Variability Impact and Human-source Contribution on Multi-pathway Fecal Exposure Assessment: A Case Study in an Urban Slum of Bangladesh

Min Li CHUA

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1. INTRODUCTION

Bangladesh has large slum population with concerning diarrheal risks due to poor sanitation conditions. Fecal exposure should be assessed to learn threatening fecal exposure trends, especially by human-specific sources. Studies in slum context which integrates microbial source tracking into their exposure analysis were limited. Also, probabilistic exposure simulation can be characterized to involve large variability using censored microbial concentration data. This study was conducted in an urban slum of Bangladesh with the objectives: (1) to identify the major exposure pathways and associated media based on daily living activities of children by Monte Carlo simulation; (2) to evaluate variability impact of censored microbial data by approaches of probabilistic distribution fitting and to conduct sensitivity analysis on each input variable; and (3) to obtain human-specific *E. coli* proportion in exposure media to be integrated into the exposure simulation.

2. METHODS

The study site was a slum in Khulna, Bangladesh. Nine exposure pathways including drinking, bathing in pond, indoor play and outdoor play, were identified in slum child's daily living activities. *E coli* concentration in the corresponding ten media, including pond water, drinking cup surface, outdoor soil and indoor soil were obtained, containing censored data. Three fitting methods were compared to convert the censored microbial data into probabilistic distribution functions (PDFs) to be used in probabilistic exposure simulation. Using the most suitable fitting method, exposure calculation on non-specific *E. coli* was carried out by Monte Carlo simulation together with sensitivity analysis. Then, the human-specific *E. coli* proportion was estimated for five exposure media by real-time PCR with human-specific genetic marker H8. Finally, exposure simulation of human-specific *E. coli* was performed.

3. RESULTS AND DISCUSSION

Assuming three fitting methods, maximum likelihood estimation was the recommended fitting method under conditions of sample size > 5 and censoring data percentage < 80%. From Table 1, pond bathing was the most critical exposure pathway for both non-specific and human-specific *E. coli*, to be prioritized for exposure-reducing interventions. The second major pathways for non-specific and human-specific *E. coli* were drinking and indoor play respectively. Indoor play should be prioritized similarly as drinking pathway despite its relatively minor exposure amount of non-specific *E. coli*. It is notable that drinking cup contamination accounted 58.9% of exposure amount in drinking pathway. Thus, interventions were proposed based on these findings: (1) to select alternative water source like well water instead of pond for children bathing; (2) to wash drinking cups in sanitary manner; (3) to wear protective shoes outdoor; (4) to keep animals and their feces away from playground space.

Table 1 Daily *E. coli* exposure by major pathways

Major pathways	Major exposure media	Human-specific *E. coli* Median (CFU/day)	Non-specific *E. coli* Median (CFU/day)
Pond bathing	Pond water	535.4	1677.4
Drinking	Drinking cup	87.3	277.5
Indoor play	Indoor soil	34.6	34.7
Outdoor play	Outdoor soil	11.4	57.8