Published in final edited form as:

Pediatr Infect Dis J. 2016 May ; 35(5): 488–493. doi:10.1097/INF.0000000000001061.

Risk Factors for Pertussis Among Hispanic Infants:

Metropolitan Portland, Oregon, 2010–2012

Kara M. Levri, MD, MPH[*,†], **Laura Reynolds, RN, MPH**[‡], **Juventila Liko, MD, MPH**[§], **Mary Dott, MD, MPH**[†], **Byron F. Robinson, PhD**[†], **Paul R. Cieslak, MD, MPH**[*]

[*]Acute and Communicable Disease Prevention Section, Oregon Public Health Division, Portland, OR;

[†]Epidemiology Workforce Branch, Centers for Disease Control and Prevention, Atlanta, GA;

[‡]Communicable Disease Services, Multnomah County Health Department, Portland, OR;

[§]Oregon Immunization Program, Oregon Public Health Division, Portland, OR.

Abstract

Background: In 2012, Oregon observed its highest numbers of reported pertussis cases since 1953. The greatest morbidity occurred among infants <6 months of age, with higher rates among Hispanics than non-Hispanics. To explain this disparity, we analyzed pertussis surveillance data.

Methods: An analysis was conducted among infants <6 months of age in the Portland metropolitan area during 2010–2012. Characteristics examined were ethnicity (Hispanic or non-Hispanic), household size (>4 or ≤4 persons), pertussis vaccination status (upto-date or not up-to-date for age), child care center attendance (yes or no), infant birth weight (<2500 or ≥2500 g) and maternal age (<20 or ≥20 years).

Results: Eighty-two infants <6 months of age with pertussis were identified. Twenty-eight case-infants (34%) were Hispanic, and 54 (66%) were non-Hispanic. By ethnicity, infants with pertussis were similar in illness confirmation method, sex, age, hospitalization status, vaccination status, child care center attendance, infant birth weight and maternal age. Hispanic infants were more likely than non-Hispanic infants to live in households with >4 persons. Univariate analysis showed Hispanic infants had approximately 2.3 times the risk for pertussis, compared with non-Hispanic infants, and infants living in households >4 persons had approximately 2.4 times the risk for illness, compared with those in households with <4 persons; stratified risk ratios did not differ between Hispanic (2.4; confidence interval: 1.0–5.7]) and non-Hispanic infants (2.0; confidence interval: 1.2–3.5).

Conclusions: A household size of >4 persons is a potential risk factor for pertussis; the magnitude of this risk is similar for Hispanic and non-Hispanic infants.

Keywords

whooping cough; Hispanic Americans; infant

Address for correspondence: Kara M. Levri, MD, MPH, CDC Quarantine Station, Tom Bradley International Terminal, 380 World Way, Los Angeles, CA 90045. wjf3@cdc.gov.

The authors have no conflicts of interest or funding to disclose.

Pertussis is a highly contagious respiratory disease caused by the bacterium *Bordetella pertussis*. Infants are typically exposed to pertussis by a symptomatic household member.[1,2] Infant morbidity and mortality are considerable with a hospitalization rate >50% and >80% of reported pertussis-related deaths occurring among infants.[3–5] Infants are at high risk for severe pulmonary disease because they are not considered fully protected from pertussis until they have received 3 diphtheria, tetanus, and pertussis (DTaP) vaccinations by approximately age 6 months and because their small airways become easily obstructed when infected.[3,6]

Unlike most other childhood vaccine-preventable diseases, reported pertussis rates are increasing, and the disease remains endemic in the US.[7,8] In 2012, Oregon observed its highest number of reported pertussis cases since 1953 and surpassed national rates. As a notifiable disease in Oregon, pertussis cases are reported by laboratories, clinicians and other health care personnel to local and state health departments. Notably, at ages <6 months Hispanic infants in Oregon had substantially higher rates than non-Hispanic infants. Hispanics in this age range had approximately twice as high a risk for pertussis, compared with non-Hispanics. After age 6 months, this ethnic disparity diminished, presumably because of acquired immunity from 3 pertussis vaccinations.[3,6]

Higher rates of pertussis among Hispanic infants were reported in the California and Washington outbreaks of 2010 and 2012, respectively, and similar reports can be found throughout the literature.[2,3,9–11] Although the etiology of this ethnic disparity has been deemed unknown, unexplained and incompletely understood,[3,9,10] one hypothesis has been generated that it might be related to larger household sizes among Hispanic populations.[2,12] No studies evaluating reasons for this ethnic disparity have been reported. Our study objectives were to describe the epidemiology of pertussis among Hispanic and non-Hispanic infants, to identify risk factors that might explain the disparity, to test the aforementioned household size hypothesis and to recommend prevention measures.

