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Perception of risk for domoic acid related health problems: A cross-cultural study

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ABSTRACT

Risk perception is a complex process that refers to the way people approach, think about, and interpret risks in their environment. An important element of risk perception is that it is culturally situated. Since HABs can present a health risk in many places around the world, looking at cultural parameters for understanding and interpreting risks is important. This study examined how two different groups of people perceive the potential health risks of low-level exposure to domoic acid (DA) through razor clam consumption. The risk perceptions of Washington State, USA coastal dwelling Native American nations (NA) were compared to that of a community sample of recreational razor clam harvesters (CRH). Overall, the findings support the hypothesis that cultural and community specific contexts impact the perception of risk of a DA related illness. Specifically, the NA sample was distinguished from the CRH group in particular, by their worries about ocean pollution, attribution of DA risks to climate change, concerns about the potential impact of DA on future generations, and feeling of being better informed than the CRH group. The CRH group was more likely to attribute the DA problem to anthropogenic or industrial causes and view the risk of health problems from DA as lower than those associated with smoking, high cholesterol, anxiety or depression, alcoholism, high blood pressure or obesity. The CRH group was also more likely to turn to the media for DA-related information. Both groups trusted the decisions of state and tribe health and natural resources officials, and demonstrated a complex pattern of findings that involved gender. In summary, risk communication and outreach activities should be designed to take into consideration the specific factors that are unique to each cultural community.

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1. Introduction

Risk perception refers to the characteristic way people approach, think about, and interpret the risks in their environment (Slovic, 1987; Renn, 2004). Risk perception of harmful algal blooms (HABs) involves how individuals and communities perceive, understand, and process information about toxic bloom events and related health risks. This is a complex process that involves gathering information from a variety of sources; interpreting it through a broad range of cognitive, emotional and personality processes; and further filtering it through personal experience and socio-cultural windows (Slovic, 1987; Boholm, 1998; Finkel, 2008). These processes are important for HAB scientists, managers, and risk communicators to understand as the perception of risk triggers the chain of the events that result in both protective and reactive behaviors, regardless of the accuracy of risk judgments.

Most cross cultural risk perception research is organized around distinguishing the hazards of greatest concern to people in different

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culture groups (Jones et al., 2013). Thus, little is known about how different culture groups perceive the same hazard. Since a HAB problem can impact diverse cultures worldwide, there is much to be gained by examining how different groups perceive the risk of the same problem. This is especially important as perceptions of risk can differentially motivate individuals and communities to actively avoid, mitigate, adapt to, or completely ignore risks.

Cross-cultural studies are also important tools that can be used for effective risk communication. Reiterating the same scientific facts to different communities may not be effective if judgments are made based upon cultural lore or reliance on traditional food consumption rather than objective information (McAuley and Knopper, 2013). Reassurance will be futile if community members do not trust the outside sources from which it came. Finally, rationally based arguments will be unproductive if a long history of injustice or inequity in the community predates the HAB event. Thus, increasing knowledge about how specific groups of people, in specific at-risk communities, view a specific HAB risk is important for promoting and regulating their health-safety needs.

The purpose of this study was to examine, describe, and compare risk perceptions of domoic acid poisoning (DA) in two groups of people who dig and consume razor clams, the established vector of dietary exposure. The first group includes members of three Pacific Northwest Native American Tribes (NA) who regularly harvest and consume razor clams as a primary source of protein because of the availability, cultural practices, and historic importance associated with this food product (Fialkowski et al., 2010). The second group represents community recreational harvesters (CRH) who seasonally have the opportunity to dig for razor clams at the same or adjacent beaches. It was hypothesized that there would be differences in the perceived risk of DA poisoning between the two groups.

2. Methods

2.1. Participants

2.1.1. Native American (NA) sample

Participants included 221 men and women from the Makah, Quileute, and Quinault Nations where there was regular access to razor clam harvesting beaches. Volunteers represented a wide range of consumers who were 18 years of age or older, and who participated in recreational, subsistence, and/or commercial razor clam harvesting activities. Recruitment took place within the context of the larger CoASTAL cohort study (Tracy et al., 2016).

2.1.2. Community recreational harvester (CRH) sample

Participants included 315 volunteers, 18 years of age or older, who resided in the state of Washington and participated in an open razor clam dig over a three day period in Ocean Shores and Westport, WA. Participants in the CRH sample represented a diverse range of razor clam consumers.

