Proceedings of the National Conference
On Undergraduate Research (NCUR) 2020
Montana State University, Bozeman MT
March 26-28, 2020

Batavia Residents' Knowledge and Perception of the Potential Health and Environmental Risks of an Upstream Cyanide Spill from Gold Mining

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Abstract

In 1995, a tailings dam at Omai Gold Mining Limited collapsed, releasing over 3.2 billion litres of cyanide into the Essequibo River. This incurred both ecological and socio-economic consequences, affecting residents reliant on the river for multiple uses. Mining operations using dangerous chemicals to aid gold extraction are often established and communities are unaware of their existence and risks they pose downstream. This study aimed to assess community knowledge and perception of the risks associated with an upstream cyanide spill in the Cuyuni River, given that yet another mining operation upstream is using cyanide. A cross-sectional survey was conducted in the riverine community of Batavia, Region 7, Guyana. A census was done for this community, which had 60 households participate in the completion of a structured survey. The interviews revealed 41.7% (n=25) of respondents were not knowledgeable of the environmental and health risks of cyanide. More females were knowledgeable of environmental risks (n= 26, 43.3%) and health risks (n= 21, 35%) than males (n= 9, 15%) and (n= 14, 23.3%) respectively. 86.7% were very concerned about contamination of the fish they eat, while 81.7% were very concerned about cyanide polluting their rivers. More females had greater consideration than males for the potential health risks; females (n=21, 35%), males (n=15, 25%), and environmental risks; females (n=18, 30%), males (n=14, 23.3%). 83.3% (n= 50) of the respondents had no prior information of the risks associated with a cyanide spill. Batavia's lack of awareness regarding the risks a cyanide spill may have on the community renders them unprepared to effectively understand and address the associated risks.

Keywords: Cyanide Spill, Risk Knowledge, Risk Perception

1. Introduction

Cyanide is used by approximately 90% of significant gold producing operations worldwide,[1] primarily for gold extraction because has been found to be more efficient at extracting gold from the ore in areas previously unsuitable when compared to using tradition placer or load mining techniques.[2] If ingested, cyanide can be lethal to humans, this coupled with public concern about the potential environmental implications of cyanide used by the mining industry have led to documented statements of fear and opposition by both the surrounding and environmental community.[2] This is an acutely poisonous chemical which gives rise to a number of effects including uncontrolled breathing, effects on the nervous system, tremors and in extreme cases, death.[3] Vomiting, skin irritation and sudden cardiac arrest are also common health implications associated with cyanide exposure.[4] Cyanide is associated with short-term environmental effects leading to the injury or death of aquatic life,[1] as accidental cyanide spills have produced massive fish kills, with freshwater fish as the most cyanide-sensitive group of aquatic organisms.[5] At high exposure levels, cyanide is highly potent and acts rapidly on plants and animals,[6] and this toxic chemical has an affinity to combine with the metals readily available in soils.[2]

Mining incidents involving intermediate and large mining companies have occurred throughout the world, with the majority of environmental incidents accounted for by tailings dam related causes.[1] As a result, downstream aquatic ecosystems have experienced catastrophic environmental impacts.[6] In January 2000, following the rupture of a tailing pond retention dam at the Aurul Mine near Baia Mare, Romania, released 100,000 m^3 of liquid and suspended solid containing 50-100 tons of cyanide.[2] The Baia Mare spill travelled approximately 2000 km downstream the Danube river,[2] which had acute effects including the death of a number of aquatic species and also affected drinking water wells.[3] Following the spill it was revealed by the UNEP/OCHA investigation mission that the level of public knowledge of toxic chemicals and future mining risks was very low and that there was a need for more objective and reliable information from local authorities and the media.[3] A lack of knowledge or an incomplete understanding of risks can transform incidents into crises, and as such it is essential to inform communities of hazards they may face before an incident to reduce the likelihood that communities would be put at risk.[7]

Risk encompasses people's subjective judgments about the likelihood of negative occurrences such as injury, illness, diseases and death.[8] Mining is usually associated with a number of risks, as the activities have the potential to impose negative implications on both the immediate vicinity and more distant areas.[9] The knowledge and perception of people regarding the health and environmental risks of mining has been previously assessed, however to the author's knowledge, no prior studies have examined the community's knowledge and perception of these risks prior to a mining accident such as a spill. According to Boulander and Gorman, most of the people in mining communities do not know of the challenges mining poses to their health until they are affected with diseases or start showing symptoms of infections.[10]

