

Assessment of the microbial contamination of stairwell door handles in blocks of flats

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The stairwell door handles in blocks of flats are the objects that every resident and guests touch at least several times a day. For this reason, many microorganisms collect on them, which can cause infections of varying severity. Therefore, it is very important to observe proper hand hygiene and disinfection of frequently touched surfaces on the stairwells of blocks of flats. Research samples were taken in the months of October–November in 2021 and December–January in 2022, in the morning (between 7:00 and 8:00) and in the evening (between 19:00 and 20:00), from the stairwells of the blocks of flats in the city of Kaunas. One-hundred samples were taken in the autumn season (50 in the morning and 50 in the evening) and 100 samples in the winter season (50 in the morning and 50 in the evening). The research sample consisted of 200 samples; four analytes were analysed in each sample: *Enterococcus* spp., *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus*. The stairwell door handles of multi-apartment buildings were contaminated with *Enterococcus* spp. the most and with *S. aureus* bacteria the least. Slightly higher microbial contamination of multi-apartment stairwells was observed in the evening. Microbial contamination of multi-apartment stairwell door handles was observed to be higher in the autumn season than in the winter season.

Keywords: *Enterococcus* spp., *Escherichia coli*, *Staphylococcus aureus*, stairwell door handles, multi-apartment

INTRODUCTION

Skin is the largest external human organ and the largest protective barrier of the body against external factors. The ecosystem of the skin varies considerably: some surfaces such as forearms and the back are dry, other areas are moist (palms), and some surfaces are quite wet (armpits) (Bacevičienė et al., 2019; Jankauskienė,

Šniepienė, 2020). The skin a favourable environment environment for microorganisms to multiply (Jankauskienė, Šniepienė, 2020).

Bacteria, fungi, and viruses can be found on environmental surfaces. Microorganisms can enter surfaces during direct contact, in the form of aerosol droplets or body fluids (saliva, blood, urine, etc.). On human hands, there are mostly normal microflora bacteria, but there can also be temporary microorganisms that find their way on the hands from the environment. The probability

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of transmitting microorganisms through frequently touched surfaces depends on how long the organism can survive in the environment under the influence of environmental conditions (Odigie et al., 2017). In previous studies, gram-positive *Staphylococci* and gram-negative *Escherichia coli* were found on contact surfaces such as doorknobs and chairs. Gram-negative bacteria have virulent properties and endotoxins in their outer membrane, which cause various infections (Baadhaim et al., 2011). Gram-positive bacteria can also cause infections, but they are easier to treat due to the sensitivity of gram-positive bacteria to antibiotics. This is due to the fact that the walls of gram-positive bacteria are not as dense as that of gram-negative bacteria, so larger molecules can pass through (Silhavy et al., 2010).

Staphylococcus epidermidis is found on almost every hand. The number of colonies of these bacteria on healthy hands far exceeds the number of *Staphylococcus aureus* bacteria (Odigie et al., 2017). *Corynebacterium*, *Micrococcus* species, and some bacteria of the *Enterobacteria* family are also found on the hands. The most common temporary bacteria on the hands that cause diseases are *E. coli*, *Salmonella* species, *Shigella* species, *Clostridium perfringens*. Viruses such as norovirus and hepatitis A virus are also found on hands (Odigie et al., 2017). Poor hand hygiene facilitates the entry of pathogenic bacteria from environmental surfaces into the human body (Tsaku et al., 2017). Staircase door handles touched by people in multi-apartment buildings harbour potentially pathogenic bacteria and may act as sources of infectious agents.

The aim of this study was to assess the microbial contamination of stairway door handles in blocks of flats.

