Predicting water filter and bottled water use in Appalachia: a community-scale case study

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ABSTRACT

A questionnaire survey was conducted in order to assess residents' perceptions of water quality for drinking and recreational purposes in a mid-sized city in northcentral West Virginia. Two logistic regression analyses were conducted in order to investigate the factors that influence bottle use and filter use. Results show that 37% of respondents primarily use bottled water and that 58% use a household filter when drinking from the tap. Respondents with lower levels of environmental concern, education levels, and lower organoleptic perceptions were most likely to perceive health risks from tap water consumption, and were most likely to use bottled water. Income, age, and organoleptic perceptions were predictors of water filter use among respondents. Clean water for recreational purposes was not found to be significant with either of these models. Our results demonstrate that bottle use and filter use are explained differently. We argue that more education and better communication about local tap water quality would decrease the use of bottled water. We demonstrate that household filters could be used as an alternative to bottled water.

Key words | bottled water, communication, filters, perceptions, water quality

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INTRODUCTION

Water is one of the most elementary resources on earth, and its access is crucial for life. In a context of population increase and global climate change, water management and water quality are becoming more and more critical (World Bank 2016). In parallel, bottled water consumption globally has increased significantly over the past decades (Doria 2010; Hu *et al.* 2011; Varga 2011; Guadayol *et al.* 2016). Recent literature has identified different factors that explain variations in tap water quality perceptions, in some cases resulting in the search for alternatives and the use of bottled water (Doria 2006; Doria *et al.* 2009; Zivin *et al.* 2011). When comparing tap water in Texas with one brand of bottle water, Raj (2005) found that the tap water was safer because of the presence of anti-bacteriological agents not found in the bottled water. More recent literature also indicates that tap water is more strictly controlled than bottled water in the USA (Hu *et al.* 2011; Zivin *et al.* 2011). In this regard, Raj explained that tap water is regulated by the US Environmental Protection Agency while bottled water is controlled by the US Food and Drug Administration. However, many studies have found that bottled water is perceived by the general public as having better quality, fewer health risks, and better taste than tap water (Anadu & Harding 2000; Raj 2005; Hu *et al.* 2011; Zivin *et al.* 2011).

The 2014 Elk River spill, in West Virginia, represents an example where the population was placed in a position of risk from tap water consumption (Whelton *et al.* 2015). In addition, Zivin *et al.* (2011) stated that alternatives to tap water consumption increased when water-related incidents occurred in the USA, having direct consequences on the economy through the use of bottled water and filters. Hu *et al.* (2011) added that risk perceptions can go both ways, and that incidents related to certain brands of bottled water have impacts on the consumption of these

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products. In fact, the literature points to the fact that water quality perceptions are affected by organoleptic perceptions (i.e., taste, odor, and color) and health risk perceptions (Doria 2006). These two latter factors are related, as the literature shows that health risk perceptions are significantly associated with organoleptic perceptions (Turgeon *et al.* 2004; Doria 2006; Hu *et al.* 2011; Proulx *et al.* 2012). In addition, Hu *et al.* (2011) found that perceptions regarding both surface water quality (i.e., streams, rivers, and lakes) and groundwater water quality in the immediate geographic area of respondents' homes significantly impacted the perceptions of the tap water quality. Socio-economic factors were found to be significant in multiple studies when related to the use of bottled water (Doria 2006; O'Donnell & Rice 2012; Akpinar & Gul 2014). For example, Akpinar & Gul (2014) found that lower income would predict the absence of bottle use in Turkey. Still other studies (Abrahams *et al.* 2000; O'Donnell & Rice 2012) found that non-white populations were more likely to use bottled water in the USA. Added to these factors, Espinosa-García *et al.* (2015) explained that a high level of bottled water use in Mexico was also due to misinformation and marketing of bottled water companies. These different results suggest important differences between countries and regions. According to the International Bottle Water Association (2013), it takes 1.39 liters of water to make 1 liter of bottled water in the USA. Still other literature suggests the environmental cost (i.e., fabrication, transport, pollution) associated with bottled water consumption is significantly high (Hu *et al.* 2011; Saylor *et al.* 2011; Van Der Linden 2015). Thus, in the context of reduced freshwater availability at a global scale, combined with global climate change, people who are more concerned about the environment favor less using bottled water (Saylor *et al.* 2011; Merkel *et al.* 2012; Van Der Linden 2015). As well, environmental risks associated with human activities such as mining and gas drilling can increase risk perceptions linked with drinking tap water (Merkel *et al.* 2012). In the case of the Appalachia region, human activities have played a major role in that environmental risk, historically as a result of coal mining, and now with the expansion of natural gas extraction (Sams & Beer 2000; Higginbotham *et al.* 2010; Underwood *et al.* 2014). Therefore, concern about the environment seems to be relevant in defining bottled water use in the USA.