According to DeBrouwer et al. in a West African study on the knowledge and perception of health and environmental risks of artisanal gold mining among gold miners, the potential of gold mining to incur health risks was identified by all respondents.[11] The study reported that 60% had identified 3 out of the 5 health impacts of gold mining listed, while at least 3 impacts were known by 49.5% based on the environment.[11] A similar study by Charles et al. was conducted in Tanzania, and assessed the existing community knowledge and perception of potential mercury and arsenic toxicity and/or exposure from artisanal gold mining.[12] Their study reported that a high number of respondents were unable to identify any specific symptoms associated with arsenic as 89.4% were not aware of the health effects of arsenic exposure, while 40.6% of the respondents were not aware of the associated health effects of mercury exposure.[12] Males were found to be significantly more knowledgeable of risks than females, revealing a statistical association between the gender of the respondents and their knowledge of health-related risks of mining.[12]

Ackley reported on the findings of a perceptual study done in a Fijian mining town in 2007 that the majority of their respondents were 'very concerned' about the risks of toxic chemicals from mining.[13] According to Ackley, environmental and health concerns were accounted for by 95.2% and 59.4% of the respondents in the English and Fijian Version of the survey respectively.[13] While 76.8% of the participants had no emergency plan in the event of a spill, findings showed that majority of its participants thought they had all the information needed to decide how they feel about the risks.[13] The relevance of socio-economic and demographic variables when explaining people's perception of environmental risks is suggested by previous literature.[14] Concerning gender, studies have found that women tend to perceive a higher risk than men, particularly in cases of technological risks, and health and safety implications of risks.[14]

Previous studies that addressed knowledge and perception of the health and environmental risks associated with gold mining, reported the lack of awareness within their respective target groups.[11,12] Lack of knowledge and awareness can transform a minor incident into a crisis, and one such case was demonstrated following the Three Mile Island Nuclear accident.[15] Though not related specifically to mining, it entailed valuable information, where uncertainty and panic were induced and led to the evacuation of more than 10,000 persons driven by hearsay and a lack of public information.[15] Therefore, the inclusion of communities downstream of mining operations that are using cyanide would improve the level of preparedness for and effectiveness of the response to an accident such as a cyanide spill.[16]

The health of Guyana's rivers and streams are of great importance to the country's riverine communities, predominantly our Indigenous populations who rely on these waterways as a means of survival.[17] In 1995, Omai Gold Mining Limited (OMGL) tailings dam collapsed and released over 3.2 billion liters of cyanide into the Essequibo River.[18] This incurred ecological and environmental consequences including the death of numerous aquatic Species.[18] The knowledge of cyanide's presence in the water and uncertainties regarding its concentration justified the communities' refusal to use the water,[19] coupled with the lack of awareness and preparedness which led to inappropriate actions and claims.[20] Whether perceptions are high or low, they can potentially expose people to hazards, give rise to fear and isolation, or even start conflict.[21] As Batavia is downstream from a large-scale mining operation currently using cyanide,[22] it was questioned whether or not the residents were aware of this operation using cyanide and their exiting knowledge and perception of the potential health and environmental risks a spill may impose. Therefore, this research sought to assess the knowledge and perceptions of residents regarding the health and

environmental risks of a potential cyanide spill from the upstream mining operation, and also the prevailing level of awareness among residents based on whether they had received prior information regarding these risks.

2. Methodology

2.1 Research Design & Approach

This research followed a cross-sectional design, using researcher-administered questionnaires designed to quantify and evaluate knowledge and perception of environmental and health risks associated with upstream cyanide spill. The questionnaire comprised five (5) sections; upstream mining awareness, risk knowledge, risk perception, risk awareness and demographic information, with a total of 53 questions. The questionnaire utilized a 5-point Likert scale questions, which ranged from strongly disagree to strongly agree. Five-point Likert type questions were also used which ranged from very unlikely to very likely, and 4-point Likert type questions were used, which ranged from not concerned at all to very concerned, and not important to very important.

A census was conducted for Batavia which recorded 70 households (N=70) in the community. The participation rate in this study was 85.7% (n=60), sampling one person per household. All participants were 16 years or older and residents of the study community. The data collection phase was conducted from October 28-31, 2019 in Batavia.

