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# Welfare, Maternal Work, and On-Time Childhood Vaccination Rates

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## KEY WORDS

welfare reform, maternal employment, childhood vaccination

## ABBREVIATIONS

TANF—Temporary Assistance for Needy Families  
AFDC—Aid to Families With Dependent Children  
IFS-CWB—Illinois Families Study: Child Well-being  
IFS—Illinois Families Study  
ACIP—Advisory Committee on Immunization Practices  
AAP—American Academy of Pediatrics  
OR—odds ratio  
CI—confidence interval

This article presents the findings and conclusions of the authors; it does not necessarily represent the views of the Health Resources and Services Administration.

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**WHAT'S KNOWN ON THIS SUBJECT:** Children in low-income families exhibit poor compliance with immunization guidelines. Although work requirements for mothers receiving welfare may hinder mothers' ability to take children for preventive care, there is no information on how such requirements may affect timely vaccination rates.



**WHAT THIS STUDY ADDS:** Welfare cash assistance was associated with increased on-time administration of childhood vaccinations, but maternal employment was not. Among mothers receiving welfare assistance, however, maternal employment was associated with significantly decreased on-time vaccination rates.

## abstract

**OBJECTIVE:** To examine effects of Temporary Assistance for Needy Families welfare cash assistance and maternal work requirements on “on-time” childhood vaccination rates.

**METHODS:** A stratified random sample of Illinois children from low-income families affected by welfare reform was monitored from 1997 to 2004. Medical records from pediatricians' offices and Medicaid claims data were used to identify the timeliness of 18 recommended vaccinations. Random-intercept logistic models were used to estimate on-time vaccine administration as a function of welfare receipt and maternal work with adjustment for characteristics of the children and mothers and time-varying covariates pertaining to the administration window for each recommended vaccine dose.

**RESULTS:** Of all recommended vaccinations, 55.9% were administered on time. On-time vaccination rates were higher when families were receiving welfare than not (57.4% vs 52.8%). Children in families that either were receiving welfare or had working mothers were 1.7 to 2.1 times more likely to receive vaccinations on time compared with children in families that were not receiving welfare and did not have working mothers. When vaccine doses were stratified according to welfare status, maternal work was associated with decreased on-time vaccination rates (odds ratio: 0.73 [95% confidence interval: 0.59–0.90]) when families received welfare but increased on-time vaccination rates (odds ratio: 1.68 [95% confidence interval: 1.27–2.22]) when they did not receive welfare.

**CONCLUSIONS:** These results indicate that maternal work requirements of Temporary Assistance for Needy Families had negative effects on timely administration of childhood vaccinations, although receipt of welfare itself was associated with increased on-time rates. *Pediatrics* 2011;128:1109–1116

The provision of welfare support to families with children in the United States was dramatically redesigned in 1996 with the enactment of the Personal Responsibility and Work Opportunity Reconciliation Act, which replaced Aid to Families With Dependent Children (AFDC) with Temporary Assistance for Needy Families (TANF). Whereas AFDC provided cash assistance for all low-income mothers with young children and did not permit receipt of additional income through work, TANF requires mothers who receive welfare cash assistance (referred to here as “welfare”) to work or to participate in job training programs.

During the initial welfare reform debate, concerns were raised that the work requirements might hinder mothers’ ability to take their children for needed medical care and might affect children’s health negatively.<sup>1–4</sup> The National Vaccine Advisory Committee recognized these concerns and passed a resolution in 1995 that “all relevant federal agencies involved with welfare reform . . . monitor the possible impact of these reforms on the immunization status of children and adults.”<sup>5</sup> However, no study has examined systematically the effects of welfare and maternal work requirements on “on-time” childhood vaccination rates.

In this study, we examined the roles of welfare and maternal work in on-time vaccination for children in low-income families in Illinois between 1997 and 2004. We hypothesized that welfare would be associated with increased on-time vaccination rates but maternal work requirements would be associated with decreased on-time rates. TANF requires reauthorization in 2011. This study provides important information about the effects of welfare and work requirements on vaccination rates that should be taken into

consideration during reauthorization discussions.