STUDY PURPOSE

Although bottled water use has been widely studied, the frameworks utilized by researchers vary considerably, with focuses ranging from health to economics (Doria 2010). In contrast, filter use has received less attention in the literature. For example, Dupont *et al.* (2010) focused on health risks related to filter use, while Abrahams *et al.* (2000) used an economics approach. Our study aims to understand residents' perceptions of tap water quality, and to understand the factors that predict bottled water and filter use in a mid-sized city in northcentral West Virginia. We propose to analyze filter use and to contrast it with bottle use, utilizing a non-economic approach, similar to Doria *et al.* (2009) and Hu *et al.* (2011). Using Doria *et al.*'s variables, we replicated items related to perceived water quality, perceived health risks, and organoleptic perceptions. Building on Hu *et al.*, we explore how clean water and its link to recreation, environmental concern, and satisfaction with living in the area predict the uses of bottled water and filters. As recreation is important in West Virginia it seemed reasonable to test the presence or absence of a relationship between recreation and tap water quality (West Virginia Division of Tourism 2012). Tested in various studies, environmental concern seemed to be of interest in studying tap water quality, especially regarding the context of West Virginia and its recent chemical spill (Saylor *et al.* 2011; Merkel *et al.* 2012; Whelton *et al.* 2015). Satisfaction with living in the area was based on Syme & Williams (1993), as they found that Australian residents who had a positive perception of water quality were significantly more satisfied with the area where they lived.

More precisely, we defined the following hypotheses:

H1: Higher perceived health risks, lower perceived water quality, lower organoleptic perceptions of the tap water, and lower satisfaction with living in the area were hypothesized to increase the likelihood of bottle and filter use.

H2: Respondents who indicated higher importance for clean water for recreation and who perceived local streams, rivers, and lakes as having a poor water quality were hypothesized to be more likely to use bottled water and filters.

H3: A higher level of environmental concern was hypothesized to decrease the use of bottled water and to increase the use of filters.

H4: Based on several studies, we hypothesized that women, younger generations, higher incomes, and lower education were more likely to use bottles and filters.

METHODS

Study area

The city of Morgantown (WV) and its suburban area was chosen in order to conduct the survey. This area represents about 90,000 residents (total population). Morgantown Utility Board is responsible for pumping the water from the Monongahela River, treating and distributing the tap water in the surveyed area. In that respect, Morgantown can be considered to have medium density housing.

Data collection

A questionnaire survey was designed at West Virginia University, under the Appalachian Freshwater Initiative, funded by the National Science Foundation. A sample of 5,492 residents of Morgantown (WV) and suburban areas were randomly drawn by the third-party contractor who provided the database. These residents were asked to take part in an online survey regarding their home tap water quality. The data were collected between November 2015 and January 2016. The targeted residents received a first invitation by e-mail followed by four reminders: 3 days, 13 days, 30 days, and 45 days after the first invitation. Using a separate database available from West Virginia University, 184 residents were randomly prompted to participate in a mail-back survey (Dillman *et al.* 2014). These residents received a postcard announcing the survey, followed by two mail-back surveys, with 1 week separating each (Dillman *et al.* 2014). The mail-back letter included a cover letter, the survey instrument, and a self-addressed stamped envelope. Combining these two methods, 557 respondents answered the online survey while 46 respondents answered the mail-back survey. A total of 603 residents completed the survey, reaching a response rate of 11.3% (after deleting false addresses). The targeted adult population was 77,500 residents (adult population). The sample size reached the necessary 385 responses needed for analyses (Dillman *et al.* 2014).

Survey design

The questionnaire asked residents about the perceived water quality of their home tap water, the associated perceived health risks generated by tap water consumption, the organoleptic perceptions with it, items related to their environmental concern (Syme & Williams 1993; Dutcher *et al.* 2007; Doria *et al.* 2009). The respondents were also asked their perceptions of the surface water quality in local lakes and rivers, the importance of clean water for recreation, and their satisfaction with living in the area, similar to previous research (Syme & Williams 1993; Hu *et al.* 2011; Smith & Desvousges 2012). A five-point Likert scale was used to measure levels of agreement: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. Scales were created by combining several items. The Cronbach's α was employed to measure the reliability of the scales, with any value above 0.70 indicating appropriate consistency of the scales (Vaske 2008).