METHODS

Since 2010, Oregon has participated in the Centers for Disease Control and Prevention's (CDC) Enhanced Pertussis Surveillance (EPS)/Emerging Infection Program Network.[13] The EPS catchment area for Oregon comprises 3 counties in the Portland metropolitan area with a total population of approximately 1.7 million persons. This enhanced surveillance is operated under the collaborative agreement of the 3 counties health departments, the state public health laboratory and the Oregon Public Health Division. EPS strives for completeness in its standard data collection and also entails enhanced data collection (contacting the case-family and clinician, plus review of vaccination records) by a dedicated public health nurse for disease characteristics supplemental to those in the National Notifiable Disease Surveillance System. These additional variables include information regarding hospitalization, clinic visits, source of infection, school versus child care attendance, household residents, infant birth and maternal data and coinfections with other Bordetella species. Although ethnicity is a standard variable in Oregon's disease registry, race is not captured.

We conducted an analysis of infants in the Portland metropolitan area <6 months of age at the time of diagnosis (determined by cough onset) during 2010–2012 meeting the Council of State and Territorial Epidemiologists case definition for confirmed pertussis.[14] By using Oregon's disease registry and EPS, data for pertussis cases were obtained. Incidence rates were calculated by using half of the respective tricounty birth registry cohort to estimate number of infants <6 months of age by ethnicity during the study's time frame. Infant characteristics examined were ethnicity (Hispanic or non-Hispanic), household size (>4 or ≤4 persons), DTaP vaccination status (up-to-date or not up-to-date for age, according to recommendations made by CDC's Advisory Committee on Immunization Practices),[15] child care center attendance (yes or no), infant birth weight (<2500 or ≥2500 g) and maternal age (<20 or ≥20 years). Hispanic ethnicity of infants was based on parent responses. A household size cutoff (>4 or ≤4 persons) was based upon a review of the literature.[16–18] Vaccination status of infants was determined by review of Oregon's vaccination registry for each case. Infants <2 months of age and infants receiving a DTaP vaccine <14 days before illness onset (lack of time to mount immunity) were excluded from vaccination status analysis. The proportion of cases attending a child care center was calculated out of those with a complete response.

The exposure variables of ethnicity, household size, vaccination status, child care center attendance, infant birth weight and maternal age were available for infants with pertussis; for infants without pertussis, population-based estimates were obtained by ethnicity from multiple sources. Household size estimates (>4 or ≤4 persons) were obtained from the American Community Survey of the U.S. Census Bureau for 2009–2011 on the basis of infants <1 year of age in the Portland metropolitan area. DTaP vaccination status estimates (up-to-date or not up-to-date) were obtained from the Oregon vaccination registry on the basis of the number of pertussis vaccinations needed for age in calendar months (without a grace period) and calculated by using a 6-month time frame in 2012 for infants <6 months of age in the Portland metropolitan area. Child care center attendance estimates (yes or no) were obtained from the National Survey of Children's Health of the National Center of Health Statistics for 2007 and were based on infants <6 months of age nationwide.[19] Infant birth weight (<2500 or ≥2500 g) and maternal age (<20 or ≥20 years) were obtained from Oregon birth registry statistics for 2008–2010 for the Portland metropolitan area. Of note, data collected from the American Community Survey (source of household size denominator) and National Survey of Children's Health (source of child care center denominator) respondents were adjusted by their respective agencies to represent the population from which the sample was drawn. These estimate percentages were then applied to the nonill infant numbers by ethnicity in order to provide nondiseased exposed or unexposed values.