## METHODS

### Study Design and Sample

This was a retrospective cohort study using a sample of children in families enrolled in the Illinois Families Study: Child Well-being (IFS-CWB). The IFS-CWB was a 4-year study of a subsample in the Illinois Families Study (IFS).<sup>6,7</sup> The IFS cohort consisted of a stratified random sample of 1899 families that were receiving welfare in Illinois between September and November 1998. The IFS-CWB child sample consisted of “target” children who were younger than 3 years at the time of the first IFS survey. Annual in-person surveys were conducted with the target children’s primary caregivers for the IFS and IFS-CWB.

### Medical Records and Medicaid Claims Data

Detailed information about the children’s medical care utilization during the past year was collected in each survey and was used to contact providers to obtain all medical charts for the target children. Medical records for all hospitalizations and outpatient visits were abstracted, by using a standardized tool, into a computerized database that included information on all vaccinations. The completeness of each child’s medical records was estimated.

Eighty-seven percent of the IFS-CWB sample (513 participants) consented to the review of their children’s medical charts. Children with incomplete medical charts ( $n = 18$  [3.5%]), children whose primary caregivers were not their mothers ( $n = 10$ ), and children with no vaccination records ( $n = 28$ ) were excluded. The final study cohort included 457 children. To supplement medical records, Medicaid claims were obtained from the Illinois

Department of Human Services for all children enrolled in Medicaid during the study period.

### Child Vaccination Records and Timeliness of Vaccination

For each child, data on all 18 vaccinations recommended for children 0 to 6 years of age, which was the age range for children in the study cohort in 1997–2004, were abstracted from the medical records. The vaccinations included 3 doses of hepatitis B vaccine, 5 doses of diphtheria-tetanus-acellular pertussis vaccine, 4 doses of *Haemophilus influenzae* type b vaccine, 4 doses of inactivated poliovirus vaccine, and 2 doses of measles-mumps-rubella vaccine. These doses correspond to the 14 doses in the 4:3:1:3:3 series for children up to 35 months of age and an additional 4 doses recommended for children between 36 months and 6 years of age. A small number of vaccination records (1.6% of all doses administered) were obtained through Medicaid claims.

The timeliness of administration of each vaccine dose was determined on the basis of the window of time in the recommended schedule approved by the Advisory Committee on Immunization Practices (ACIP) and the American Academy of Pediatrics (AAP).<sup>8</sup> The minimal acceptable age for each vaccination in the guideline was used as the beginning date of the window.<sup>8,9</sup> The end date for routine administration in the guideline was used as the end date of the window. The dates (in months or years) were converted to ages (in days) by using an algorithm that produced the widest possible window, in part to be consistent with previous research and in part to make the definition of on-time administration as lenient as possible.<sup>10</sup> Any vaccine dose that was administered during the window was defined as being on-time. Table 1 lists the window for each vaccine

**TABLE 1** ACIP/AAP-Recommended Windows for Childhood Vaccinations and Ages Used to Determine Timeliness of Vaccine Administration

Vaccine Dose	Recommended Age for Routine Administration	Minimal Acceptable Age <sup>a</sup>	Age at Which Delay Count Was Initiated, d <sup>a</sup>	Age Used to Determine On-Time Vaccination, d <sup>a</sup>
<b>Hepatitis B vaccine</b>				
1	0–2 mo	0 wk	93	0–92
2	1–2 mo	4 wk	154	28–153
3	6–18 mo	24 wk	580	42–579
<b>Diphtheria-tetanus-acellular pertussis vaccine</b>				
1	2 mo	6 wk	93	42–92
2	4 mo	10 wk	154	70–153
3	6 mo	14 wk	215	98–214
4	15–18 mo	12 mo	580	364–579
5	4–6 y	4 y	—	1461–2192
<b>Haemophilus influenzae type b vaccine</b>				
1	2 mo	6 wk	93	42–92
2	4 mo	10 wk	154	70–153
3	6 mo	14 wk	215	98–214
4	12–15 mo	12 mo	489	364–487
<b>Inactivated poliovirus vaccine</b>				
1	2 mo	6 wk	93	42–92
2	4 mo	10 wk	154	70–153
3	6–18 mo	14 wk	580	98–579
4	4–6 y	4 y	—	1461–2192
<b>Mumps-measles-rubella vaccine</b>				
1	12–15 mo	12 mo	489	364–487
2	4–6 y	13 mo	—	395–2192

