

The Impact of Social Networks on Parents' Vaccination Decisions

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KEY WORDS

immunizations, decision-making, social network analysis

ABBREVIATIONS

AIC—Akaike Information Criterion

CI—confidence interval

OR—odds ratio

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WHAT'S KNOWN ON THIS SUBJECT: Previous studies have suggested that health care providers, family members, friends, and others play a role in shaping parents' vaccination decisions. Other research has suggested that the media can influence whether parents decide to vaccinate their children.



WHAT THIS STUDY ADDS: Through the application of social network analysis, this study formally examines and quantifies how parents are influenced by the people and sources around them. Its findings suggest that social networks are important, particularly for parents who do not completely vaccinate.

abstract



BACKGROUND AND OBJECTIVE: Parents decide whether their children are vaccinated, but they rarely reach these decisions on their own. Instead parents are influenced by their social networks, broadly defined as the people and sources they go to for information, direction, and advice. This study used social network analysis to formally examine parents' social networks (people networks and source networks) related to their vaccination decision-making. In addition to providing descriptions of typical networks of parents who conform to the recommended vaccination schedule (conformers) and those who do not (nonconformers), this study also quantified the effect of network variables on parents' vaccination choices.

METHODS: This study took place in King County, Washington. Participation was limited to US-born, first-time parents with children aged ≤ 18 months. Data were collected via an online survey. Logistic regression was used to analyze the resulting data.

RESULTS: One hundred twenty-six conformers and 70 nonconformers completed the survey. Although people networks were reported by 95% of parents in both groups, nonconformers were significantly more likely to report source networks (100% vs 80%, $P < .001$). Model comparisons of parent, people, and source network characteristics indicated that people network variables were better predictors of parents' vaccination choices than parents' own characteristics or the characteristics of their source networks. In fact, the variable most predictive of parents' vaccination decisions was the percent of parents' people networks recommending nonconformity.

CONCLUSIONS: These results strongly suggest that social networks, and particularly parents' people networks, play an important role in parents' vaccination decision-making. *Pediatrics* 2013;131:e1397–e1404

In the United States, the majority of vaccinations are given to children aged <5 years. Parents thus play a key role in vaccine acceptance. More than any other persons, they determine whether their children will receive the recommended vaccines.

When making decisions about vaccination, however, parents rarely reach conclusions completely on their own. Rather, they rely on others, such as health care providers, family members, and friends, for information, direction, and advice. In the United States and other developed countries, most parents also have the option to consult sources such as the Internet, magazine articles, and television programs to obtain additional information and advice. Thus, instead of deciding to accept or reject vaccination independently, parents make vaccination decisions in concert with their social networks, broadly defined here as including the people they interact with as well as the sources of information they consult.

Despite awareness that parents are influenced by the people and sources around them,¹⁻⁸ parents' social networks relating to their vaccination decision-making have not been well studied. The formal study of social networks is referred to as social network analysis. Social network analysis is a broad and flexible research methodology that includes examinations of the networks of single individuals within populations. This specific approach is referred to as egocentric network analysis.

The purpose of this research was to use egocentric network analysis to examine parents' networks specifically relating to their vaccination decisions whether they conformed to the nationally recommended vaccination schedule by having their children vaccinated completely and on time (conformers) or whether they did not by delaying vaccination, partially vaccinating, or not

vaccinating at all (nonconformers). In addition to providing general descriptions of typical people and source networks for conformers and nonconformers, this study also tested the a priori hypothesis that variables related to parents' people and source networks would be better predictors of parents' vaccination decisions than more conventional variables including parents' demographic characteristics and parents' own perceptions of vaccination.

METHODS

Study Population and Sampling

Data for this study were collected via an online survey between March and July 2010. Participants were drawn from parents living in King County, Washington, an area known for lower-than-average vaccination rates.^{9,10}

Participation was limited to US-born, first-time parents with children aged ≤ 18 months. To ensure that data on parents' social networks were independent, participation was also limited to 1 parent per household.

Careful convenience sampling was used to recruit parents who met these eligibility criteria. Methods successfully used to recruit parents included fliers hung at local community centers, baby stores, and coffee shops; e-mails sent to online parenting groups and community listservs; and handouts provided to local health care providers and day care centers.

