Journal of Environmental and Occupational Health, 2022
VOL 12, NO. 6, PAGE 207-212

RESEARCH ARTICLE

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Public Health Microbiological Quality and Safety Assessment of Addis Ababa City Drinking Water Sources, Addis Ababa, Ethiopia

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ABSTRACT

Objective: Water of poor quality can cause water borne diseases by microorganisms. It has been frequently described responsible for millions morbidity and mortality worldwide. Therefore, determining the quality and safety status of municipal drinking water sources is very important task. Generally, the aim of the study was to assess the microbiological quality and safety status of municipal drinking water sources in Addis Ababa city administration.

Methodology: A cross-sectional study was conducted on drinking water sources (public taps, reservoirs, springs and wells). All water sources were analyzed for bacteria by Presence-Absence (P-A) method and samples filtered through a membrane filters by vacuum pump and tested by saline wet mount for parasites.

Results: The study revealed that there were 10% of all samples were positive for bacteria (7% total coliforms and 3% faecal coli forms). On the other hand, there were no parasites findings.

Conclusion: Most Addis Ababa city drinking water sources had acceptable quality and were safe to drink.

ARTICLE HISTORY
Received: 30-May-2022, Manuscript No. JENVOH-22-65327; Editor assigned: 02-Jun-2022, PreQC No. JENVOH-22-65327 (PQ); Reviewed: 17-Jun-2022, QC No. JENVOH-22-65327; Revised: 24-Jun-2022, Manuscript No. JENVOH-22-65327 (R); Published: 04-Jul-2022

KEYWORDS
Presence-Absence test; Faecal coliforms; Total coliforms; Municipal drinking water; Quality and safety

Introduction

Background

Microorganism contamination of drinking water has been caused serious illnesses and associated mortality worldwide [1]. It serves as a mechanism to transmit communicable diseases such as diarrhea, cholera, dysentery, typhoid and guinea worm infection [2]. In the developing world, diseases associated with poor water and sanitation still have imposed economic development in addition to threaten million lives [3]. World Health Organization estimated that in 2008 diarrheal disease claimed the lives of 2.5 million people [2]. In 2013, there were nearly 1.8 million deaths mainly with diarrhea and cholera caused by unsafe water supply in conjunction with inadequate sanitation and hygiene [4]. In Africa, roughly 40% of the population does not have access to improved water supply and sanitation [5]. The safety of drinking water is challenged due to contaminants from natural and man-made situations at global scale [6]. The quality and safety of the drinking water continues to be an important public health issue. It is a pillar of primary prevention and control of pathogenic microorganisms such as bacteria, viruses, protozoa and helminthes [2]. Therefore, a microbiological aspect is one of the specific standards to provide a basis for determining the quality of drinking water [7] which is free from any microorganisms known to be pathogenic and free from bacteria indicative of pollution with excreta [8].

Statement of the problem

Availability of safe and wholesome drinking water for all is one of the most significant challenges faced by the municipal authorities worldwide. A clean and treated water supply to each house may be the norm in Europe and North America, but in developing countries, access to both clean water and sanitation are not the rule, and waterborne infections are common [9]. Lack of safe drinking water is associated with high morbidity and mortality from excreta related diseases [10].

Significance of the study

This study improves the scientific basis of drinking water quality and safety monitoring in Addis Ababa, an evidence for the AAWSA and the related stake holders to evaluate the quality and safety of public municipal drinking water of the city, in regular basis. It helps to evaluate how drinking water of the city is safely treated, handled and free from burden of microbiological contaminants and can be base-line information for further studies concerning the municipal drinking water of the

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city. It can also be helpful for planning and policy development for water quality and safety.

Objective

To assess public health microbiological quality and safety of drinking water sources in Addis Ababa City, Ethiopia.

Materials and Methods

Study setting

The study was carried out in Addis Ababa Water and Sewerage Authority water quality and drainage administration microbiology laboratory from October 2015 to June 2016. A total of two thousand nine hundred seventy six samples: two thousand nine hundred fifty one water samples for bacteria and twenty five water samples for parasites were collected and tested from all service sources of public municipal drinking water.

Study area

In Addis Ababa city administration all sub-cities and all districts.

Study design

A cross-sectional study design was conducted to assess the microbiological quality and safety of public municipal drinking water samples from all public municipal drinking water sources in Addis Ababa city administration.

Study period: The study had been conducting from October 2015 to June2016.

Laboratory testing

Bacteria quality testing: Principle of Presence-Absence (P-A) coliform test: The Presence-Absence (P-A) test for the total coliform group is a simple modification of the multiple-tube procedure. Use of one large test portion (100 ml) in a single culture bottle to obtain qualitative information on the presence or absence of coliforms, is justified on the theory that no coliforms should be present in 100ml of drinking water sample [11,12].