The following items were used to produce these scales:

- Perceived health risks scale (Doria *et al.* 2009) combining four items, 'There are health risks associated with drinking tap water in my home,' 'I don't believe there is any possibility of becoming ill from drinking water straight from the tap' (reverse coded), 'There are so many chemicals and additives in my home tap water that it must be unhealthy,' 'My home tap water would not harm anybody' (reverse coded) (Cronbach's $\alpha = 0.840$).
- Perceived water quality scale (Syme & Williams 1993; Doria *et al.* 2009) combining two items, 'I don't believe the quality of my home tap water is so bad that it needs improvement,' 'My tap water is usually of high quality' (Cronbach's $\alpha = 0.810$).
- Organoleptic scale (Doria *et al.* 2009) combining three items, 'I am happy with the taste of my tap water,' 'I

am happy with the color of my tap water,' 'I am happy with the odor of my tap water' (Cronbach's α = 0.882).

- Environmental concern scale (Dutcher *et al.* 2007) combining five items, 'If things continue on their present course, we will soon experience a major ecological catastrophe,' 'The problems of the environment are not as bad as most people think' (reverse coded), 'We are quickly using up the world's natural resources,' 'People worry too much about human progress harming the environment' (reverse coded), 'We are spending too little money on improving and protecting the environment' (Cronbach's α = 0.867).
- Area satisfaction scale (Syme & Williams 1993) combining two items, 'If I had the opportunity, I'd rather live in another area' (reverse coded), 'In general, I would be happy living in this area for the next 15 years' (Cronbach's α = 0.792).

A clean water for recreation scale (Smith & Desvousges 2012) was based on a five-point Likert scale measuring different levels of importance with (1) being not at all important, (2) somewhat not important, (3) neutral, (4) somewhat important, and (5) very important. The five items composing the scale were: 'Clean water for my own recreation on/in water is…,' 'Clean water for my potential future recreational use is…,' 'Preserving clean water for future generations is…,' 'Satisfaction from knowing that there is clean water is…,' 'Satisfaction from knowing that others can enjoy clean water for recreation is…' (Cronbach's α = 0.828).

Respondents were asked to rate the surface water quality in local streams, lakes, and rivers (based on Hu *et al.* 2011) with a five-point. Likert scale: (1) very poor, (2) poor, (3) fair, (4) good, and (5) excellent. Respondents were also asked whether they primarily purchase bottled water for their drinking purposes by the use of a yes/no question (based on Hu *et al.* 2011). Using a similar dichotomous choice, respondents were asked to indicate whether they were using a filter when drinking water from the tap. The survey instruments also included items designated to gather demographic data.

Data processing and analysis

The data were analyzed using Statistical Package for the Social Sciences version 24. In order to understand what factors predict the use of bottled water and the use of water filters, two logistic regression models were used. Demographics were included in the models: income, age, gender, and level of education were expected to influence the use of bottles or filters according to previous literature. The scales defined in the previous section were created based on Vaske (2008) using the mean of the other items in the scale in order to reduce missing data and create more accurate scales. Perception of the surface water quality and income were missing data ($n = 34$ and $n = 76$, respectively). We replaced the missing data with the mean of the variables (Vaske 2008). This technique has the disadvantage of diminishing estimations of R^2 but seems a reasonable approach for these two variables (Vaske 2008). The different variables used for the two logistic regressions were as follows: the perceived health risks scale, perceived water quality scale, organoleptic scale, environmental concern scale, area satisfaction scale, perception of surface water quality, clean water for recreation, as well as gender, age, income, and education. Since previous studies indicate strong significant prediction of perceived water quality from perceived health risks and organoleptic perceptions (Doria *et al.* 2009), the assumption of multicollinearity was checked and was not found to be of concern. However, even though multicollinearity was not high among these variables (variance inflation factor below 3), initial testing of the logistic regression model that included the perceived water quality scale resulted in a poor fitting model and suppression effects on other variables. This scale was removed for these analyses.

