The Concordance of Parent and Child Immunization

Steve G. Robison, MPH, Andrew W. Osborn, MBA

abstract

BACKGROUND: A substantial body of work has related survey-based parental vaccine hesitancy to noncompliant childhood immunization. However little attention has been paid to the connection between parents' own immunization behavior and the immunizations their children receive.

METHODS: Using the Oregon ALERT Immunization Information System, we identified adult caregiver–child pairs for children between 9 months and 17 years of age. The likelihood of adult–child concordance of influenza immunization per influenza season from 2010–2011 through 2014–2015 was assessed. The utility of adult immunization as a predictor was also assessed for other, noninfluenza recommended immunizations for children and adolescents.

RESULTS: A total of 450 687 matched adult caregiver–child pairs were included in the study. The children of immunizing adults were 2.77 times more likely to also be immunized for seasonal influenza across all seasons (95% confidence interval, 2.74–2.79), with similar results applying within each season. Adult immunization status was also significantly associated with the likelihood of children and adolescents getting other noninfluenza immunizations, such as the human papillomavirus vaccine (HPV). When adults improved their own behavior from nonimmunizing to immunizing across influenza seasons, their children if not immunized in the previous season were 5.44 times (95% confidence interval, 5.35–5.53) more likely to become immunized for influenza.

CONCLUSIONS: Children's likelihood of following immunization recommendations is associated with the immunization behavior of their parents. Encouraging parental immunization is a potential tool for increasing children's immunization rates.

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Mr Robison conceptualized and designed the study, carried out initial analyses, drafted the initial manuscript, and revised the manuscript; Mr Osborn assisted in conceptualizing and designing the study, performed data extracts and analyses, and reviewed and revised the manuscript; and both authors approved the final manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: Parental vaccine attitudes are well known to be predictive of children's immunizations; less is known about the relation of parent's own immunizations to those of their children.

WHAT THIS STUDY ADDS: To the best of our knowledge this is the first population-based study linking parents' own immunization behavior to what their children receive. Tracking and encouraging parental immunization may lead to increases in children's immunization rates.

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A central tenet of public health is the need to immunize children, both to build herd immunity and to provide for early-life protection against infectious disease. Herd immunity among children in the United States is built through a combination of recommended early childhood immunizations and mandated school immunizations. Most parents voluntarily follow the recommended childhood immunization schedule, although a substantial minority of parents are vaccine hesitant and likely to miss ≥1 recommended immunization. Parental vaccine hesitancy is a common and well-recognized factor in incomplete childhood immunizations.[1–4] The current degree of hesitancy is problematic in public health for several reasons: Clusters of the hesitant create opportunities for outbreaks, unimmunized or delayed infants are vulnerable to diseases such as pertussis, and increasing hesitancy is a factor behind increasing exemptions to school immunization mandates.[5,6] In addition, not all recommended immunizations are covered by school mandates, so the problem of compliance may be left to the ability of providers to cope with hesitant parents.

Identifying vaccine-hesitant parents before they decline vaccination for their children is potentially of use in clinical practice and would allow providers to deliver additional education. Recently studies have examined the use of attitudinal surveys as screening tools in clinical practice for hesitancy.[7,8] Measuring parental attitudes toward immunization is also a common approach in survey research on vaccine acceptance and children's immunizations.[9,10] However, routinizing attitudinal surveys into clinical practice for new parents is likely to face challenges of time, cost, and patient trust. In addition, interventions based on early attitudinal screening may be problematic in effect.[11]

This study presents an alternative approach to the use of attitudinal measures to screen parents for their likelihood of refusing or limiting immunizations. The utility of attitudinal measurement arises largely from its lower cost and ease as compared with collecting observational or behavior-based data.[12] Vaccine hesitancy as a category is not well defined, with academic debate about whether it is an attitude or a behavior.[13] For assessing children's immunization likelihood, there is a relevant and readily available piece of behavioral data: the parent's own immunization record. In the United States many immunization registries hold robust collections of child immunization, and they are expanding into adult immunizations.[14–16] As seasonal influenza immunization is recommended anew every year, tracking the receipt of this vaccine provides a record of parents' own past and current behaviors. The primary aim of this study was to assess whether parental behavior as measured by their receipt of seasonal influenza immunization is predictive of whether their children receive immunizations. A secondary aim of this study was to assess whether changes in parental immunization behavior over time predict changes in their children's immunization likelihood for seasonal influenza or other vaccines. A positive finding for the change over time suggests that immunization noncompliance should be viewed as a family issue, with increasing adult immunization rates a possible intervention for increasing childhood immunization rates.

