Original Article

Analysis of the quality of the water and affectation on the health of the inhabitants of Guamachito, Colombia

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Abstract

Background: The study focuses on the evidence of the relationship between water quality and the health of populations. Colombia, a country with high levels of economic, social, and environmental vulnerability, does not have a population that has full access to drinking water. The study analyzes this relationship in Guamachito, Zona Bananera, Colombia.

Objective: Analyze the water quality and the effect on the health of the population of Guamachito, Zona Bananera, Colombia.

Method: Cross-sectional quantitative study, which was carried out in phases: First, an analysis of secondary data was carried out through a review of the web pages of the government institutions of public health in the region and the country; subsequently, a survey was applied to contrast the results of the documentary review to 450 inhabitants of Guamachito, Colombia, corresponding to members of a rural educational institution in the municipality, with 24 teachers and 426 students.

Results: The results suggest that the microbiological characteristics are above the reference limits, as well as poor procedures for collecting and cleaning water in the houses, likewise, high rates of water-borne diseases are identified.

Conclusion: It is inferred that there is an incidence of water quality on the health of the inhabitants of the Guamachito municipality. [*Ethiop. J. Health Dev*. 2022; 36(4):000-000]

Keywords: health, water quality, diseases, Colombia.

Introduction

Water quality is of vital importance for the social development of the population, both for the health of citizens and for the growth of the economy (1). Thus, this quality of the water, specifically for human consumption, will depend on its origin and purification process (2). At an international level, quality water for human consumption due to its cleanliness characteristics is not accessible to the entire population, which can cause various diseases (3). The classification of water quality processes is based on aspects such as their purity and contamination, which include indices that link various attributes, which have a causal relationship due to the concentration levels of toxic compounds (4).

In Latin America and the Caribbean, diseases caused by poor water quality, such as acute diarrheal disease, correspond to one of the ten main causes of death (5). In Colombia, although work has indeed been done to improve these conditions, many communities still do not have the environmental health conditions to have good water quality (5). Studies such as the one carried out by Briñez, Guarnizo, and Arias in Tolima, Colombia, show that the inhabitants of the municipalities under study have a greater probability of having water-borne diseases, due to the quality of this in their main sources of supply (6). On the other hand, Guzmán, Nava, and Bevilacqua state that there are various difficulties and challenges related to environmental health in the country, more specifically in the surveillance of water quality by the different local, departmental, and national entities for this purpose (7), where the development of environmental education components is necessary.

In Colombia, when we talk about environmental education, we refer to a model of a person and society that lives sustainably with its environment. This environmental education is based on the different approaches to policies and activities that institutions must develop to form supportive, conscious, and responsible citizens with their environment and the development of a society that lives within its local context (8). Environmental education is essential to achieve a change in how people relate to their environment, to improve the use and management of natural resources and reduce impacts on the environment, and its implementation is mandatory in institutions. Educational programs in Colombia must develop a School Environmental Project (PRAE for its acronym in Spanish). It is about approaching an educational task from a preventive point of view, which is more convenient both in economic and environmental terms, trying to promote a change in daily habits and attitudes that are materialized in environmentally appropriate actions.

The Zona Bananera, a certified municipality of the Magdalena Department, is made up of several townships, with diverse situations of social, environmental, and health-educational vulnerability. The town of Guamachito presents within the Zona Bananera one of the highest rates of economic and social vulnerability, therefore, it is necessary to undertake an analysis that allows knowing the current state of the water quality and how it affects its population. Along these lines, the purpose of the following study is to analyze the water quality and the

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effect on the population's health of Guamachito, Zona Bananera, Colombia.

Method
Design: Cross-sectional quantitative study, which included a documentary review of the web pages of state entities for public health management and surveys with closed questions were applied to the population.

Population: The study considers 450 inhabitants of Guamachito, Colombia. These correspond to members of a rural educational institution in the municipality, corresponding to 24 teachers and 426 students. The sample was a census, where 100% of the academic town's community was used. The context of the institution and its surroundings is one of socioeconomic vulnerability, where the population that attends has low economic income. The reason why the population of an educational institution was used for the study was to contrast the data identified by the websites of educational institutions, with the perceptions of populations of different ages in the same context.

