Relationship Between Medical Well Baby Visits and First Dental Examinations for Young Children in Medicaid

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Objectives. We examined the relationship between preventive well baby visits (WBVs) and the timing of first dental examinations for young Medicaid-enrolled children.

Methods. The study focused on children born in 2000 and enrolled continuously in the Iowa Medicaid Program from birth to age 41 months (n = 6322). The main predictor variables were number and timing of WBVs. The outcome variable was timing of first dental examination. We used survival analysis to evaluate these relationships.

Results. Children with more WBVs between ages 1 and 2 years and ages 2 and 3 years were 2.96 and 1.25 times as likely, respectively, to have earlier first dental examinations as children with fewer WBVs. The number of WBVs before age 1 year and the timing of the WBVs were not significantly related to the outcome.

Conclusions. The number of WBVs from ages 1 to 3 years was significantly related to earlier first dental examinations, whereas the number of WBVs before age 1 year and the timing of WBVs were not. Future interventions and policies should actively promote first dental examinations by age 12 months at WBVs that take place during the first year of life. (*Am J Public Health.* 2013;103:347–354. doi:10.2105/AJPH.2012.300899)

The 2011 Institute of Medicine report *Improving Access to Oral Health Care for Vulnerable and Underserved Populations* highlighted the persistent disparities in dental care access that affect young children.[1] Fewer than 5% of children have a dental examination by age 12 months as recommended by the American Academy of Pediatrics and the American Academy of Pediatric Dentistry.[2–5] A cornerstone in prevention, dental examinations provide dentists the opportunity to deliver risk-based anticipatory guidance to caregivers, allow for less invasive restorative interventions when disease is already present, and are a source of preventive care provided throughout childhood.[6,7]

Dental examinations are part of a comprehensive strategy to prevent early childhood caries, a type of tooth decay that affects children aged younger than 6 years.[8] Early childhood caries is the most common pediatric disease in the United States and is a public health problem that disproportionately affects low-income children.[9–11] A 70% increase occurred in the prevalence of untreated early childhood caries among low-income children aged 2 to 5 years between 1988 to 1994 and 1999 to 2004.[12] Thus, it is a growing problem. Untreated early childhood caries can lead to pain, infection, hospitalization, and in rare cases death[13–15] and is associated with subsequent tooth decay in the permanent teeth, poor school attendance, and low quality of life—consequences that have deleterious effects throughout the life course.[16–18]

From a public health perspective, earlier first dental examinations are likely to help prevent early childhood caries among low-income children enrolled in state Medicaid programs.[19] One study reported that earlier first dental examinations for Medicaid-enrolled children reduce the need for invasive restorative treatments and are cost effective.[2] The barriers to early first dental examinations include dentists' unwillingness to treat young children, limited caregiver knowledge of when to take their child to a dentist, medical provider uncertainty of when to refer young children, and low Medicaid reimbursement.[20–22]

Although few children have a first dental examination by age 12 months, most have multiple well baby visits (WBVs) by this age.[23] Previous studies have reported associations between preventive medical and dental care use as well as between preventive medical care use and the timing of first dental visits for Medicaid-enrolled children aged 3 to 8 years.[24–26] However, no study has focused on the relationship between WBVs and first dental examinations for young Medicaid-enrolled children younger than 3 years, with an emphasis on how the frequency and timing of WBVs are related to the timing of first dental examinations.

In this study, we adapted a sociocultural oral health disparities model presented by Patrick et al.[27] to test 3 hypotheses: (1) young children with more WBVs are more likely to have earlier first dental examinations than those with fewer WBVs, (2) young children with earlier first WBVs are more likely to have earlier first dental examinations, and (3) other social and behavioral factors are associated with earlier first dental examinations. We focused on WBVs because of the conceptual link between medical and dental care use.[24–26] These first 2 hypotheses are based on the premise that WBVs are proxies for health-related behaviors and beliefs influenced by the motivations, values, and personal preferences for earlier first dental examinations by caregivers.[27] The third hypothesis is based on the premise that factors at the system, community, and family level make up the milieu in which decisions are made by caregivers to seek dental care for their child.[27] The information gleaned from this study could help identify specific points in the WBV periodicity schedule at which future population-based interventions aimed at getting infants to the dentist earlier for their first dental examination could be implemented.