2.2. Questionnaire

The Health and Environment Risk Questionnaire (HEQ-II) was used to assess risk perception related to DA poisoning. This measure was developed based upon risk perception theory and in collaboration with tribe leaders and members. It was field tested and modified for readability, clarity, content, and language prior to field study use. The measure has good face validity (i.e., the items superficially appear to measure the construct under study) and can be readily adapted for use in a variety of community based environmental health risk studies (e.g., Grattan et al., 2011). The HEQ-II has 19 dichotomous-choices, is open ended, and yields independent scores for each item or section. The measure has four subscales comprised of rank-ordered items: environmental worry, environmental knowledge, reliable sources of information, and shellfish safety and risk.

(1) *Environmental worry* refers to the level of concern that people have over environmental health risks associated with DA poisoning and their attributions. Items on the HEQ-II included the extent to which participants worried about pollution in the Pacific Ocean, the threat of DA related biotoxins, or the ability of scientists to solve the DA biotoxin problem.
(2) *Environmental knowledge* assessed the participants' factual knowledge about DA that leads to judgments about risk. Although indicators of exposure and risk in DA poisoning are not well defined, this scale generates an overall estimate of current knowledge. Participants were asked to consider whether or not DA related biotoxins cause memory loss, if scientists and community members are knowledgeable, if DA biotoxin exposures can be treated, and what they know about general causes for elevated levels of DA in the region. Benchmarks for accuracy of "Environmental Knowledge" were provided by the scientific literature and experts in the field representing the tribes, Washington Department of Fish and Wildlife, and scientists.
(3) *Reliable sources of information* refer to the resources the participant uses to seek accurate information for questions about DA as a potential threat to safety, health, or the environment. Sources of information queried in this section included tribal natural resources, fisheries, and environmental health or natural resource departments; the Washington Department of Fish and Wildlife; family physician, friends and media.
(4) The *shellfish safety and risk scale* of the HEQ-II measured comparative risk judgments about how the perception of DA poisoning compared to other health risks. DA risks were compared to smoking, high cholesterol, anxiety or depression, alcoholism, high blood pressure and obesity.

2.3. Informed consent

All study participants provided general demographic information (no identifiers were obtained) and completed the HEQ-II in the field, which took about 15 min. Participants were provided with informational brochures regarding amnesic shellfish poisoning, stress management, memory, and a small gift (tote bag or water bottle) for study participation. The study team included seven examiners formally trained in survey administration and a licensed psychologist. Standard informed consent procedures were followed as required by University of Maryland Institutional Review Board. Data were analyzed using Stata 10 software (Stata Corp, 2007).

3. Results

The CRH group was older, included more males and was represented by more ethnic diversity, although was predominantly Caucasian. The NA sample was younger and predominantly female (Table 1). The general findings of the differences between the cultural groups may be found in Table 2. Since gender differences were found between groups, follow-up comparisons were made and findings with respect to gender are reported in Tables 3–5.

With respect to *environmental worry*, the NA group worried significantly more about ocean pollution than the CRH participants. Regardless of cultural group, men thought that "others over reacted to the threat of toxins," more than women. In the category

Table 1
Demographic characteristics of study participants.

	Community Recreational Harvesters (n = 315)	Native American Group (n = 221)	
	N (%)	N (%)	p-Value[a]
Age	48.9 ± 14.8	41.8 ± 15.6	<0.01[b]
Gender			
Male	180 (58.6)	47 (22.7)	<0.01
Female	127 (41.4)	160 (77.3)	
Not declared	8	14	
Race			
Caucasian	260 (84.7)	5 (3.3)	<0.01[c]
African American	4 (1.3)	0 (0.0)	
Native American	10 (3.3)	140 (91.5)	
Hispanic	9 (2.9)	2 (1.3)	
Mixed	0 (0.0)	3 (2.0)	
Other	24 (7.8)	0 (0.0)	
Not declared	8	71	

Data are presented as frequency and percentage. Age presented as mean age ± standard deviation.
[a] Probability associated with a Chi square test (two-tailed distribution).
[b] Probability associated with a Student's t-test (two-tailed distribution).
[c] Probability associated with a Fisher's exact test (two-tailed distribution).

