Article by an MPIfG researcher
Edward T. Walker, Christopher Rea: Pediatric Care Provider and Personal Belief Exemptions from Vaccine Requirements in California Kindergartens. In: American Journal of Public Health 106(7), 1336-1341 (2016). American Public Health Association
The original publication is available at the publisher's web site: http://dx.doi.org/10.2105/AJPH.2016.303177

Pediatric Care Provider Density and Personal Belief Exemptions From Vaccine Requirements in California Kindergartens

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Objectives. To understand contextual associations between medical care providers—pediatricians, family medical practitioners, and alternative medicine practitioners—and personal belief exemptions (PBEs) from mandated school entry vaccinations.

Methods. Data on kindergarten PBEs from the California Department of Public Health were analyzed for 2010, 2011, and 2012, with each school sorted into Primary Care Service Areas (PCSAs). Provider data from federal sources and state records of alternative medicine providers, alongside controls for school factors, were used to estimate panel models.

Results. Each 10% increase in the relative proportion of pediatricians in a given PCSA was associated with a statistically significant 11% decrease in PBE prevalence. The same increase in the proportion of family medical practitioners was associated with a 3.5% relative increase. Access to alternative medicine practitioners was also associated with a significantly higher PBE prevalence.

Conclusions. Medical provider contexts are associated with PBEs, reflecting a combination of contextual effects and self-selection of families into schools and PCSAs that share their preferences. The geographic distribution of child primary care services may be a key factor in a school's health risk associated with lack of immunization or underimmunization. (*Am J Public Health.* 2016;106:1336–1341. doi:10.2105/AJPH.2016.303177)

A critical issue for public health involves popular concerns about the safety and efficacy of childhood immunizations that have led many parents to question the necessity of some or all vaccines for their children.[1–3] At the same time, the recommended childhood immunization schedule has expanded significantly, from only 7 recommended shots in the late 1970s to 9 by the mid-1990s and 14 as of 2010.

Many parents see an apparent contradiction in these trends and worry that the immunization schedule has become excessive. Some have come to believe that vaccines may "overwhelm" the immune system of young children, despite extensive evidence to the contrary, including a major summary published by the Institute of Medicine.[4] Popular commentators such Bob Sears and a variety of vaccine-critical Web sites now offer suggested alternative immunization schedules for skeptical families, and significant numbers of parents are opting their children out of some or all recommended childhood vaccinations.[5]

Schools are a central battleground for contestation over childhood immunization, as state policies mandate immunizations at the point of school entry. In California, the site of the study described here, parents must provide documentation of immunization against 10 vaccine-preventable diseases when their children enter kindergarten.[6] However, prior to 2015 in California (and, as of this writing, in 18 other states), parents could file personal belief exemption (PBE) forms indicating that at least one of the required immunizations violates the parents' personal beliefs, thus allowing the child to enroll in school either without any immunizations or with some subset of the required shots.

These exemptions themselves have become the topic of a heated public debate,[7] leading, for example, to the passage of a California Assembly bill in June 2015 (SB 277) that eliminated PBEs in the state. Although PBEs are no longer allowed in California, evidence about their prevalence before this shift may be instructive to policymakers and others concerned about relationships between medical contexts, schools, and population health. High rates of PBEs clustered in localized areas are a significant risk to child health, as immunization rates that fall below herd immunity thresholds represent a threat not only for exemptors but also for immunocompromised children.[8]

A wave of recent studies have investigated the prevalence,[9] spatial clustering (and related exposure risks),[6,10] and temporal variation of PBEs[11] as well as contextual correlates, including cultural beliefs of parents about immunization and their trust in conventional medicine,[2,12–14] exemption-granting practices of public authorities,[9] whether the child's school is public or private,[11] and sociodemographic factors (e.g., income, race).[15,16]

Importantly, investigations have also shown evidence that contexts of medical care provision may be consequential in shaping child immunization practices, with obvious implications for school PBE rates as well.[17–20]