METHODS

This study was a retrospective cohort study based on Iowa Medicaid enrollment and claims data (2000–2008) and was approved by the University of Iowa institutional review board.

Study Participants

In calendar year 2000, 14 364 children were born and were enrolled in Iowa Medicaid at birth. We excluded 7611 children who were enrolled less than 41 continuous months to allow for complete identification of each of the 10 recommended WBVs (see Main Predictor Variables section). In addition, we excluded 133 children who received dental care from a community health center to focus on children seen in private practice clinics.

Because our interest was on prevention-oriented dental examinations rather than treatment-driven visits, we also excluded children who received any restorative dental care before the first examination (n = 170) and those who received restorative dental care but no examination (n = 128). The final study population consisted of children born in calendar year 2000 who were enrolled for 41 or more continuous months starting from birth and who received dental care from private practice dental clinics (n = 6,322).

Study Variables

We organized model covariates into 5 domains (Figure 1): ascribed factors (immutable individual-level variables), proximal factors (modifiable individual-level variables), immediate factors (household-level mediators between proximal and intermediate variables), intermediate factors (community-level variables), and distal factors (system-level variables).

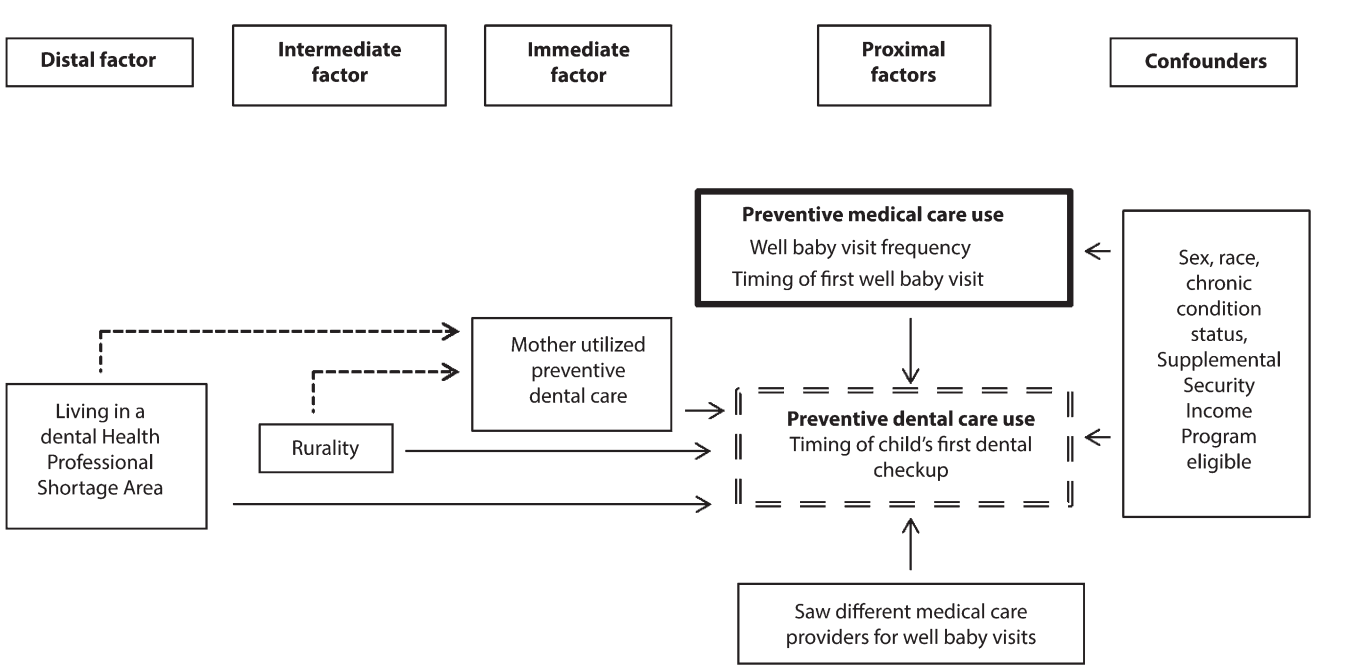
We conceptualized the predictor variables and the outcome measure as proximal factors, and they reflect the hypothesized link between medical and dental care use.[24–27]