Power calculations, assuming $\alpha = .05$ and power = .80, indicated that a minimum of 74 conforming and 50 nonconforming parents needed to be sampled to test the hypothesis. To ensure a sample with a sufficient proportion of nonconformers, locations/resources where nonconformers were likely to be found were purposefully oversampled.

Recruitment materials instructed interested parents to contact the author

via phone or e-mail to receive access to the online survey. After having their eligibility verified, parents were provided with additional instructions as well as a login ID and password for the survey. For parents who did not have computer or Internet access, the recruitment materials indicated that the author was able to provide them with the temporary use of a laptop computer with Internet access. Despite this availability, no parent requested the use of the laptop during this study. After completing the survey, parents received a \$20 gift card as compensation.

Survey

The online survey included 3 modules. The first asked parents about their social networks related to their vaccination decision-making. In this module, parents listed the people they obtained information, advice, and/or direction from, as well as the sources they consulted for information and/or advice. In addition, parents reported supplemental information on the 5 people and 5 sources they ranked as being the most influential in their lists of people and sources, including (for the people) the gender, race/ethnicity, and vaccination advice of each person and (for the sources) the type of source; how each source was found; and the vaccination advice provided. The second module asked parents about their vaccination decision-making. Information provided by parents included their current vaccination decision and their perception of vaccines and vaccine-preventable diseases. The third module asked parents to provide basic demographic information about themselves, their households, and their children.

Although some of the questions in the vaccination decision-making module were adapted from existing surveys, including the National Immunization Survey, other questions in this module as well as all of the questions in the

social network module emerged from in-depth qualitative research.¹¹ Survey questions were pretested with 20 parents for reliability and validity. For additional information on the methodology of this study, see Supplemental Information.

The survey questions, along with all of the study procedures described in this article, were approved by the institutional review board at the University of Washington. Informed consent was obtained from all participants.

Data Analysis

To determine how parent, people network, and source network variables compared in predicting parents' vaccination decisions and to avoid potential multicollinearity, it was necessary to consider these variables independently, that is, to run separate models for the respondent, people network, and source network variables. Thus, 3 models were compared in this analysis.

Logistic regression, using parents' vaccination decisions (as conforming/not conforming) as the dependent variable, was used to analyze each model. Model comparisons were made by using Akaike Information Criterion (AIC) values.¹² AIC measures goodness of fit; a lower AIC score indicates a better model fit.

RESULTS

One hundred ninety-six eligible parents completed the survey, 126 conformers and 70 nonconformers (28 parents who were completely vaccinating but on a delayed schedule, 8 parents who were partially vaccinating on time, 29 parents who were partially vaccinating on a delayed schedule, and 5 parents who were not vaccinating at all). The demographic characteristics of conforming and nonconforming parents were similar (Table 1). The only

significant differences were in parents' perception of vaccination, calculated by taking the average score of 11 Likert questions (Table 2), and parents' intent to have their children completely vaccinated by the time they begin kindergarten. Nonconformers were more likely to have an unfavorable opinion of vaccination (2.8 vs 2.1, $P < .001$) and were less likely to intend to have their children vaccinated by the time they enter school (51% vs 100%, $P < .001$).

Network Descriptions

People networks were equally common among both groups of parents; 95% of conformers and 96% of nonconformers reported having a people network (Table 3). While conformers' and nonconformers' network members were similar in terms of race/ethnicity, nonconformers had a significantly greater number of network members (mean of 6.7 vs 4.8, $P = .05$)

and a significantly higher percentage of women included in their networks (71% vs 65%, $P = .05$). The greatest difference between the groups, however, was in the percent of network members recommending nonconformity. In typical people networks, 72% of nonconformers' network members recommended nonconformity, compared with only 13% of conformers' network members. Recommendations for nonconformity in this study included complete but delayed vaccination; partial, on-time vaccination; partial vaccination on a delayed schedule; and complete nonvaccination. The specific advice provided by conformers' and nonconformers' network members is detailed in Table 4.