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This article was accepted March 6, 2016.
doi: 10.2105/AJPH.2016.303177

This work builds on earlier studies that highlighted how provider characteristics affect child immunization levels in general.[21] In particular, previous investigators have found that systematic differences exist between the immunization-related practices of pediatricians and family medical doctors; for instance, pediatricians are more likely to require a signed form from parents who refuse their child's immunizations (53% vs 31%),[19] more likely to bring up the issue again at a later visit,[17] and, notably, more willing to go so far as to dismiss vaccine-refusing families as patients (25% vs 3%).[19]

Thus, it appears that patients who receive care from pediatricians rather than family medical doctors are likely to face somewhat stronger insistence on immunization from their providers. Patients, it is also worth noting, self-select into provider contexts that more closely match their preferences regarding child immunization and other health-related practices[22]; family practice doctors may be more supportive of shared decision-making between doctor and patient, a feature that may be attractive to parents who have concerns about vaccines.

The study described here is the first of which we are aware to investigate the extent to which geographic imbalances in child primary care services,[23,24] in particular lack of access to pediatricians, are associated with higher PBE rates in schools. In a secondary area of inquiry, we assessed the association between PBEs and access to alternative medicine. A variety of previous studies have revealed associations between alternative medicine and vaccine-skeptical attitudes and practices.[25–27] We investigated how access to alternative medicine providers, including naturopaths and midwives, may shape PBEs. (In additional models, we tested for associations with chiropractic providers; because this measure was highly collinear with our other measures of alternative medicine, we did not include it in the findings reported here.)

METHODS

In our analyses, we used data on all California public kindergartens over 3 school years: 2010–2011, 2011–2012, and 2012–2013 (we refer to these school years by the year of the fall in question, that is, 2010, 2011, and 2012). We focused on public schools in the state given that many key school-level measures for private schools are not reported by the California Department of Education. However, in supplemental models not included here (available by request), we found largely similar associations between medical contextual variables and PBE rates in California private schools over the study period, although of course private schools tended to feature much higher overall PBE rates.

Measures

Our outcome of interest was PBE rates in California kindergartens, as reported by the California Department of Public Health. The data included yearly information on an average of 5620 kindergartens. The measure was logged to correct for skew (before-transformation mean = 2.79; SD = 6.45; range = 0–88.2).

All of our measures of medical care provision were aggregated to the Primary Care Service Area (PCSA) level; PCSAs build from Medicare records to group zip codes into regional aggregations that reflect patterns of care use.[23] Other studies in which PCSA boundaries have been used to investigate patterns of pediatric service use have shown that they serve well as an indication of where families receive pediatric care.[24] We used the revised 2010 PCSA boundaries in our analyses, and we grouped schools into PCSAs according to their zip codes. Each PCSA in California includes a median of 9 kindergartens (mean = 15.7; SD = 18.6).

Our data on the PCSA-level density of pediatricians (mean = 8%; SD = 4%; range = 0%–50%) and family doctors (mean = 17%; SD = 11%; range = 0%–100%) were derived from the Health Resources and Services Administration. We used provider type counts to calculate the percentage of doctors in a PCSA who are pediatricians and family medicine doctors; the total number of doctors was the sum of the counts of pediatricians, family medicine doctors, specialists, obstetricians and gynecologists, internal medicine practitioners, and other doctors.

Also, we used data provided by the California Department of Consumer Affairs (DCA) to examine 2 measures of access to alternative medicine in a given PCSA: counts of naturopaths and counts of midwives. DCA provided address lists for all registered practitioners in each of these domains, and these lists were converted into zip-code counts of provider density, aggregated to the PCSA level, and logged to account for data skew. DCA houses records from a wide variety of state regulatory boards for particular professions in the state. We used the department's data on naturopaths and midwives (note that, in addition to the state medical board, midwives may also be approved in California as certified nurse midwives through the state board of registered nursing; however, this certification is somewhat closer to traditional nursing than to alternative medicine, and thus we used medical board certifications).