<sup>a</sup> For each dose, the lower value of the age range is the minimal acceptable age and the higher value the age when delay count would be initiated minus 1. For the fifth dose of diphtheria-tetanus-acellular pertussis vaccine, the fourth dose of inactivated poliovirus vaccine, and the second dose of mumps-measles-rubella vaccine, the lower values were computed as  $365.25 \times 4$  and the higher values as  $365.25 \times 6$ ; decimal values were rounded up.

dose that was used to determine ACIP/AAP guideline-compliant administration of childhood vaccinations.

Doses recommended before the establishment of the TANF program ( $N = 472$ ) and after the study period ( $N = 681$ ) were excluded. For the third dose of *H influenzae* type b vaccine, the algorithm proposed by Luman et al<sup>11</sup> was used to identify children who were following the 3- or 4-dose schedule. The 6-month dose for children who were following the 3-dose schedule ( $n = 112$ ) was excluded.

### Receipt of Welfare Cash Assistance and Maternal Employment

Data on the mothers' work status were obtained from the Illinois Department of Employment Security unemployment insurance database for 1997–2004. Data on enrollment in and receipt of welfare cash assistance from AFDC and TANF were obtained from the Illinois Department of Human Services

registries. For each window, the number of days on which the family and child received welfare and the number of days worked by the mother were determined. Children whose families received welfare for  $\geq 50\%$  of days during a window were classified as receiving welfare. The 50% cutoff value was chosen because almost 90% of families that were classified as receiving welfare with this cutoff value received assistance for  $\geq 85\%$  of days during the recommended windows for all vaccine doses. For the same reason, we chose to classify mothers who worked  $\geq 50\%$  of days during a window as working.

### Covariates

Data on characteristics of the children and mothers were obtained from the first IFS survey; these characteristics included the child's gender, race/ethnicity, and birth weight, the mother's age at the child's birth and highest ed-

ucational attainment, the number of children born before the target child, and the county of residence. All counties other than Cook County were combined into a single "downstate" group, which included the cities of East St Louis and Peoria and rural counties surrounding Peoria.<sup>7</sup>

Data on the child's usual place of care, the marital status of the mother, and family member availability for child care were obtained from the IFS-CWB survey closest to each vaccine window and thus varied for each vaccine dose. Medicaid eligibility was determined from the Illinois Medicaid enrollment data. A child was considered eligible if he or she was enrolled in Medicaid or in a 90-day retroactive eligibility period for  $\geq 50\%$  of the days during a recommended window.

The response to the question regarding the usual place to go for routine care, such as a physical examination,

well-infant check, or shot, or when the child is sick was used to determine the usual source of care. A child was considered to have another adult available for care when responses to the question regarding “who provided the most child care for [the target child] when you were unable to be with him/her” included any of the following: other biological parent, stepparent, or respondent’s spouse/partner, grandparent, great-grandparent, or other relative.

### Statistical Analyses

The key outcome was on-time administration of each vaccine dose. A child/vaccine data set that included up to 18 vaccines for each child was constructed. Covariates were observed at baseline and during each recommended window. Random-intercept logistic regression was used to adjust for autocorrelation between vaccine doses. Sampling weights were applied at the child level to adjust for oversampling in downstate counties and nonresponses and to derive estimates reflecting the welfare population in 1998 in Illinois from which the IFS sample was originally derived.<sup>12</sup>

Sensitivity analyses were conducted to examine how different cutoff values defining welfare receipt and maternal work status might have affected study results. Sensitivity analyses also were conducted by using an alternative definition of the on-time window, which was based on ACIP/AAP–recommended windows for “routine” administration. The study was approved by the institutional review boards of Northwestern University and Seoul National University.

