Supporting information

For

Research on the spatial distribution characteristics and inhalation health risk assessment of bacterial aerosols in spraying environments

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Test S1

(1) Preparation of antibiotic solution

The preparation of antibiotics was in accordance with the American Clinical Laboratory Standards Institute - 2012 standard:

Nalidixic acid (10 mg/mL): Weigh 0.4 g of nalidixic acid solid powder into a 50 mL centrifuge tube, add 20 mL of 0.1 mol/L NaOH solution and 20 mL of ultrapure water, and centrifuge and mix until the solid particles are completely dissolved.

Rifampicin (50 mg/mL): Weigh 2 g of rifampicin solid powder into a 50 mL centrifuge tube, add 20 mL of DMSO (Dimethyl sulfoxide) solution and 20 mL of methanol solution, and centrifuge and mix evenly.

The antibiotic solution was stored in a refrigerator at 4°C and kept in a dark place for standby.

(2) Preparation of resistant plates

Weigh 33 g of nutrient agar powder into a 1 L beaker, add 1 L of pure water, heat and boil until completely dissolved, autoclave at 121°C for 20 minutes, place it on a super clean bench, cool to about 50°C, add the prepared antibiotic (1 L system: 6 mL of rifampicin, 10 mL of nalidixic acid), and use disposable petri dishes (90 mm) for dispensing the Anderson sampler, about 20 mL in each petri dish. Use 70 mm petri dishes for dispensing the BioSampler, about 10 mL in each petri dish, and store in a refrigerator at 4°C for use. The concentration of the resistant medium is 300 μg/mL of rifampicin + 100 μg/mL of nalidixic acid.

(3) Preparation of PBS buffer solution

Weigh 1.42 g of disodium hydrogen phosphate (Na_2HPO_4), 0.27 g of potassium dihydrogen phosphate (KH_2PO_4), 0.2 g of potassium chloride (KCl), and 8 g of sodium chloride (NaCl) into a 1 L beaker, add 800 mL of pure water, and stir until fully dissolved. Then add concentrated hydrochloric acid or sodium hydroxide to adjust the pH of the solution to 7.4, and make the solution up to 1 L. Store at 4°C for standby.

Test S2

The QMRA model consists of four steps: hazard identification, exposure assessment, dose-response analysis, and risk characterization. As follows:

(1) Hazard identification

Pathogenic Escherichia coli can cause symptoms such as diarrhea in the human body and cause harm to human health. Therefore, in this study, Escherichia coli was selected as the evaluation index. In China's "Water Quality Standards for Reclaimed Urban Sewage for Landscape and Environmental Uses", it is stipulated that the fecal coliform in ornamental landscape environmental water (water feature type) is ≤2000 per liter, and fecal coliform shall not be detected in recreational landscape environmental water (water feature type). There is no standard for Escherichia coli. The European Union stipulates in the reuse standard for landscape environmental water that the total number of bacteria in public contact recreational impounded water is <10000-100000 CFU/mL. In Japan's reuse standard for landscape environmental water, it is stipulated that the number of Escherichia coli colonies in landscape water is ≤1000 CFU/100mL, and Escherichia coli shall not be detected in water for wading. The U.S. EPA "Landscape Recreational Water Standards" has specific concentration standards for Escherichia coli concentration, and its limit is 126 per 100mL. Considering the actual use of landscape and recreational water bodies in China and the dose-response parameters of Escherichia coli in the QMRA model, in order to make the evaluation results more meaningful, the Escherichia coli concentration stipulated in the U.S. EPA is adopted.

(2) Exposure assessment

Combined with the exposed population, exposure routes, annual exposure frequency and single exposure time in the spraying environment obtained from the questionnaire survey, the exposure dose of the population in different environments was determined. The breathing rate of the population was cited from the "Manual of Exposure Parameters for Chinese Population (Adult Volume)" and the "Manual of Specific Exposure Factors for Children" of the U.S. EPA. The distribution of exposure parameters of the population in the spraying environment was the questionnaire survey result of this study. The atomization factor (F) (mL water/m^3 air) was derived from the average value at a distance of 3 meters from the nozzle in the simulated spraying experiment of this study: 0.81. The activity coefficient (a) is defined as the ratio of the concentration of live bacteria in aerosols obtained by flow cytometry detection to the plate count result. According to the experiment, this value is 1000.

(3) Dose-response analysis

In the QMRA model, the dose-response relationship model of Escherichia coli was selected as the Beta-Poisson model. The inhalation health risk Pi of a single exposure was calculated according to Eq. S1, where the slope parameter α corresponding to Escherichia coli and the number of viruses infecting 50% of the population N_{50} were 0.1778 and 8.6×10^7.

$$P_i = \left[1 + Dose\frac{2^{\frac{1}{\alpha}} - 1}{N_{50}}\right]^{-\alpha} \qquad \text{Eq. S1}$$

(4) Risk characterization

Let the annual exposure frequency be n. Then the calculation formula for the annual health risk Pa of the exposed population is as shown in Eq. S2

$$P_a = 1-(1-P_i)^n \qquad \text{Eq. S2}$$

Considering the uncertainty of bacterial aerosol concentration, the exposure frequency and time of the population in the spraying environment, in this study, Matlab software was used to calculate the probability distribution of the single health risk and annual health risk of the population in different exposure environments through Monte Carlo simulation. The number of calculations I was 10,000. On this basis, the health risk values of the population in different regions (north and south) in different exposure environments were further calculated to evaluate whether the risk was within an acceptable range.