Main Predictor Variables

The 2 sets of predictor variables were both proximal factors: (1) the total number of WBVs from birth to age 41 months (WBV frequency) by period and (2) the age at which the first WBV took place (timing of the first WBV). WBVs were identified from claims files using the following *International Classification of Diseases, Version 9, Clinical Modification* (*ICD-9-CM*)[28] and Current Procedural Terminology (CPT) codes: V20.2, V70.0, V70.3, V70.5, V70.6, V70.8, V70.9, 99381, 99382, 99391, 99392, and 99432.[29]

We used the 2000 American Academy of Pediatrics WBV schedule to assess whether a child received each of the following 10 recommended WBVs (no or yes): 1 month, 2 months, 4 months, 6 months, 9 months, 12 months, 15 months, 18 months, 24 months, and 36 months.[4] We calculated the age at which each WBV took place by subtracting the child's date of birth from the WBV date of service and applying previously published age ranges around each WBV to allow flexibility in when WBVs occurred.[30] For example, we classified a child who had a WBV between age 7 days and younger than 1 month as having had the 1-month WBV (Table 1).

To measure WBV frequency, we classified each WBV into 1 of 3 periods on the basis of age ranges relevant in dentistry and summed them (Table 1): number of WBVs before age



Note. Dotted arrow indicates potential mediating pathway not evaluated in current study.
Source. The 5 model domains under which covariates were organized are based on Patrick et al.[27]

FIGURE 1—Conceptual model of relationship between well baby visits and timing of first dental examinations for Medicaid-enrolled children.

TABLE 1—Age Ranges Applied to Each Well Baby Visit by Period and American Academy of Pediatrics Well Baby Visit Schedule Recommendations

WBV Schedule[4]	Age Ranges[30]
Period 1	
Total no. WBVs by age 1 y (minimum 0, maximum 5)	
1 mo	7 d–< 1 mo
2 mo	1 mo–2 mo
4 mo	3 mo–4 mo
6 mo	5 mo–7 mo
9 mo	8 mo–10 mo
Period 2	
Total no. WBVs between age 1 and 2 y (minimum 0, maximum 3)	
12 mo	11 mo–13 mo
15 mo	14 mo–16 mo
18 mo	17 mo–19 mo
Period 3	
Total no. WBVs between age 2 and 3 y (minimum 0, maximum 2)	
24 mo	20 mo–29 mo
36 mo	30 mo–41 mo

Note. WBV = well baby visit.

1 year (period 1, age at which primary incisors begin to erupt; as many as 5 visits possible), number of WBVs between ages 1 and 2 years (period 2, age at which primary molars begin to erupt; as many as 3 possible visits), and number of WBVs between ages 2 and 3 years (period 3, age at which all primary teeth have erupted; as many as 2 visits possible).

The timing of the first WBV consisted of 2 variables: (1) whether the first WBV took place by time *t* (a time-dependent indicator variable) and (2) the interaction between the first variable and the exact age (in days) at which the first WBV took place.

Main Outcome Measure

The main outcome measure, a proximal factor, was the timing of the child's first dental examination measured as the first prevention-oriented dental examination. We used the following American Dental Association Current Dental Terminology Codes to identify dental examinations from the claims files: D0150 (comprehensive dental examination) or D0120 (periodic dental examination).[31] We included the D0120 code because some dentists use this to code young children's first dental examination rather than the more appropriate D0150.

