BMJ Open

Referendum opposition to fluoridation and health literacy: a cross-sectional analysis conducted in three large US cities

John A Curiel,[1] Gary D Slade,[2] Thu-Mai L Christian,[1] Sophia Lafferty-Hess,[1] Thomas M Carsey,[1] Anne E Sanders[2]

To cite: Curiel JA, Slade GD, Christian T-ML, *et al*. Referendum opposition to fluoridation and health literacy: a cross-sectional analysis conducted in three large US cities. *BMJ Open* 2019;**9**:e022580. doi:10.1136/bmjopen-2018-022580

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2018-022580).

Received 18 April 2018
Revised 5 October 2018
Accepted 14 November 2018

[1]Odum Institute for Research in Social Science, University of North Carolina, Chapel Hill, North Carolina, USA
[2]Department of Dental Ecology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Correspondence to
Dr Anne E Sanders;
Anne_Sanders@unc.edu

ABSTRACT

Objective To explore health literacy as a marker of voter confusion in order to understand the basis for public opposition to community water fluoridation.

Design A cross-sectional study.

Setting Conducted in three large US cities of San Antonio, Texas (602 voting precincts); Wichita, Kansas (171 voting precincts); and Portland, Oregon (132 voting precincts). Precinct-level voting data were compiled from community water fluoridation referendums conducted in San Antonio in 2002, Wichita in 2012 and Portland in 2013.

Participants Voter turnout expressed as a percentage of registered voters was 38% in San Antonio (n=2 92 811), 47% in Wichita (n=129 199) and 38% in Portland (n=164 301).

Main outcome measures The dependent variable was the percentage of votes in favour of fluoridating drinking water. Precinct-level voting data were mapped to precinct scores of health literacy, and to US Census and American Community Survey characteristics of race/ethnicity, age, income and educational attainment. Multilevel regression with post-stratification predicted the precinct mean health literacy scores, with weights generated from the National Association of Adult Literacy health literacy survey, with item response theory computed scoring for health literacy. Predictive models on voter support of community water fluoridation were compared using robust linear regression to determine how precinct-level characteristics influenced voter support in order to determine whether health literacy explained more variance in voting preference than sociodemographic characteristics.

Results Precinct-level health literacy was positively associated with voter turnout, although sociodemographic characteristics were better predictors of turnout. Approximately 60% of voters opposed community water fluoridation in Wichita and Portland, whereas in San Antonio, a small majority (53%) voted in favour of it. Models suggest that a one SD increase in health literacy scores predicted a 12 percentage point increase support for community water fluoridation.

Conclusion Educational attainment and health literacy are modifiable characteristics associated with voting precincts' support for community water fluoridation.

Strengths and limitations of the study

- This study used an established theory of voter confusion to understand public preferences for water fluoridation.
- The US Census and the American Community Survey provide precise data on community sociodemographic characteristics.
- The assessment of health literacy in national surveys is inherently complex and hence prone to bias.
- Results from the three cities in this study cannot be generalised to the nation or to other countries.

INTRODUCTION

Support for community water fluoridation (CWF) as an efficacious public health measure is unreserved in the scientific community and among major health organisations. The Centers for Disease Control and Prevention lauded CWF as one the great public health achievements of the 20th century[1] because of its effect in reducing the incidence and severity of dental caries in people of all ages. One objective of the Healthy People 2020 initiative is to increase the proportion of the US population served by fluoridated water to 80%, up from 72% in 2008. However, progress towards that target is thwarted by anti-fluoridation organisations such as the National Health Federation and the Fluoride Action Network (FAN). In the 1980s, two-thirds of approximately 1000 CWF referendums were defeated at the ballot box.[2]

Given the scientific endorsement of CWF, the prevalence of opposition is puzzling. Rational choice theory predicts voters to vote in their own best interest, which fluoridation fulfils.[3] Yet, the theory assumes that voters have complete information to compare expected utilities with and without fluoridation. In reality, voters face incomplete or conflicting information. Arguably the voter confusion/uncertainty hypothesis[4] offers a better explanation. It proposes that conflicting information, whether credible or not, can alter what voters understand to be their best interest. Conflicting information creates confusion, which prompts voters to maintain the status quo and to avoid potential risk, or to simply not vote at all. The informational environment of voters is critical to understanding how voters behave.

