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# Infection Risk of Fecal Coliform Contamination in Drinking Water Sources of Urban Slum Dwellers: Application of Quantitative Microbiological Risk Assessment

Sri Yusnita Irda Sari, Deni Kurniadi Sunjaya, Ardini Saptaningsih Raksanagara

**Abstract**—Water is one of fundamental basic needs for human life, particularly drinking water sources. Although water quality is getting better, fecal-contamination of water is still found around the world, especially in slum area of mid-low income countries. Drinking water source contamination in urban slum dwellers increases the risk of water borne diseases. Low level of sanitation and poor drinking water supply known as risk factors for diarrhea, moreover bacteria-contaminated drinking water source is the main cause of diarrhea in developing countries. This study aimed to assess risk infection due to Fecal Coliform contamination in various drinking water sources in urban area by applying Quantitative Microbiological Risk Assessment (QMRA). A Cross-sectional survey was conducted in period of August to October 2015. Water samples were taken by simple random sampling from households in Cikapundung river basin which was one of urban slum area in the center of Bandung city, Indonesia. About 379 water samples from 199 households and 15 common wells were tested. For drinking water sources, half of the households used refill water gallon which mainly produced in drinking water refill station. Others used raw water sources which needed treatment before consumed as drinking water such as tap water, borehole, dug well and spring water source. Annual risk to get infection due to Fecal Coliform contamination from raw water sources were dug well ( $1127.9 \times 10^{-5}$ ), spring water ( $49.7 \times 10^{-5}$ ), borehole ( $1.383 \times 10^{-5}$ ) and tap water ( $1.121 \times 10^{-5}$ ). Annual risk infection of refill drinking water was  $1.577 \times 10^{-5}$  which is comparable to borehole and tap water. Household water treatment and storage of raw water sources is essential to be improved to prevent risk of water borne diseases. Strong regulation and intense monitoring of refill water gallon quality should be prioritized by the government; moreover, distribution of tap water should be more accessible and affordable especially in urban slum area.

**Keywords**—Drinking water, quantitative microbiological risk assessment, slum, urban.

## I. INTRODUCTION

**W**ATER, sanitation and hygiene are known among the most fundamental for human needs, and are a prerequisite to human health and development. Clean water is essential for human's daily living, especially drinking water. An adequate supply of safe drinking water is universally recognized as a basic human need, however, millions of people in the developing world still have no access to adequate and safe water supply. In the last decade, the number

of people without access to safe water in urban areas was rising sharply in developing countries, as a result of rapid urbanization and much of which was occurring in peri-urban and slum areas [1]. Fecal-contamination in water source as one of indicator for low level of sanitation and poor hygiene are still found around the world, especially in slum area and mid-low income countries [2]. Globally, 4% of all deaths and 5.7% of total preventable disease burden were associated to health impacts of poor water, sanitation, and hygiene [3]. Diarrhea or gastroenteritis is among the main cause of health problems whereas 1.5 million deaths caused by diarrhea in 2012 and 280,000 were caused by poor sanitation [4]. In Indonesia, diarrhea known as common infection among infants and children. Risk factors of diarrhea in Indonesia were contact and ingestion of unsafe water, lack of water supply, poor personal and domestic hygiene, and inadequate development & management of water resources & water systems [5]. The United Nations had projected a rapid population growth in urban areas between 2000 and 2030, 6 out of 10 people will be living in cities, consequently accessible and adequate safe drinking water and sanitation in urban areas particularly for urban poor dwellers should be prioritized by policy makers to decrease risk of water related diseases [6].

The level of contamination among water sources varies which mainly caused by lack of hygiene and sanitation of the environment. Surveillance for quality of water sources, especially microbiologically, is required to prevent further contamination. Quality is normally assessed against both microbial indicators and chemical parameters, although the microbial quality is the most important aspect from a public health perspective, because onset of illness (and possibly epidemic outbreaks) caused by some pathogenic organisms can be very fast. Microbiological water contamination monitoring can be accomplished by fecal indicator bacteria identification using *Escherichia coli* (*E. coli*) and Coliform bacteria. *E. coli* is the most used water source contamination indicator because it has a rapid, easy, and the most specific identification process [7]. WHO Guideline for Drinking Water Quality recommended ensuring the safety of drinking water supplies by development and implementation of risk management strategies to control hazardous constituents in water [8]. QMRA is a risk-based approach which provides an exhaustive evidence for effective multi-barrier measures in