Data collection and Process: The following data collection instruments and techniques were used: 1) Documentary analysis: a) Database of the Drinking Water Quality Index (SIVICAP - for its acronym in Spanish) of the National Government, during the years 2010-2018 in all of the country's municipalities. b) Database of the Water Quality Risk Index (IRCA - for its acronym in Spanish) to determine the Departmental risk levels (Regional public health websites). Secondary information was extracted and statistically analyzed. 2) To contrast the results of the documentary review, a survey was applied to the population group specified above, which had six items focused on the sources of supply, treatment, use, and physical characteristics of the water. Once the data have been obtained, the relationship between the results of each unit of analysis and their response to the survey is tabulated. Once the tabulation is established, the information is processed in SPSS version 21 software. In which the nominal and percentage frequencies of the results are established. Subsequently, the data from the frequency tables were graphed to proceed with their analysis and interpretation.

Ethical Approval: The study was carried out based on the observations given in Resolution 8430 (9) on ethics in population research in terms of anonymity and confidentiality of the responses obtained. According to said Resolution, it is considered in the "No Risk" category.

Result
Documentary Review
When conducting the first phase of the research on the first study variable "water quality", we based the diagnosis on the SIVICAP and IRCA documents. From this perspective, a first information search was carried out in six municipalities in the northern region of the Magdalena department close to the municipality and village under study, these being: Zona Bananera, Aracataca, Fundación, Algarrobo, Ciénaga, and Santa Marta, to show the behavior of the municipality and township under study compared to nearby municipalities. Table 1 shows the average results for the years 2016-2018 regarding the physical, chemical, and microbiological characteristics; in this table we find in the third column the tolerable reference values for water consumption (6).

Table 1: **Drinking Water Quality Index (SIVICAP) North Region of the Magdalena Department.**

Characteristics	Code	Maximum	Zona Bananera	Aracataca	Algarrobo	Santa Marta	Fundación	Ciénaga
Physical								
Apparent colour	CA	1,5	0,50	0,65	0,50	0,50	0,74	0,40
Turbidity	TU	2	1,00	1,00	1,39	0,20	0,43	1,67
Chemical								
PH	PH	0,8	0,70	0,67	0,72	0,71	0,68	0,70
Total alkalinity	AT	2	1,80	1,80	0,89	1,10	2,20	2,57
Chlorides	CL	2,5	0,89	0,00	0,00	0,00	0,00	0,00
Total hardness	DT	3	1,40	2,06	0,83	1,20	3,20	3,60
Sulfates	SU	2,5	0,00	0,00	0,00	3,60	0,00	0,00
Microbiological								
Total coliforms	COL	0	1,80	1,50	0,54	0,19	0,29	0,20
E- Coli	E-C	0	0,60	0,22	0,15	0,00	0,21	0,09

When reviewing the physical characteristics, the apparent color (CA) and the turbidity (TU) are described, these have reference maximums between 1.5 and 2, respectively. We found that the municipality with the highest risk of the quality of the water with the apparent color is Ciénaga and with the turbidity, it is the municipality of Fundación (Figure 1).

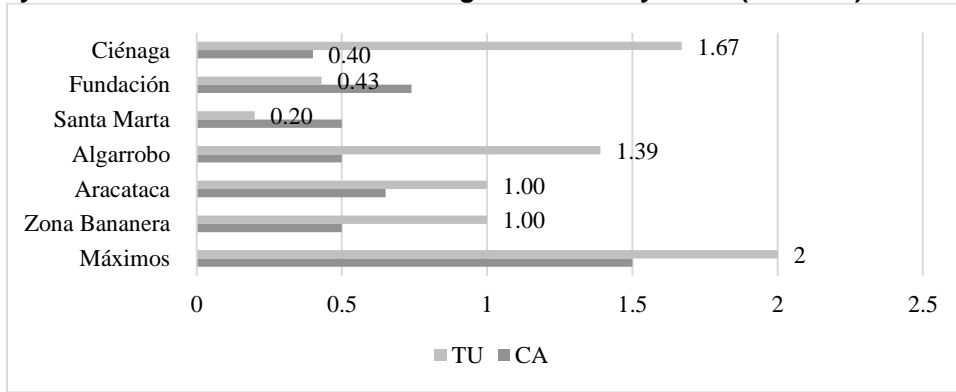Figure 1. **Physical Characteristics from Drinking Water Quality Index (SIVICAP) source**