We performed analysis by using Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA) and OpenEpi, version 3.01 (Open Source Epidemiologic Statistics for Public Health, Atlanta, GA). Annual incidence rates were calculated for each year studied. Three-year incidence rates were calculated to estimate risk ratios with 2-sided 95% confidence intervals for the dichotomized risk factors of ethnicity, household size, vaccination status, child care center attendance, infant birth weight and maternal age. To evaluate for confounding and effect modification, the 3-year incidence rates for household size, vaccination status, child

care center attendance, infant birth weight and maternal age were further stratified by ethnicity to calculate crude, stratum-specific and Mantel–Haenszel adjusted risk ratios and 2-sided 95% confidence intervals. Testing for interactions was performed by using the Breslow–Day test.

One of the 2 analytic explanations for our ethnic disparity among infants with pertussis was anticipated; either (a) significant difference in risk ratios for an exposure existed between Hispanic and non-Hispanic infants, suggesting something inherent in Hispanic ethnicity modified this risk factor for pertussis or (b) the risk ratios would be similar for both ethnicities when stratified, but the exposure prevalence of the attributable variable (eg, household size hypothesis) was higher in Hispanics.

RESULTS

Figure 1 shows the reported pertussis incidence rates in the Portland metropolitan area for all ages from 1995 to 2012. When examined for our <6 months of age population, one can see a dramatic increase in 2012 (Table 1). During 2010–2012 in the Portland metropolitan area, 84 infants <6 months of age were reported as having confirmed cases of pertussis; 2 of these case-infants were excluded from analysis for lack of ethnicity information. Of the 82 remaining case-infants, 81 (99%) were laboratory-confirmed; 33 (40%) were female; 33 (40%) were <2 months of age and 23 (28%) were hospitalized (Table 2). Among 45 case-infants age-eligible to receive DTaP vaccine, 17 (38%) were up-to-date for their age; among 73 case-infants with known attendance to child care status, and 8 (11%) had attended a child care center. A total of 5 (6%) case-infants had weighed <2500 g at birth; 7 (9%) had mothers <20 years of age; they lived in households with a mean size of 5.62 persons. Twenty-eight case-infants (34%) were Hispanic, and 54 (66%) were non-Hispanic (Table 2). When comparing Hispanic with non-Hispanic case-infants, they were similar in illness confirmation method, sex, age, hospitalization, vaccination status, child care center attendance, infant birth weight and maternal age. The mean household size for case-infants was 6.36 for Hispanics compared with 5.24 for non-Hispanics. Hispanic case-infants were more likely than non-Hispanic case-infants to live in a household with >4 persons ($P = 0.03$).

Univariate analysis of potential risk factors among this population demonstrated that Hispanic infants had 2.3 times the risk for pertussis, compared with non-Hispanic infants (Table 3). Additionally, infants living in households of >4 persons had 2.4 times the risk for illness, compared with those in households with ≤4 persons. Although results for child care center attendance were not statistically significant, the risk ratio of 1.9 with a confidence interval of 0.9–4.0 were suggestive of a positive association for pertussis. No significant differences were detected by vaccination status, maternal age or infant birth weight.

Although no significant interactions between ethnicity and the 5 other exposure variables were detected, this could also be attributed to using an underpowered test (ie, Breslow–Day) on a small sample size (Table 4). The adjusted risk ratios indicated that household size was the only variable significantly associated with pertussis. Child care center attendance was again suggestive for an association with pertussis, but only in non-Hispanic infants. The

proportion of all infants with a household size >4 persons was higher among Hispanic infants compared with non-Hispanic infants (55% vs. 33%, respectively; *P*=0.002), yet adjusted risk ratios did not differ between Hispanic and non-Hispanic infants. Using a strict definition for vaccination status, the majority of infants were not up-to-date with pertussis vaccinations for their age, regardless of Hispanic or non-Hispanic ethnicity (40% vs. 37% up-to-date, respectively). Child care center attendance was similar between Hispanic and non-Hispanic infants (5.3% vs. 6.2%, respectively), as was the proportion of infants with a birth weight<2500 g (6.1% vs. 6.4%, respectively). Maternal age <20 years was more common among Hispanic infants than non-Hispanic infants (12.8% vs. 4.7%, respectively) yet risk ratios were not significant.