Voter confusion about water fluoridation is well established. Many voters are unable to distinguish credible from non-credible sources of information in fluoridation campaigns.[4 5] For example, Sapolsky noted that voters could not differentiate between the American Dental Association's support for water fluoridation and the American Academy of Nutrition's opposition of it.[6] Interestingly, the pro-fluoridation movement originally intended to avoid CWF campaigns altogether, choosing to restrict decision-making to the city manager or commission offices.[7] Healthcare professionals purposefully kept fluoridation outside the realm of party machine politics in order to keep it non-partisan. Voter education requires reception and processing of conflicting information. It is common for voters to hear information from different sources and fail to weigh the scientific rigour appropriately.[6]

Voter confusion may be a consequence of lower educational attainment. Yet, education may not be the ideal construct to analyse voting preferences, as more highly educated voters tend to be more politically aware, polarised, and ideological.[8–10] Measuring education may simply capture the cognitive bias of voters who actively seek political information to confirm their pre-existing worldview. A more useful construct for studying fluoridation politics is health literacy, defined by the American Medical Association as the 'constellation of skills, including the ability to perform basic reading and numerical tasks, required to function in the health care environment'.[11] Health literacy serves as an indicator of voter ability to process health information, including dental information.

The objective of this study is to identify factors that influence community support for the fluoridation of public drinking water, using characteristics of polling precincts to predict ballot outcomes from CWF referendums conducted in three large US cities: San Antonio, Texas in 2002, Wichita, Kansas in 2012 and Portland, Oregon in 2013.

METHODS

This study was exempt from Institutional Review Board approval on the grounds that it did not constitute human studies research.

Data source

We compiled publicly available precinct-level data from fluoridation referendums conducted in San Antonio, Texas in 2002, Wichita, Kansas in 2012 and Portland, Oregon in 2013. The vote in favour of fluoridation was the primary outcome variable. A secondary outcome was voter participation in the CWF referendums. While not intended to constitute a representative sample of US voting preferences, these three referendums were conducted in three distinct regional locations, each being highly populous cities with differing but stable political ideologies. Wichita is politically conservative, San Antonio leans liberal and Portland is liberal.[12] Fluoridation referendums appeared on the ballot on multiple occasions in these three cities. In each city, the referendum proposed to commence public water system fluoridation where a vote in favour would change the status quo. See online appendix A and appendix table 1 provides full details of each city's referendum language and their referendum histories.

Dependent variable

Support for CWF in these three cities was quantified as the percentage of votes in favour of fluoridating drinking water at the precinct level. County election offices in Bexar County for San Antonio, Sedgewick County for Wichita and Multnomah County for Portland provided the referendum data.

Health literacy and its components: census block group data on demographic characteristics

We constructed health literacy using multilevel regression with post-stratification (MRP) by constructing a latent variable for health literacy using the nationally representative National Association of Adult Literacy (NAAL) survey data—conducted in 2003— using item response theory methods. We then created a predictive model of health literacy with demographic variables, and applied the predictive model to voter precincts' relevant demographic variables. MRP methods guarantee the best sub-national level estimates of a construct of interest,[13] and prevents temporal instability,[14] making it ideal for this study.

Health literacy predictors included sex, age, race/ethnicity, income-to-poverty ratio, educational attainment, language spoken, marital status and region. See online appendix B describes the Item Response Theory (IRT) methods used to predict these scores, along with evidence presented in online appendix figures 1 and 2 attesting to the sufficient variance in item difficulty and range of health literacy scores from which to apply to the nation at large. The marginal maximum likelihood results reported in online appendix table 2 suggests sufficient significant predictors readily applicable to census information. See online appendix C which describes the Census variables used in greater detail. We used the mean predicted health literacy score at the precinct level as the main independent variable of interest.