In terms of network composition, both conformers and nonconformers were likely to rank health care providers among the top 5 network members in their people networks (90% and 88%, respectively). The individuals most

TABLE 1 Parents' Demographic Characteristics

| | Conformers | Nonconformers |
|---|---------------------------|---------------------------|
| <i>n</i> | 126 | 70 |
| Parent characteristics | | |
| Mean age, y | 31.2 (SD 4.9) | 32.3 (SD 4.5) |
| Highest level of education, % | | |
| Less than high school to some college | 17 | 19 |
| Bachelor's degree | 48 | 43 |
| Graduate degree | 35 | 39 |
| White, % | 85 | 81 |
| Female, % | 94 | 90 |
| Average perception of vaccination ^a | 2.1 (SD 0.5) ^b | 2.8 (SD 0.5) ^b |
| Plan to have child completely vaccinated by the time he/she enters school | 100 ^b | 51 ^b |
| Household characteristics | | |
| Household income, % | | |
| <\$50 000 | 16 | 23 |
| \$50 000–\$75 000 | 18 | 17 |
| \$75 000–\$100 000 | 18 | 23 |
| \$100 000–\$150 000 | 29 | 17 |
| >\$150 000 | 19 | 20 |
| Location, % | | |
| Urban | 36 | 39 |
| Suburban | 56 | 59 |
| Rural | 8 | 3 |
| Child characteristics | | |
| Percent female | 52 | 53 |
| Average age, mo | 8.7 (SD 4.5) | 8.9 (SD 4.6) |

^a See Table 2 for an explanation of how this variable was calculated.

^b A significant difference exists between the groups $P < .001$.

TABLE 2 Likert Questions^a Used to Assess Parents' Perceptions of Vaccination

1. Vaccination is necessary to prevent disease.^b
2. Immunity from having a disease is better than immunity from having a vaccination.
3. Vaccination is foolproof; once vaccinated children cannot get the diseases they were vaccinated against.^b
4. Without a vaccination a child may get a disease and consequently cause others to get the disease.^b
5. The body can protect itself from the diseases children are currently vaccinated against.
6. Vaccines are given to prevent diseases that children are not likely to get.
7. Vaccination is generally safe for children.^b
8. Vaccines contain substances that are harmful.
9. Children get more vaccines than are good for them.
10. Vaccination may cause autism.
11. Children are more likely to be harmed by diseases than by vaccines.^b

^a The Likert questions were scored on a scale of 1 to 5 where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Average scores were computed by taking the average of parents' responses to these 11 questions. Chronbach's α was used to assess the reliability of the average of these scores. This test provided an α value of .84, suggesting a good degree of internal consistency in the measurement.

^b When the average score was calculated the answers to this question were inverted. This was done to make the scoring of this question comparable to the scoring of questions where a low value corresponds to a favorable perception of vaccination and a high value a negative perception of vaccination.

commonly ranked as the most important person in parents' people networks, however, were respondents' spouses or partners. This was true for both conforming and nonconforming parents. Other persons included in parents' people networks were friends, family members, coworkers, parenting class instructors, doulas, midwives, and university professors. In terms of ranking, the individuals most commonly ranked third in both conformers' and nonconformers' networks were family members. Friends were most commonly ranked fourth and fifth in the networks of both groups.

Unlike people networks, source networks were significantly more common among nonconformers. Although all nonconformers (100%) reported having a source network, only 80% of

conformers reported having such a network ($P < .001$). Nonconformers' source networks also included a significantly greater number of sources (4.4 vs 3.4, $P = .01$) and a significantly higher number of sources actively sought out (39% vs 26%, $P = .05$). The greatest differences between conformers and nonconformers, however, occurred in terms of the percent of network sources recommending nonconformity. In typical source networks, 59% of nonconformers' sources recommended something other than complete, on-time vaccination, compared with only 20% of conformers' sources ($P < .001$). The specific advice provided by conformers' and nonconformers' sources is provided in Table 5.