Limitations

Non-response bias was checked by comparing responses from individuals who answered the survey after the first survey invitation with responses from those who answered the survey after the last reminder (Israel 2011). No significant differences were found either in individual items or within the demographics. In addition, a comparison of the data from this study and the US Census Bureau (2016) demographics data was made, showing the respondents in this study were somewhat different from the local population. More women (56%) answered the survey than the actual population (48%), and income was higher within this database than seen in the general population. Although the survey was designed using Dillman *et al.* (2014) to increase the response rate, biases present in the sample are the result of a low response rate that typically affects web surveys (Sax *et al.* 2003). By using two different data collection methods, we searched for biases and found that mail-back respondents ($n = 46$) were older, reported higher income levels, were more educated, and had generally higher perceptions of water quality than the respondents from the web survey. However, when controlling for this group during the analyses, the results were similar and indicated the same pattern.

The consequence of these biases is not considered to be of large magnitude for two reasons: (1) we are interested in understanding the relationship between variables, which is less affected by non-response bias than univariate variables analyses (Blair & Zinkhan 2006); and (2) with 45 days between the first respondents and the last respondents, the method used to test non-response bias is said to be reliable (Blair & Zinkhan 2006; Dillman *et al.* 2014).

Table 1 | Demographics from the sample under study

Demographic variable	n	%	M	SD
Female	326	56		
Age	584		51.74	13.91
18–29	32	5		
30–39	105	18		
40–49	116	20		
50–59	151	25		
60–69	120	20		
70–79	50	8		
80 +	9	1		
Household income	527		$89.051	/
$0–$24,999	27	5.1		
$25,000–$49,999	98	18.6		
$50,000–$74,999	102	19.4		
$75,999–$99,999	86	14.2		
$100,000–$149,999	125	20.7		
$150,000 or more	89	14.7		
Education				
Some high school	4	0.7		
High school graduate	49	8.3		
Some college	96	16.3		
Two-year college	50	8.5		
Four-year college	166	28.2		
Graduate or professional degree	223	37.9		

RESULTS

Descriptive summary of the sample

Table 1 summarizes the main demographics of the respondents. A total of 37% of the respondents indicated that they primarily used bottled water for their drinking purposes. Over half of the respondents (58%) affirmed they used a filter when drinking from the tap. Almost half of the respondents (46%) affirmed that they agreed or strongly agreed with being happy with the taste, color, and odor of their tap water. A majority of respondents (60%) disagreed or strongly disagreed with statements related to risk perceptions associated with drinking water from the tap (mean = 2.64), indicating that most respondents thought there were not many health risks involved with drinking from the tap. Respondents felt rather neutral about the environment (mean = 3.44), with 21% agreeing or strongly agreeing with the proposed statements (high environmental concern) and 9% disagreeing or strongly disagreeing with the statements (low environmental concern). A majority of respondents (60%) agreed or strongly agreed with items related to their satisfaction with living in the area. Regarding the perceived surface water quality, respondents felt rather neutral (mean = 3.21) with 43% evaluating the water quality of lakes, rivers, and streams as fair. Most respondents felt strongly about the importance of clean water for recreation (mean = 4.70), with 57% of respondents indicating that the statements were very important to them.

Logistic regression model 1: predicting bottled water use

Logistic regression was conducted to assess whether the demographic variables and the water quality perceptions significantly predicted the use of bottled water for drinking purposes. The assumptions of independence of observations and the linearity of independent variables with the log of the dependent variable were met. When considered together, the ten variables predict whether a respondent uses bottled water ($\chi^2 = 123.55$, $df = 10$, $p < 0.001$). Table 2 presents the odds ratios that suggest that the odds of drinking bottled water significantly decrease as education, organoleptic perceptions, and environmental concern scores increase. Specifically, the odds of drinking bottled water deteriorate by 0.78 per unit increase of education, by 0.46 per unit increase of organoleptic perceptions, and by 0.76 per unit increase of environmental concern. In contrast, as the score of perceived health risks increases by one unit, the odds of drinking bottled water significantly increase by 1.36. Interestingly, gender, age, income, area satisfaction, perceived surface water quality, and clean water for recreation did not prove significant in modifying the odds of drinking bottled water. The Nagelkerke pseudo R^2 indicates a moderate strength of the model in predicting the use of bottled water by respondents (see Table 2). The Hosmer and Lemeshow test of good fit is non-significant, indicating a good model fit ($\chi^2 = 5.89$, $df = 8$, $p = 0.659$).