Because data on individual voters do not exist for these three referendums, we computed demographic precinct characteristics using US Census 2000 information[13] for San Antonio, Texas and 2012 American Community Survey (ACS) data for Portland, Oregon and Wichita, Kansas. Since we needed these characteristics at the precinct level,

Curiel JA, et al. BMJ Open 2019;9:e022580. doi:10.1136/bmjopen-2018-022580

which is larger than census block groups, we aggregated and then merged all of the Census Block Group (CBGs) into the voter precincts. We weighted demographic data by the percentage of geographic overlap between CBGs and precincts for non-completely nested CBGs. This technique was used for all CBG variables, and is the standard best estimate technique to account for varying degrees of geographic overlap.[14–16]

We next calculated the expected precinct mean health literacy score from Census information per precinct. Health literacy scores measure the ability to comprehend information related to one's health and take correct action in planning health matters.[11] Health literacy scores range in value from 0 (below basic health literacy) to 500 (high proficiency). We expected health literacy to serve better than general knowledge, as measured by educational attainment, since not all general knowledge is continually updated, with unused knowledge domains susceptible to loss.[17] Past research also suggest that educational attainment leads to higher confirmation and cognitive bias on politicised issues, making it a poor predictor of comprehension of the merits of fluoridation. Further, the more specific a knowledge area (eg, health policy), the poorer general knowledge items perform in predicting skill.[18] We expect that health literacy better equips voters to understand CWF and its benefits than general knowledge. As demonstrated in online appendix figure 3, there is sufficient variance in precinct health literacy scores in which to gauge its effect on voting behaviour. We run a competing model of health literacy against educational attainment in order to test whether health literacy performs better to educational attainment in raising support for fluoridation.

To compare the effect of health literacy versus sociodemographic variable in determining voting preference, we estimated two linear robust regression models in Stata v.13 which regressed CWF support on the explanatory variables. We employ the standard definition of two-tailed hypothesis testing where significant results are at $p<0.05$. These two models contrast the explanatory power of health literacy versus its component parts, which determine whether health literacy, as a function of its components, is superior. Failing to do so would lead to a null effect for health literacy given the complete multicollinearity. Model 1 included health literacy, voter turnout and city effects. We included turnout in the model due to early work on CWF referendums, suggesting that higher turnout is associated with CWF defeat.[19] Model 2 includes the sociodemographic variables, turnout and election effects. Finally, we compared post-estimation statistics to determine whether health literacy explained election precinct outcomes better than sociodemographic variables. We ran a robustness check as well by determining whether higher health literacy leads to higher participation in the CWF referendum. It might be the case that more health literate people simply turnout to vote at higher rates. See online appendix D which presents the results and discusses them. Online appendix E compares the robust and regular ordinary least squares (OLS) regression results, finding minimal differences.

Patient and public involvement

Patient and/or the public were not involved in this study.

RESULTS

In Wichita and Portland, the final referendum count resulted in rejection of water fluoridation with approximately 40% support of CWF both cities. In contrast, San Antonio approved water fluoridation with a small minority of 53% in favour of CWF (online appendix table 1). Descriptive statistics in table 1 reveal sufficient variation across the dependent and independent variables. Although there were wide variations across the independent variables of interest, this is to be expected with geographic information given the non-uniform distribution of demographic characteristics.[18]

However, none of the data suggest serious problems that cannot be checked with robust regression.

Results evaluating health literacy in explaining participation in CWF referendums are presented in online appendix table 3. In brief, although health literacy is a significant factor in increasing participation in CWF referendums, its demographic components perform better in explaining participation. Given the better post-estimation fit statistics, traditional drivers of increased election participation, such as race/ethnicity, age and education better explain election turnout.