Figure 2 shows that the PH in the water has a regulation that is below the reference in all the municipalities described. In the alkalinity, Ciénaga and Fundación present higher indices above the reference maximums. Regarding Chloride in water, only the Zona Bananera presents indices above zero, but below the reference limits. In total hardness, the highest indices are those of Ciénaga and Fundación above the reference maximums. Finally, the presence of sulphates is found only in the Santa Marta report located above the reference levels.

Figure 2. Chemical characteristics from Drinking Water Quality Index (SIVICAP) source.
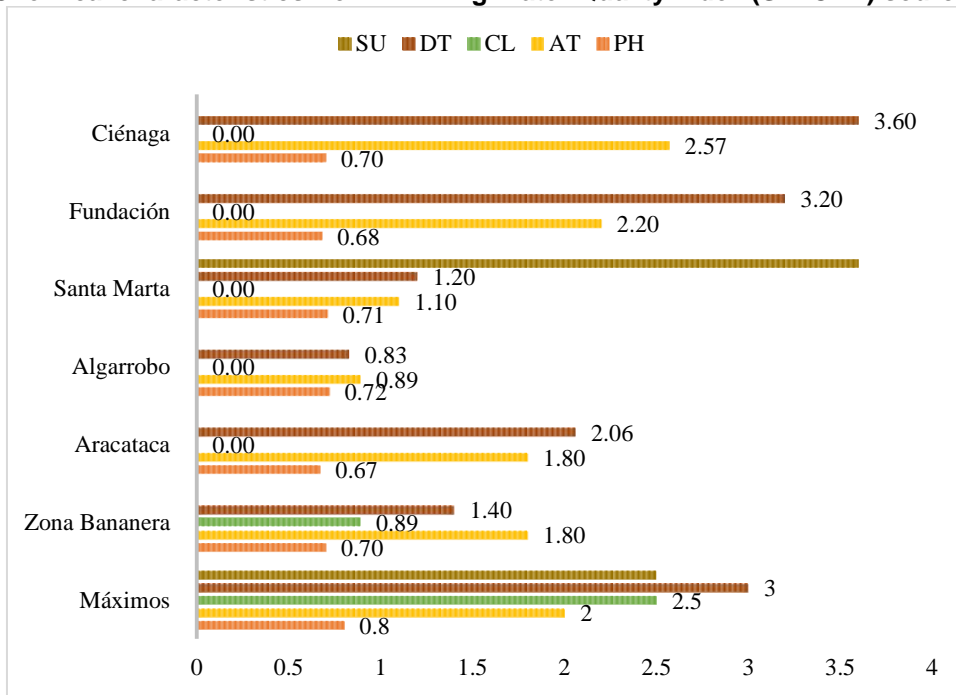
In the microbiological characteristics associated with the presence of total coliforms (COL) and E-coli (EC), the presence of bacterial agents that affect the quality of the water and the aspect with greater weight in the index (IRCA) were identified, whose reference margin is 0 U / 100 cm3 is the most relevant of the finding of this first research variable when finding the municipality of Zona Bananera presents an index of 1.8 of total coliforms and 0.6 of E-coli index. These are the highest rates in the northern region and in the entire department of Magdalena, which represents a high risk for water quality, as shown in figure 3.