DISCUSSION

This analysis reaffirmed that pertussis rates among Hispanic infants were greater than non-Hispanic infants <6 months of age in the Portland metropolitan area. Nationwide data have shown similar excess rates of pertussis among Hispanic infants.[2,3,9,10,20] Reports of pertussis to National Notifiable Disease Surveillance System demonstrate a more than expected number of pertussis cases among Hispanic infants <6 months of age for 2012 compared with its proportion of Hispanic births (29–36% of pertussis case-infants versus an estimated 23% of Hispanic infants born each year in the US).[5,21] We observed a similar excess in our case-infants (34% [28/82] vs. 18% of Hispanics born in the Portland metropolitan area).[22]

We observed that household size >4 persons was associated with an increased risk for pertussis, and the magnitude of this relative risk was approximately the same for Hispanic and non-Hispanic infants. In other words, the relationship between household size and risk of pertussis was not confounded by ethnicity. To our knowledge, the risk factor for household size has not been previously demonstrated in an analytic study.

Also notable was that a greater proportion of Hispanic infants than non-Hispanic infants resided in households with >4 persons; this could explain certain aspects of why Hispanics are overrepresented among case-patients. In the US, Hispanic households contain a greater number of persons than non-Hispanic households (mean 3.52 vs. 2.45, respectively); these numbers are similar for the state of Oregon (mean 3.68 versus 2.37, respectively).[12] This supports previous hypotheses that very young Hispanic infants might be at greater risk for being exposed to pertussis than non-Hispanic infants.[2]

Similar vaccination rates were reported among the Hispanic and non-Hispanic infants in our study population; thus, this variable did not explain the difference in risk for pertussis by ethnicity. Data obtained from the 2004 National Immunization Survey reported that Hispanic and non-Hispanic infants had similar uptake of the first dose of DTaP vaccine at ages 6 weeks (0.5% and 1.0%, respectively), 8 weeks (8.1% and 9.6%, respectively) and 12 weeks (83.3% and 86.2%, respectively).[23] Hispanic and non-Hispanic children 19–35 months of age had similar pertussis rates of vaccination with ≥4 DTaP doses in the 2012 National Immunization Survey.[24] However, Hispanic adults in the 2012 National Health Interview Survey were among the least likely to receive the onetime tetanus, diphtheria and pertussis

vaccine, compared with the total population (8.7% and 14.2%, respectively).[25] This increased exposure to unvaccinated adults might also explain certain aspects of the Hispanic overrepresentation among this infant pertussis population.

Therefore, 2 characteristics of Hispanic households may be contributing to higher rates of pertussis infection among Hispanic infants younger than 6 months. First, a greater proportion of Hispanic infants live in households with 4 or more persons. Our study found that household size >4 persons is associated with pertussis infection. We propose that increased infections may be because of more opportunities for an infant who is not fully protected by 3 DTaP vaccines to be exposed to an infected household member. Second, according to national data, Hispanic adults have lower rates of pertussis booster vaccination than other US adults. This may also be increasing the opportunity for a young infant to come into contact with a pertussis infected household contact.

Our study has multiple limitations. The pertussis case counts of 28 Hispanic and 54 non-Hispanic infants yielded limited cell sizes when case exposure variables were stratified and when an exposure variable's status was unknown for cases. The relatively small number of cases in this outbreak, and the consequent low statistical power, may explain why we did not find significant associations between pertussis and previously identified risk factors such as maternal age and low birth weight.[26,27] The total number of infants <6 months of age was estimated from the birth registry which could result in information bias if families moved out of state or had an out-of-state birth. And estimates of denominators for the rate calculations were derived from different sources with varying ages and time frames from the infant-case population.

Oregon public health efforts as a result of this study include targeting all infants residing in households with >4 persons for pertussis vaccination education. Focusing on Hispanic populations given their higher exposures to households with >4 persons has also been performed. Second, employing the cocooning strategy, which entails ensuring the vaccination of all noninfant household members when ≥1 infants in the household are too young to be fully vaccinated, is also an option. The evidence for this intervention has differed in prevention outcomes, feasibility and cost-effectiveness.[28–31] Third, given the morbidity and mortality associated with infant pertussis among those too young to be actively vaccinated, observing the 2012 Advisory Committee on Immunization Practices recommendation to vaccinate women for pertussis during every pregnancy to provide immunity to both mother and baby might be the most important preventive measure.[32] Results evaluating the effectiveness of maternal tetanus, diphtheria and pertussis vaccination (primarily during pregnancy but also postpartum) by the CDC and 5 other Emerging Infection Program Network sites, including Oregon, are pending.