2.2 Measurement of Outcome Variables

2.2.1 risk knowledge & risk perception

To assess knowledge, respondents had to identify health and environmental risks of cyanide from a list which comprised of both correct and incorrect responses. A threshold of 3 out of 5 correct answers was used to objectify respondent's knowledge of health and environmental risks in order to determine whether they were knowledgeable or not. This method proved effective in assessing knowledge as done in DeBrouwer et al..[11] The combined knowledge score for each variable was used to represent respondents' knowledge for the purpose of the correlation analysis.

To assess perception, scores were obtained by coding Likert-type and Likert scaled questions, in order to quantify responses. This research utilized three Likert scaled questions on respondents' agreement with perceptions concerning environmental risks, and two Likert scaled questions on respondents' agreement with perceptions concerning health risk. The computed score represented the respondents' perception of these risks for the correlation analysis.

2.2.2 community awareness

Five-point likert scaled questions were computed to establish a 'satisfaction with information' (SWI) score by summing the scores for three questions, where the maximum total score attainable was 15. The SWI rating was established using ranges; 1-5 (low satisfaction), 6-10 (moderate satisfaction), 11-15 (high satisfaction).

2.3 Statistical Analysis

All statistical analysis was conducted using Statistical Package for Social Sciences (SPSS) version 20. The data were grouped, coded, and reverse coded when statements were negatively worded, i.e. where the negative statement reflected a value of 1 it was recoded to 5, and where it originally reflected a value of 5 it was recoded to 1. This ensured that a high value would represent the same type of response on each question. The inferential statistics used for this study included Chi-square analysis and Pearson's Correlation Coefficient. All inferential statistics were interpreted at a significance level of 0.05. Conventional statistics were used to conduct univariate data analysis of variables irrespective of relationships.

2.4 Ethical Approval and Considerations

Permission was granted by the Ministry of Indigenous Peoples' Affairs in Guyana and the Batavia Village Council. Research observed all principles of free, prior and informed consent (FPIC), and maintained anonymity.

3. Results and Discussion

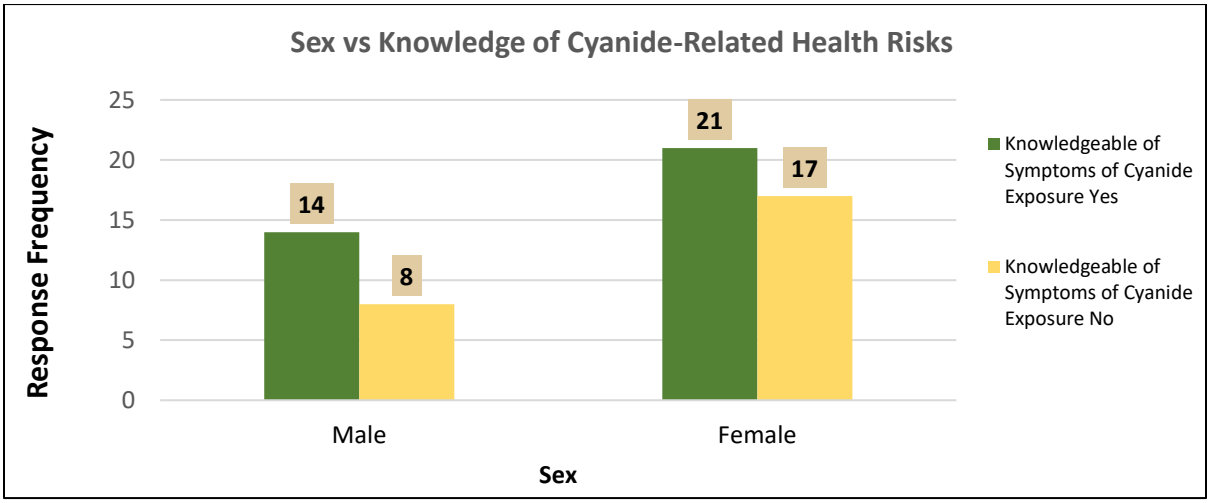

Figure 1. Sex vs knowledge of cyanide related health risks

The study revealed that 58.3% of the respondents satisfied the requirements and were knowledgeable of the health risks associated with exposure to cyanide, whereas 41.7% were not knowledgeable. This is akin to the findings in DeBrouwer et al. which also had over half of their respondents deemed as having knowledge of the potential impacts of mining based on health.[11] The prevailing knowledge of health risks among respondents may be a function of the lack of access to information on health risks, as 83.3% of the respondents had no prior information regarding these risks.