Figure 3. Bacterial characteristics.
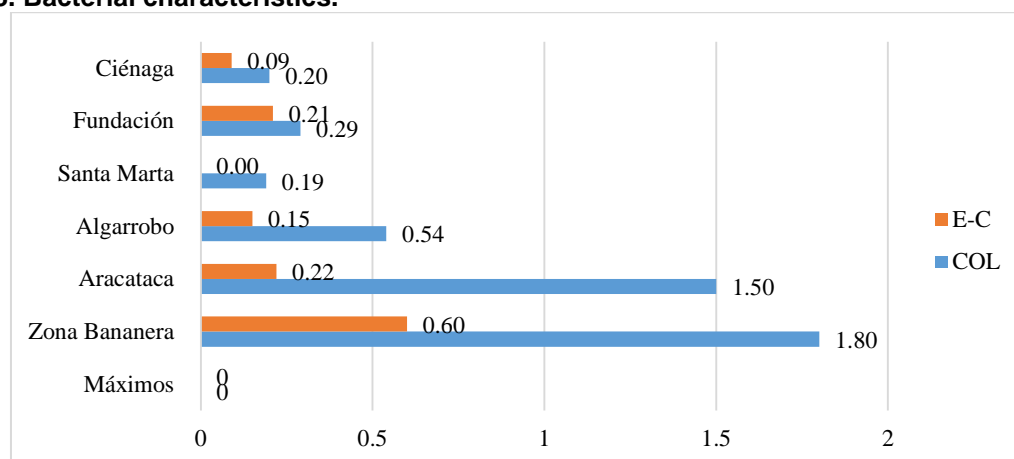
The behavior of quality indices measurements by the drinking water quality surveillance system shows how the physical and chemical conditions, although they increase year after year, do not exceed the maximum tolerance of the system, but not with the conditions of bacterial organisms in which a rising index is presented for both total coliforms and E-coli particles (table 2).

Table 2. Drinking Water Quality Index (SIVICAP) - Zona Bananera. 2016-2018

Characteristics	Code	2016	2017	2018	Maximum
Physical					
Apparent colour	CA	0,50	0,70	0,71	1,5
Turbidity	TU	1,00	1,00	1,39	2
Chemical					
PH	PH	0,70	0,75	0,79	0,8
Total alkalinity	AT	1,80	1,70	1,60	2
Chlorides	CL	0,89	0,50	0,45	2,5
Total hardness	DT	1,40	2,06	2,30	3
Sulfates	SU	0,00	0,00	0,00	2,5
Microbiological					
Total coliforms	COL	1,80	1,50	1,81	0
E- Coli	E-C	0,60	0,45	0,62	0

In the Water Quality Risk Index (IRCA) we find that the municipality and the neighboring one have an index of 63 and 68 units with a high-risk level, in Zona Bananera and Aracataca, largely determined by the presence of the agent's bacteria in the water and what configures a favorable scenario for the development of diseases associated with these pathogens, as shown in Table 3.

Table 3. Water Quality Risk Index (IRCA)

Municipality	IRCA Average Base	Average Risk Level
Zona Bananera	63,00	High
Algarrobo	23,00	Half
Aracataca	68,00	High
Ciénaga	3,10	Risk-free
Fundación	20,00	Half
Santa Marta	5	Risk-free

The second variable, "The impact of water quality on health" was investigated on the IRCA levels of the departments of the Caribbean region to show the high risk of the Zona Bananera municipality compared to the other municipalities in the region. For the Caribbean region, two departments were identified as having at least one municipality that has a high-risk IRCA value and an incidence of acute diarrheal diseases higher than the minimum risk margin, with very high impact, being the department of Cesar (two municipalities) and Magdalena (two municipalities) of high impact due to having a sanitary risk of unviable water quality, among them the municipality of Zona Bananera.

The conditions of water quality in function of bacteriological risk, in Zona Bananera municipality and the village of Guamachito, present a high risk.