### RESULTS

The study sample included 6961 vaccine doses for 457 children in the study cohort. Characteristics of the children and mothers are reported in Table 2. The cohort consisted of more girls

**TABLE 2** Characteristics of Children and Mothers in Study Sample and On-Time Vaccination Rates (N = 457)

Characteristic	Weighted Proportion, %	Weighted On-Time Rate, %
All children	100.0	55.9
Child’s gender		
Male	44.1	57.7
Female	55.9	54.6
Child’s race/ethnicity		
Non-Hispanic black	79.4	54.7
Hispanic	11.5	66.8
Non-Hispanic white	6.9	52.3
Other	2.2	53.0
Child’s birth weight		
<2500 g	14.9	56.0
≥2500 g	85.1	55.6
Mother’s age at child’s birth <sup>a</sup>		
<20 y	10.0	54.1
20–35 y	80.3	57.8
>35 y	9.7	42.1
Mother’s education <sup>a</sup>		
Less than high school	40.8	51.0
High school or GED completed	41.4	60.9
Some college or higher	17.8	54.6
County of residence		
Cook	90.0	55.7
Downstate	10.0	57.8
Children born before target child		
0	12.1	64.3
1	29.8	59.3
≥2	58.1	52.3

GED indicates graduate equivalency diploma.

<sup>a</sup> A weighted Pearson  $\chi^2$  test of independence between the characteristic and average on-time vaccination rates yielded results significant at  $P < .05$ .

than boys (55.9% vs 44.1%), was overwhelmingly non-Hispanic black (79.4%), and resided in Cook County (90.1%). Ten percent of the children were born to teen-aged mothers and 13% to mothers who were older than 35 years at the child’s birth. Twelve percent of the children were firstborn and 58% were born to families with ≥2 older children.

Table 2 also shows on-time vaccination rates for all 18 vaccine doses according to the characteristics of the children and mothers. After application of sampling and nonresponse weights, we found that 55.9% of all vaccine doses were administered on time. Unadjusted on-time rates differed significantly according to the mothers’ education and the number of children born before the target child. Children of Hispanic ethnicity had the highest on-time rates (67%), followed by non-

Hispanic black children (55%). Children of other race/ethnicity (53%) and non-Hispanic white children (52%) had on-time rates that were almost 15% lower than those for Hispanic children.

Table 3 shows data pertaining to the recommended windows. Sixty-eight percent of all doses were recommended during windows when families were receiving welfare, and 62% were recommended when mothers were not working. When welfare receipt and maternal work were combined, almost one-half of all recommended doses were during windows when families were receiving welfare and mothers were not working. Fifty-two percent were recommended during windows when children were eligible for Medicaid. Slightly more than one-half of all vaccine doses were recommended during windows when mothers identified public health clin-

**TABLE 3** Child/Vaccine-Level Characteristics During Recommended Vaccination Windows (*N* = 6961)

Child/Vaccine Characteristic	Weighted Proportion, %	Weighted On-Time Rate, %
All vaccine doses	100.0	55.9
Welfare status		
No welfare	32.2	52.8
Welfare	67.8	57.4
Mother's work status		
No work	62.0	55.6
Work	38.0	56.4
Welfare and mother's work status <sup>a</sup>		
No welfare-no work	15.1	44.6
No welfare-work	17.2	60.0
Welfare-no work	47.0	59.1
Welfare-work	20.8	53.5
Medicaid coverage <sup>a</sup>		
Not covered	48.5	53.6
Covered	51.5	58.1
Usual place of care		
Hospital-based clinic	31.6	56.7
Physician's office	15.2	61.0
Public health clinic	50.6	54.5
No usual place or not known	2.6	44.4
Marital status of mother		
Not married	85.5	55.6
Married	14.5	57.6
Family member available for child care <sup>a</sup>		
No	25.5	50.0
Yes	74.6	58.3

Welfare indicates that mothers received welfare assistance for  $\geq 50\%$  of days during each window; work indicates that mothers were working  $\geq 50\%$  of days.