Results showed that females had comprised the majority (35%) of the respondents knowledgeable of health risks regarding cyanide, while less males (23.3%) were knowledgeable of the associated health risks which contradicts the findings of Charles et al..[12] The difference in health-related risk knowledge regarding cyanide relative to sex may be due to the sample characteristics of this study, which had more females (n=38, 63.3%) participate in the study than males (n=22, 36.7%), and as such it increased the probability of more females identifying three or more health related risks of cyanide. The study found no statistically significant relationship between sex and knowledge of health risks.

However, while some participants were aware of cyanide being used upstream at the mining operation, this awareness did not always translate to knowledge of health-related risks of cyanide exposure as some respondents associated cyanide with a communicable disease such as HIV/AIDS (13.3%) and vector borne diseases such as malaria (35%) and dengue (20%). Similar misconceptions were found in the work of Charles et al., which had respondents associate health implications of mercury and arsenic with evil spirits and contagious diseases.[12]

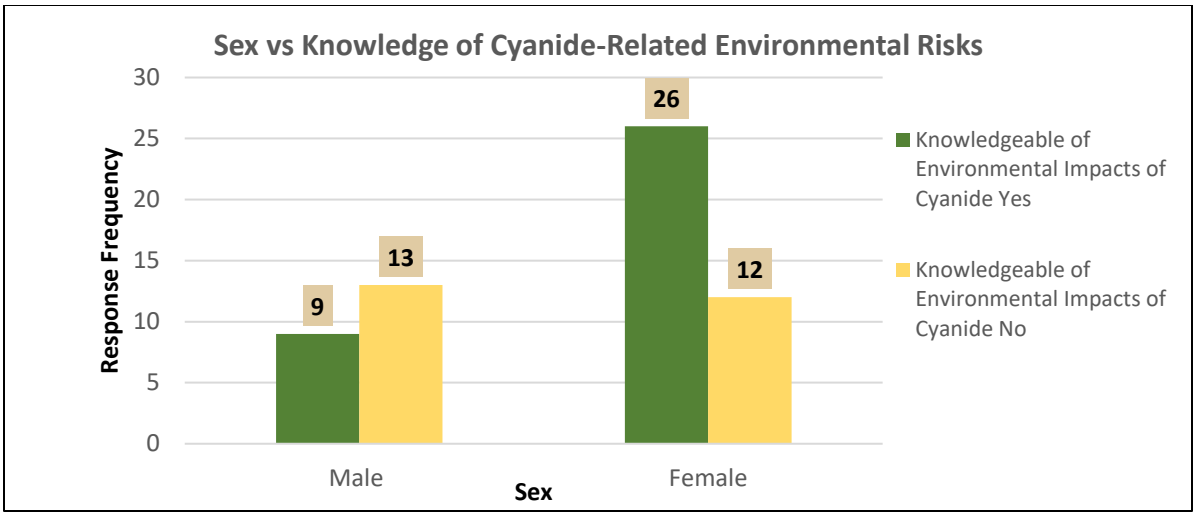

Figure 2. Sex vs knowledge of cyanide-related environmental risks

It was found that 58.3% of the participants satisfied the threshold of 3 out of 5 correct answers and were knowledgeable of the environmental risks associated with a potential cyanide spill, whereas the remaining 41.7% were not knowledgeable. These findings were consistent with that of DeBrouwer et al.,.[11] The prevailing knowledge of environmental risks among respondents may be attributed to the lack of access to information as 83.3% of the respondents had no prior information of these risks. These results support previous literature which convey that communities often lack appreciable knowledge of the potential destruction and challenges inherent of mining activities until after a community is affected.[10]

Further analysis showed that females had comprised 43.3% of the respondents knowledgeable of the environmental risks regarding cyanide and a potential spill, while only 15% of males were knowledgeable of these risks. This study found a statistically significant relationship between participants' sex and their knowledge of environmental risks (χ^2 =4.339, p = 0.037).

While 58.3% of the sample was knowledgeable of these risks, lesser proportions of the sample did select incorrect response options that were mixed with the correct responses as they associated a potential cyanide spill with increased fish population (5%) and improved water quality (3.3%). Some respondents even associated a potential cyanide spill with having 'no effect' (8.3%) on the environment.