The relationship between health literacy and support for CWF is strong (figure 1). There is a clear positive linear relationship between precinct mean health literacy and voting in favour of CWF, even when controlling for city. San Antonio has clustered higher health literacy scores, whereas Portland and Wichita tend to be lower. These results support the notion that higher health literacy leads to greater CWF support, especially as San Antonio was the only city to approve CWF.

Table 2 presents models that predict CWF support. Model 1 included health literacy as the primary explanatory variable of interest. Health literacy attained a positive and significant ($p<0.01$) effect of 0.37. Therefore, one unit increase in health literacy increased the vote in favour of CWF by nearly four-tenths of a percentage point.

Because measurement of health literacy occurred on a 0–500 scale, there is potential for a substantial effect (figure 2). A one SD increase in health literacy increased the vote in favour of CWF by an expected 12 percentage points. This would have been enough to turn the losses in Portland and Wichita into CWF victories. These results suggest that health literacy can be decisive in affecting CWF outcomes.

Other factors in model 2 include an expected negative effect ($p<0.01$) for Portland, and positive effect ($p<0.01$) for San Antonio. There was some evidence that voter turnout significantly decreased ($p<0.01$) support for CWF, though the effect was not substantive. Only

Table 1 Summary statistics of census demographic variables, precinct mean health literacy and voter turnout

	Mean	SD	Minimum	Maximum
CWF yes vote (%)	45.6	14.7	0.0	100.0
White (%)	73.6	14.7	10.3	99.2
African American (%)	7.1	10.2	0.0	74.9
Asian/Pac. Islander (%)	3.1	4.0	0.0	37.0
Hispanic (%)	37.6	28.7	0.0	99.1
Other race (%)	16.3	11.6	0.0	65.1
Age under 17 (%)	25.8	7.0	2.3	45.5
Ages 18–24 (%)	10.2	7.0	0.0	86.1
Ages 25–34 (%)	15.1	5.5	1.9	44.6
Ages 35–44 (%)	14.7	3.4	1.0	24.7
Ages 45–54 (%)	12.8	3.3	0.8	24.0
Ages 55–64 (%)	9.5	3.9	0.1	27.2
Ages 65 and older (%)	12.0	6.5	0.1	74.8
Less than high school (%)	18.2	16.3	0.0	67.9
High school degree (%)	81.8	16.3	32.1	100.0
Some college (%)	58.0	22.0	6.2	97.4
B.A., M.A. or Ph.D. (%)	40.6	30.6	0.0	100.0
Professional degree (%)	3.4	4.4	0.0	24.3
Below poverty line (%)	12.4	10.8	0.0	70.9
Poverty line 100%–199%	20.2	10.8	0.6	57.0
Poverty line above 200%	64.4	20.1	8.4	99.4
Precinct health literacy (%)	271.0	33.9	196.8	353.8
Turnout (%)	35.6	23.4	0.0	100.0
Observations	901			

Values comprise all precincts and data used in the voter turnout model. The second stage model only uses 739 observations. A reduction in data occurs due to the lack of voting in some precincts. No substantive differences exist between the descriptive statistics. For the cities present, 13.8% (102) come from Portland, 19.8% (147) from Wichita and 66.31% (490) from San Antonio.
CWF, community water fluoridation.

the education values of *some college experience* or *professional degree* offered a substantive and significant effect. However, the explanatory power of health literacy is stronger. While model 2 has a slightly higher R-square, R-square values lose meaning in robust regression models due to the weighting that occurs.[20] Therefore, goodness of fit measures, such as Akaike information criterion (AIC) and Bayesian information criterion (BIC) are better, where lower values denote a better fit. The differences are substantive enough to suggest that the health literacy model is superior (table 2). As discussed in online appendix E and appendix table 4, the significance and direction of the coefficients do not change with regular OLS regression, suggesting that the effect of health literacy is not due to overfitting the data. This suggests that a relationship between health literacy is more likely due to the confusion hypothesis rather than just noise in the data.