of *environmental knowledge*, CRH felt that consuming local fish and shellfish was safe while the NA group were more likely to acknowledge risks of biotoxins and the potential impact of these problems on future generations. The latter risk also had a significantly greater likelihood of endorsement by women across both groups. Both groups were aware of the potential for memory loss to be associated with DA exposure. The NA group believed their community was better informed about the potential risks of biotoxins than the CRH participants. Based upon a follow-up question, 23.7% of the NA group believed they were immune to the potential effects of DA poisoning. Both groups had a similar level of trust of officials to effectively close beaches, although in general, women were more trusting than men (Table 3). Across both cultural groups, women were more likely to trust in the decisions of officials than men and identified WA State and tribal fisheries/natural resources departments as reliable sources of information. With respect to causes of the DA problem, the NA group was more likely to attribute this to climate change while the CRH group was more likely to explain it by population growth, sewage, and industrial waste.

Both groups (especially the males) identified state and tribal health, fisheries, and natural resources personnel as sources for trusted information, with the CRH group seeking information from Washington state agencies and the NA group turning to their

Table 2
Perception of risk for a DA related illness in CRH and NA groups.

	Community recreational harvesters (n = 315)	Native American group (n = 221)	
Risk perception construct	N (%)	N (%)	p-Value[a]
Environmental worry			
Ocean pollution	118 (37.6)	109 (49.3)	0.01
Overreact to threat of DA/biotoxins	133 (42.2)	104 (47.3)	0.25
Science will provide remedies	100 (31.9)	84 (39.1)	0.09
Environmental knowledge			
DA/biotoxins causes memory loss	173 (58.3)	128 (61.0)	0.54
Doctors/scientists know about risk	165 (59.1)	126 (64.0)	0.29
Community knows about risk	74 (24.8)	86 (44.6)	<0.01
Biotoxin exposure can be treated	29 (51.8)	18 (45.0)	0.51
Biotoxin cause: Population growth	96 (33.2)	47 (24.9)	0.05
Biotoxin cause: Climate change	43 (14.9)	52 (27.5)	<0.01
Biotoxin cause: Ag. chemicals	55 (19.0)	25 (13.2)	0.10
Biotoxin cause: Ship ballast waste	37 (12.8)	34 (18.0)	0.12
Biotoxin cause: Sewage/Ind. waste	85 (29.4)	35 (18.5)	0.01
Shellfish safety and risk			
Eating fish/shellfish is safe	291 (94.5)	193 (89.4)	0.03
Direct risk of biotoxins	93 (31.4)	114 (56.2)	<0.01
Risks can be controlled	151 (53.7)	99 (51.8)	0.68
Risk affects future generations	184 (62.0)	168 (82.8)	<0.01
Officials effectively close beaches	285 (91.4)	201 (93.9)	0.27
Reliable biotoxin information sources[b]			
Fisheries/natural resources	175 (55.6)	109 (49.3)	0.16
State/local health department	70 (22.2)	30 (13.6)	0.01
Family physician	14 (4.4)	21 (9.5)	0.02
Friends/neighbors	24 (7.6)	22 (10.0)	0.34
Media	95 (30.2)	39 (17.7)	<0.01
Tribe environmental health office		54 (24.4)[*]	
Comparative risks			
Smoking greater risk	193 (63.5)	83 (40.7)	<0.01
High cholesterol greater risk	168 (55.6)	75 (37.3)	<0.01
Anxiety/depression greater risk	175 (57.8)	80 (39.6)	<0.01
Alcoholism greater risk	181 (59.3)	85 (42.1)	<0.01
High blood pressure greater risk	163 (53.3)	74 (35.8)	<0.01
Obesity greater risk	177 (57.8)	85 (41.3)	<0.01

Abbreviations: DA, domoic acid; Ag., agricultural; Ind., industrial.
Data are presented as frequency and percentage of available responses after missing data was removed.
[a] Probability associated with a Chi square test (two-tailed distribution).
[b] Totals for reliable information sources are more than 100% because participants indicated more than one reliable source of information.
[*] Question was only asked of NA group due to relevance.

Table 3
Gender differences in risk perception across both cultural groups.