Logistic regression model 2: predicting filter use

A second logistic regression was conducted to assess whether the demographic variables and the water quality perceptions predicted the use of a filter when drinking tap water. The assumptions of independence of observations and the linearity of independent variables with the log of the dependent variable were met. When considered together, the ten variables adequately predict whether a respondent uses a filter ($\chi^2 = 63.56$, $df = 10$, $p < 0.001$). Table 3 presents the odds ratios that suggest that the odds of using a filter significantly decrease as age and organoleptic perceptions scores increase. Specifically, the odds of using a filter deteriorate by 0.99 per year gained and by 0.55 per unit increase of organoleptic perceptions. In contrast, as the score of income increases by one unit, the odds of using a filter significantly increase by 1.38. Gender, education, perceived health risks, environmental concern, area satisfaction, and clean water for recreation did not prove significant in modifying the odds of using a filter when drinking tap water. The Nagelkerke pseudo R^2 specifies a modest strength of the model in predicting the use of filter by respondents (see Table 3). This model was not as strong as the previous model, even though the Hosmer and Lemeshow test of good fit is non-significant, indicating a good model fit ($\chi^2 = 14.99$, $df = 8$, $p = 0.059$).

DISCUSSION

Our first logistic regression model shows that education and health risk perceptions are predictors of bottled water use.

Table 2 | Summary of logistic regression analysis predicting drinking bottled water ($N = 555$)

Predictor	B	SE	R	95% CI	Wald statistic	p
Female	0.08	0.21	1.09	[0.72, 1.66]	0.17	0.678
Age	−0.01	0.01	0.99	[0.97, 1.00]	3.28	0.070
Income	−0.01	0.07	0.99	[0.86, 1.15]	0.01	0.917
Education	−0.25	0.08	0.78	[0.67, 0.91]	10.16	0.001
Perceived health risks	0.31	0.15	1.36	[1.01, 1.85]	3.99	0.046
Organoleptic perceptions	−0.77	0.14	0.46	[0.35, 0.61]	28.89	<0.001
Environmental concern	−0.27	0.13	0.76	[0.59, 0.98]	4.46	0.035
Area satisfaction	−0.08	0.12	0.93	[0.73, 1.17]	0.40	0.525
Perceived surface water quality	0.04	0.14	1.04	[0.79, 1.38]	0.08	0.773
Clean water for recreation	0.49	0.25	1.64	[0.99, 2.69]	3.79	0.051
Pseudo R^2 (Nagelkerke)	0.274					

Drinking bottled water coded as 0 = does not use bottled water, 1 = uses bottled water.
SE = standard error for regression coefficient (B).
CI = confidence interval for odds ratio (OR).

Table 3 | Summary of logistic regression analysis predicting using a filter ($N = 546$)

Predictor	B	SE	R	95% CI	Wald statistic	p
Female	−0.01	0.19	0.99	[0.67, 1.46]	0.02	0.992
Age	−0.01	0.01	0.99	[0.97, 0.99]	4.28	0.039
Income	0.32	0.07	1.38	[1.20, 1.59]	20.93	<0.001
Education	−0.09	0.07	0.91	[0.79, 1.05]	1.64	0.200
Perceived health risks	−0.16	0.15	0.85	[0.64, 1.13]	1.24	0.265
Organoleptic perceptions	−0.59	0.14	0.55	[0.42, 0.73]	17.48	<0.001
Environmental concern	0.02	0.12	1.02	[0.82, 1.29]	0.04	0.834
Area satisfaction	0.03	0.12	1.03	[0.82, 1.30]	0.07	0.795
Perceived surface water quality	−0.26	0.13	0.77	[0.59, 1.00]	3.71	0.054
Clean water for recreation	−0.04	0.21	0.96	[0.64, 1.45]	0.03	0.859
Pseudo R^2 (Nagelkerke)	0.148					

Using a filter coded as 0 = does not use a filter, 1 = uses a filter.
SE = standard error for regression coefficient (B).
CI = confidence interval for odds ratio (OR).