In terms of network composition, nonconformers were more likely to have ranked books as the most important source in their networks, whereas conformers were more likely to have ranked the Internet as their most important source. These differences were not significant, however. Other sources included in parents' source networks were journal/research articles, handouts from parenting classes and doctor's offices, public health mailings, and local and national news programs. In terms of ranking, conformers most often ranked books second and Internet sources third, fourth, and fifth. Among nonconformers, Internet sources were most often ranked second, third, and fourth and magazines were most commonly ranked fifth.

Model Analyses

To make comparisons between models, all cases with missing data, specifically all cases missing people and/or source networks, were dropped from the model analyses. This left 97 conformers and 69 nonconformers in the sample.

The AIC value of the respondent model, which included parents' demographic characteristics as well as parents'

perceptions of vaccination, was 163.1 (Table 6). In this model, having a household income between \$100,000 and \$150,000 was significantly associated with conformity (odds ratio [OR] 0.17, confidence interval [CI]: 0.03–0.81), whereas having a graduate degree was significantly associated with nonconformity (OR 5.34, CI: 1.05–27.08). The most significant variable, however, was parents' perception of vaccination. For this variable, the odds of being a nonconformer increased by 30.07 (CI: 10.13–89.31) per unit increase on the Likert scale of parents' perception of vaccination.

For the people network model, the AIC value was 99.9 (Table 7). In this model, the only significant variable was the percent of network members recommending nonconformity. In comparison with the reference group (0%–25% recommending nonconformity), the odds of nonvaccination increased to 30.57 (CI: 5.75–162.65) for respondents with 26% to 50% of their network members recommending nonconformity; to 272.84 (CI: 36.71–2027.52) for respondents with 51% to 75% of their network members recommending nonconformity; and to 1642.74 (CI: 130.58–20 663.27) for respondents with 76% to 100% of their network members recommending nonconformity.

The AIC of the source network model was 168.3 (Table 8). As with the people network model, the only significant variable in the source network model was the percent of sources recommending nonconformity. Compared with the reference group (0%–25% recommending nonconformity), the odds of nonvaccination increased to 8.81 (CI: 3.08–25.17) for respondents with 26% to 50% of their sources recommending nonconformity; to 15.64 (CI: 4.85–50.42) for respondents with 51% to 75% of their sources recommending nonconformity; and to 35.75 (CI: 9.96–128.27) for respondents with

TABLE 3 Characteristics of Parents' Social Networks

| | Conformers | Nonconformers |
|---|-----------------|-----------------|
| <i>n</i> | 126 | 70 |
| People network characteristics | | |
| Percent who have a people network | 95 | 96 |
| Average number of network members | 4.8 (SD 3.2)*** | 6.7 (SD 4.4)*** |
| Relationship of network member ranked 1, % | | |
| Spouse | 55 | 48 |
| Health care provider | 34 | 36 |
| Other family member | 6 | 10 |
| Friend | 3 | 1 |
| Other person | 2 | 4 |
| Percent with a health care provider included in their top 5 network members | 90 | 88 |
| Average percent of female network members | 65 (SD 23.4)* | 71 (SD 21.3)* |
| Average percent of white network members | 88 (SD 24.3) | 86 (SD 17.7) |
| Average percent of network members recommending nonconformity ^a | 13 (SD 18.6)*** | 72 (SD 26.5)*** |
| Source network characteristics | | |
| Percent who have a source network | 80*** | 100*** |
| Average number of sources | 3.4 (SD 1.7)** | 4.4 (SD 3.3)** |
| Type of source ranked 1, % | | |
| Internet | 27 | 34 |
| Handouts, public health mailings | 26 | 9 |
| Magazine/newspaper articles | 6 | 6 |
| Journal/research articles | 6 | 9 |
| Book | 28 | 41 |
| Other | 8 | 1 |
| Average percent of sources actively sought out ^b | 26 (SD 25.7)* | 40 (30.2)* |
| Average percent of sources recommending nonconformity ^a | 20 (SD 26.8)*** | 59 (SD 33.4)*** |

^a A recommendation for nonconformity included a recommendation for anything other than complete, on-time vaccination.

^b Parents were asked how they obtained their sources. Sources that parents found on their own (eg, through library searches) were considered actively obtained sources. Sources provided by others, such as books given by friends or public health literature received in the mail, were considered passively obtained sources.

