991 National Maternal and Infant Health Survey model included child's sex, child's race, family income, mother's age, mother's education, employment status, number of children in family and mother's marital status. The 1993 National Health Interview Survey model included family income and education.

†UTD (up-to-date) denotes immunization with four diphtheria, pertussis, and tetanus vaccines; three oral polio vaccines; and one each measles, mumps, and rubella vaccine before 36 months of age.

‡Variables from the 1991 National Maternal and Infant Health Survey; n = 738 for the multivariate analysis.

§Variable from the 1993 National Health Interview Survey; n = 497 for multivariate analysis.

‖ $P < .01$

¶ $P < .05$

adult with some college education. This relationship was also found in the multivariate analysis after adjusting for family income. Child's sex, child's race, family income, poverty index, family size, and family composition were not significantly related to immunization status in rural areas in the 1993 NHIS. There was no significant difference in immunization rates between children living in a universal purchase state and children living in other states. Adding universal purchase to the logistic regression model did not affect the relationship of family education or income with immunization status.

DISCUSSION

Previous analyses of the relationship of demographic factors and immunization rates in rural areas are dated or were performed in narrowly defined populations.[13,19,20] This study adds to existing knowledge because of the national representativeness of the two surveys. We found that in 1991 and 1993 rural immunization rates were similar to those in urban areas with approximately one third of 2-year-old rural children being underimmunized. Belonging to a racial minority, unemployment, low income, low family education, and being a female child were associated with lower immunization rates in rural children in at least one of the surveys, even when other demographics factors were taken into account. Residence in a universal purchase state did not change the relationships between demographic variables and immunization status.

A key limitation of these data is calculation of immunization status on the basis of parental records or recall. Both the NMIHS and the NHIS are based on parental records or parental recall in the absence of any written record. Immunization levels on parent-held records may vary from immunization levels on medical records. Medical record review is an expensive method of data collection and was not performed for our study sample, though it has been performed for more recent NHIS surveys beginning in 1994 and in the National Immunization Survey.[35] A second limitation is reliance on a non-MSA definition of rural. Metropolitan statistical areas follow county lines, resulting in some misclassification of rural residents who live in metropolitan areas. Data were not available to use other rural classification methods.

It is possible that differences in health care delivery that exist between urban and rural areas could increase childhood immunization rates and counteract some of the demographic influences. Rural areas have historically had a limited and changing supply of physicians compared with urban areas, and rural physicians are less likely to provide childhood immunization than urban physicians.[14,15] The historical absence of a large supply of physicians in rural areas, and an established pattern of primary care provided by private physicians and immunizations provided by local health departments may have encouraged parents to seek timely immunizations. Future research could examine the association of health delivery system factors with childhood immunization status in rural areas.

Findings of associations between nonwhite race, low income level, and underimmunization are consistent with those from other studies in both urban and rural settings.[17,19-21,28,29] We did not compare data concerning urban and rural differences in demographic factors using the NMIHS and the NHIS data, since there is consensus in the literature about the association of demographic factors with underimmunization in urban areas. We focused our study on the less well-established associations of demographic factors and immunization status in rural areas. The associations between unemployment, low education, and underimmunization were consistent with other studies in urban and some rural populations,[3,21,22,27,28] but only partially consistent with the findings of older studies of rural populations in one state.[19,20] Significant findings were not consistent across the two data sets, but the trends were similar in both data sets for children in racial minorities, families with lower income, and families with fewer years of education having lower immunization rates.

Universal purchase could mitigate the relationship of demographic variables with immunization status by removing the barrier of cost of vaccine. In this study, however, residence in a universal purchase state did not change the association of demographic factors and immunization status. Further research could test the association of residence in a universal purchase state and immunization status using more recent data for both urban and rural populations so that the states with a universal purchase program implemented after 1987 could be included in the analysis.

CONCLUSIONS

We found that in 1991 and 1993, more than one third of the children in rural areas remained underimmunized and, despite increased immunization rates since that time, pockets of need may remain in rural areas. As in urban areas, children from families with lower incomes, families with fewer years of education, and of racial minorities are less likely to be immunized. Although the results of this study indicate that demographic characteristics of underimmunized children in rural areas are similar to those of underimmunized children in urban areas,[9,10,17,19-26,29-31] the special characteristics of rural areas, such as a more limited supply of physicians and poorer families that are more likely to lack health insurance, may suggest solutions to the problem of underimmunization that are uniquely tailored to rural needs.

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