Risk perception construct	Male (n = 227) N (%)	Female (n = 287) N (%)	p-Value[a]
Age	48.1 ± 15.5	44.2 ± 15.4	<0.01[b]
Environmental worry			
Ocean pollution	97 (42.9)	118 (41.5)	0.68
Overreact to threat of DA/biotoxins	116 (51.1)	110 (38.5)	<0.01
Science will provide remedies	75 (33.3)	104 (36.8)	0.42
Environmental knowledge			
DA/biotoxins causes memory loss	126 (57.8)	163 (60.6)	0.53
Doctors/scientists know about risk	131 (63.0)	152 (60.1)	0.52
Community knows a lot about risk	72 (33.6)	81 (31.2)	0.56
Biotoxin exposure can be treated	26 (52.0)	19 (46.3)	0.59
Biotoxin cause: Population growth	70 (33.7)	72 (28.0)	0.19
Biotoxin cause: Climate change	41 (19.7)	50 (19.5)	0.95
Biotoxin cause: Ag. chemicals	31 (14.9)	47 (18.3)	0.33
Biotoxin cause: Ship ballast waste	34 (16.4)	33 (12.8)	0.28
Biotoxin cause: Sewage/Ind. waste	50 (24.0)	66 (25.7)	0.68
Shellfish safety and risk			
Eating fish/shellfish is safe	216 (96.4)	251 (89.6)	<0.01
Direct risk of biotoxin	76 (35.2)	119 (45.1)	0.03
Risks can be controlled	109 (51.2)	131 (53.5)	0.62
Risk affects future generations	140 (64.8)	202 (75.4)	0.01
Officials effectively close beaches	204 (90.3)	265 (95.0)	0.04
Reliable biotoxin information sources[c]			
Fisheries/natural resources	131 (57.7)	143 (49.8)	0.08
State/local health department	42 (18.5)	54 (18.8)	0.93
Family physician	09 (4.0)	25 (8.7)	0.03
Friends/neighbors	20 (8.8)	24 (8.4)	0.86
Media	52 (22.9)	80 (27.9)	0.20
Tribal environmental health office[*]	9 (19.2)	44 (27.5)	0.25
Comparative risks			
Smoking greater risk	136 (61.3)	136 (49.3)	0.02
High cholesterol greater risk	122 (55.5)	117 (42.9)	0.02
Anxiety/depression greater risk	124 (56.6)	126 (45.8)	<0.01
Alcoholism greater risk	131 (59.0)	131 (47.5)	0.02
High blood pressure greater risk	117 (52.2)	116 (41.9)	0.04
Obesity greater risk	131 (58.5)	126 (45.5)	0.02

Abbreviations: DA, domoic acid; Ag., agricultural; Ind., industrial.
Data are presented as frequency and percentage of available responses after missing data was removed.
Age presented as mean age ± standard deviation.
[a] Probability associated with a Chi square test (two-tailed distribution).
[b] Probability associated with a Student's t-test (two-tailed distribution).
[c] Totals for reliable information sources are more than 100% because participants indicated more than one reliable source of information.
[*] Question was only asked of NA group due to relevance.

Table 4
Gender differences in risk perception for community recreational harvesters.

Risk perception construct	Males (n = 180) N (%)	Female (n = 127) N (%)	p-Value[a]
Age	49.4 ± 15.1	47.9 ± 14.5	0.39[b]
Environmental worry			
Ocean pollution	69 (38.6)	45 (35.4)	0.58
Overreact to threat of biotoxins	88 (48.9)	43 (33.9)	0.01
Science will provide remedies	56 (31.3)	44 (34.7)	0.54
Environmental knowledge and shellfish safety			
DA exposure causes memory loss	99 (57.9)	68 (57.1)	0.90
Doctors/scientists know about risk	102 (62.2)	61 (55.5)	0.27
Community knows a lot about risk	50 (29.1)	22 (18.3)	0.04
Biotoxin exposure can be treated	20 (54.1)	9 (50.0)	0.78
Biotoxin cause: Population growth	62 (36.7)	33 (29.0)	0.18
Biotoxin cause: Climate change	28 (16.6)	13 (11.4)	0.23
Biotoxin cause: Ag. chemicals	27 (16.0)	26 (22.8)	0.15
Biotoxin cause: Ship ballast waste	22 (13.0)	12 (11.4)	0.69
Biotoxin cause: Sewage/Ind. waste	48 (28.4)	36 (31.6)	0.57
Shellfish safety and risk			
Eating fish/shellfish is safe	174 (97.2)	110 (90.9)	0.02
Direct risk of biotoxin	53 (30.6)	37 (31.9)	0.82
Risks can be controlled	92 (54.8)	55 (51.4)	0.59
Risk affects future generations	105 (60.7)	77 (65.3)	0.43
Officials effectively close beaches	163 (90.6)	116 (93.4)	0.35
Reliable biotoxin information sources[c]			
Fisheries/natural resources	109 (60.6)	68 (48.8)	0.04
State/local health department	36 (20.0)	32 (25.2)	0.28
Family doctor	07 (3.9)	07 (5.5)	0.50
Friends/neighbors	12 (6.7)	11 (8.7)	0.51
Media	46 (25.6)	48 (37.8)	0.02
Comparative risks			
Smoking greater risk	113 (64.2)	78 (63.4)	0.90
High cholesterol greater risk	103 (58.9)	63 (51.2)	0.41
Anxiety/depression greater risk	105 (60.7)	67 (53.6)	0.22
Alcoholism greater risk	109 (61.9)	69 (55.2)	0.48
High blood pressure greater risk	97 (54.8)	63 (51.2)	0.64
Obesity greater risk	107 (60.5)	66 (53.2)	0.46