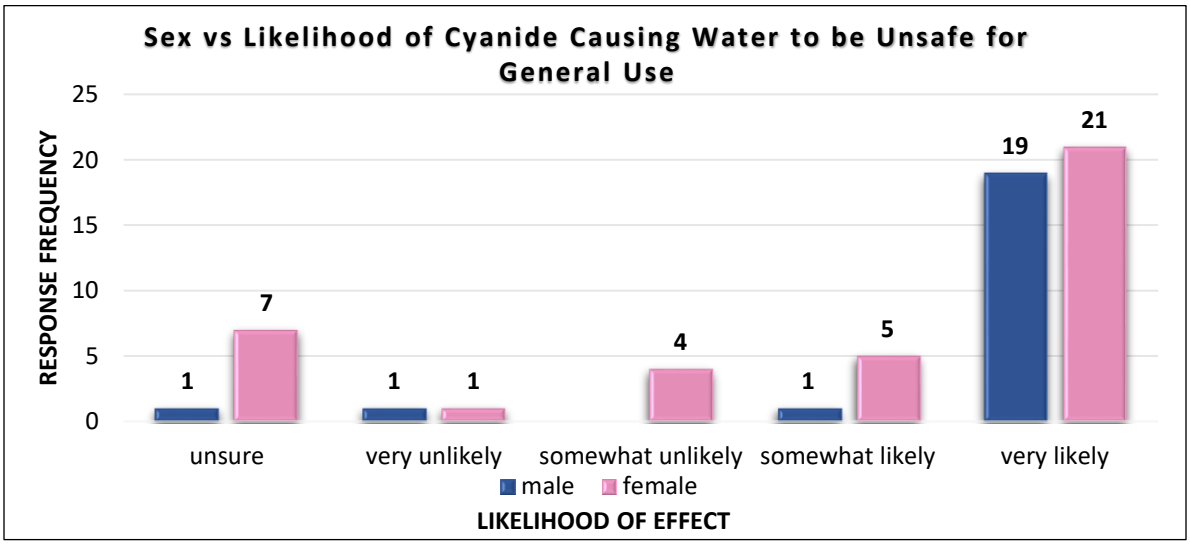

Figure 3. Sex vs likelihood of cyanide causing water to be unsafe for general use

It was found that more females had greater consideration than males for the potential health risks; females (n=21, 35%), males (n=15, 25%), and environmental risks; females (n=18, 30%), males (n=14, 23.3%) of a cyanide spill, as more females thought it 'very important' to consider these potential risks. More females in this study also thought it likely that cyanide would cause their water to be unsafe for general use than males did. These results are similar to the findings of previous studies which reported that females were found to perceive greater risks than males, particularly in the cases of technological risks and health implications.[14] Moreover, the difference in perception relative to sex may also be due to this study's higher female to male ratio.

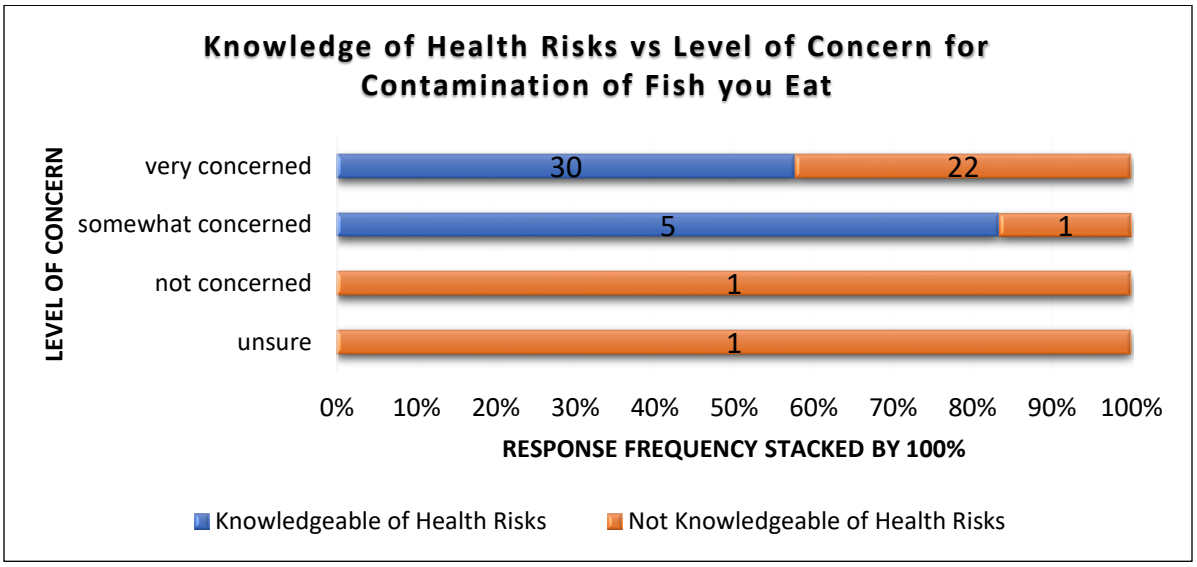

Figure 4. Knowledge of health risks vs level of concern for contamination of fish you eat