METHODS

This study was set in the Oregon Sentinel Surveillance Region, which as of 2016 consisted of 6 counties around the Portland metropolitan area and the upper Willamette Valley. This Sentinel Region is part of a Centers for Disease Control and Prevention–sponsored immunization surveillance network across 6 sites (5 US states and New York City) that monitors trends in immunizations. The study population consisted of matched adult caregiver–child pairs, based on children between 9 months and 17 years of age as of January 1, 2015, with a last-reported residence in the Oregon Sentinel Region. Immunization records for study children and adults were collected from the ALERT Immunization Information System (ALERT IIS). For adults, influenza immunization records were collected covering the 2010–2011 through 2014–2015 influenza seasons, defined as August through May. Children's immunizations for all recommended series including influenza were collected from birth through June 30, 2015. The ALERT IIS is a life span immunization registry, collecting immunization records from almost all immunizing Oregon providers and payers. Clinics and health care systems participating in the Vaccines for Children program in Oregon, which serve >95% of Oregon children, are required to report all administered immunizations to the ALERT IIS regardless of whether the client is using a Vaccines for Children vaccine and regardless of age. In the Sentinel region >95% of immunizations are submitted to ALERT IIS within 7 days of administration, primarily through real-time and bidirectional exchange of immunization data between electronic health records and ALERT IIS. Similarly, Oregon pharmacies, which deliver >40% of adult influenza immunizations and adolescent immunizations, are required by the Oregon Board of Pharmacy to use and report all immunizations through the ALERT IIS. In the 2014–2015 influenza season, >1.3 million influenza immunizations were reported to the ALERT IIS, out of an estimated total of 1.6 million given during the season.

Adult caregivers were matched to children based on who accompanied the child on immunization visits. For each child immunization visit reported to the ALERT IIS, a provider also reports information on the accompanying adult caregiver, labeled in ALERT IIS as the child's responsible party (RP). Typically an RP is identified as a parent, although if this relationship is not provider identified the ALERT IIS default will set their role as "guardian." RP records contain the adult's name, address, and phone number; in contrast, adult immunization encounter records contain name, address, phone number, and date of birth. In Oregon, the combination of the first 3 letters of the first name, first 4 letters of the last name, and a date of birth are >99.9% unique (Oregon Health Division, unpublished data); a challenge for matching RP data to adult immunization encounters is the lack of an adult date of birth in the child's encounter data. As an alternative matching approach, RP adult records were matched to adult immunization records based on either name substrings and exact phone number matches or name substrings and address matches. In cases where >1 RP was identified for a child, adult selection was based first on who had accompanied the child on any visits in the most recent influenza season and, second, if multiple RPs for a child had records in the same influenza season, then on whether the RP was identified as a parent rather than as a guardian. For analysis the RP was taken as a proxy for parents.

In this study the primary analysis compared adult caregiver influenza immunization status in each of the influenza seasons from 2010–2011 through 2014–2015 with influenza immunization among their children in the same season, with adult caregiver–child pairs used for analysis. Results are presented as the likelihood, per influenza season, of child immunization given adult influenza immunization receipt. This likelihood was calculated as the rate of child immunization among those with immunizing adults divided by the rate of child immunization among those with nonimmunizing adults, which is a relative risk (RR). This form of test direction, comparing likelihoods of being immunized rather than likelihoods of not being immunized, was chosen so that potential biases from adult underreporting of immunizations would be conservative.

Adult immunizations have a greater degree of underreporting compared with well-reported childhood immunizations in Oregon. The effect of this adult underreporting is likely to be to bias true results downward. To illustrate this point, consider that the premise here is of adult–child agreement on immunization behavior. Then the null hypothesis is that independence holds between adult and child immunizations. If the null hypothesis is true, then the rate of childhood immunization is the same between those with immunizing and nonimmunizing adults. In that case, adult underreporting will shift adult–child pairs between categories without changing rates. On the other hand, if independence is rejected, then some degree of adult–child concordance exists. Then, for underreported adults, more children will have immunizations than among those with true nonimmunized adults. Correcting underreporting then will decrease the apparent immunization rate among the children with nonimmunized adults and increase the calculated likelihood ratio. Thus, the present likelihood calculation probably understates true concordance, so a significant result here will remain so if underreporting did not occur. Another potential bias is that families may move out of state while still appearing active in the IIS, leading to inflated population counts. As a check on this potential bias, we calculated population-adjusted likelihoods controlling for potential unreported mobility.[17]