<sup>a</sup> A weighted Pearson  $\chi^2$  test of independence between the characteristic and average on-time vaccination rates yielded results significant at  $P < .05$ .

ics as the usual place of care for their children. Unadjusted on-time rates were 5% higher if a family was receiving welfare than not (52.8% vs 57.4%), but there was no difference according to maternal work status (55.6% vs 56.4%).

With controlling for baseline and dose-specific covariates in multivariate analyses, children in families receiving welfare were 42% more likely to receive vaccinations on time, compared with children in families not receiving welfare (odds ratio [OR]: 1.42 [95%

confidence interval [CI]: 1.21–1.68]), independent of maternal work. Maternal work was not significantly associated with on-time vaccination (OR: 0.97 [95% CI: 0.81–1.15]) with adjustment for welfare receipt and other covariates (data not shown).

When terms for interactions between welfare and maternal work were included in the models, maternal work and on-time vaccination were significantly associated (Table 4). Each model was estimated twice with different omitted categories for the combination of welfare and maternal work status (no welfare-no work in the first model and welfare-no work in the second). The first model showed that maternal work was associated with a 68% greater likelihood of on-time vaccination (OR: 1.68 [95% CI: 1.27–2.22]) among children in families not receiving welfare during the recommended windows but was associated with a 27% lower likelihood (OR: 0.73 [95% CI: 0.59–0.90]) among children in families receiving welfare. Overall, children in families in the welfare-no work group had the highest odds and those in the no welfare-no work group had the lowest odds of on-time vaccination. Results for all vaccine doses recommended before 36 months (4:3:1:3:3 se-

**TABLE 4** Adjusted ORs for Welfare Receipt and Maternal Work

Models	OR (95% CI) <sup>a</sup>			
	No Welfare		Welfare	
	No Work	Work	No Work	Work
All vaccines ( <i>N</i> = 6961)				
No welfare-no work omitted	Reference	1.68 (1.27–2.22)	2.12 (1.69–2.66)	1.55 (1.18–2.02)
Welfare-no work omitted	0.47 (0.38–0.59)	0.79 (0.63–0.99)	Reference	0.73 (0.59–0.90)
Vaccines recommended within 1 y ( <i>N</i> = 4073)				
No welfare-no work omitted	Reference	1.41 (0.72–2.75)	4.02 (2.34–6.90)	2.20 (1.21–3.99)
Welfare-no work omitted	0.25 (0.15–0.43)	0.35 (0.20–0.62)	Reference	0.55 (0.36–0.83)
Vaccines in 4:3:1:3:3 series ( <i>N</i> = 5959)				
No welfare-no work omitted	Reference	1.32 (0.92–1.90)	2.43 (1.81–3.25)	1.66 (1.18–2.33)
Welfare-no work omitted	0.41 (0.31–0.55)	0.55 (0.41–0.73)	Reference	0.68 (0.54–0.87)

<sup>a</sup> Welfare indicates that mothers received welfare cash assistance for  $\geq 50\%$  of days during each vaccine dose window, and work indicates that mothers were working  $\geq 50\%$  of days during each window. Rows represent adjusted ORs from the same model estimated twice, with the omitted category being no welfare-no work in the first and welfare-no work in the second. The models were adjusted for child's gender, race, Medicaid enrollment status during the window, birth order, and birth weight, mother's age at the child's birth, education level at the first IFS survey, and marital status, availability of a family member (parent, grandparent, sibling, or other relative) at home for child care, county of residence (Cook County versus downstate), and usual place of care (hospital-based clinic, physician's office, public health clinic, or data not available).

ries) and during the first year of life were consistent with those for the full sample (Table 4). In comparisons across the 3 models, effects of maternal work during periods when families received welfare were stronger for vaccines recommended within 1 year of life (OR: 0.55 [95% CI: 0.36–0.83]) than for all vaccines combined (OR: 0.73 [95% CI: 0.59–0.90]).