Analysis showed that 50% (n=30) of the respondents knowledgeable of health risks associated with cyanide exposure indicated to be 'very concerned' about the contamination of fish they eat, 8.3% (n=5) that were knowledgeable were 'somewhat concerned', while none of the respondents knowledgeable of health risks indicated to be 'not concerned' about the contamination of the fish they eat by cyanide. Concern was not only found among those knowledgeable of health risks as the majority of those respondents (n=22, 36.7%) not knowledgeable were 'very concerned' about cyanide contaminating the fish they eat.

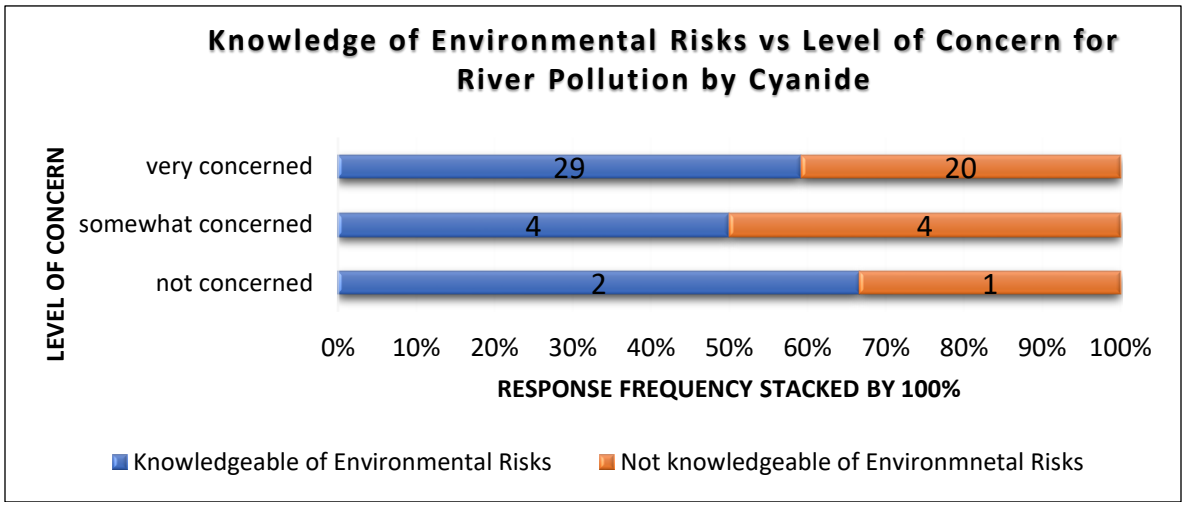

Figure 5. Knowledge of environmental risks vs level of concern for cyanide pollution of the river

Further it was found that 43.3% (n=29) of the respondents that were knowledgeable of the environmental risks associated with cyanide were 'very concerned', 6.7% (n=4) that were knowledgeable of environmental risks were 'somewhat concerned', while 3.3% (n=2) that were knowledgeable of the environmental risks were 'not concerned' about the pollution of the river by cyanide. Again, concern was not only found among those knowledgeable of environmental risks, as the majority of respondents (n=20, 33.3%) who were not knowledgeable of these risks were 'very concerned' about their river being polluted by cyanide.

The prevailing perception among respondents was confirmed as the majority, whether knowledgeable or not, expressed concern for the potential risks of a cyanide spill, as a total of 86.7% were very concerned about contamination of the fish they eat (86.7%), while 81.7% were very concerned about cyanide pollution in their rivers and streams. These findings may be attributed to plethora of uses of the rivers on which the respondents are dependent, increasing the perceived likelihood that they'd be exposed to this toxic chemical if it were to enter their waterways. These results were akin to that of Ackley, which reported that majority of the respondents also expressed a high degree of worry for similar risks such as contamination of fish resource, and pollution of their rivers.[13]