Parasites quality testing: Principle- 10-50 liters of water samples are filtered through a 47 mm diameter, 0.450 µm pore size membrane filters by vacuum pump. The sediment is then prepared for wet smear and using a 0.9% saline for parasite cysts, and helminthes ova/eggs [13,14].

Quality assurance

Distilled water was taken to all sample collection sites and carried along with the water sample back to the laboratory and tested. Tests were run with positive and negative controls for the whole quality of the study under the whole supervision of culture media, reagents and samples were run with positive and negative controls for the whole quality of the study under the whole supervision of Environmentalist, water quality case team and Biologists of AAWSA.

Statistical analysis

The frequencies and percentages were calculated to evaluate statistical significance of the microorganisms. The data were analyzed by Statistical Package for Social Science (SPSS) statistical software version 20.0.

Results

Distribution of faecal coli forms and total coli forms in water sources

This study showed that drinking water sources of the municipal drinking water were contaminated with faecal coliforms and total coliforms (Figure 1). Microorganisms were detected in four sources of municipal drinking water sources of Addis Ababa. The overall bacterial result showed that the least results were shown in public taps and reservoirs while the highest results were shown in springs and wells. Finally, 106 (6%) samples of all public taps, 26 (6%) samples of reservoirs, 34 (24%) samples of springs and 115 (21%) samples of wells were contaminated with bacterial contamination (Table 1).

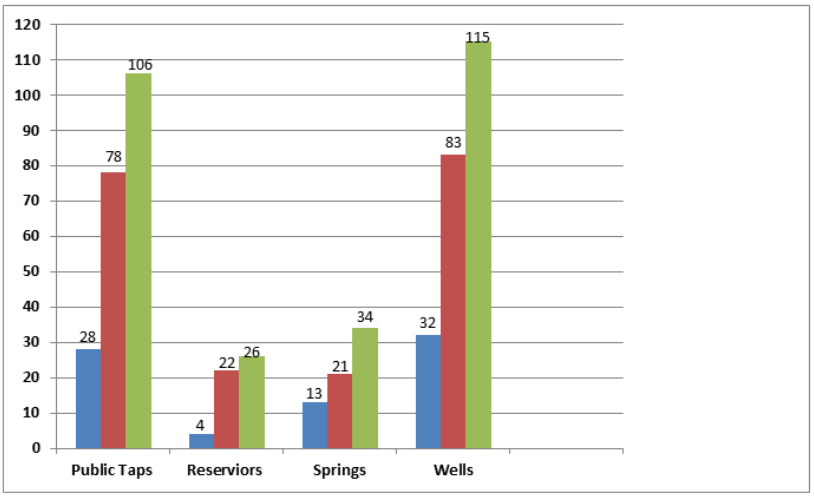

Figure 1. Distribution of faecal coli forms and total coli forms in water sources.

Note: (■) Faecal Coliforms, (■) Total Coliforms, (■) Total

Table 1. Post-operative wound complications (N=402).

Sample Source	Total Negative	Total Positive	Total Coli forms	Faecal coli forms Positives	Total Samples
Public Taps	1727 (59%)	106 (6%)	78 (4%)	28 (2%)	1833
Reservoirs	403 (94%)	26 (6%)	22 (5%)	4 (1%)	429
Springs	109 (76%)	34 (24%)	21 (15%)	13 (9%)	143
Wells	431 (79%)	115 (21%)	83 (15%)	32 (6%)	546
Total	2670 (90%)	281(10%)	204 (7%)	77 (3%)	2951

Parasitological test results

The twenty five selected reservoirs were negative for parasites by conventional microscopic examination.