* A significant difference exists between the groups $P = .05$.

** A significant difference exists between the groups $P = .01$.

*** A significant difference exists between the groups $P < .001$.

TABLE 4 The Percent of Network Members Providing Specific Vaccination Advice

| Rank ^a | <i>n</i> ^b | Network Member Advice | | | | |
|-------------------|-----------------------|------------------------------|---|---|--|--------------------------------------|
| | | Complete On-time Vaccination | Complete but Delayed Vaccination ^c | Partial, On-time Vaccination ^c | Partial Vaccination on a Delayed Schedule ^c | Complete Nonvaccination ^c |
| Conformers | | | | | | |
| 1 | 120 | 96 | 3 | 2 | 0 | 0 |
| 2 | 111 | 91 | 5 | 2 | 2 | 1 |
| 3 | 87 | 85 | 5 | 3 | 3 | 3 |
| 4 | 71 | 76 | 15 | 4 | 4 | 0 |
| 5 | 53 | 68 | 15 | 4 | 9 | 4 |
| Nonconformers | | | | | | |
| 1 | 69 | 19 | 41 | 9 | 28 | 4 |
| 2 | 68 | 34 | 29 | 4 | 28 | 4 |
| 3 | 62 | 23 | 37 | 8 | 23 | 10 |
| 4 | 51 | 37 | 24 | 8 | 22 | 10 |
| 5 | 43 | 23 | 28 | 12 | 26 | 12 |

^a Rank of network member.

^b The number of parents with data for the category. Numbers are lower than the total number of respondents because some parents did not report a network and other parents reported networks with <5 network members.

^c Recommendations counted as recommendations for nonconformity.

76% to 100% of their sources recommending nonconformity.

When considering all of the models and each of the variables included, the variable that appeared to be the most important in determining parents' vaccination decisions was the percent of parents' people networks recommending nonconformity. As is apparent from the data (Table 9), nonconformers were much more likely to have a higher percent of their network members recommend nonconformity compared with conforming parents. Furthermore, in a direct comparison with other related variables, specifically parents' own perceptions of vaccination and the percent of parents' source networks recommending nonconformity, the percent of parents' people networks recommending nonconformity was still the most predictive of parents' vaccination decisions. The AIC value of a model containing only this variable (95.3) was much lower than the AIC values for models containing only parents' own perceptions of vaccination (160.4) or only the percent of parents' source networks recommending nonconformity (184.1).

DISCUSSION

These results suggest that social networks, and particularly people networks, play a key role in shaping parents' vaccination decisions. Although previous researchers have argued for a broader study of factors that have an impact on parents' vaccination decisions,³ this is among the first studies to use social network analysis to formally examine how parents are influenced by the people and sources around them.

In terms of sources specifically, previous research has suggested that the media does influence parents' vaccination decision-making.^{8,13-15} These results clarify, to a greater extent, how the media influences parents. Nonconforming

TABLE 5 The Percent of Sources Providing Specific Vaccination Advice

| Rank ^a | n ^b | Source Advice | | | | |
|-------------------|----------------|------------------------------|---|---|--|--------------------------------------|
| | | Complete On-time Vaccination | Complete but Delayed Vaccination ^c | Partial, On-time Vaccination ^c | Partial Vaccination on a Delayed Schedule ^c | Complete Nonvaccination ^c |
| Conformers | | | | | | |
| 1 | 101 | 93 | 5 | 1 | 0 | 1 |
| 2 | 89 | 82 | 9 | 2 | 1 | 2 |
| 3 | 69 | 70 | 22 | 3 | 1 | 4 |
| 4 | 26 | 70 | 11 | 5 | 11 | 3 |
| 5 | 21 | 57 | 24 | 5 | 10 | 5 |
| Nonconformers | | | | | | |
| 1 | 70 | 36 | 29 | 4 | 24 | 7 |
| 2 | 58 | 31 | 38 | 5 | 21 | 5 |
| 3 | 48 | 48 | 19 | 2 | 25 | 6 |
| 4 | 36 | 64 | 6 | 6 | 17 | 8 |
| 5 | 27 | 52 | 11 | 7 | 22 | 7 |

^a Rank of the source.