Another question is whether adults' own influenza immunization behavior affected children's immunizations other than influenza. To address this question in brief, we also compared adult influenza immunization in the 2014–2015 season with their children's immunizations in a 4:3:1:3:3:1 series (4 diphtheria–tetanus–acellular pertussis [DTaP], 3 polio, 1 measles–mumps–rubella, 3 hepatitis B, 3 *Haemophilus influenzae* type b, 1 varicella) for those age 4 to 10, to 3+ DTaP among those aged 9 months to 3 years, and to adolescent meningococcal and human papillomavirus (HPV) immunizations for those age 11 to 17.

The potential to increase child immunization rates by encouraging adult immunizations depends not only on whether an association exists between child and adult immunizations but also on whether this relationship is dynamic, with yearly changes in adult influenza immunization behavior tied to changes in their children's immunization receipt. To test this dynamic potential, we assessed whether adult changes in influenza immunization across consecutive seasons, from 2010–2011 through 2014–2015, were associated with changes in their children's influenza immunizations across seasons. Adult increases and decreases in immunization behavior were assessed separately. All likelihood statistics were calculated in WinPepi.[18]

RESULTS

For the Oregon Sentinel Region, as of the assessment date there were

TABLE 1 Study Population and 2014–2015 Influenza Immunizations

Child Age	*N*	Rate (%)
11–17 y	193 621	22.4
7–10 y	118 971	27.9
4–6 y	81 712	35.8
6 mo–3 y	56 383	52.8
Total	450 687	30.4

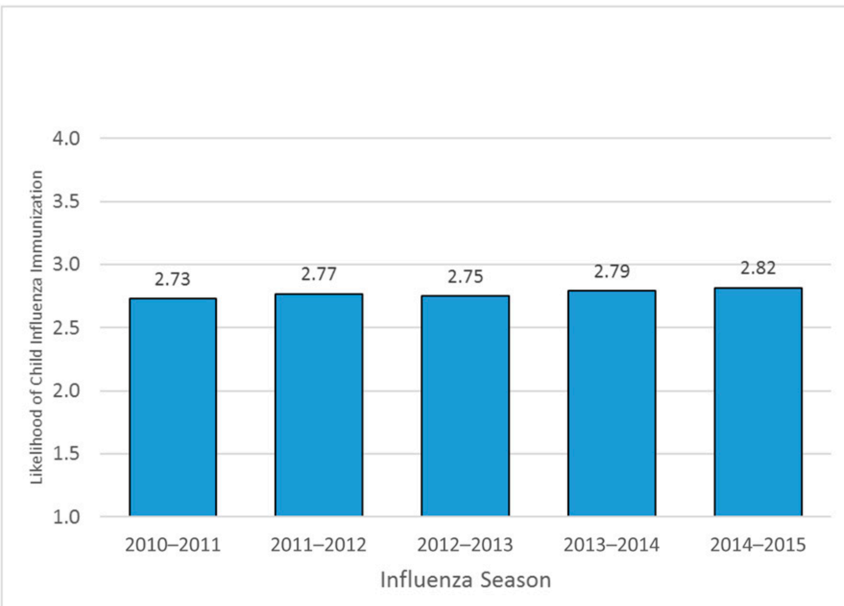

FIGURE 1
Increased likelihood of child influenza immunization given parent or guardian influenza immunization by influenza season, Oregon Sentinel Region.

450 687 children between the ages of 9 months and 17 years for whom an adult caregiver (RP at immunization visits) was identified in the ALERT IIS. For comparison, we estimated that there were 483 000 adult–child pairs for children age 9 months to 17 years in the study region as of the assessment date, based on census household data. Among study children, 73.8% of their adult caregivers were identified as parents, and 21.3% were in the ALERT IIS default category of “guardian”; 2.0% of adult caregivers were listed as nonparental relatives of study children, such as grandparents; and 2.8% were unspecified. Overall, 36.5% of study children received an influenza immunization in the 2014–2015 season, along with 17.2% of their adult caregivers. Influenza immunization rates decreased in relation to the age of the child (Table 1).