According to the 2019 Analysis of the Health Situation of Magdalena - ASIS, an incidence of diseases associated with water-borne diseases (EVA - for its acronym in Spanish) and acute diarrheal diseases (ADD) are reported for the municipality of Zona Bananera, these being the highest incidence in the municipality. The information analyzed shows that diseases (EVA) represent an average of 1.6% of the diseases in the municipality in the years 2017-2019, conditioned by the bacterial characteristics of the water quality described in a previous section. Also, ADDs accounted for 1.4% of mortality in ages 0-4 years in 2017, 2.3% in 2018, and 1.1 in 2019, which represents a significant impact on infant mortality, and caused infant mortality in ages 5-9 years of 0.9% in 2017, 0.7% in 2018 and 0.41% in 2019.

The level of morbidity recorded by acute diarrheal diseases in ages 0-4 years affected by 21% for the year 2017, 23% for the year 2018, and 22% for the year 2019, which means that it drastically affects the municipality's infants and by default their daily activities including the study. Also, we related the morbidity in ages between 5-9 years old, where we found that there is also an affectation that shows the incidence of this disease in the municipality and the need to control the conditions of origin associated with the quality of the water, thus we found that the in 2017 it affected 9.7% of children between 5-9 years old, in 2018 7.7% and in 2019 11%.

Contrast of Results in Population

In relation to the survey applied to contrast the data, it was found that 48% of the population is supplied from water wells, 51% from ditches, and 1% from other sources of supply, this shows the high risk of vulnerability to the phytosanitary conditions of the supply and in the way the water is stored, as this implies that there is another risk associated with the transport of water, as shown in figure 4.

Figure 4. Water supply sources.
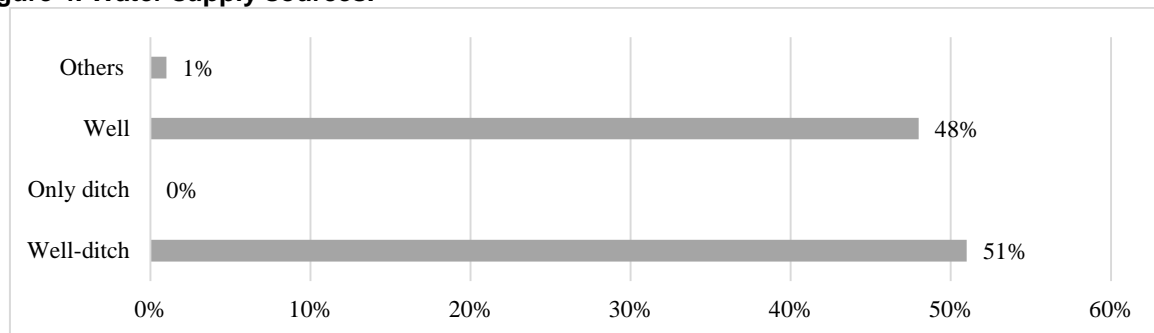
In a second item, it was inquired about the water treatment processes once the liquid was acquired, finding that 72% do not use any type of water treatment, 21% use flocculation methods, 7% boiling processes, and no standardized purification process. This reflects that there is no knowledge of the water treatment processes, which increases the bacterial risk in relation to the quality of the water. In item three of the characterization, it was inquired about the usability that is given to the water taken from the supply sources, it was found that 48% do not have a reference of water use according to the labels that were defined for the characterization, 47% drink irrigation water for direct consumption and for cooking, 1% drink it exclusively for cooking, 4% use all the uses described in the measurement labels (cooking, bathing, washing, cooking and consuming directly).

It is identified that there are no defined uses or sanitary protocols that describe minimum conditions to guarantee an improvement in the quality of the water taken from sources with a high risk of contamination. When asked about the use of the ditches for washing clothes, 67% stated that it was the most comfortable place to do their work, and 33% that they did not use the ditch to wash their clothes. This phenomenon increases the risk of contamination by altering the chemical composition and increasing the risk conditions by altering the bacteriological characteristics of the water quality.