In conclusion, we determined that a household size >4 persons may be a risk factor for pertussis, and this potential risk is approximately the same for Hispanic and non-Hispanic infants <6 months of age. A greater proportion of Hispanic infants resided in households with >4 persons. This finding, in addition to the nationally lower Hispanic *adult* pertussis vaccination rates (a common contact source of pertussis in infants), likely explains certain aspects of why Hispanics are overrepresented among the infant pertussis population.[2] Thus,

household size, regardless of ethnicity, might be an important marker of increased exposure of infants to *B. pertussis*. Studies of a larger sample size analyzing the household size variable are needed. Further examination of the role of child care center attendance is also warranted.

ACKNOWLEDGMENTS

We thank Tami Skoff and Amanda Faulkner, Centers for Disease Control and Prevention; Peter Fisher, Child and Adolescent Health Measurement Initiative; Charles Rynerson, Portland State University Population Research Center; Joyce Grant-Worley, Vital Records, Oregon Public Health Division and Andrew Osborn, Oregon Immunization Program, Oregon Public Health Division.

REFERENCES

1. Wendelboe AM, Njamkepo E, Bourillon A, et al.; Infant Pertussis Study Group. Transmission of Bordetella pertussis to young infants. Pediatr Infect Dis J. 2007;26:293–299. [PubMed: 17414390]
2. Bisgard KM, Pascual FB, Ehresmann KR, et al. Infant pertussis: who was the source? Pediatr Infect Dis J. 2004;23:985–989. [PubMed: 15545851]
3. Tanaka M, Vitek CR, Pascual FB, et al. Trends in pertussis among infants in the United States, 1980–1999. JAMA. 2003;290:2968–2975. [PubMed: 14665658]
4. O'Brien JA, Caro JJ. Hospitalization for pertussis: profiles and case costs by age. BMC Infect Dis. 2005;5:57. [PubMed: 16008838]
5. Centers for Disease Control and Prevention. 2012 Final Pertussis Surveillance Report. MMWR 2013;62
6. Centers for Disease Control and Prevention. Pertussis: epidemiology and prevention of vaccine-preventable diseases The Pink Book: Course Textbook; Washington D.C.: Public Health Foundation, 2012
7. Centers for Disease Control and Prevention. Vaccination coverage among children in kindergarten—United States, 2009–10 school year. MMWR 2011;60:700–704 [PubMed: 21637184]
8. Centers for Disease Control and Prevention. Summary of notifiable diseases: United States, 2009. MMWR 2011;58:1–100 [PubMed: 21566560]
9. Winter K, Harriman K, Zipprich J, et al. California pertussis epidemic, 2010. J Pediatr. 2012;161:1091–1096. [PubMed: 22819634]
10. Vitek CR, Pascual FB, Baughman AL, et al. Increase in deaths from pertussis among young infants in the United States in the 1990s. Pediatr Infect Dis J. 2003;22:628–634. [PubMed: 12867839]
11. Wortis N, Strebel PM, Wharton M, et al. Pertussis deaths: report of 23 cases in the United States, 1992 and 1993. Pediatrics. 1996;97:607–612. [PubMed: 8628595]
12. U.S. Census. American Community Survey Reports; 2010 Available at: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed March 29, 2013.
13. Centers for Disease Control and Prevention. Enhanced Pertussis Surveillance. Available at: http://www.cdc.gov/abcs/methodology/pertussissurveillance.html. Accessed September 12, 2012.
14. Council of State and Territorial Epidemiologists (CSTE). Pertussis Case Definition. 2010 Position Statement 09-ID-51.
15. Centers for Disease Control and Prevention. Use of diphtheria toxoid-tet-anus toxoid-acellular pertussis vaccine as a five-dose series: supplemental recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR 2000;49:1–16.
16. Schuller KA, Probst JC. Factors associated with influenza vaccination among US children in 2008. J Infect Public Health. 2013;6:80–88. [PubMed: 23537820]
17. Perla ME, Rue T, Cheadle A, et al. Population-based comparison of biomarker concentrations for chemicals of concern among Latino-American and non-Hispanic white children. J Immigr Minor Health. 2015;17:802–819. [PubMed: 24668388]
18. Strachan DP. Hay fever, hygiene, and household size. BMJ. 1989;299:1259–1260. [PubMed: 2513902]