Model Covariates

There were 8 additional model covariates organized into the following domains:

- Ascribed factors, modeled as confounders: child's sex (male or female); child's race, a factor related to the timing of dental visits for children,[32] as reported by the child's caregiver (White, non-White, or missing); whether the child was at risk for developing a chronic condition (no or yes), a measure developed in consultation with a pediatrician with expertise in chronic conditions (John Neff, MD, personal communication, November 18, 2010; defined as an *ICD-9-CM,* CPT, or Healthcare Common Procedure Coding System codes indicating ventilator use, gastrostomy, tracheotomy, premature birth, low birth weight, infantile seizures, or newborn apnea during the first 16 months of life)[26]; and whether the child was eligible for Medicaid through the Supplemental Security Income Program for 6 or more months during the first year of life (no or yes), a measure of chronic condition severity.[33]
- Proximal factor: whether the child saw different medical providers for WBVs (no or yes), a measure of the caregiver's preference for or ability to obtain child health care services consistent with the medical home concept.[34]
- Immediate factor: whether the child's mother used any preventive dental care 12 months before the child was born (no or yes), a proxy for the caregiver's preferences for preventive dental care.[35]
- Intermediate factor: rurality, a 4-level variable based on the 2003 US Department of Agriculture Rural and Urban Continuum Codes associated with the child's residence (rural, urban nonadjacent to metropolitan, urban adjacent to metropolitan, metropolitan), which measures the physical, social, and economic resources available within the community.[26]
- Distal factor: whether the child lived in a dental Health Professional Shortage Area (no or yes), a measure of the dentist resources available at the system level.[26]

Statistical Analyses

We used survival analysis to test our study hypotheses. Data were censored for children with no examination by age 41 months, the end of the study period. For the survival analyses, children were part of the risk set until their first dental examination. Before running our regression models, we evaluated the proportional hazards assumption using time-dependent covariates in the form of {covariate * [log(time) − mean log(time)]}.[36] For any variable that violated this assumption, we included both the main effect and the time-dependent covariate in the model. We ran 3 multiple-variable Cox proportional hazards regression models ($\alpha = .05$) that included the following as time-dependent variables: (1) WBV frequency across 3 periods, (2) timing of the first WBV, or (3) both WBV frequency and the timing of the first WBV. Because we found no differences across the models, we reported hazard ratios and 95% confidence intervals from model 3. We completed all analyses using SAS version 9.3 (SAS Institute, Cary, NC).

RESULTS

The proportions of boys and girls in our study were near equal (49.5% and 50.5%, respectively; Table 2). Most children were White (76.6%), 20.2% were non-White,

TABLE 2—Descriptive Data on Study Population of Children in the Iowa Medicaid Program (n = 6322): 2000–2008

Model Covariate	No. (%)
Ascribed factors	
Sex	
Female	3129 (49.5)
Male	3193 (50.5)
Race	
White	4842 (76.6)
Non-White	1277 (20.2)
Missing	203 (3.2)
At risk for developing a chronic condition	
No	4261 (67.4)
Yes	2061 (32.6)
Eligibility for Medicaid through the Supplemental Security Income Program	
No	6191 (97.9)
Yes	131 (2.1)
Proximal factor	
Saw different medical providers for well baby visits	
No	366 (5.8)
Yes	5956 (94.2)
Immediate factor	
Mother used any preventive dental care in the 12 mo before the child was born	
No	5320 (84.2)
Yes	1002 (15.8)
Intermediate factor	
Rurality	
Metropolitan	3507 (55.5)
Urban adjacent to metropolitan	1227 (19.4)
Urban nonadjacent to metropolitan	1217 (19.3)
Rural	371 (5.9)
Distal factor	
Lived in a dental Health Professional Shortage area	
No	2178 (34.5)
Yes	4144 (65.5)

and 3.2% had unknown or missing race/ethnicity. About 1 in 3 children were at risk for developing a chronic condition, and 2.1% were enrolled in Medicaid through the Supplemental Security Income Program. Only 5.8% of children saw the same medical provider for WBVs. Nearly 16% of children had a mother who used preventive dental care prenatally. Finally, 55.5% of children lived in a metropolitan area, and 65.5% lived in a dental Health Professional Shortage Area.