Regarding the physical characteristics of the water quality, the residents of Guamachito stated that its color is 67% light cloudy, 24% colorless, and 7% dark. Regarding its flavor, 13% describe it as bitter, 35% as brackish, and 52% as pleasant. Regarding its smell, 27% attribute a metal odor and 16% vegetation, while 57% do not find any odor. That is, the contamination of water sources is directly manifested from the same physical conditions, which adds greater risk to the conditions described above and is aligned with the water analysis reports described in the IRCA 2018 water reports.

The last item characterized was the question related to how conscious they were when using water under irrigation conditions for health, the answer was overwhelming; 100% are aware of the health effects that the non-treatment of water implies, although they were not particularly sure what types of effects directly affected their health. Being an embedded nested methodology, the problem was analyzed from different points of view, to identify which sub problem underlay the other, a cross-check was made with the institution and the percentage of absences to the reason for absences, to identify some type of correlation between the incidence of diseases reported in the territory, the characterization of the population and its incidence in the absence of students in the institution.

For this, the absence report for the year 2019 was taken and the types of factors that affected the presence of students in the school were identified, where it was

found that the indicator, after personal reasons with 34%, were the effects on health, which by having the report of diseases and the levels of morbidity we can infer that they are diseases associated with Serious Diarrheal Diseases and Water-borne Diseases.

Discussion

Previous studies of the impacts on health or water pollution have found evidence of diseases associated with water quality that is also leading to indirect diseases such as cancer and affectations in the liver system (13). Water-related risk mitigation and social, economic, and environmental stability can only be achieved through well-managed water resources. Thus, management by aligning community and public interests can result in benefits for all stakeholders, including government, civil society, and the private sector, because the responsibility for sustainable water supply is shared with all users and thus allow a long-term and equitable distribution, as well as economic growth without destroying the ecological systems that sustain life (14).

Understanding that water is a shared resource, communities must generate collective processes to mitigate risk levels on water quality. According to Delgado, Trujillo, and Torres (15), most solutions for water supply, quality, and sanitation problems require an adaptive management approach that allows, in the first instance, self-care techniques, phytosanitary protocols, and processes, that guarantee the quality of the water from supply to consumption. However, while there is a high risk of damage to health and few institutional strategies, it will be complex to reduce the conditions of damage to health due to water consumption.

The so-called raw water sources, due to their null treatment or processing, represent a serious risk because they contain macrobiotic diversity, including pathogens and non-pathogens; pathogens are understood as those microorganisms with the capacity to affect human health (16). It is evident that the population of the Zona Bananera and its townships, including Guamachito, present a high-risk margin since the collection of information shows a significant percentage of inhabitants who do not apply treatment processes to the water they consume.

Finally, the presence of E-colis and fecal coliforms in water sources is a threat to public health in that territory since these bacterial agents affect mortality and morbidity rates from water-borne diseases (17). From this perspective, it can be considered that the research findings corroborate water quality measurement reports in the presence of bacterial agents above the tolerable minimums; in addition, it shows that the problem can become a public health problem in which the most affected scenario would be school-age children and adolescents.

Conclusion

The physical and chemical conditions of the territory are at tolerable levels, but the microbiological conditions are above the minimum reference levels,

making the municipality a focus of attention given its risk index classified by the [IRCA] as "High". According to the analysis of the Magdalena Health System about the municipality of Zona Bananera, they present risk indices in diseases associated with Dengue, Water-borne Diseases [VAS], Mortality from Acute Diarrheal Diseases [ADD], and high rates of associated morbidity to [EDA].

From the perception of the population and its characterization regarding the use and treatment of water, this occurs under very low margins of sanitation, with low management of treatment processes, supply from contaminated sources, and direct consumption without processing, which is a direct health risk. In addition, when reviewing the absences of the students, we found that the second line is associated with health issues, after the item on personal issues. These findings lead us to infer that there is an incidence of water quality on the health of the inhabitants and students of the municipality of Guamachito.

Conflict of interests

The authors state that there is no conflict of interest in the study.

Contribution of Authors

All have participated actively in the process of methodological design, collection of information, analysis of the results, and preparation of the manuscript.

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