Further, the effects for health literacy are the same when health literacy is measured as quintiles, as seen in online appendix F, appendix table 5 and appendix figure 4. These models suggest that after accounting for the high level of statistical noise in interpreting election outcomes, as modelled with robust regression, health literacy is the superior predictor of CWF support.

DISCUSSION

Main findings

CWF support was associated with both educational attainment and health literacy, signifying influences of generalised and specialised knowledge, respectively, when electors cast their vote. While education attainment and other demographic variables better predict participation in a CWF referendum, health literacy better explains fluoridation support. Although other sociodemographic variables reached significance in explaining turnout, these same variables explain voter participation in general.[21]

We do not have survey or exit poll data from the referendums, so we cannot conclude that more health literate individuals directly support fluoride without risking the error of making an ecological fallacy. However, the

Curiel JA, *et al. BMJ Open* 2019;**9**:e022580. doi:10.1136/bmjopen-2018-022580

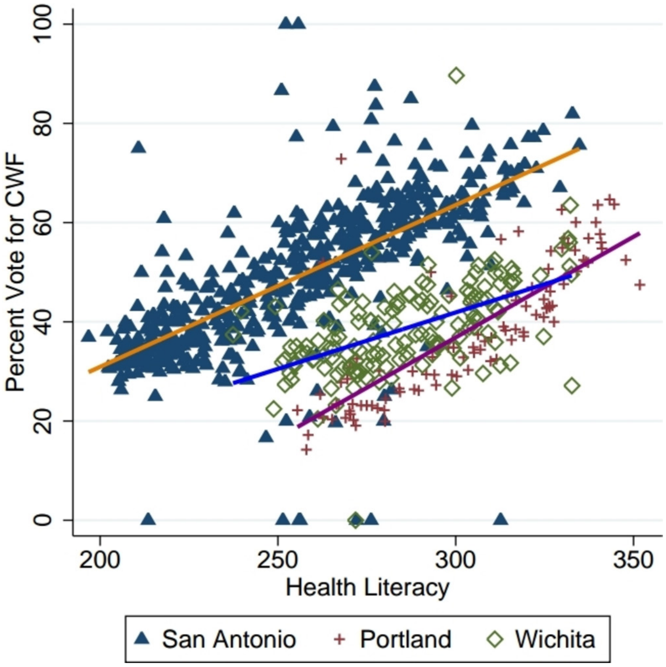

Figure 1 Precinct support for community water fluoridation (CWF) by mean health literacy. These results are the precinct vote percentage in favour of initiating CWF by health literacy. Results are clustered by city, with best fitting lines for each city. The x-axis range reflects the observed range of precinct health literacy. Although health literacy at the individual scale ranges from 0 to 500, the aggregation of people in precincts makes such extreme scores nearly impossible.

connection between preference for CWF and ability to understand health news and information is a reasonable one. The results of our analysis are consistent with the uncertainty/confusion hypothesis. Further, the results suggest that health literacy is a decisive factor due to its size and the marginal nature of CWF referendums.

Methodologically, it is unfortunate that health literacy cannot be directly included in models that incorporate the Census demographic variables. Health literacy is limited by the original NAAL 2003 survey, which contained virtually no variables related to geography, producing high multicollinearity with its predictors. In particular, its relationship with education is so strong as to lead to a complete loss in efficiency. However, comparing the explanatory power of health literacy to its Census components suggests that health literacy has higher explanatory power.

Even with some of the methodological limitations, the decisive effect of health literacy warrants greater consideration in CWF referendum campaigns. While health literacy was measured as the precinct mean, past research suggests that increased health literacy leads to substantive changes in lifestyles and health outcomes, as well as the ability to comprehend and act rationally on health information.[11 20 22] If health literacy of a geographic area effectively reflects a general ability of its population to comprehend new health information and weigh its merits, then it is reasonable to conclude that higher health literacy leads to greater acceptance of fluoride. The results support such a conclusion. In the least, it appears that educational attainment alone is insufficient in explaining CWF support. Further, given the need to consider the covariance of different populations within a category, the interpretations are not straightforward. The effect of educational attainment was non-linear, as only the population of some college and professional degrees substantively increased support for CWF (higher degrees did not). These results are consistent with past research demonstrating that more years of education lead to more polarised opinions on social and policy issues.[23]