^b The number of parents with data for the category. Numbers are lower than the total number of respondents because some parents did not report a network and other parents reported networks with <5 sources.

^c Recommendations counted as recommendations for nonconformity.

TABLE 6 Regression Results for the Respondent Model

| | OR (95% CI) | P Value | AIC |
|---------------------------|---------------------|---------|-------|
| Respondent model | | | 163.1 |
| Education | | | |
| Some college or less | 1.00 (reference) | — | |
| Bachelor's degree | 2.32 (0.54–10.01) | .26 | |
| Graduate degree | 5.34 (1.05–27.08) | .04 | |
| Age, y | | | |
| ≤29 | 1.00 (reference) | — | |
| 30–34 | 1.13 (0.40–3.22) | .82 | |
| ≥35 | 2.39 (0.74–7.74) | .15 | |
| Race/ethnicity | | | |
| White | 1.00 (reference) | — | |
| Not white | 0.80 (0.24–2.60) | .71 | |
| Household income | | | |
| <\$50 000 | 1.00 (reference) | — | |
| \$50 000–\$75 000 | 0.32 (0.07–1.55) | .16 | |
| \$75 000–\$100 000 | 0.64 (0.14–2.98) | .57 | |
| \$100 000–\$150 000 | 0.17 (0.03–0.82) | .03 | |
| >\$150 000 | 0.43 (0.10–2.67) | .44 | |
| Perception of vaccination | 30.07 (10.13–89.31) | .00 | |

parents were significantly more likely to have source networks compared with conforming parents. Nonconforming parents were also significantly more likely to include more sources in their networks and have a higher percentage of sources that were actively sought. This seems to support previous research that suggests that the media generally has a negative impact on parents' perceptions of vaccination.^{13–18}

However, the results of this research suggest that the impact of sources may not be as detrimental to parents' vaccination decisions as previously thought. Whereas conformers' sources were more likely to recommend nonconformity compared with the people included in their networks, the differences were slight. Furthermore, among nonconformers, sources were actually more likely to be supportive

of complete, on-time vaccination compared with the people included in parents' networks. Most important, however, this research suggests that, for the majority of parents in this study, sources were not as influential as the people included in parents' networks.

Almost all parents surveyed reported a people network. Although nonconformers were significantly more likely to have more members in their people networks and a higher percentage of female network members, who was included was fairly similar in both groups. Health care providers, for example, were included among the top 5 network members in 90% of conformers' people networks and 88% of nonconformers' people networks. This validates previous research, not using social network analysis, that suggests health care providers play an important role in parents' decision-making.^{5,7,8,19} However, this research also clarifies that health care providers are not the only important members of parents' social networks. Among both conformers and nonconformers, spouses/partners were typically ranked as parents' most important network members. Health care providers were typically ranked second for both groups. In addition, for the majority of parents in this study, people networks included many individuals besides health care providers. The average size of people networks for conformers was 4.8 persons and for nonconformers 6.7 persons; meaning that in typical cases conformers had ~4 non-health care providers in their people networks and nonconformers ~6. This is important to note because of all of the variables considered in this study, the percent of network members recommending nonconformity was the most important in terms of predicting parents' vaccination decisions. Considered by itself, this variable was

TABLE 7 Regression Results for the People Network Model

| | OR (95% CI) | P Value | AIC |
|---|----------------------------|---------|------|
| People network model | | | 99.9 |
| Number of network members | 1.15 (0.96–1.38) | .14 | |
| Percent of female network members | | | |
| 0–50 | 1.00 (reference) | — | |
| 51–75 | 0.46 (0.09–2.42) | .36 | |
| 76–100 | 0.79 (0.15–4.27) | .79 | |
| Median age of network members, y | | | |
| >40 | 1.00 (reference) | — | |
| <41 | 2.66 (0.76–9.26) | .12 | |
| Percent of white network members | | | |
| 0–75 | 1.00 (reference) | — | |
| 76–100 | 1.25 (0.33–4.70) | .74 | |
| Percent of network members recommending nonconformity | | | |
| 1–25 | 1.00 (reference) | — | |
| 26–50 | 30.57 (5.75–162.65) | .00 | |
| 51–75 | 272.84 (36.71–2027.52) | .00 | |
| 76–100 | 1642.74 (130.58–20 663.27) | .00 | |