Discussion

This study revealed that about 10% of all bacteriological samples were positive for total coliforms and faecal coliforms (Table 1). This finding confirms previous similar studies conducted in different parts of the world that drinking water samples had been contaminated with microorganisms such as total coli forms with the percentages of 100%, 90%, 70%, more than 51%, 33.33%, 23% and 12% [4,15-19], faecal coli forms with the percentages of 100%,73.94%, 70%, 61.1% and 40% [16,17,20-23], both total and faecal coliforms together with the percentages of more than 50%, 50%,33.33%and 31.2% [24-27] and *Escherichia coli* with the percentages of 80%, 78.1%, 70%, 27.1%, 20% and significant number [5,16,17,28-30]. This study revealed that 7% of the municipal drinking water samples were contaminated with total coliforms during the study period (Table 1). Coliform bacteria were detected in the sample tested. Sample is considered unsatisfactory for drinking water purposes. Similar studies were conducted in Peshawar, Pakistan by Ahmad et al. in 2013, by Bhatnagar et al. in 2012 in Jaipur, by Metgaud et al. in 2011 in Karnataka and by Rana et al. in 2014 in Bhilai and El badawy et al. in 2013 in Tabuk, India had showed that 70%, 66.67%, 33.33%, 23% and 12% of drinking water samples were positive for total coliform bacterial contamination respectively [15,17,18,25]. This study also revealed that 3% of the municipal drinking water samples were contaminated with faecal coliforms during the study period (Table 1). Faecal coliform bacteria were also detected in the samples tested. Sample is considered unsatisfactory for drinking water purposes. Presence of faecal coliform bacteria indicates fecal contamination of the water supply has occurred. Similar studies conducted by Misra et al. in Assam, India in 2010, by Ahmad et al. in Peshawar, Pakistan in 2013, and by Stenger et al. in 2012 in Bo, Sierra Leone had showed that 78.1%, 70% and 61% of drinking water samples were contaminated with *Escherichia coli* and faecal coliforms bacterial contamination respectively [17,21,29]. In developing countries particularly in Ethiopia, drinking water is obtained from different sources. Such as taps, reservoirs, springs and wells. This study revealed that samples collected from the municipal drinking water sources of this study area were contaminated with microorganisms during the study period. Accordingly, 6% of drinking water samples collected from public taps was positive for bacterial groups; and 6% of drinking water samples collected from service reservoirs was positive for bacterial groups (Table 1). Similar studies conducted by Bhatnagar et al. in 2012 in Jaipur, in Lahore, Pakistan by Siddiqi et al. in 2010, by Traistaruin Cyprus in 2011, by El badawy et al. in 2013 in Tabuk of Saudi Arabia had showed that 66.67%, 37.2%, 14%, 12% of bacteriological samples were contaminated with total coliforms [15,25,31-33]. Other similar studies had showed that most samples collected from reservoirs were both total and faecal coliforms positives whereas; in some reservoirs the contaminations were with similar bacterial groups [16,24]. This study also revealed that all samples collected for parasitological quality and safety assessment were negative for parasites species. Similar study by El badawy et al. in 2013 in Tabuk, Saudi Arabia had showed that parasitological examination revealed that giardia cysts were detected in 25% of water samples and *C. parvi oocysts* were detected in 16.6 % of water samples by both microscopy and ELISA methods [15]. This was may be due to the water sources differences where wells and surface water samples were used and/ or ELISA method while our sample sources were from treated service reservoirs and direct microscopy respectively. Similar study had showed by Rostami et al., 2015 in Shush, Iran 40% samples were infected with at least one of the active stages of parasitic organisms; out of these, 28.7% the protozoa and 18 11.2% were infected with the worm process of living organisms. According to the study 6.3% were related to the parasite *Entamoeba histolytica*. Therefore, prevalence of *Entamoeba histolytica* was 6.3% of drinking water in the city of Shush [34]. Even though, our study was similar methodology to the report from Shush, Iran, the differences were sample sources. According to Gobena et al. in 2015 water analysis demonstrated that all water sources

from Dire Dawa were contaminated by pathogenic parasites. From the recapitulate results, above (83.34%) of unprotected wells water sources, (50%-100%) from unprotected springs and protected wells, (33.34%-66.67%) from protected springs and (50%) from tap water were positive both for the presences of *Cryptosporidium* oocysts and *Girdia lamblia* cysts [35-46].

Conclusion

This research strengthens the scientific foundation for monitoring drinking water quality and safety in Addis Ababa, providing evidence for the AAWSA and other stakeholders to assess the quality and safety of the city's public drinking purposes on a regular basis. It aids in determining how the city's drinking water was safely treated, handled, and free of microbiological contaminants, and it can serve as a starting point for future research into the city's municipal drinking water. It's also useful for water quality and safety planning and policy formulation. The study concluded that most Addis Ababa city drinking water sources had acceptable quality and were safe for microbiological to drink.

Recommendation

Protecting springs and wells of the drinking water sources by building safe them from human, animal, heavy rain and flood contact. Regular monitoring of drinking water quality is essential as it is an important factor that has a direct effect on human health. Operational research need to be conducted to evaluate the trends of water quality and safety practices.

Limitation

The significant limitation of the study was missing acid fast staining for dried smear for parasites detection. The sample size for parasites was small and limited to reservoirs.

Ethics Approval and Consent to the Study

Written consent was obtained from AAU College of Health Sciences Ethical and research review committee. The confidentiality of all sample sources was maintained by unique identification code.

Consent for Publication

Not applicable

Availability of Data and Materials

The data for this study was made available with me.

Competing Interests

I declare that this study is my original work so that there is no competing interest.

Funding

The fund was obtained from AAU and AAWSA.

Author's Contributions

I (the author) performed all activities of the study.

Acknowledgements

I express my gratitude to advisors, AAU, AAWSA and Addis Ababa city dwellers water owners.

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