In addition, we used data from the California Health Interview Survey to control for 2 measures of child access to health care and medical service use in a given PCSA (as of 2011–2012): the (logged) number of children in the California Health Interview Survey sample who had health insurance coverage and the mean (logged) number of child visits to doctors' offices in the preceding year.[28]

We also included data on a number of school-level measures available from the California Department of Education. We used the percentage of students in a school who were not eligible for reduced-price lunches (i.e., the percentage of nonpoor students) to assess school socioeconomic status. We determined parents' educational level according to the (log-transformed) percentage of parents with graduate or professional degrees (as their highest level of educational attainment). We also included measures of racial/ethnic composition and kindergarten enrollment size. We expected racial/ethnic composition in particular to have a significant effect on PBE rates.

Data Analysis

We examined PBE patterns using random-effects regression models of logged PBE rates for all California kindergartens. We estimated these models in a random-effects framework to both account for unobserved heterogeneity within schools over time and examine differences across schools and

school years; a fixed-effects specification, by contrast, would not have allowed us to examine differences across schools. We nested our models such that all specifications included school-level covariates as well as dummy variables for school year (the reference category was 2010).

In model 1, we included only school-level measures. In model 2, we added the proportions of pediatricians and family medical doctors in PCSAs. Finally, in model 3, we included all of our main covariates, and this model was used to generate the final estimates. All of the models included robust standard errors clustered by school. We also estimated separate spatial autoregressive models with spatial autoregressive disturbances (available upon request) that tested for spatial dependence in the data; the results of these analyses were similar to those reported here.

RESULTS

Descriptive statistics for our measures are presented in Table 1 (note that Table 1 presents nonlogged values for these measures and all of the measures described subsequently, and Table A, available as a supplement to the online version of this article at http://www.ajph.org, presents the transformed variables used in the analysis). Table 2 provides an initial comparison of school PBE rates according to racial/ethnic composition.

Our findings regarding school-level measures are generally consistent with past research. Schools with more nonpoor students generally had higher PBE rates, such that each 10% increase in the percentage of students who were not eligible for free or reduced-price lunches was associated with a 2.2% increase in a school's PBE rate ($P < .001$). The results are summarized in Table 3; a full version of our estimates is shown in Table B (available as a supplement to the online version of this article at http://www.ajph.org). More substantial were the racial/ethnic differences found in PBE rates, such that schools with greater proportions of non-White students had significantly lower PBE rates. Each 10% increase in a school's Asian population was associated with a 17.5% relative decrease in exemption rates ($P < .001$). Similarly, 10% increases in the proportions of African Americans (13.1%; $P < .001$), Hispanics (15.0%; $P < .001$), Filipinos (17.9%; $P < .001$), other Pacific Islanders (20.9%; $P < .001$), and Native Americans (12.1%; $P < .01$) were all associated with significantly lower PBE rates.

We also found consistent effects for the school-level measure of parent education, in line with past studies indicating that vaccine-skeptical parents are often those with higher educational attainment.[3] Specifically, there was a significant association between PBEs and the proportion of parents in a school with graduate or professional degrees ($P < .001$). We caution, however, that parental education was the only measure whose effect modulated slightly between the random effects models described here and alternative spatial regression estimations.

Moving to our core measures of interest—regarding providers of care in a school's PCSA—we found consistent support for our expectation that PBEs are associated with imbalances in primary care for children across California, such that access to pediatricians was associated with significant decreases in PBEs and access to family doctors was linked to higher PBEs (Figure 1). Each 10% increase in the proportion of pediatricians in a school's PCSA was associated with an 11.0% relative decrease in the PBE rate. By contrast, each 10% increase in the proportion of family doctors was associated with a 3.5% relative increase. These results support our expectation of an association between pediatrician access and PBEs, an association that is likely attributable to a combination of practice differences between pediatricians and family medical practitioners and families' self-selection into particular medical contexts. Of course, these findings do not mean that family practitioners are actively counseling their patients to avoid immunization.

