Faecal contamination of commuters’ hands in main vehicle stations in Dhaka city, Bangladesh


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Background: Faecal-oral carriage via hands is an important transmission pathway for diarrhoeal pathogens. The level of faecal contamination of commuters’ hands in Dhaka, Bangladesh, was examined in this study.

Methods: A total of 900 hand washing samples, including both left and right hands, were collected during one year to cover three different seasons in Bangladesh: winter, summer and rainy seasons. Standard membrane filtration technique was used to quantify total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS), Escherichia coli (EC) and Clostridium perfringens (CP).

Results: The hands of the commuters were contaminated with TC, FC, FS, CP and EC. The TC, FC, FS, CP and EC counts were 1.95, 1.65, 4.04, 1.54 and 1.46 log10 colony forming units (cfu) in the left hand; and 2.13, 1.82, 4.11, 1.52 and 1.61 log10 cfu in the right hand, respectively. There were no statistically significant differences in counts of left and right hands. The highest counts were observed for FS in all seasons.

Conclusions: This evidence based study may be used to provide interventions to reduce the contamination of commuters’ hands through washing with detergent and, thus, help to prevent the spread of infectious diseases.

Keywords: Bangladesh, Commuters hand, Faecal contamination, Hand washing, Vehicles, Seasons

Introduction

Infectious diseases are generally more prevalent in developing countries compared to countries in the developed world. As a result, 62% and 31% of all deaths in Africa and Southeast Asia, respectively, are caused by infections. The WHO recognises the spread of diarrhoeal diseases as a serious global problem, and estimates that each year there are more than 2.2 million lives lost due to these infections, a death toll which is higher than that caused by malaria, HIV/AIDS and measles combined. Remarkably, a half of all child deaths each year are due to diarrhoea and acute respiratory infections, both of which are transmitted from person to person during everyday interactions: through droplet, airborne spread, skin contact and contamination of water, food and the environment.

It has been suggested that hygiene and hand-washing promotion may be one of the most cost-effective interventions for preventing infectious diseases in developing countries, and hand washing in particular, if globally practised, could save over a million lives.

Faecal-oral carriage via the hands is thought to be an important transmission pathway for diarrhoeal pathogens. The promotion of improved hand hygiene continues to be a key public health goal both in low and high income countries, both in communities and in health care settings.

A number of studies have detected bacteria on hands of health care workers in hospitals, caregivers after changing a nappy, homemakers, and on surfaces in public places, few have looked at faecal contamination of the hands of the general adult public. Judah et al. (2010) investigated faecal bacteria on the hands of commuters in five UK cities and found 28% of 404 commuters sampled had contamination of their hands with bacteria of faecal origin. They also found that commuters travelling by bus were more contaminated than those travelling by train. However, these investigators did not include commuters who use waterways like launch or boats. We are not aware of any study that has investigated the contamination of commuters’ hands at different seasons and by different mode of transport.
used e.g., train, bus and launch in Dhaka, Bangladesh. Therefore, the present study was conducted to investigate the levels of faecal contamination of commuters’ hands in Dhaka city.

Materials and methods

Sample and data collection

The main railway station, bus station and launch terminal in Dhaka city were selected as study sites. There is only one railway station and one launch terminal in Dhaka city. There are three main bus stations of which one was randomly selected by lottery method. The selected bus station is situated in the middle of the city. The commuters use this station for moving in different directions of the city. All three bus stations are comparable in terms of number of daily commuters and the number of vehicles. Therefore, three main vehicle stations were considered in this study. A total of 900 hand washing samples (3 stations x 100 samples each x 3 seasons) were collected for one year from September 2011 to August 2012 to cover winter, summer and rainy seasons in Bangladesh. The field workers approached the commuters at the sites, explained the study and asked whether they would like to participate. After having given written consent, participants were then asked to soak their hands (left and right hand separately) in a Whirlpak bag containing 200 mL sterile Ringer’s solution for 30 seconds. Hand rinses, including rinse of the palm and fingertips, were collected by immersing the entire hand in Whirlpaks containing Ringer’s solution. Left and right hands were rinsed separately in two different Whirlpak bags. The Whirlpak containing the hand rinse samples were labelled and placed in a cool box with ice packs to maintain a temperature of 4–8°C and were transported to the Environmental Microbiology Laboratory of the International Center for Diarrhoeal Disease Research, Bangladesh (icddr,b), and processed within 6 h after collection of samples.

Estimation of faecal indicator bacteria

We used standard membrane filtration methods to quantify the number of colony forming units (cfu) of total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS), Escherichia coli (EC) and Clostridium perfringens (CP). For each sample, we filtered 20 and 2 mL separately through 0.22 µm Millipore (Merck Millipore, Billerica, Massachusetts, USA) membrane filters, then placed the filters on modified faecal coliform (mFC), membrane-thermotelant E. coli (mTEC), Kenner Fecal Streptococcus Agar (KFSA) and modified C. perfringens (mCP) agar plates for enumeration of TC, FC, EC, FS, and CP, respectively. For all samples, we also inoculated 100 µL of sample on to mFC, mTEC, KFSA and mCP media following the drop plate technique to quantify samples where the colonies on the filter were too numerous to count. The count was expressed as colony forming unit per hand (cfu/hand). If the number of cfu were too numerous to count from 100 µL, we made 10-fold dilutions and plated following the same procedure described above.