In the debate on fluoride, more education may simply make individuals sceptical consumers of information and lead voters to reach out to sources, like FAN or their affiliated journals, without understanding the methodological flaws in much of the anti-fluoridation research, and the false equivalence between scientific and anti-fluoride research. The uncritical examination of the new conflicting information presented in a quasi-scientific manner may allow uncertainty to raise anxiety, leading to choices that avoid perceived risk. It is somewhat ironic that the confusion/uncertainty hypothesis might afflict the more educated voters, but this seems to be the case, and has been demonstrated repeatedly in prior survey and polling research.[21 22] We infer from the evidence that more than just an increase in general education is necessary for greater public approval of community water fluoridation.

We can be certain that the results were not driven simply by the behaviour of registered voters given the model analysing voter turnout in the CWF referendum (online appendix D). Ultimately, it appears that participation is motivated by the traditional factors of age, education and income. Although we cannot measure the decision to register, there is no reason to believe that the behaviour of the three cities analysed substantively differs from the consistent trends demonstrated in the USA and around the world.[21 23 24] If one were to follow through on improving health literacy, and in turn support for CWF, the best path forward would be to look to the National Action Plan to Improve Health Literacy. The plan suggests offering targeted counselling and educational services to areas, such as free health Saturday schools, to improve health literacy. It would take only a slight modification of existing practices to include a focus on dentistry and oral healthcare into such community interventions. These interventions would need to be sustained, however, to maintain the impact. Thus, dentists would need to be civically active even during non-referendum years to create an environment more accepting of CWF.

Generalisability of findings

The results of this study of three cities cannot be generalised to the nation. Every city is unique and the cause of one city's decision to forgo fluoridation may differ from another. Further, all of these cities voted on whether to

Table 2 Robust regression models of support for—community water fluoridation

	Model 1	Model 2
Health literacy	0.37 (0.01)***	
City		
Wichita (ref)		
Portland	−9.63 (0.90)***	−11.77 (1.02)***
San Antonio	20.39 (0.69)***	14.82 (1.04)***
Race/ethnicity (%)		
White (referent)		
African American		0.03 (0.03)
Asian/Pac. Islander		0.11 (0.06)*
Hispanic		−0.04 (0.03)
Other		0.04 (0.04)
Age in years (%)		
<17		0.05 (0.05)
18–24		−0.02 (0.05)
25–34		0.11 (0.06)*
35–44		−0.00 (0.09)
45–54		−0.16 (0.10)*
55–64		−0.27** (0.10)
≥65 (ref)		
Educational attainment (%)		
Incomplete high school (ref)		
High school degree		0.06 (0.05)
Some College		0.35 (0.05)***
B.A., M.A. or Ph.D.		0.06 (0.03)**
Professional degree		0.81 (0.12)***
Income		
Below poverty threshold (ref)		
Poverty line 100%–199%		0.02 (0.05)
Poverty line above 200%		−0.08 (0.03)**
Voter turnout (%)	−0.08 (0.02)***	0.00 (0.02)
Constant	−62.07 (2.32)***	14.46 (4.80)***
R^2	0.62	0.66
AIC	872.65	963.63
BIC	898.14	1063.70
N	739.000	739.000

Coefficients for health literacy in model 1 reflects a one point change on the 0–500 scale on the percentage of the vote in favour of CWF. Model 2's coefficients reflect a one percentage point change in the proportion of the demographic group on support for CWF. Note that all categories of demographic variables are necessarily zero sum, so that an increase in a sub-group of a demographic group (ie, the professional degree population) must lead to a decrease in the other sub-groups within that category (ie, B.A., M.A. or Ph.D.). Standard errors are in parentheses.
*P<0.10, **P<0.05, ***P<0.01.

initiate fluoridation as a change from the status quo. Therefore, cities in which CWF is already in place, where residents have experienced the benefits and lack of adverse health outcomes, may be more willing to discount anti-fluoridation arguments and retain the practice. However, San Antonio, Wichita and Portland differ from each other in terms of geography, history and population demographics, which does increase external validity.

