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Microbial quality of community drinking water supplies: A ten year (2004–2014) analyses in west Amhara, Ethiopia

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ABSTRACT

Access to safe drinking water is an important public health and development issue at national, regional and local levels. Community drinking water supplies such as piped water, dug wells and springs are the predominant sources in rural villages and towns in Ethiopia. A retrospective analysis was conducted on microbial quality of community drinking water sources that had been processed from 2004–2014. Water samples were collected from 36 districts in west Amhara region. As per standard operational procedures, bacteriological analyses had been performed using multiple tube fermentation technique. A total of 1030 drinking water samples from (tap water n = 680), wells (n = 198), spring (n = 128) and reservoir (n = 24) were analyzed for microbial qualities. Overall, 29.0% (95% CI: 26.3–31.8%) and 44.7% (95% CI: 41.7–47.7%) of water samples had *Escherichia coli* and total coliforms (TC), respectively. Furthermore, 52.0%, 43.0%, and 20.2% of water samples from wells, spring and tap water were positive for *E. coli*. For faecal coliforms, 72.1% of drinking water supplies complied with World Health Organization and Ethiopian Standards. Tap water samples were 3.8 times less likely to be faecal contaminated than water samples from dug wells and spring water sources (OR = 3.8, 95% CI: 2.8–5.1, P = 0.001). This ten year trend analyses showed that microbial qualities of community drinking water supplies were not to the standards. This study reinforces the need to monitor microbial quality and chlorine treatment of community water supplies.

1. Introduction

Access to quality of drinking water is an important public health and development issues from local to national levels. Microbial contaminated water sources are reservoirs that transmit communicable diseases such as diarrhea, cholera, dysentery and typhoid. Every year, 2.2 million deaths are attributed to diarrhoea alone, with the majority of deaths among children under the age of 5 years (WHO, 2008). According to WHO report, 88% of diarrhoea cases are attributed to unsafe water, inadequate sanitation and hygiene (WHO, 2002). In Ethiopia, 60–80% of communicable diseases are attributed to limited access to safe water, inadequate sanitation and hygiene services (WHO, 2008, 2011).

Over 780 million people worldwide are still without access to improved sources of drinking water (WHO, 2012). Thus, in developing countries; control of the microbial quality of drinking water is a much higher health priority. In addition, the use

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of chlorine for the disinfection of drinking water is also critical for the control of waterborne diseases. Therefore, it is necessary to monitor drinking water quality for faecal contamination.

Escherichia coli and other coliform bacteria are recommended to be an ideal indicator of drinking water quality. *E. coli* must not be detected in 100 ml sample (WHO, 2001). A study in Pakistan showed that 81% untreated and 19% treated water samples were positive for coliforms which indicated contamination and inadequate treatment of water supplies. *Escherichia coli* was found in 43.28% of the samples indicated faecal pollution (Ghulam et al., 2004). A survey conducted in some part of Ethiopia collected from six districts of 21 community drinking water sources had unacceptable level of contamination (>50 coliform/100 ml of water). Likewise, protected springs had undesirable sanitary conditions (Tensay, 1991).

In sub-Saharan Africa, community water supplies in rural areas significantly lag behind their urban counterparts in the microbial quality of drinking-water (WHO, 2010). Thus, microbial quality monitoring of community drinking water sources is an important plan for safe water supply strategies. In Ethiopia water quality monitoring is not well developed. Because, microbial quality of drinking water testing is limited to few referral laboratories. Moreover, still the reported microbial data on drinking water was not analyzed for comprehensive intervention and trend monitoring. Thus, this study was conducted to assess the microbial quality of community drinking water supplies that were processed from 2004 to 2014 in west Amhara, Ethiopia.

2. Materials and methods

2.1. Study design and area

A retrospective study was carried out on microbial quality of drinking water samples that had been processed from 2004–2014. Thus, the ten year retrospective water quality data were retrieved in December 2014 in Bahir Dar Regional Health Research Laboratory Center. According to their standard operation procedures for bacteriological analyses, 400 ml samples were collected using sterile glass bottles in the morning (8 a.m. to 11 a.m.). The samples were quickly transported, using a cold chain box, to the Microbiology Laboratory at Bahir Dar Regional Health Research Laboratory Center. Purposive sampling was used to collect water samples from sites according to d according to WHO (WHO, 2004). All water samples were collected from 36 districts in west Amhara Region by environmental health science experts. Drinking water samples had been collected from pipe lines, reservoirs, dug wells and springs. In the last ten years, a total of 1030 water samples from community drinking water supplies were analyzed for *E. coli* and total coliforms.

2.2. Data collection

The faecal contamination of water indicator bacteria such as *E. coli*, coliforms, the mean most probable number (MPN), sources of drinking water and chlorination status were retrieved from the registration records using a standard data collection format.

2.3. Microbial analysis of water

According to the standard operational procedure, microbial analyses of water had been performed using the multiple-tube fermentation method. Standard operational procedure showed that within 6 h of collection, all water samples were inoculated onto 11 tubes containing double strength MacConkey broth (Oxoid, UK) and single strength MacConkey broth (APHA, 1998; WHO, 2004). All inoculated tubes were incubated at 37 °C for 48 h aerobically and examined for both acid and gas production. Bottles and tubes that showed gas or acid production were considered as presumptive positive for total coliforms (TC). All presumptive positive samples were further inoculated into *E. coli* (EC) broth for *E. coli* isolation and incubated for 48 h at 44 °C (APHA, 1998).

2.4. Quality control

According to standard optional procedure for bacteriological analysis of drinking water showed that reference strain *E. coli* ATCC 25922 with serial dilution was used to check whether MacConkey broth supports the growth of *E. coli* and total coliforms drinking water or not.

2.5. Data analysis

Data was compiled manually using data sheet from the log book of microbiology laboratory in BRHRLC, cleaned for completeness and transcribed electronically to Statistical Package for Social Science (*IBM Corp. Released 2011. IBM SPSS Statistic Armonk, NY: IBM Corp*). A categorical variable were tested using the Chi-square tests and OR was calculated to measures the associations between predictor and outcome variables. All statistical tests were two-tailed, and the significance level was set at $P < 0.05$.

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