19. National Survey of Children's Health. Maternal and Child Health Bureau in collaboration with the National Center for Health Statistics. NSCH Indicator Data Set Prepared by the Data Resource Center for Child and Adolescent Health, Child and Adolescent Health Measurement Initiative; 2007.
20. DeBolt C, Tasslimi A, Bardi J, et al. Pertussis Epidemic—Washington, 2012. MMWR 2012;61. [PubMed: 22298301]
21. Martin JA, Hamilton BE, Osterman MJK, et al. Births: final data for 2012. Natl Vital Stat Rep; 2013;62(9).
22. Oregon Vital Statistics. 2012 Available at: http://public.health.oregon.gov/BirthDeathCertificates/VitalStatistics/annualreports/12v1/Documents/table0208.pdf. Accessed March 29, 2013.
23. Haberling DL, Holman RC, Paddock CD, et al. Infant and maternal risk factors for pertussis-related infant mortality in the United States, 1999 to 2004. Pediatr Infect Dis J. 2009;28:194–198. [PubMed: 19209089]
24. Centers for Disease Control and Prevention. National Immunization Survey; 2012
25. Williams WW, Lu PJ, O'Halloran A, et al.; Centers for Disease Control and Prevention (CDC). Noninfluenza vaccination coverage among adults—United States, 2012. MMWR Morb Mortal Wkly Rep. 2014;63:95–102. [PubMed: 24500288]
26. Izurieta HS, Kenyon TA, Strebel PM, et al. Risk factors for pertussis in young infants during an outbreak in Chicago in 1993. Clin Infect Dis. 1996;22:503–507. [PubMed: 8852970]
27. Langkamp DL, Davis JP. Increased risk of reported pertussis and hospitalization associated with pertussis in low birth weight children. J Pediatr. 1996;128(5 Pt 1):654–659. [PubMed: 8627438]
28. Terranella A, Asay GR, Messonnier ML, et al. Pregnancy dose Tdap and postpartum cocooning to prevent infant pertussis: a decision analysis. Pediatrics. 2013;131:e1748–e1756. [PubMed: 23713104]
29. Quinn HE, Habig A, Snelling TL, et al. Effectiveness of preventing infant pertussis by 'cocooning' strategy: a NSW Case Control Study Communicable Disease Control Conference 2013 Canberra, AST; 2013.
30. Healy CM, Rench MA, Baker CJ. Implementation of cocooning against pertussis in a high-risk population. Clin Infect Dis. 2011;52:157–162. [PubMed: 21288837]
31. Lim G, Deeks S, Crowcroft N. A cocoon immunisation strategy against pertussis for infants: does it make sense for Ontario? Euro Surveill. 2014;19.
32. Centers for Disease Control and Prevention. Updated Recommendations for Use of Tetanus Toxoid, Reduced Diphtheria Toxoid, and Acellular Pertussis Vaccine (Tdap) in Pregnant Women—Advisory Committee on Immunization Practices (ACIP); 2012.