The literature is rather divided regarding these results. On one hand, Levallois *et al.* (1999) found no significant relationship between bottled water use and health risk perceptions. Conversely, Hu *et al.* (2011) and Abrahams *et al.* (2000) found a significant relationship with risk perceptions but did not find education to be significant in predicting bottled water use. Our results indicate that lower levels of education predict the use of bottled water, which confirms one of the hypotheses present in (H4) and replicates the findings of Dupont *et al.* (2010) in their sample of Canadian household residents. Together with the fact that health risk perceptions are predicting bottle use (confirming H1), our results highlight the need for education about water quality concerns. By having the right information, citizens can make informed decisions on their drinking behaviors. Nonetheless, Dupont *et al.* warned that information must be explicit, since less educated people are less likely to find and make the right interpretation of the information given. As mentioned earlier, Espinosa-García *et al.* (2014) showed that marketing and miscommunication in Mexico led to higher levels of bottled water consumption. Means (2002) also made a link between marketing of bottled water companies who advertise for higher water quality, and higher sales of bottled water in the USA. De Giglio *et al.* (2015, p. 63) mentioned that recent marketing strategies of bottled water companies consist in promoting 'eco-friendly' bottles to attract people who have higher environmental concern. As hypothesized in (H3), we demonstrated that environmental concern has a significant impact in the use of bottled water, contrasting with Hu *et al.* (2011), but similar to other studies (Saylor *et al.* 2011; Merkel *et al.* 2012; Van Der Linden 2015). For example, Saylor *et al.* (2011) proposed the creation of a campaign focusing on the environmental impacts of plastic bottles in order to influence behaviors. Accordingly, it is the role of scientists, public authorities, and ultimately, water companies to decide what type of information is provided to the public to influence behaviors (Sagoff 2013). Validating part of our hypothesis (H1), our findings illustrate that organoleptic perceptions represent the most important predictor of bottle use, as indicated by much previous literature (Anadu & Harding 2000; Saylor *et al.* 2011; Zivin *et al.* 2011; Huerta-Saenz *et al.* 2012). In our study, gender does not prove to be a predictor, similar to Dupont *et al.*'s study, but contrasting with Hu *et al.* and Saylor *et al.* where women were found to drink significantly more bottled water than men. Our analyses revealed that age is not significant in predicting the use of bottled water, in line with Dupont *et al.* but differing from Hu *et al.* Satisfaction with living in the area does not predict bottled water use, disapproving our hypothesis (H1).

Our second model was expected to be similar to the bottled water model. For instance, organoleptic perceptions proved to be very important in predicting both behaviors: using bottled water or filters. This is in line with previous literature, where bottled water and filtered water was perceived as having better organoleptic qualities (Anadu & Harding 2000; Saylor *et al.* 2011; Zivin *et al.* 2011; Huerta-Saenz *et al.* 2012). In a 2007 survey in Canada, the main reason that households used filters was to improve organoleptic perceptions (Statistics Canada 2009). Turgeon *et al.* (2004) stated that organoleptic perceptions may differ from the water treatment plant to the tap of the consumers. In this sense, the state of the distribution system may alter the quality of the tap water (Turgeon *et al.* 2004). Filters are used to neutralize taste, color, and odor, indicating the same concerns as for bottled water use. Nonetheless, a major difference with the bottled water model is that income characterizes the most important variable predicting filter use, while income is not significant in predicting bottle use. Our findings suggest that the more income households have, the more likely they are to buy filters. This result is similar to Abrahams *et al.* (2000). In addition, age significantly explains the use of filters, replicating the findings of Abrahams *et al.* and Hu *et al.* Health risk perceptions are not significant in the second model, which proves that bottle use and filter use are explained differently. While organoleptic perceptions both play a role in explaining these behaviors, education, environmental concern, and risk perceptions only apply to bottle use. In the USA, several studies explained that bottled water can pose some health-related issues among children who do not have a sufficient amount of fluoride in their household water, in contrast to tap water (Lalumandier & Ayers 2000; Huerta-Saenz *et al.* 2012). In that sense, filter use enables children to receive their fluoride intake. Even though the use of filters seems to offer a solution to organoleptic perceptions of tap water, it seems to pose inequalities as more affluent households may be more likely to afford these filters. The fact that age is linked with filter use in the second model can indicate that certain audiences may be targeted. Here again, education might be helpful in determining the water quality to help the general public in understanding the quality of their tap water.