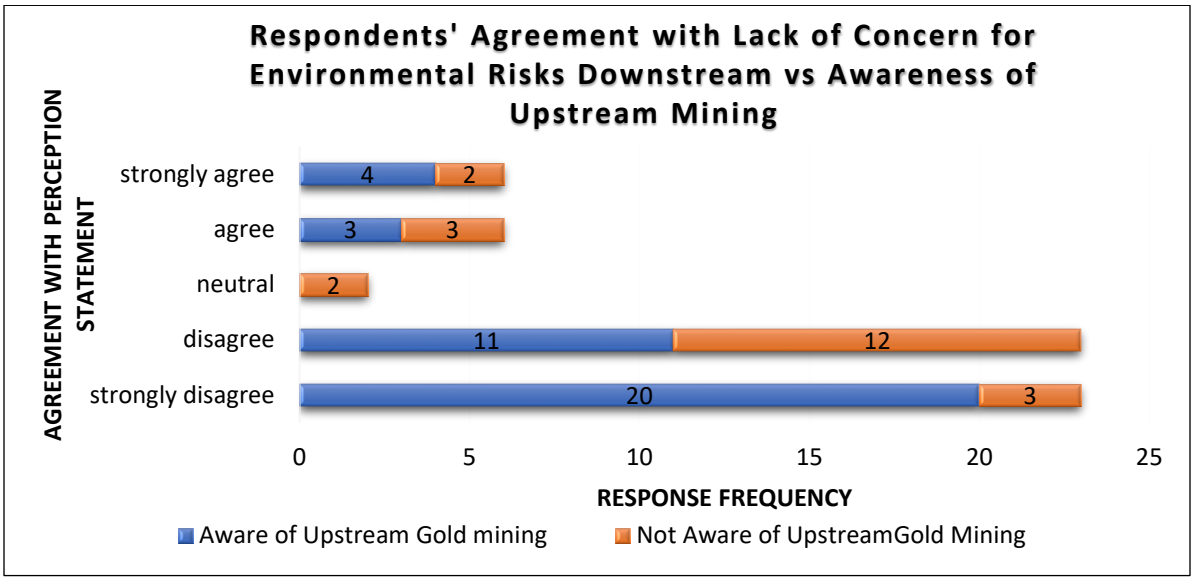

Figure 6. Respondents' agreement with lack of concern for environmental risks downstream vs awareness of upstream mining

This research found that 38.3% (n=23) of the respondents 'strongly disagreed' with not being worried about the environmental risks, while 38.3% (n=23) of respondents 'disagreed'. Only 10% (n=6) of the respondents strongly agreed with this statement which indicated a lack of concern for potential environmental risks. Further, 33.3% (n=20) were aware of upstream mining and 'strongly disagreed' with this statement, while 18.3% (n=11) were aware of the upstream mining and 'disagreed' with the aforementioned statement.

These findings may be attributed to the respondents' dependence on the river for a number of uses. As the respondents are located downstream, these findings are also supported by Dogaru et al. which declared resident's location and proximity factors as relevant attributes to be considered when examining environmental perceptions.[14]

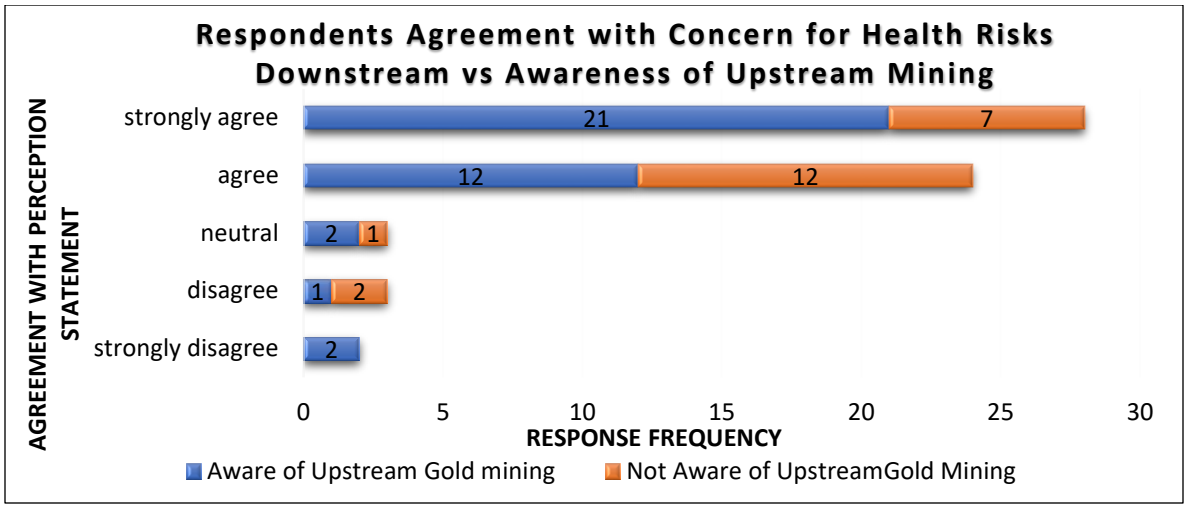

Figure 7. Respondents' agreement with concern for health risks downstream vs awareness of upstream mining