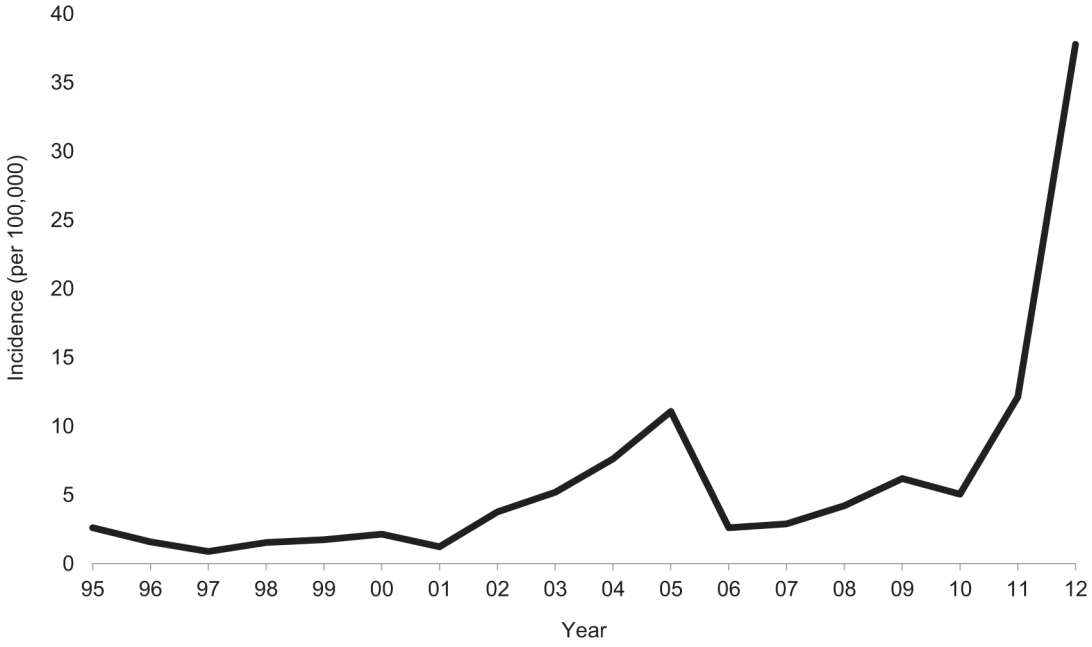

FIGURE 1.
Reported pertussis incidence rates in Portland Metropolitan Area, 1995–2012.

TABLE 1.

Incidence Rates for Pertussis Among Infants <6 Months of Age, Portland Metropolitan Area, 2010–2012 *

	2010			2011			2012		
	Hispanic	**Non-Hispanic**	**Total**	**Hispanic**	**Non-Hispanic**	**Total**	**Hispanic**	**Non-Hispanic**	**Total**
Case count	2	8	10	8	11	19	18	35	53
Estimated Age <6 mo	1952.5	8343.5	10,296	1874.5	8373.0	10,247.5	1780.5	8511	10,291.5
Incidence (per 100 K)	102	96	97	427	131	185	1011	411	515

* Incidence rates calculated using half of the respective tricounty birth registry cohort to estimate number of infants <6 months of age by ethnicity: http://public.health.oregon.gov/BirthDeathCertificates/VitalStatistics/annualreports/11v1/Documents/2–08.pdf.

TABLE 2.

Pertussis Case Characteristics Among Infants <6 Months of Age by Ethnicity, Portland Metropolitan Area, 2010–2012

Characteristic	Hispanic (n = 28), No. (%)	Non-Hispanic (n = 54), No. (%)	*P*	Total* (n = 82), No. (%)
Laboratory confirmed†	27 (96)	54 (100)	0.16	81 (99)
Female	12 (43)	21 (39)	0.73	33 (40)
Age <2 mo	12 (43)	21 (39)	0.73	33 (40)
Hospitalized	9 (32)	14 (26)	0.55	23 (28)
Household size >4‡	21 (75)	27 (50)	0.03	48 (59)
Vaccinations up-to-date§	4 (31)	13 (41)	0.54	17 (38)
Child care center attendance¶	2 (8)	6 (13)	0.51	8 (11)
Maternal age <20	3 (11)	4 (8)	0.61	7 (9)
Birth weight <2.5 kg	1 (4)	4 (8)	0.49	5 (6)

*Two infant pertussis cases of unknown ethnicity excluded from analysis (84–2=82).

†One case confirmed by epidemiologic link.

‡Average household size of 6.36 for Hispanics and 5.24 for non-Hispanics.

§Excluding infants <2 months of age and infants receiving DTaP <14 days before illness onset (15 Hispanic, 22 non-Hispanic); therefore, 28 – 15 = denominator 13; 4/13 Hispanics = 31%; 54 – 22 = denominator 32; 13/32 non-Hispanics = 41%; Total 82 – (15 + 22) = denominator 45; 17/45=38%.