TABLE 8 Regression Results for the Source Network Model

| | OR (95% CI) | P Value | AIC |
|---|---------------------|---------|-------|
| Source model | | | 168.3 |
| Number of network sources | 1.11 (0.92–1.34) | .27 | |
| Percent of sources actively sought | | | |
| 0–25 | 1.00 (reference) | — | |
| 26–50 | 0.56 (0.22–1.39) | .22 | |
| 51–100 | 3.10 (0.98–9.78) | .06 | |
| Percent of sources recommending nonconformity | | | |
| 0–25 | 1.00 (reference) | — | |
| 26–50 | 8.81 (3.08–25.17) | .00 | |
| 51–75 | 15.64 (4.85–50.42) | .00 | |
| 76–100 | 35.75 (9.96–128.27) | .00 | |

TABLE 9 Comparison of the Number of Conformers' and Nonconformers' Network Members Who Recommend Nonconformity

| Percent Recommending Nonconformity ^a | Conformers | Nonconformers | Total |
|---|------------|---------------|-------|
| 0–25 | 77 | 3 | 80 |
| 26–50 | 17 | 12 | 29 |
| 51–75 | 2 | 19 | 21 |
| 76–100 | 1 | 35 | 36 |
| Total | 97 | 69 | 166 |

^a Fisher's exact test was used to test if the groups were homogeneous. The results were highly significant ($P < .001$), indicating that the groups are in fact nonhomogeneous and thus that the percent of network members recommending nonconformity is not independent of parents' vaccination decisions.

more predictive of parents' vaccination decisions than any demographic or general characteristic of parents or their networks. It was also more predictive than the percent of parents' source networks recommending nonconformity and even parents' own perceptions of vaccination. This

strongly implies that for interventions aimed at promoting vaccine acceptance to be successful, they must take a broad approach, one that is capable of influencing not only parents but the people parents might discuss their vaccination decisions with. In other words, interventions targeted only at

parents or interventions aimed primarily at improving communication between parents and their children's health care providers will likely be inadequate because they fail to consider the broader impact of parents' people networks.

The findings of this research should be interpreted in light of a few limitations. First, the data were not collected as a random sample. This means that the results of this study cannot be interpreted as being representative of parents living in King County. Second, as this study relied on retrospective network data, it is possible that recall bias may be an issue. In addition to forgetting network members, it is also possible that parents could have retroactively linked their own vaccination decisions to the advice of their network members. However, because the study was limited to first-time parents whose children were ≤ 18 months of age, the potential for this type of recall bias is somewhat mitigated. Third, although the sample size was sufficient to detect differences between conforming and nonconforming parents, it was not large enough to determine differences between types of nonconformity. This means that potential differences between nonconforming parents (eg, between parents who decided to delay vaccination and parents who decided to not vaccinate at all) may be masked in this study. Finally, this study treats conformers and nonconformers as cohesive groups. Although this is a common practice, it is also likely incorrect.^{11,20}

Future social network research, specifically a larger study using longitudinal research methods to examine both people and source networks, would go far in addressing these limitations and in expanding the understanding of the role that parents' social networks play in their vaccination decision-making.

CONCLUSIONS

This study has shown that social networks, and particularly parents' people networks, play a key role in parents' vaccination decision-making. Out of all of the variables considered in this study, the percent of parents' network members recommending nonconformity was more predictive of parents' vaccination decisions than any other variable

including parents' own perceptions of vaccination. Because of the importance of parents' networks to their vaccination decision-making, it is essential that parents' social networks continue to be studied. It is also essential that interventions aimed at increasing vaccine acceptance not focus exclusively on parents, or parents and their children's health care providers, but rather focus

on communities more broadly so that the other people parents are likely to consult, such as their spouses/partners, family members, and friends, are also included.

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