The mFC plates were incubated at 37°C and 44°C for 18 to 24 h for TC and FC, respectively. Then the characteristic blue colonies were counted as TC and FC and expressed as cfu present per 200 mL hand rinse samples, following the same procedures described earlier. The KFSA plates were incubated at 37°C for 48 h and the characteristic light and dark red colonies were counted as FS following standard procedures. For enumeration of EC, mTEC agar plates were incubated at 35±0.5°C for 2 h followed by further incubation at 44.5±0.2°C for 22–24 h. Then the red or magenta colour colonies were counted as EC. For enumeration of CP, mCP agar plates were incubated in an anaerobic jar at 44°C for 24 h. The yellow colonies were counted as CP. Then the colonies were further tested by exposing to ammonium hydroxide. A highly specific reaction occurred due to phosphate producing CP colonies to turn a distinctive dark pink colour.

Statistical analysis

The statistical analysis was performed by using SPSS (version 16.0). Continuous variables were compared following One-Way ANOVA and Wilcoxon Test.

Results

The left and right hands of the commuters were contaminated with TC, FC, FS, CP and EC. The TC, FC, FS, CP and EC counts were 1.95, 1.65, 4.04, 1.54 and 1.46 log10 cfu/hand in the left hand; and 2.13, 1.82, 4.11, 1.52 and 1.61 log10 cfu in the right hand, respectively (Figure 1). There were no statistically significant differences in counts when the left and right hands were compared. The highest counts were observed in FS among the indicator bacteria studied in both left and right hands.

Both hands of commuters irrespective of vehicles used were contaminated (Figure 2). The counts of TC in the left hand were 1.25, 1.85 and 2.76 log10 cfu/hand, respectively. The lowest and the highest counts were observed in bus and launch, respectively. A similar trend was observed for FC, FS and EC in the left and right hands. However, the trend for CP was different compared to other faecal indicator bacteria and the highest and lowest count were observed in the left and right hands for the bus and the train commuters, respectively.

In the winter season both hands of commuters were contaminated by all kinds of indicator bacteria studied (Figure 3). In both hands, among the faecal indicator bacteria the highest count was observed by FS and the lowest contamination was by EC, except the CP count in right hands of launch commuters. The contamination also varied depending on the transport used. The highest contamination was observed in hands of the commuters who used water ways followed by train and bus commuters. The difference in counts of TC, CP and EC in the left hands of bus, train and launch commuters is not statistically significant. However, the difference in counts of FS between launch and bus commuters is significant (p<0.01). Similar significant difference in FC counts between launch and bus commuters in the left hand during winter was also found (p<0.05). In the right hand, a significant difference was observed between launch and bus commuters for FS, FC, TC and EC counts (p<0.05).

The contamination in summer season was widespread like winter in both hands by faecal indicator bacteria (Figure 4). In summer, the highest contamination was with FS. The level of
contamination was lowest in hands of bus commuters and highest in launch commuters. The same trend was observed in the case of TC, FC and EC with exception of CP. EC count in right hand where bus commuters were found more contaminated than train commuters. The difference of count of TC, FC, FS and EC in launch and bus commuters were statistically significant ($p < 0.01$) in both hands.

The contamination of both hands was observed in all kinds of commuters in the rainy season (Figure 5). There was a higher count of all the indicator bacteria (except FS) in launch commuters than the commuters of the other two types of vehicles. The FS counts were the highest in train commuters in comparison to bus and launch commuters. However, the difference in counts in both left and right hands of train and bus commuters is significant ($p < 0.01$). The counts of CP in both hands in bus and launch commuters were higher than train commuters and the difference of counts was significant ($p < 0.05$).

The counts of FS in the left hands of bus, train and launch commuters’ were 3.41, 3.68 and 4.07 $\log_{10}$ cfu in winter; 3.45, 4.03 and 4.49 $\log_{10}$ cfu in summer; and 3.94, 4.82 and 4.47 $\log_{10}$ cfu in rainy season, respectively. Therefore, the lowest count was observed in winter. A similar trend was also observed in right hands.

**Discussion**

The present study showed that both hands of commuters, irrespective of vehicles used, remained heavily contaminated by faecal indicator bacteria in all seasons of the year. The
contamination levels by the faecal bacteria e.g., TC, FC, FS, CP and EC were almost the same in both left and right hands. However, the contamination was found to always be higher due to FS in both hands and the difference in contamination due to FS was statistically significant (p<0.01) compared with other indicator bacteria (Figure 1). The higher counts of FS might be due to longer survival of FS than other indicator bacteria outside the gut environment. This finding clearly indicated that personal hygiene is a key issue to remain safe from the diseases related to faecal contamination. The usual belief in Bangladesh is that the left hand is more prone to faecal contamination because the left hand comes in direct contact with faeces during washing of the anus after defecation. The results of this study have clearly shown that although the left hand is supposed to be more contaminated as it is used for ablution in Bangladesh, the results were not as expected and both hands were found to be equally contaminated. Our findings are in agreement with other studies in which there was no statistically significant difference in counts of bacteria in left and right hands. These results suggested the importance of washing both hands together.