## DISCUSSION

This study showed that welfare receipt was associated with higher on-time vaccination rates but maternal work was not, independent of each other. When the 2 interacted, maternal work was associated with a significantly lower likelihood of on-time vaccination when families were receiving welfare but with a significantly higher likelihood when families were not receiving welfare.

This is the first study to identify unfavorable consequences of TANF work requirements on childhood vaccination rates. The divergent nature of the association between maternal work and vaccination rates in relation to welfare receipt is a notable finding. A review of 15 previous studies on maternal employment and childhood vaccination in Organization for Economic Cooperation and Development countries concluded that maternal employment was not associated with children's vaccination rates.<sup>13</sup> Two studies examining US data for children in low-income families suggested that maternal employment might have negative effects on children's health. By using IFS-CWB data, Slack et al<sup>14</sup> showed that the proxy-reported health status of children whose mothers who did not receive welfare was better if their mothers did not work than if they did. Gennetian et al<sup>15</sup> examined children's health status data from a survey of welfare-to-work program participants in 3 cities across the United States and

reported that maternal employment was modestly associated with lower child health status. Both studies showed negative effects of maternal work on children's health status. In contrast, our study found a positive association of maternal work and on-time vaccination when mothers no longer received welfare (not consistent with either study) but a negative association when mothers were receiving welfare (consistent with the study by Gennetian et al<sup>15</sup>).

One explanation for the negative effect of maternal work in families receiving welfare may be related to the nature of low-income mothers' work. There is evidence that many of the mothers had hourly wage jobs, were not paid for time off for child health visits, and lacked flexibility in their work schedules.<sup>15–20</sup> We posit that such work conditions might have limited mothers' willingness to take time off from work for recommended well-child care health visits and timely vaccinations.

Of particular concern are the significantly lower rates of on-time vaccinations when families were not receiving welfare and mothers were not working (no welfare-no work). A previous study suggested that most unemployed mothers still needed welfare assistance when they were forced off welfare because of either time limits or sanctions.<sup>19</sup> Such families experienced substantially decreased economic status,<sup>21</sup> greater food insecurity,<sup>22–24</sup> and higher odds of being hospitalized.<sup>22</sup> Although TANF enrollment was not required for Medicaid eligibility, most of those mothers were not covered by Medicaid<sup>7,12</sup> and had reduced access to health care for their children.<sup>25–27</sup> More importantly, mothers not receiving welfare were more likely than those receiving welfare to have health conditions that prevented them from working,<sup>15,19</sup> which also might have contributed to fewer health care visits

for their children and lower vaccination rates.

A study by Dominguez et al<sup>28</sup> reported a 59% on-time vaccination rate for children in public schools in Chicago, Illinois, at 36 months of age. In comparison, this study showed that only 56% of all vaccine doses were administered on time. Despite differences between the studies in the vaccine doses examined and the methods used to identify vaccination timeliness, the study by Dominguez et al<sup>28</sup> suggested that children in the IFS-CWB had a ~3% lower on-time rate than did children in Chicago public schools.

This study has several policy implications. Our results suggest that providing welfare assistance for children in low-income families can increase on-time vaccination rates overall by 43%. For mothers receiving welfare, an additional 30% increase in on-time vaccination rates might be achievable through waiving of work requirements. Illinois currently does not require mothers with children in their first year of life to work for welfare eligibility, but welfare receipt during that time is still counted toward the TANF time limit (5 years). Because most of the recommended vaccine doses are concentrated during the first year of life, excluding children's first year of life from the TANF time limit for their families might further improve timely vaccination rates.