We also investigated associations between PBEs and access to various providers of alternative medicine, given findings in earlier studies that such providers are often supportive of the concerns of vaccine-skeptical families. We found the strongest relationships between PBEs and access to naturopathic doctors, with a 10% increase in the proportion of naturopaths being associated with a 0.47% relative increase in PBE rates

TABLE 1—Sample Characteristics and Descriptive Statistics: California Kindergartens, 2010–2012

Characteristic	Mean (SD)	Range
School personal belief exemption rate (logged)	2.79 (6.45)	0–88.23
Health professionals in PCSA, %		
Pediatricians	8.08 (3.67)	0–50
Family doctors	16.90 (10.76)	0–100
Naturopaths (logged)	2.58 (4.14)	0–18
Midwives (logged)	1.60 (2.67)	0–19
No. of children with health insurance in PCSA (logged)	31.53 (1.52)	1–188
Child medical care use in PCSA, no. of visits (logged)	2.78 (0.14)	0–9
Students in school not eligible for reduced-price lunches, %	41.78 (30.81)	0–100
Parents with graduate or professional degrees, % (logged)	18.90 (13.16)	0–100
School race/ethnicity, %		
African American	7.03 (11.14)	0–100
Asian	8.15 (13.29)	0–97
Native American	0.87 (3.22)	0–93
Hispanic	49.45 (29.69)	0–100
Filipino	2.45 (4.40)	0–71
Other Pacific Islander	0.56 (1.19)	0–33
Kindergarten enrollment size, no.	86.01 (38.99)	10–981

Note. PCSA = Primary Care Service Area. For all log-transformed measures, values reflect the original measure before transformation. Additional descriptive statistics reflecting the log transformations are presented in Table A, available as a supplement to the online version of this article at http://www.ajph.org.

TABLE 2—Numbers of Pediatricians and Family Medicine Doctors and Mean PBE Rates, by School Racial/Ethnic Composition: California Kindergartens, 2010–2012

School Race/ Ethnicity	Mean No. of Pediatricians in PCSA (per 100 000 population)	Mean No. of Family Doctors in PCSA (per 100 000 population)	Ratio of Family Doctors to Pediatricians	Mean PBE Rate
Highly White (≥ 50%)	16.4	30.7	1.87	6.94
Highly Hispanic (≥ 76%)	16.1	28.1	1.75	0.46
Highly African American (≥ 8%)	16.8	28.0	1.67	1.68
Highly Asian (≥ 9%)	17.8	29.2	1.64	1.99
Highly Native American (≥ 1%)	15.9	29.7	1.88	3.84
Highly Filipino (≥ 3%)	16.7	28.5	1.70	1.85
Highly other Pacific Islander (≥ 1%)	16.8	29.0	1.73	2.42
Overall mean	16.3	28.9	1.78	2.79

Note. PBE = personal belief exemption; PCSA = Primary Care Service Area. Schools were designated as having a high representation of a given racial/ethnic group if that group's representation reached the 75th percentile or above relative to all California kindergartens; 75th percentile thresholds are shown in parentheses.

($P < .001$). This finding is consistent with the notion that naturopaths are often strongly opposed to immunization.[26] Access to midwives also increased exemption rates ($P < .001$).

We did not find any association between child health insurance coverage and PBEs. There was a weak negative association between child medical care use and PBEs, although this relationship did not reach statistical significance ($P < .1$); the magnitude of this effect suggests that when the mean number of annual child doctor visits in a PCSA increases by 10 percentage points, there is an accompanying relative decrease of 1.1% in PBE rates.