It is worth noting that these findings apply to population characteristics, not individuals. Thus, when interpreting these findings, it is beyond the scope of this study to claim that an individual's health literacy, race/

 Curiel JA, *et al*. *BMJ Open* 2019;**9**:e022580. doi:10.1136/bmjopen-2018-022580

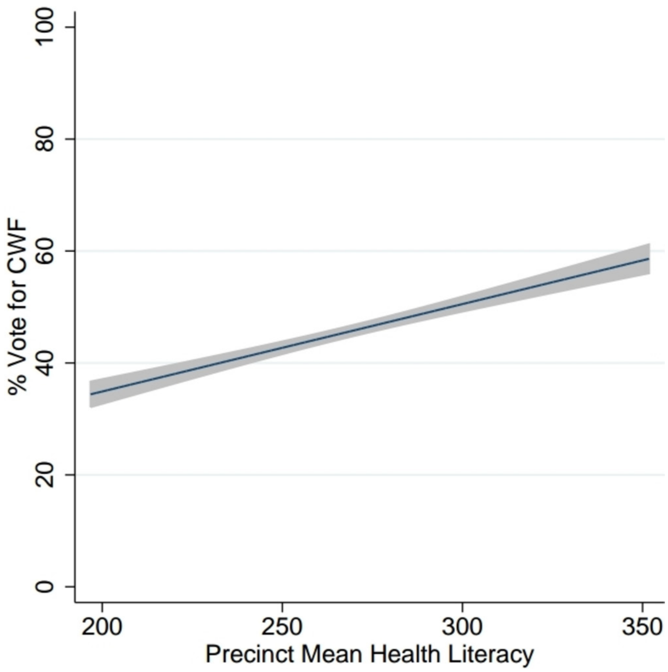

Figure 2 Predicted support for community water fluoridation (CWF) by health literacy. The shaded bar reflects the 95% CI for the expected effect of mean health literacy on precinct support for CWF. The predicted results suggest a substantive and significant effect as the mean precinct health literacy increases, with an effect substantive enough to change election outcomes. The *x*-axis range reflects the observed range of precinct health literacy. Although health literacy at the individual scale ranges from 0 to 500, the aggregation of people in precincts makes such extreme scores nearly impossible.

ethnicity, age, income or education directly makes them more or less likely to support fluoridation. What we can say is that there is something about precincts with highly health literate populations that lead to more support for fluoridation, all else being equal. We are confident that these results are not driven by voter turnout alone. Given the theoretical underpinnings of the confusion hypothesis, we argue that it is the specialised knowledge and comprehension of the true benefits of fluoride drives support for fluoridation.

There is an advantage to using geographic aggregate level findings. As King notes, geographic aggregate analysis takes advantage of the common political experiences people draw from their communities and captures how this influences political behaviour (70–1).[23] Given that the goal of studies in the field of public health is to identify macro-level trends that shape health and behaviours, aggregate level analysis is suited to our study.

Another limitation is the construction of the health literacy data. We improve on past estimates of health literacy by integrating regional effects into our predictive model of health literacy. As mentioned previously, the original NAAL survey was not designed to be applied to small geographic units. However, our predicted health literacy scores via MRP methods are the best that can be estimated given the limitations. Efforts to validate health literacy geographic imputation will need to wait until another mass health literacy survey is conducted designed for small area estimation from the outset.

Contributors JAC substantially contributed to conception, design, analysis and drafting of the manuscript. Along with AES and GDS, JAC is accountable for all aspects of the work. TMC†, AES and GDS contributed to drafting the manuscript, and critically revising the manuscript for intellectual content. TLC and SLH contributed to the acquisition of data. All authors contributed to interpretation of findings and gave final approval of the manuscript.