In addition, children who live in families that are no longer receiving welfare and whose mothers are not working are especially vulnerable to missing timely vaccinations. Targeted interventions for this group of children might include the use of an immunization registry,<sup>29</sup> door-to-door canvassing of urban housing development neighborhoods,<sup>30</sup> and outreach initiatives of local governments.<sup>31</sup> As part of these outreach programs, a concerted effort by state agencies responsible

for welfare, unemployment, and health may be necessary to identify such children.

Future TANF legislation should consider mandating that states (1) exclude the 1-year work exemption period from the welfare receipt time limit; (2) create a carve-out rule for families that are no longer receiving welfare and have mothers who are not working, to permit them to be TANF-eligible at least for the first 12 months of their child's life; and (3) intervene with families at the time of removal from welfare when mothers are not working, to ensure that the child is connected with appropriate vaccination outreach programs. Such targeted TANF policies may be a cost-effective way of improving on-time vaccination rates for all US children.

This study has several limitations. First, proximate linking was used to merge survey data with children's vaccine records. The first IFS and IFS-CWB surveys were conducted in 1999 and 2000, respectively, and survey data

may lag by up to 2 years for vaccine doses recommended in 1997. Second, arbitrary cutoff values were used to classify a family as receiving welfare or a mother as working (50% for both). Sensitivity analyses using 40% and 60% cutoff values showed no significant changes in results (data not shown). Third, very conservative windows for defining on-time vaccination were used. A sensitivity analysis with windows for "routine" administration also was consistent with the results. Finally, our data do not reflect recent changes in the economic climate. During the economic downturn in 2007–2010, unemployment rates for women and members of minority groups<sup>32</sup> and TANF enrollment<sup>33</sup> both increased. We conjecture that these changes might have intensified the relationships between welfare, maternal employment, and vaccination rates described here.

## CONCLUSIONS

Despite the study's limitations, the overall on-time vaccination rates were consistent with those in previous re-

search, and the results were robust in sensitivity analyses. Our results indicate that welfare receipt overall was associated with increased on-time vaccination rates but maternal employment among welfare recipients was associated with decreased on-time vaccination rates. This study provides highly relevant information about a subpopulation of children at significant risk for delayed vaccinations. The 3 policy changes we recommended would contribute significantly to reaching the Healthy People 2020 childhood vaccination goal.

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**TOO MUCH LOVE:** Like many others, I have admired both the beauty and engineering of the mollusk called the Chambered Nautilus. Nautilus pompilius, the best-known species of nautilus, has figured prominently in popular culture since the Renaissance when the shells became the staple of curiosity cabinets or made into elaborate drinking vessels. In Victorian England, the Chambered Nautilus was both the subject of poems and a popular decorative item. Now, however, this creature, whose fossil record dates back 500 million years, may be loved too much and because of that, faces extinction. According to an article in The New York Times (*Science: October 24, 2011*), the Chambered Nautilus is facing extinction because jewelry made from its lovely shell has become increasingly popular. The shell, often substituted for pearls or made into a variety of items, can be purchased relatively inexpensively on numerous web sites and in stores. Unfortunately, for the Chambered Nautilus, it is easy to catch. The creature lives along the steep banks of deep corals in warm waters off the western Pacific Ocean. While the depths preclude diving, baited traps are quite effective in capturing the cephalopod. No regulations govern the catching and sale of the Chambered Nautilus. This has led to over-harvesting. Because it may take the Chambered Nautilus up to 15 years to reach sexual maturity, the rapidly dwindling stocks are of great concern. A recent expedition to the Philippines documented orders of magnitude fewer specimens. While other creatures facing extinction (e.g., the Polar Bear), have been accorded endangered species status, no such protection has been afforded the Chambered Nautilus. While scientists are trying to learn more about this ancient creature and others lobby for its protection, I will avoid purchasing products made from its shell and advise others to do the same.

Noted by WVR, MD

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Min-Woong Sohn, Joan Yoo, Elissa H. Oh, Laura B. Amsden and Jane L. Holl  
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