46.7% (n=28) of respondents 'strongly agreed', while 40% (n=24) 'agreed' with the perception statement "I am concerned for my family's health even though we live downstream". 35% (n=21) and 20% (n=12) of the respondents who were aware of the upstream mining had 'strongly agreed' and 'agreed' respectively with the aforementioned statement. These results indicated that distance away from the mine did not negate their concern for potential health risks, which is similar to their perception of environmental risks, may be a function of their dependence on the waterway for various uses.

Further analysis revealed there was a weak, positive correlation between knowledge of health and environmental risks and the perception of these risks among participants ($r = .29$, $N=60$, $p < .05$). This inferred that study respondents' increased knowledge of the risks regarding cyanide was related to higher perception scores, which indicated higher level of concern and more negative risk perception regarding a potential cyanide spill.

Examining respondents' awareness further, it was established that the majority had no prior information about the health and environmental risks associated with an upstream cyanide spill (n=50, 83.3%). This study further revealed that most of the respondents that were not informed of these risks had moderate (41.7%) and low (38.3%) SWI. Even respondents who indicated having prior information recorded a moderate SWI (n=7, 11.6%), followed by low SWI (n=1, 1.7%). Only three participants in this study had a high SWI (n=3, 5%) concerning the potential implications of cyanide. This indicated that awareness was low as majority of the respondents had no prior risk information and were not adequately satisfied with this lack of information regarding the upstream operation and the possible threats to their health and environment. These findings differed from that of Ackley, which reported a majority of their participants believed they had all the information needed to decide how they feel about the risks.[13]

4. Conclusion

There existed knowledge gaps regarding risks among respondents, as even though respondents were knowledgeable of some health and environmental risks associated with a cyanide spill, misconceptions among participants regarding these risks were still evident. Findings also showed that respondents' distance away from the mining operation did not negate their concerns, as even though located downstream, rather than in the immediate vicinity of the mining area, most participants expressed having concern for the potential health and environmental risks. Further this study established that the level of awareness among community respondents was low due to the lack of information received by respondents, as the majority had no prior information regarding the potential implications of a cyanide spill from the upstream mining operation.

5. Recommendations

1. More research should be done regarding downstream communities' knowledge and perception of risks associated with cyanide as such is currently lacking.
2. Future comparative research can also be done to examine how community knowledge and perceptions of the health and environmental risks of cyanide vary with differing distance away from the mine.
3. The Guyana Geology and Mines Commission in collaboration with the Environmental Protection Agency-Guyana and the mining company should conduct meaningful community engagement in Batavia. These key stakeholders should also partner with the local Health center in Batavia to create health and environmental awareness campaigns and education programmes in order to improve community understanding and awareness of health and environmental risks of cyanide.
   This may serve to increase risk knowledge and awareness in community. Such an initiative should:
   - Inform the residents of how a cyanide spill may affect their environment and how exposure to cyanide may affect their health.
   - Liaise with the community leader as a trusted representative of the community in order to effectively execute education programmes and awareness campaigns in order achieve maximum reach.

6. Acknowledgements

The author would like to express gratitude to the residents of Batavia for participating in this study and the Ministry of Indigenous Peoples' Affairs for authorizing the conduct of this research. Special thanks are extended to Guyana Geology and Mines Commission (GGMC) and Republic Bank (Guyana) Limited (RBL) for contributing funding to support this project. The author also extends gratitude to Mr. Cecil Boston for the advice given during this process. Heartfelt thanks are also extended to Ms. Sona Huntley, Mr. Carlos Bernard and Mr. Calvin Bernard for their intangible contributions in preparation for data collection. Immense gratitude also goes to Ms. Rila Harlequin, Ms. Nikita LaCruz, Ms. Madhavi Indarjeet and Ms. Miracle Miller for their support throughout this research period. Last but not least, the author acknowledges Yahweh for continuously providing spiritual strength, wisdom, and guidance.

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