Well Baby Visits and First Dental Examinations

All children had at least 1 WBV during the first 41 months of life. The 2nd-month WBV was the most frequently received WBV (85.6%) and the 36th-month WBV was the least frequently received (41.7%; data not shown).

In terms of frequency of WBVs, 55.1% of children had 4 or 5 WBVs in period 1, 64.7% had 2 or 3 WBVs in period 2, and 74.3% had 1 or 2 WBVs in period 3 (data not shown).

As for the timing of the first WBV, 57.1% of children had their first WBV by age 30 days and 24.8% had it between age 31 days and age 60 days. The remaining 18.1% of children had their first WBV after age 61 days but before age 42 months.

Fewer than 2% of children had a first dental examination by age 12 months and about 25% had an examination before age 3 years (data not shown). About 10% of children had their first dental examination after age 3 years but before age 41 months and 35% had an examination after age 41 months. Nearly 30% of children had no first dental examination.

Cox Regression Model

Two variables—the number of WBVs in period 2 and whether the child saw different medical providers for WBVs—violated the proportional hazards assumption ($P = .01$ and $P = .01$, respectively). Thus, we included the main effect and time-dependent forms of both covariates in the regression models.

Children with more WBVs in period 2 (between ages 1 and 2) and period 3 (between ages 2 and 3) were 2.96 and 1.25 times as likely to have earlier first dental examinations (Table 3). WBV frequency in period 1 (between birth and age 1) and the timing of first WBV were not related to the timing of examinations.

Three other model covariates were significantly related to earlier first dental examinations: non-White race, whether the child saw different medical providers for WBVs, and whether the child's mother used preventive dental care prenatally. Non-White children were 1.14 times as likely to have earlier first dental examinations as White children ($P = .02$), whereas those who saw different medical providers for WBVs were less likely to have earlier examinations (hazard ratio = 0.10; $P = .001$). Children whose mothers used preventive dental care prenatally were 1.40 times as likely to have an earlier examination as children whose mothers did not ($P < .001$).

DISCUSSION

This is the first study, to our knowledge, to examine the relationship between the frequency and timing of WBVs and the timing of first dental examinations for Medicaid-enrolled

TABLE 3—Final Cox Proportional Hazards Regression Model for Time to First Dental Examination for Medicaid-Enrolled Children (n = 6322) in Iowa: 2000–2008

Model Covariate	Hazard Ratio (95% CI)	*P*
Main predictor variables		
WBV frequency		
Period 1	0.97 (0.93, 1.02)	.203
Period 2	2.96 (1.41, 6.15)	.004
Time-dependent covariate: Period 2 * [log(time) – mean log(time)]	0.76 (0.63, 0.93)	.006
Period 3	1.25 (1.14, 1.36)	<.001
Age at first well baby visit		
Rate of the first WBV	6.07 (0.79, 46.65)	.083
Interaction between the rate of the first WBV and the time at which the first WBV took place	1.00 (0.99, 1.01)	.64
Ascribed factors		
Sex		.243
Female	0.95 (0.86, 1.04)	
Male (Ref)	1.00	
Race		
White (Ref)	1.00	
Non-White	1.14 (1.02, 1.28)	.02
Unknown or missing	1.16 (0.89, 1.53)	.276
At risk for developing a chronic condition		.443
No (Ref)	1.00	
Yes	0.96 (0.87, 1.07)	
Eligibility for Medicaid through the Supplemental Security Income Program		.281
No (Ref)	1.00	
Yes	0.82 (0.57, 1.18)	
Proximal factors		
Saw different medical providers for WBVs		.001
No (Ref)	1.00	
Yes	0.10 (0.02, 0.41)	
Time-dependent covariate: Saw different medical providers for WBVs * [log(time) – mean log(time)]	0.56 (0.38, 0.83)	.004
Immediate factor		
Mother used any preventive dental care in the 12 mo before the child was born		<.001
No (Ref)	1.00	
Yes	1.40 (1.25, 1.57)	
Intermediate factor		
Rurality		
Metropolitan (Ref)	1.00	
Urban adjacent to metropolitan	1.00 (0.89, 1.14)	.956
Urban nonadjacent to metropolitan	1.05 (0.93, 1.19)	.458
Rural	1.16 (0.96, 1.41)	.133
Distal factor		
Lived in a dental Health Professional Shortage Area		.207
No (Ref)	1.00	
Yes	0.94 (0.85, 1.04)	