For the primary study question of the association between adult caregiver and child influenza immunization, when adult caregivers received influenza immunizations, their children were 2.77 times more likely to also receive an influenza immunization (95% confidence interval [CI], 2.74–2.79). Similar levels of concordance were observed across all seasons (Fig 1). Restricting the analysis to identified parents rather than all adult caregivers did not significantly change the observed rates (RR = 2.77; 95% CI, 2.75–2.80). As a check on population representation bias, where the ALERT IIS may contain records for children and adults who are no longer resident in the region, using a weighting adjustment slightly reduced overall likelihood to 2.22 (95% CI, 2.20–2.24). For the 2014–2015 season, where data were available for all age groups 9 months to 17 years old as of January 1, observed concordance was weakest for those aged 9 months to 3 years (RR = 1.75; 95% CI, 1.73–1.78), who were also more likely to have immunization visits during the season for other, noninfluenza immunizations according to schedule. Those aged 4 to 6 years were 2.56 times more likely to receive an influenza immunization if their adult caregiver was immunized (95% CI, 2.52–2.60); those aged 7 to 10 years were 3.08 times more likely (95% CI, 3.03–3.13), and those aged 11 to 17 years were 3.23 times more likely (95% CI, 3.18–3.28). Adults were also more likely to be immunized before or on the same day as their children (RR = 2.12; 95% CI, 2.10–2.14).

With regard to the dynamic assessment of concordance across seasons, when prior season unimmunized adults increased their influenza immunizing rates, their unimmunized children were 5.44 times more likely to also be immunized (95% CI, 5.35–5.53). When adults changed from immunizing to nonimmunizing across seasons, their previously immunized children were also 1.78 times more likely to change to nonimmunized for influenza (95% CI, 1.76–1.81). These significant concordance effects were present across all seasons (Fig 2).

For noninfluenza immunization series, a small but significant concordance effect was observed between adult receipt of influenza immunization in the 2014–2015 series and both adolescent and child immunization. Children age 4 to 10 years with an immunizing adult caregiver in the 2014–2015 season were more likely to have 4+ DTaP (RR = 1.12; 95% CI, 1.11–1.12), 3+ polio (RR = 1.09; 95% CI, 1.08–1.09), 1+ measles–mumps–rubella (RR = 1.09; 95% CI, 1.08–1.09), 3+ *Haemophilus influenzae* type b (RR = 1.10; 95% CI, 1.10–1.11), 3+ hepatitis B (RR = 1.12; 95% CI, 1.11–1.12), and 1+ varicella (RR = 1.10; 95% CI, 1.10–1.11). Children age 9 months to 3 years were 2.97 times (95% CI, 2.65–3.34) more likely to have ≥3 DTaP with immunizing adult caregivers. Adolescents age 11 to 17 years with an immunizing adult caregiver were 1.68 times (95% CI, 1.65–1.71) more likely to have initiated the HPV series, 2.06 times (95% CI, 2.03–2.10) more likely to have 3 HPV, and 1.96 times (95% CI, 1.93–2.00) more likely to have 1+ meningococcal vaccine.

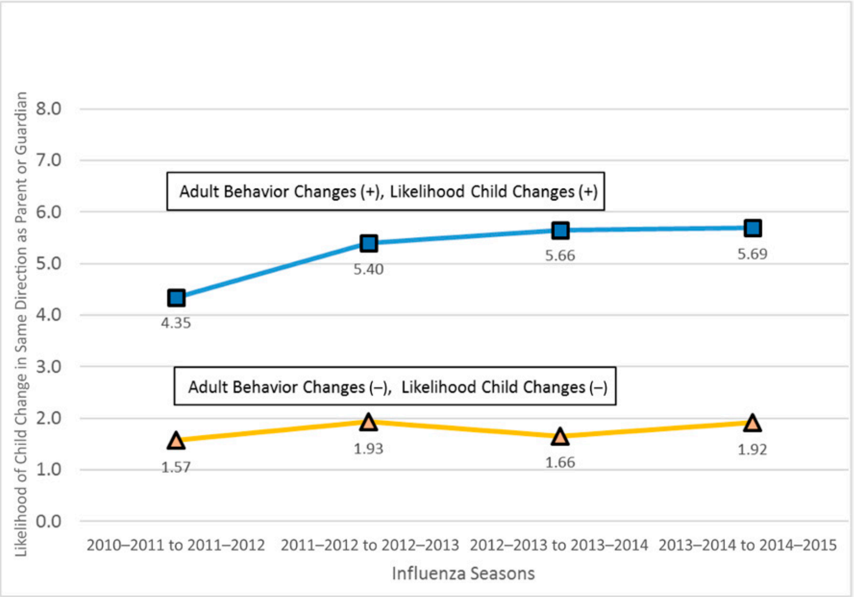

FIGURE 2
Likelihood of child influenza immunization status changing when parent or guardian immunization behavior changes across influenza seasons, Oregon Sentinel Region.