Abbreviations: DA, domoic acid; Ag., agricultural; Ind., industrial.
Data are presented as frequency and percentage of available responses after missing data was removed.
Age presented as mean age ± standard deviation.
[a] Probability associated with a Chi square test (two-tailed distribution).
[b] Probability associated with a Student's t-test (two-tailed distribution).
[c] Totals for reliable information sources are more than 100% because participants indicated more than one reliable source of information.

tribes' natural resource, fisheries and environmental health offices for information. Nearly one-third of the CRH group turned to the media for reliable information while significantly fewer members of the NA group used that resource. Because participants could select more than one response as a trusted source of information, data were reanalyzed to control for total number of responses for each group. Findings of this analysis indicated that the only difference between the groups was a tendency for the CRH group to turn to the media ($p = 0.06$) for reliable information.

Shellfish safety and risk was assessed by comparing the risks of DA poisoning to other health risks in both groups. There was a systematic difference in shellfish safety and risk, with the NA group more likely to believe that DA poisoning was a greater health risk than smoking, high cholesterol, anxiety/depression, alcoholism, high blood pressure and obesity, while the community group reported the opposite. However, these findings could also be explained by gender differences. Across both groups, men consistently endorsed smoking, high cholesterol, anxiety/depression, alcoholism, high blood pressure and obesity as surpassing DA-related illness as a greater relative health risk. Meanwhile, women in the NA group reported that anxiety and depression were a greater health risk than a DA-related illness.

4. Discussion

The primary objective of this study was to demonstrate how two different cultural groups perceive the potential health risk of a HAB related illness, specifically DA poisoning. The risk perceptions of three coastal dwelling NA nations were compared to that of a community sample of recreational harvesters (CRH) in the state of Washington. Overall, the findings support the hypothesis that cultural and community specific contexts impact the perception of DA-related illness risk. Moreover, sociocultural factors may have a greater influence on some elements of risk perception compared to others. In summary, the NA group worried more about ocean pollution than the CRH group; viewed the health risk of DA poisoning as greater than smoking, high cholesterol, anxiety or depression, alcoholism, high blood pressure or obesity; and believed their tribal members were well-informed. Their most trusted sources of information were tribal fisheries, natural resources, and environmental health

Table 5
Gender differences in risk perception for Native American group.