¶Nine cases of unknown child care status (2 Hispanic, 7 non-Hispanic); therefore, 28–2 = denominator 26; 2/26 Hispanics = 8%; 54 – 7 = denominator 47; 6/47 = 13%; Total 82–9 = denominator 73; 8/73 = 11%.

TABLE 3.

Univariate Analysis of Risk Factors for Pertussis Among Infants <6 Months of Age, Portland Metropolitan Area, 2010–2012

Characteristic	Case Count	Incidence Rate* (per 100 K)	Risk Ratio (95% confidence interval)
Ethnicity			
Hispanic	28	499	2.3 (1.5–3.7)
Non-Hispanic	54	214	Ref.
Household size			
>4	48	420	2.4 (1.5–3.7)
≤4	34	175	Ref.
Vaccination status†			
Up-to-date	17	147	1.0 (0.5–1.8)
Not up-to-date	28	146	Ref.
Child care center attendance‡			
Yes	8	429	1.9 (0.9–4.0)
No	65	224	Ref.
Maternal age			
<20	7	368	1.4 (0.7–3.1)
≥20	75	259	Ref.
Infant birth weight			
<2.5 kg	5	255	1.0 (0.4–2.4)
≥2.5 kg	77	267	Ref.

*Three year rate for all 2010–2012 cases using estimated <6 months of age birth cohort from 2010 to 2012.

†Excluding infants <2 months of age and infants receiving DTaP <14 days before illness onset.

‡Nine cases of unknown child care status (2 Hispanic, 7 non-Hispanic).

Pediatr Infect Dis J. Author manuscript; available in PMC 2020 January 03.

Pediatr Infect Dis J. Author manuscript; available in PMC 2020 January 03.

TABLE 4.

Risk Factors for Pertussis Among Infants <6 Months of Age, Stratified by Ethnicity, Portland Metropolitan Area, 2010–2012 [*]

Characteristic		Case Count	Incidence Rate (per 100 K)	Stratified RR (95% CI)	Adjusted RR[†] (95% CI)
Household size >4	Hispanic	21	680	2.4 (1.0–5.7)	2.2 (1.4–3.4)
	Non-Hispanic	27	324	2.0 (1.2–3.5)	
Household size ≤4	Hispanic	7	277	Ref.	Ref.
	Non-Hispanic	27	160	Ref.	
Vaccination status up-to-date[‡]	Hispanic	4	179	0.7 (0.2–2.2)	1.0 (0.5–1.8)
	Non-Hispanic	13	139	1.2 (0.6–2.4)	
Vaccination status not up-to-date	Hispanic	9	268	Ref.	Ref.
	Non-Hispanic	19	120	Ref.	
Child care center attendance[§]	Hispanic	2	671	1.5 (0.4–6.2)	2.0 (0.9–4.1)
	Non-Hispanic	6	383	2.2 (0.9–5.2)	
No child care center attendance	Hispanic	24	452	Ref.	Ref.
	Non-Hispanic	41	173	Ref.	
Maternal age <20	Hispanic	3	418	0.8 (0.2–2.7)	1.2 (0.5–2.5)
	Non-Hispanic	4	337	1.6 (0.6–4.5)	
Maternal age ≥20	Hispanic	25	511	Ref.	Ref.
	Non-Hispanic	50	208	Ref.	
Infant birth weight, <2.5 kg	Hispanic	1	291	0.6 (0.1–4.2)	1.0 (0.4–2.4)
	Non-Hispanic	4	247	1.2 (0.4–3.2)	
Infant birth weight, ≥2.5 kg	Hispanic	27	512	Ref.	Ref.
	Non-Hispanic	50	212	Ref.	

[*] Breslow–Day testing for interaction of risk ratio over strata did not indicate a significant difference for any variables.

[†] Mantel–Haenszel calculation for adjusted risk ratios used.

[‡] Excluding infants <2 months of age and infants receiving DTaP <14 days before illness onset.

[§] Nine cases of unknown child care status (2 Hispanic, 7 non-Hispanic).