DISCUSSION

This study suggests that kindergarten PBEs are shaped not only by the demographic characteristics of communities but also by the types of medical care available to children who attend local schools. Schools located in areas characterized by higher proportions of family practitioners and lower proportions of pediatricians tend to have significantly higher PBE rates. Areas that feature greater access to alternative medicine practitioners also consistently have higher exemption rates; this finding may reflect both the direct influences of providers and the fact that their patrons are generally those more skeptical of established biomedicine.

Most important, then, this study encourages future researchers to consider medical contexts as noteworthy features of the institutional environment surrounding the immunization of children in local schools. At the same time, we recognize that there is significant internal variation within the practices of pediatricians and family medical practitioners: outside the generalized findings described here, any given provider, whether a pediatrician or family medicine physician, may be more or less tolerant of PBEs.

Our results also provide support for the notion that PBEs tend to cluster in areas characterized by higher socioeconomic status, in terms of not only income but also education. We found striking associations as well between PBEs and school racial composition. Schools with larger proportions of White students featured markedly higher PBE rates than schools with larger proportions of non-White students, and differences between predominantly Hispanic and predominantly White schools were especially significant (additional analyses focusing on racial/ethnic differences are available upon request). Our findings indicate the need for future research investigating whether, for instance, race/ethnicity might serve as a proxy for feelings of trust in the safety of one's children in their schools and communities; that is, parents who opt not to vaccinate their children (who are much more likely to be White) may also be more likely to trust in the health and wellness of others in their community.

It is important to note that selection processes probably affected our results in a few respects. At an individual level, of course, vaccine-skeptical parents are likely to seek out medical providers who support their beliefs about childhood vaccination. At the PCSA and school population levels analyzed here, physicians as well as parents may differentially select into PCSAs where their cultural values are reflected, perhaps even searching out communities and schools in PCSAs that feature higher proportions of families or physicians who share their views on childhood immunization.

At the very least, parents and medical care providers, including practitioners of alternative medicine, may unwittingly select into areas with cultural and political milieus that feature views about vaccines that are similar to their own views. Once situated in such a region, both parents and medical care providers are, of course, exposed to the beliefs of peers and institutions that inhabit the same professional and cultural spaces, including schools. This may also contribute to some of the racial and ethnic differences described earlier. Residential segregation and, in particular, heavily White areas where vaccine exemption seems to be more widely accepted may help reproduce higher PBE rates, whereas the reverse may be true in more racially diverse areas.

In general, then, we suspect that our finding of higher PBE rates in PCSAs with fewer pediatricians and more family practitioners in part reflects recursive feedback loops: parents and medical care providers may select into communities and schools friendly (or hostile) to vaccine skepticism, and

TABLE 3—Associations of Medical and School Contexts With Kindergarten PBE Prevalence Rates: California, 2010–2012

	Associated Relative Change in PBE Rate	P
One-unit increase in:.		
Pediatricians in PCSA, %	1.16% decrease	<.001
Family doctors in PCSA, %	0.34% increase	<.001
Students in school not eligible for reduced-price lunches, %	0.22% increase	<.001
African American students in school, %	1.39% decrease	<.001
Asian students in school, %	1.91% decrease	<.001
Native American students in school, %	1.28% decrease	<.01
Hispanic students in school, %	1.61% decrease	<.001
Filipino students in school, %	1.95% decrease	<.001
Other Pacific Islander students in school, %	2.32% decrease	<.001
Kindergarten enrollment size	No significant change	
10% increase in:		
Naturopaths in PCSA, %	0.47% increase	<.001
Midwives in PCSA, %	0.62% increase	<.001
Children with health insurance in PCSA	No significant change	
Child medical care use in PCSA	1.06% decrease	<.1
Parents with graduate or professional degrees, %	0.37% increase	<.001
Controls (1-unit increase)		
Year: 2011	No significant change	
Year: 2012	11.24% increase	<.001

Note. PBE = personal belief exemption; PCSA = Primary Care Service Area. Full results are available in Table B, available as a supplement to the online version of this article at http://www.ajph.org.

subsequently preexisting cultural beliefs characteristic of those PCSAs and schools reinforce the effects of these selection choices. As others have noted, such effects and the associated clustering of PBE rates should be investigated further.[29] Although we cannot fully account for these processes here, we are confident that contexts of care, particularly differences in provider distributions, are among the factors that need to be considered carefully.