Funding Research reported in this publication was supported by the National Institute of Dental & Craniofacial Research of NIH under Award Number UH2DE025494.

Disclaimer The content is solely the responsibility of the authors and does not necessarily represent the official views of NIH.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Extra data and code for analysing National Assessment of Adult Literacy data are available by contacting John Curiel by email: jcuriel@live.unc.edu

Author note The dagger can be removed. It would have pointed to a footnote notifying readers that this author (Tom Carsey (TMC)) died earlier.

REFERENCES

1. Centers for Disease Control and Prevention (CDC). Ten great public health achievements--United States, 1900-1999. *MMWR Morb Mortal Wkly Rep* 1999;48:241–3.
2. Christoffel T. Fluorides, facts and fanatics: public health advocacy shouldn't stop at the courthouse door. *Am J Public Health* 1985;75:888–91.
3. Downs A. An economic theory of political action in a democracy. *J Polit Econ* 1957;65:135–50.
4. Sapolsky HM. The fluoridation controversy: an alternative explanation. *Public Opin Q* 1969;33:240–8.
5. Crain RL, Katz E, Rosenthal DB. *The politics of community conflict: the fluoridation decision*: Bobbs-Merrill Company, 1969.
6. Sapolsky HM. Science, voters, and the fluoridation controversy. *Science* 1968;162:427–33.
7. E C B, JQ W. *City Politics*. Cambridge, MA: Harvard University Press, 1963.
8. Baldassarri D, Gelman A. Partisans without constraint: political polarization and trends in american public opinion. *AJS* 2008;114:408–46.
9. Hetherington MJ. Resurgent mass partisanship: the role of elite polarization. *Am Polit Sci Rev* 2001;95:619–31.
10. Garner A, Palmer H. Polarization and issue consistency over time. *Polit Behav* 2011;33:225–46.
11. Anon. Health literacy: report of the Council on Scientific Affairs. Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs, American Medical Association. *JAMA* 1999;281:552–7.
12. Tausanovitch C, Warshaw C. Measuring constituent policy preferences in congress, state legislatures, and cities. *J Polit* 2013;75:330–42.
13. U.C. Bureau. *Census 2000, Census 2000, U.S. Census Bureau., in Social Explorer 2017*. New York City, 2017.
14. Alam MS. On matching census tracts and electoral boundaries: the bottom-up aggregation approach. *Economic and Political Weekly* 2010:64–72.
15. Speer PW, Gorman DM, Labouvie EW, *et al*. Violent crime and alcohol availability: relationships in an urban community. *J Public Health Policy* 1998;19:303–18.
16. Rao J. *Small area estimation*. Hoboken (NJ): John ile & Sons, 2003.

17. Jerit J, Barabas J, Bolsen T. Citizens, knowledge, and the information environment. *Am J Pol Sci* 2006;50:266–82.
18. Barabas J, Jerit J, Pollock W, *et al*. The question(s) of political knowledge. *Am Polit Sci Rev* 2014;108:840–55.
19. Hahn H. Voting in Canadian communities: a taxonomy of referendum issues. *Can J Econ Political Sci* 1968;1:462–9.
20. Willett JB, Singer JD. Another cautionary note about R 2 : its use in weighted least-squares regression analysis. *Am Stat* 1988;42:236–8.
21. Niemi RG, Stanley HW, Evans CL. Age and turnout among the newly enfranchised: life cycle versus experience effects*. *Eur J Polit Res* 1984;12:371–86.
22. Huber JT, Shapiro RM, Gillaspy ML. Top down versus bottom up: the social construction of the health literacy movement. *Libr Q* 2012;82:429–51.
23. King G, Tanner MA, Rosen O. *Ecological inference: new methodological strategies*: Cambridge University Press, 2004.
24. Gilliam FD. Influences on voter turnout for U. S. House elections in non-presidential years. *Legislative Studies Quarterly* 1985;10:339–51.