In West Virginia, a long history of extractive industries may possibly increase risk perceptions associated with drinking tap water. Notably, the 2014 Elk River spill in Charleston (WV) and the miscommunication that emerged during that crisis may have increased risk perceptions linked with tap water consumption (Zivin *et al.* 2011; Zivin & Neidell 2013; Whelton *et al.* 2015). After two and a half years, the US National Toxicology Program (2016, p. 1) produced its final update about the risks involved with the raw content of this spill and found that 'exposure at or below the screening level is considered not likely to be associated with any adverse health effects.' This statement demonstrates that the tap water is safe to drink. However, Zivin *et al.* (2011) showed that catastrophes such as the Elk River spill or the lead contamination in Flint (MI) increase the number of bottled water sales in the USA resulting from avoidance behavior. In parallel, Dupont & Jahan (2012) found that these avoidance behaviors (purchasing bottled water or using filters) varied across regions in Canada, ranging from $34 per household per year in Quebec versus $60 in Ontario. These authors showed that memorability can affect behaviors since Ontario saw water contamination of *Escherichia coli* in 2000 (Dupont & Jahan 2012). In consequence, health risks and avoidance behaviors have ramifications on the economy and on the environment.

Our results are important because they showcase the dissimilarities between bottled water use and filter use. For instance, these results prove that organoleptic perceptions are their common predictor but that risk perceptions, environmental concern, and education only affect bottle use. Income and age affect solely filter use. Our findings suggest that a substitution of bottle use by filter use is possible in the case of organoleptic perceptions but that communication and education efforts are needed to diminish bottle use. It is important to deliver messages that effectively communicate the factual quality differences between drinking tap water and bottled water. In addition, these results suggest that filter use can be an alternative to bottle use. A reduction in filter prices could enhance the shift toward filter use instead of bottled use. It could also be part of a campaign to advocate for the use of filters to increase the organoleptic qualities of the tap water.

Additionally, our results indicate that the importance of clean water for recreational activities does not predict bottle or filter uses, nor does perceptions of the water quality of streams, rivers, or lakes in the local area. These are interesting results in terms of perceptions and how they affect the psychology of drinking water since the tap water from this municipality comes from a local river. Our results show that communication efforts regarding tap water quality might not need to include surface water quality to affect drinking behaviors. This may also indicate that most residents do not know where their water is coming from. This highlights the need to better inform Morgantown residents on the origin of their water. In the USA, a 2001 national survey indicated that 86% of the respondents expressed some concern regarding their tap water quality, suggesting the need for more information to be given to the general public (Means 2002). Van der Linden (2015) found that specific normative-induced messages would have the greatest reduction in bottled water use. Means (2002) called for better marketing strategies from municipal water suppliers in order to reassure the general public. In addition, Queiroz *et al.* (2012) added the role of media as an important tool for communicating water quality issues. As suggested by Dupont & Jahan (2012), infrastructure planning and investments should be made in accordance with the needs of the general public, together with delivering the right information. Nonetheless, our results must be interpreted with caution as the survey was conducted in an area that did not suffer from a large-scale chemical spill, as was seen in Charleston (WV). This indicates that further studies with larger geographic areas may find regional differences with the perceived water quality of rivers, streams, or lakes and its importance for recreation and whether they affect bottle and filter consumptions.

CONCLUSION AND IMPLICATIONS

In conclusion, our study aimed at understanding the differences between bottle use and filter use as well as the roles of perceptions of surface water quality and clean water for recreation to predict these uses. The examination of two logistic regression models to test the factors predicting bottle use and filter use as alternatives to tap water use showed that organoleptic perceptions are very important for the general public. Previous literature (Anadu & Harding 2000; Raj 2005; Hu *et al.* 2011; Zivin *et al.* 2011) found that taste is especially responsible for bottled water use, which was verified in our study. Examined in parallel with the second model, it is possible to say that filters could be an alternative for the use of bottled water. If better information and education programs are presented to the general public about tap water quality, and efforts to promote filter use as an alternative to low organoleptic perceptions, the consumption of bottled water could decrease, reducing its environmental impacts (Saylor *et al.* 2011). Interestingly, perceptions of clean water for recreation and surface water quality were not found to be valid predictors for either of the two dependent variables, invalidating our hypothesis (H2). Our study as well demonstrated that income is a strong predictor of filter use: perhaps lower costs of filters could lead to a higher demand for them. Further economic studies could estimate the willingness to pay for filter use.

Two main implications of our results are that: (1) public institutions and leaders should work together to communicate effectively about the safety of tap water quality, about the environmental costs of bottled water, and to promote the use of filters as a substitute for bottled water; and (2) the use of clean water for recreation to bolster communication strategies in drinking water might not be effective, as there is no link between clean water for recreation or perceptions of surface water quality and water drinking behavior.

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