Limitations

Our study has a number of limitations worth noting. First, the study was based on observational data, so we are naturally limited in our ability to make causal inferences about the association between the contextual presence of various care providers and a family's immunization decisions (and, in turn, the downstream effects of visits to various providers on ultimate PBE decisions). We did not have within-school family-level data on service use, and thus we are unable to state definitively that PBE rates are lower among families visiting pediatricians than among those receiving care from family doctors, not to mention naturopaths or midwives. However, we believe that our use of PCSAs helped mitigate this concern to some extent, given that PCSA boundaries are drawn on the basis of real patterns of service use.

Second, additional selection effects may have been at work in that highly educated parents might prefer the greater degree of shared decision-making that often characterizes family practice medicine. Third, many school-level factors are, other evidence suggests, shaped by the social networks of families both within and between schools[30]; future research should investigate such effects on PBEs. Fourth, we acknowledge that PBEs are, in some cases, not indicative of under-immunized or unimmunized children (e.g., some families may file PBEs for immunized children because it is easier to file for an exemption than to locate immunization records); this also calls for additional research.[3] Finally, the representation of Hispanic students in California kindergartens (50.3% in 2012) is significantly higher than the national average (25.5% according to the 2012 American Community Survey[31]).

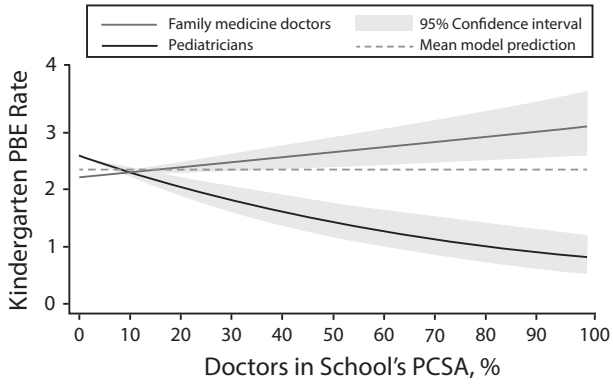

FIGURE 1—Primary Care Service Area (PCSA) Provider Densities and Predicted Personal Belief Exemption (PBE) Prevalence in California Kindergartens, 2012

Conclusions

PBEs are a topic of critical importance for public health. In schools that fall below herd immunity thresholds for particular immunizations, there are significant risks to children who are immunocompromised. Vaccine-preventable illnesses may spread at a rapid pace in the absence of strong population-level protections. Our study suggests that contexts of medical care are a significant factor in shaping school exemption rates. This research therefore has implications for health policy in terms of the need to focus on improving immunization rates among children visiting

family practitioners. Furthermore, our findings call for a reconsideration of how contexts of medical care and schooling are jointly associated with risks to early child health; it is worth emphasizing that PBEs are a product of complex interactions between families, medical providers, and schools. AJPH

CONTRIBUTORS

E. T. Walker originated the study, collected the data, and wrote the results section. C. M. Rea assisted in the data analysis, contributed to the creation of the tables and the figure, and helped revise the article.

ACKNOWLEDGMENTS

We thank Paula Lantz and Mark Wolfson for feedback on this project. We also thank the Center for Health Policy Research at the University of California, Los Angeles, for providing limited access to data from the California Health Interview Survey.

HUMAN PARTICIPANT PROTECTION

No protocol approval was needed for this study because it was based on analyses of secondary data sources and did not include human participants.

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