Note. WBV = well baby visit.

preschool-aged children. We had 3 main findings.

First, we tested the hypothesis that children with more WBVs during 3 periods of early childhood would have earlier first dental examinations. Only between ages 1 to 2 and 2 to 3 years were more WBVs significantly associated with earlier examinations. These findings are consistent with previous work suggesting significant relationships between preventive medical and preventive dental care use[24,25] and first preventive dental visits[26] for Medicaid-enrolled children. Conversely, the number of WBVs received before age 1 year was not significant. There are 3 possible reasons: (1) primary (baby) molar teeth begin erupting around age 1 year, which may also be the age at which physicians begin to introduce the importance of dental examinations to caregivers[37]; (2) mothers may be more receptive to the message of first dental visits after children have more of their teeth; and (3) it takes time for dental disease to manifest clinically. The period after age 1 year is when physicians may first detect dental disease, at which time dental referrals for treatment become necessary.

Second, we tested the hypothesis that children with an earlier first WBV would also have an earlier first dental examination. We found that the timing of the first WBV was not related to the timing of the first examination. Although this variable is conceptually relevant, the reason it failed to reach statistical significance in our model may be related to low variance. More than 90% of children had their first WBV by age 3 months, and 99% had their first WBV by age 11 months.

Third, we tested the hypothesis that other social and behavioral factors would be related to the timing of first dental examinations, and we identified 3 important factors. First, non-White children were significantly more likely to have earlier first dental examinations than were White children. Previous studies have suggested race- and ethnicity-based variation in dental care use.[32,38,39] Earlier first dental examinations for non-White children may indicate greater levels of dental disease and caregiver motivation to take their child to the dentist, although this interpretation requires verification in a future study. Second, children who saw the same medical provider for WBVs had significantly earlier first dental

examinations, which suggests additional benefits associated with having a usual source of medical care.[38] Seeing the same medical provider increases the likelihood of consistent anticipatory guidance and may facilitate enhanced communication between caregivers and pediatricians.[34,40] Third, children whose mothers used preventive dental care prenatally were significantly more likely to have earlier examinations. A possible explanation is that these mothers may learn about the importance of infant oral health from their dentist. However, knowledge gaps among dentists make this unlikely.[41–43] A more plausible explanation is that these caregivers have higher levels of health literacy and a stronger preference for oral health,[44,45] which translate into prevention-oriented health behaviors and earlier first dental examinations for their children. This finding is consistent with previous work linking mother and child dental care use[35] and supports policies aimed at ensuring dental homes for mothers both prenatally and postnatally.

In regard to our conceptual model, it appears that 1 proximal factor (whether the child saw different medical providers for WBVs) and 1 immediate factor (whether the child's mother used preventive dental care) were related to the timing of first dental examinations. We found no significant differences across the intermediate factor (rurality) and the distal factor (living in a dental Health Professional Shortage Area). These findings suggest that the determinants of the timing of first dental examinations for young Medicaid-enrolled children are influenced by child- and family-level factors rather than upstream community- and system-level factors. Future studies should examine the potentially modifying role of upstream factors such as rurality and living in a dental Health Professional Shortage Area.