Risk perception construct	Males (n = 47) N (%)	Female (n = 160) N (%)	p-Value[a]
Age	43.0 ± 16.2	41.4 ± 15.5	0.54[b]
Environmental worry			
Ocean pollution	28 (59.6)	73 (45.6)	0.09
Overreact to threat of DA	28 (59.96	67 (42.1)	0.04
Science will provide remedies	19 (41.3)	60 (38.5)	0.73
Native Americans are immune	11 (23.4)	36 (23.4)	0.99
Knowledge and shellfish safety			
DA exposure causes memory loss	27 (57.5)	95 (63.3)	0.47
Doctors/scientists know about risk	29 (65.9)	91 (63.6)	0.78
Community knows a lot about risk	22 (52.4)	59 (42.1)	0.24
Biotoxin exposure can be treated	06 (46.2)	10 (43.5)	0.88
Biotoxin cause: Population growth	08 (20.5)	39 (27.3)	0.39
Biotoxin cause: Climate change	13 (33.3)	37 (25.9)	0.36
Biotoxin cause: Ag.chemicals	04 (10.3)	21 (14.7)	0.48
Biotoxin cause: Ship ballast waste	12 (30.8)	20 (14.0)	0.02
Biotoxin cause: Sewage/Ind. waste	02 (5.1)	30 (21.0)	0.02
DA is not really a problem	16 (34.8)	54 (35.3)	0.95
Shellfish safety and risk			
Eating fish/shellfish is safe	42 (93.3)	141 (88.7)	0.36
Direct risk of biotoxin	23 (53.5)	82 (55.4)	0.82
Risks can be controlled	174 (37.8)	75 (55.1)	0.04
Risk affects future generations	35 (81.4)	125 (83.3)	0.77
Officials effectively close beaches	41 (89.1)	149 (96.1)	0.07
Reliable biotoxin information sources[c]			
Fisheries/natural resources	22 (46.8)	81 (50.6)	0.65
State/local health department	06 (12.8)	22 (13.8)	0.86
Family physician	02 (4.3)	18 (11.3)	0.15
Friends/neighbors	08 (17.0)	31 (8.1)	0.08
Media	06 (12.8)	32 (20.0)	0.26
Tribal environmental health office	09 (19.2)	44 (27.5)	0.25
Health risks of DA poisoning vs. other risks			
Smoking greater risk	23 (50.05)	58 (37.9)	0.24
High cholesterol greater risk	19 (42.2)	54 (36.0)	0.24
Anxiety/depression greater risk	19 (41.3)	59 (39.3)	<0.01
Alcoholism greater risk	22 (47.8)	62 (41.1)	0.62
High blood pressure greater risk	20 (42.3)	53 (34.4)	0.27
Obesity greater risk	24 (51.1)	60 (39.2)	0.27

Abbreviations: DA, domoic acid; Ag., agricultural; Ind., industrial.
Data are presented as frequency and percentage of available responses after missing data was removed.
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[a] Probability associated with a Chi square test (two-tailed distribution).
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[c] Totals for reliable information sources are more than 100% because participants indicated more than one reliable source of information.

departments. The NA group was less likely than the CRH group to turn to the media for reliable information. Within this context, most people from this NA group (89%) viewed their shellfish as safe.

The CRH group as a whole worried less about the health risk of a DA-related illness and believed it was lower than the risk of smoking, high cholesterol, anxiety or depression, alcoholism, high blood pressure or obesity. This may reflect that access to knowledge regarding health risks through media and other sources was more widely accessed by the CRH group. With respect to attributed causes of DA in the environment, the CRH group blamed anthropogenic and industrial sources (population growth as well as agricultural chemicals, sewage and industrial waste) while the NA group looked toward natural causes (climate change).

Although these findings support the hypothesis that cultural and community specific contexts impact the risk perception for a DA related illness, it also highlights a complex pattern of findings for gender. The results of this study indicate that in some domains of risk perception (e.g., worry about health threats), gender differences were stronger than cultural group differences. Comparing this finding to the reports of others, some consistency is found as it is generally well accepted that men tend to judge risks as smaller and as less problematic than women (Slovic, 2000). Future research on the impact of gender on risk perception within the context of DA or other HAB events is indicated.

The findings of this study need to be interpreted with the following limitations in mind. First, this study team cautions against attributing all differences between the study groups as cultural. Risk perception is a complex process and there likely are numerous other factors that need to be considered when interpreting data. For example, gender played a big role in perceptions of risk in the study. In environmental health, another factor important in risk assessment includes distance from the hazard under study. Since the data collected in this study were completely anonymous, address or zip code data for the CRH group was not collected, therefore the relationship between distance and risk assessment cannot be determined. A final consideration is that "actual knowledge" is limited and generally not available for risk assessment in people with low level, chronic exposure of DA through razor clam consumption. Although studies are underway (Tracy et al., 2016; Grattan et al., 2016), at this time perceived risk is being assessed to an ambiguous hazard. Meanwhile, it is anticipated that knowledge from cross cultural studies such as this one, can contribute to more effective risk communication, outreach, and education efforts to HAB communities in distress.

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