DISCUSSION

This study found a high degree of concordance between adult caregivers and their children with regard to receiving seasonal influenza immunizations. Overall, children with an immunizing caregiver were almost 3 times more likely to also to receive a seasonal influenza immunization. This effect was observed for all child ages in the study, including adolescents, although it was weaker for infants, whose immunizations are driven also by early well-baby visits. The observed adult–child concordance effect was also observed across all 5 study years, with little variation between years. This finding suggests that the processes parents use in making their own and their children's immunization decisions are not only linked but also stable despite seasonal differences.

The strongest component of the findings in this study is that parental changes in influenza immunization behavior across seasons are mirrored by their children. When parents change from immunizing to nonimmunizing, their children are almost twice as likely to miss an influenza immunization, and when parents improve their own behavior, their children are more than 5 times more likely to also receive influenza immunization. This finding indicates that parents' own behavior is dynamically related to their children's immunizations, as opposed to a weaker and static finding that parent and child immunizations are correlated. Implications of this dynamic relationship are that interventions targeting parents may lead to increased children's immunization rates and, conversely, that not including parents and families in interventions aimed at improving childhood immunizations may limit their potential for success.

For the set of child and adolescent immunizations examined in this study other than seasonal influenza, significant associations were also found between adult caregiver influenza immunization status and child current immunization status. For immunizations covered by school mandates in Oregon, we expected that the role of adult caregiver behavior would be lower than for influenza but still significant, which is what we observed. For HPV immunization of adolescents, which is not mandated for school attendance in Oregon, a strong association between adult caregiver influenza immunization and adolescent HPV was observed. Increasing the voluntary uptake of HPV among adolescents is a national priority in the United States.[19] In this study, both initiation and completion of HPV were related to adult caregivers' own immunization behavior. Completion of the HPV series was more influenced than initiation by adult caregivers' own immunization behavior, with adolescent boys benefiting more from having influenza immunizing adult caregivers than did adolescent girls.

The relative importance of assessing and changing behavior rather than attitudes has been observed in other public health areas such as injury prevention, where interventions are known that improve adult knowledge of child safety issues without changing safety behavior.[20–22] In immunizations, an association between self-reported prenatal influenza immunization and later infant immunization series has recently been noted.[23] Providing information about children's immunizations such as influenza and HPV may similarly improve adult knowledge without increasing child immunization rates, if adults' own behavior does not change.

These findings also bear on the issue of whether vaccine hesitancy should be viewed as an attitude or a behavior. Theoretical concerns exist in the literature as to whether vaccine hesitancy can accurately be described as a single entity, rather than a broad catch-all category for behavior in differing circumstances.[13,24] That adult immunization behavior is mirrored in how they immunize their children, including their adolescents, argues for an underlying dimension of reluctance to immunize apart from the individual circumstances of each vaccine and its age of administration. In particular, for vaccines that depend on voluntary acceptance rather than being incorporated into school mandates, the connection of adults' own behavior to what they do for their children is direct.

The results of this study are subject to multiple limitations. Detailed family composition information was not available, so that each test case represented a single parent or guardian and child, rather than an entire family. It was also assumed that the parent or guardian who had most recently attended a child's immunization visit was the adult whose own behavior was most likely to influence decisions about the child's immunizations. For children with multiple responsible parties and >1 parent, the reality of immunization decisions is probably more complicated. Similarly, family sociodemographic information was not available to be factored into the analysis. Another concern was that some level of adult influenza immunization probably was not reported to the registry, which will affect the accuracy of presented results but is less likely to affect the significance of findings. More research is needed that includes family composition data. Interventions also need to be tested that focus on changing parents' own immunization behavior as a way to increase children's immunization rates.

CONCLUSIONS

Adult caregivers' own immunization behavior influences how they immunize their children. Increasing children's immunization rates for seasonal influenza and other vaccines may depend on increasing parents' access to and acceptance of immunizations for themselves.

ABBREVIATIONS

ALERT IIS: ALERT Immunization Information System
CI: confidence interval
DTaP: diphtheria–tetanus–acellular pertussis
HPV: human papillomavirus
RP: responsible party
RR: relative risk

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