Our findings are relevant to the development and improvement of medical office–based interventions aimed at reducing oral health disparities in young children, such as North Carolina's Into the Mouth of Babes Program.[46] Because children are more likely to visit a physician for preventive care than a dentist by age 12 months, WBVs are a point of intervention to train physicians and nurses to recommend first dental examinations for all children by age 12 months. Formal partnerships between medical and dental offices may facilitate the referral process and allow medical office personnel to follow up with dentist referrals. In areas with dentist shortages or waiting lists for dental appointments, oral health screenings and direct preventive care in the form of fluoride varnish by physicians may be the only care children receive until they are seen by a dentist. Although 46 state Medicaid programs reimburse physicians for applying fluoride varnish,[47] Medicaid reimbursements alone are not likely to create an incentive for medical offices to participate in formal oral health prevention programs.[48] Medical office–based preventive interventions should incorporate intensive training to help medical providers overcome knowledge barriers and increase their confidence in providing oral health–related anticipatory guidance.[21,49]

Limitations

Our study had 4 main limitations. The first is that our findings are only generalizable to children continuously enrolled in Medicaid from birth to age 41 months. The relationship between WBVs and first dental examinations for children who are intermittently enrolled in Medicaid may be different. The second is the potential for selection bias. Caregivers whose children have more WBVs may have stronger preferences for oral health and health in general, which may induce a noncausal correlation between WBVs and dental examinations. Unobserved child health factors may also confound this relationship. Future studies should collect data from caregivers to account for other potentially important behavioral factors (e.g., perceived severity of dental disease, self-efficacy of obtaining care) associated with earlier first dental examinations. Instrumental variable and propensity score analytic methods may address selection, although both approaches have limitations that require careful consideration.[50–53] Furthermore, additional covariates from the distal, intermediate, and immediate domains need to be included. Third, children with earlier examinations may already have dental disease when they initially present at the dentist. In other words, disease rather than prevention may be a driver of earlier first examinations, which conflicts with a primary prevention model. However, fewer than 2% of children in our study received restorative treatment on the same date as the first dental examination. In the future, clinical dental data would help to identify the potential modifying role of disease. Fourth, the analyses were based on children born in 2000, which gives us a baseline perspective on how WBVs are related to first dental examinations. The American Academy of Pediatrics and Bright Futures began recommending in 2000 and 2007, respectively, that physicians assess a child's oral health risk starting at age 6 months.[4,54] Examining the relationship between WBVs and first examinations over time may reveal how changes in clinical guidelines affect children's dental care use.

Conclusions

Oral health is an integral part of the overall health and well-being of young children. Few children see a dentist by age 12 months, however, which motivates efforts to identify the factors related to earlier first dental examinations. In our study, more WBVs between ages 1 to 2 and 2 to 3 years were significantly associated with earlier first dental examinations. Although this finding provides additional evidence for a relationship between preventive medical and dental care use, it is cause for concern because these WBVs occur past the recommended age at first dental examination of 12 months. In fact, only 2% of children in our study had an examination by age 12 months and fewer than 1 in 4 children had an examination by age 3 years. It is most worrisome that 30% of Medicaid-enrolled children had no examination even though all of these children had at least 1 WBV and 97.3% had more than 1 WBV. Earlier first dental examinations are not a panacea for disparities in oral health. However, they play an important role in ensuring optimal oral health for young children. Additional research is needed to further understand the relationship between WBVs and first dental examinations with an emphasis on identifying the behavioral and social determinants of first dental examinations and uncovering the mechanisms that drive these relationships. This knowledge can then be used to develop appropriate clinical and policy solutions aimed at optimizing the oral health of all young children. ■

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Contributors

D. L. Chi conceptualized the study, synthesized the analysis plan, analyzed the data, and led the writing of the article. E. T. Momany assembled the data sets and assisted with writing the article. M. P. Jones assisted with conceptualizing study variables and the data analyses. R. A. Kuthy assisted with study conceptualization and with writing the article. N. M. Askelson assisted with study conceptualization and with writing the article. G. L. Wehby assisted with study conceptualization and with writing the article. P. C. Damiano helped synthesize the analysis plan and assisted with writing the article. All authors helped to refine the final study design, interpret findings, and review drafts of the article.

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Human Participant Protection

This study protocol was approved by the institutional review board at the University of Iowa.

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