The contamination of hands of the launch commuters was higher in comparison to both train and bus commuters. The main reasons might be the socioeconomic conditions of the passengers. Among the three methods of transport, launch is most affordable to the commuters who are the poorest. This difference in socioeconomic conditions might also have been a factor for the launch commuters’ hands being more contaminated than others. As they are the poorest community in the society, it’s possible that knowledge about personal, domestic

Figure 3. Contamination of commuters’ hands in winter. *indicates statistical significance p<0.05. CP: Clostridium perfringens; Cfu: colony forming unit; EC: Escherichia coli; FC: faecal coliforms; FS: faecal streptococci; TC: total coliforms. This figure is available in black and white in print and in color at Transactions online.

Figure 4. Contamination of commuters’ hands in summer. **indicates statistical significance p<0.01. CP: Clostridium perfringens; Cfu: colony forming unit; EC: Escherichia coli; FC: faecal coliforms; FS: faecal streptococci; TC: total coliforms. This figure is available in black and white in print and in color at Transactions online.
and environmental hygiene is also comparatively more inadequate than others. The counts of CP are similar irrespective of the vehicles used. As CP is a spore forming bacterium, the death and decaying phenomenon is different in comparison to other indicator bacteria and, as such, there was not much difference in the count of CP in both hands irrespective of transport used.

Studies among travellers have demonstrated that reported poor hygiene is associated with diarrhoeal illness, suggesting that the faecal-oral route is an important pathway of disease transmission. The presence of faecal bacteria on hands in spite of self-reported hygiene is not surprising as prior findings show that self-reported hygiene practices are unreliable. It was surprising to find such high rates of bacterial contamination of faecal origin on hands. Though these bacteria may not be a direct health hazard by itself, it is indicative of a failure of hygiene, and more specifically a failure to wash hands after contact with faecal material or surfaces where faecal material is present. If pathogens are present in excreta they could then use this route of transmission to find and infect new hosts.

The contamination of hands of commuters in the winter season was similar in both left and right hands, but the count of FS in hands of commuters of all the vehicles was comparatively lower than in summer and rainy seasons. As the indicator bacteria except CP are (non-spore formers) prone to desiccation, they cannot survive long without water which might be the reasons why the count of indicator bacteria in hands was low during winter. In winter, due to the cold weather, people do not wash their hands as hot water is not easily available. In addition to desiccation, lower temperature might be another reason for lower counts during winter as the lower temperature is unfavourable for multiplication of bacteria.

In summer, the counts of TC, FC, FS and EC were the lowest in bus commuters and highest in launch commuters. In case of CP, the bus commuters were having the highest contamination and launch commuters had the lowest contamination. This reverse situation for CP might explain the characteristics of the spore forming bacteria which can persist longer in hands than other faecal indicator bacteria as they are more resistant to adverse situations and can survive longer as spores in contrast with other bacteria. Such information could be extremely valuable because it would provide evidence supporting hygiene strategies as a preventive intervention in a population commonly affected by gastrointestinal illness.

Overall the study suggested that irrespective of the transport the commuters used the commuters’ hands were always faecally contaminated, which could potentially be a source of further contamination of surfaces that they touch. For example, even shaking hands with friends may transmit the bacteria from their hands to the person with whom they meet, and forms a vicious cycle of hand-to-hand transmission in a community. Therefore, awareness building and prevention of such contamination is imperative by adopting interventions to break the transmission cycle. The easier, simpler and better way to break this transmission route is to wash hands with soap or other detergent to achieve a clean environment and to prevent person-to-person and person-to-surface transmission.

Understanding the different factors that influence the presence of faecal bacteria will provide the basis for an appropriate awareness raising and education campaign regarding hand washing with soap. Promoting this practice is said to be one of the most cost-effective interventions for preventing infectious diseases, such as diarrhea and acute respiratory infections, in developing countries, both of which are leading causes of death. Targeted at policy makers in government, soap companies and NGOs, these findings aim to guide future interventions in the public health sector so as to reduce the spread of infectious diseases. One limitation of this study was that due to constraints on funds, only three sites had to be selected arbitrarily for the study. Also, failure to collect data on other confounding factors like socioeconomic status, personal hygiene and duration of stay in the vehicles by the commuters, limited the scope of the study. However, despite these limitations, we...
predict that the findings of the study will have relevance in reducing transmission of faecal bacteria and diarrhoeal pathogens.

Authors’ contributions: MSI, ZHM, MSI and GCS were responsible for the study design. RUZ, MRS and PSG performed the laboratory tests. Data analysis was completed by MSI, ZHM, MSI, KL, HJ, AO, SMF and JDC. ZHM and MSI interpreted the data. The major writing of the report was completed by ZHM, MSI, MSI, MRI and RUZ. All authors assisted in the review of the manuscript and approved the final manuscript. MSI is the guarantor of the paper.

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