MATERIALS AND METHODS

The study was conducted in the microbiology laboratory of the Department of Medical Technologies and Dietetics, Kaunas University of Applied Sciences, in accordance with the HN

131: 2015 and LST EN ISO 14698-1 standards. The microbiological test relied on the washing method (Zumla et al., 2010). Samples were collected from the external staircase door handles of blocks of flats. A total of 200 samples were collected in October–November 2021 (50 in the morning and 50 in the evening) and December–January 2022 (50 in the morning and 50 in the evening). The samples were collected in the same places at the same time (between 7:00 and 8:00 and between 19:00 and 20:00). Samples were collected from the entire area of the door handle.

The washing test for the evaluation of the microbiological contamination consisted of six steps: (1) sampling, (2) preparation and quality control of the media, (3) primary inoculation, (4) initial evaluation of the results and sowing in selective media, (5) initial evaluation of results, (6) bacteria identification tests and evaluation of the results.

Sampling. Samples were collected with a sterile swab and placed in universal transport media. They were examined within 24 h from the time of collection. The samples were stored at a temperature of +5–25°C until testing. In the laboratory, the samples were placed in test tubes with 1% peptone water (PV) and incubated at +35–37°C for 48 h.

Primary inoculation. The media were prepared according to the manufacturer's recommendations on the media packaging (Liofilchem, Italy). Samples were seeded on Tryptone Bile X-Gluc (TBX) agar for detected *E. coli*, mannitol salt (MDA) agar for *S. aureus*, Bile esculin azide (TEAZ) agar for *Enterococcus* spp., and *Pseudomonas* cetrimide agar (PCA) for *Pseudomonas aeruginosa*. Samples were incubated for 24 to 48 h with a control (unseeded) Petri dish +37°C thermostat.

Initial evaluation of the results and sowing in selective media. After 24 to 48 h of incubation, Petri dishes showing growth of bacteria were removed from the thermostat and re-selected. The colour, size, and abundance of the grown colonies were assessed by visual inspection of the Petri dishes.

After that, the purity of the bacterial cultures was evaluated: from the isolated bacterial culture grown in the nutrient medium, a part of the colony was transferred onto a slide using a sterile microbiological loop. After spreading the transferred colony in a thin layer under the slide, we fixed it with a spirit lamp and stained it by Gram staining. The stained smear was evaluated morphologically using the immersion system of the microscope. We observed the colour, size, shape, and arrangement of the bacteria.

Initial evaluation of the results

1. Tryptone Bile X-Gluc (TBX) agar is designed to monitor the growth of *E. coli*, and it shows the growth of blue-green colonies of *E. coli* after incubation.

2. *S. aureus* bacteria degrade mannitol to acids, so the colour of the medium changes from pink to yellow in mannitol salt agar (MDA).

3. *Pseudomonas* cetrimide agar is coloured green by growing *P. aeruginosa* bacteria.

4. TEAZ (bile esculin azide) agar: visible growth of black colonies in the presence of *Enterococcus* spp.

5. Evaluation of the smear: gram-negative (-) bacterial walls are stained red, and gram-positive (+) walls are stained blue-violet.

Bacteria identification tests

After evaluating the morphological and cultural properties of the cultured bacteria, biochemical property studies were performed to facilitate the identification of the grown bacterial colonies more accurate (Zumla et al., 2010). Oxidase test, Tryptone water, and Simmons citrate medium were used to confirm *E. coli* bacteria.

Catalase, plasma coagulase, and DNA-ase tests were used to identify *S. aureus*;

Enterococcus spp. was identified by the latex agglutination test.

RESULTS AND DISCUSSION

The study searched for the main infectious agents: *P. aeruginosa*, *Enterococcus* spp., *S. aureus*, and *E. coli* bacteria.

In the 200 samples analysed, the highest detected number was of *Enterococcus* spp. (20%; 40/200), *E. coli* (9.5%; 19/200), and the lowest number was of *S. aureus* (5%; 10/200). No *Pseudomonas aeruginosa* was detected the analyses samples (Figure).

The results of the study show that the total amount of *E. coli* bacteria detected in the evening (44.4%) was higher than in the morning

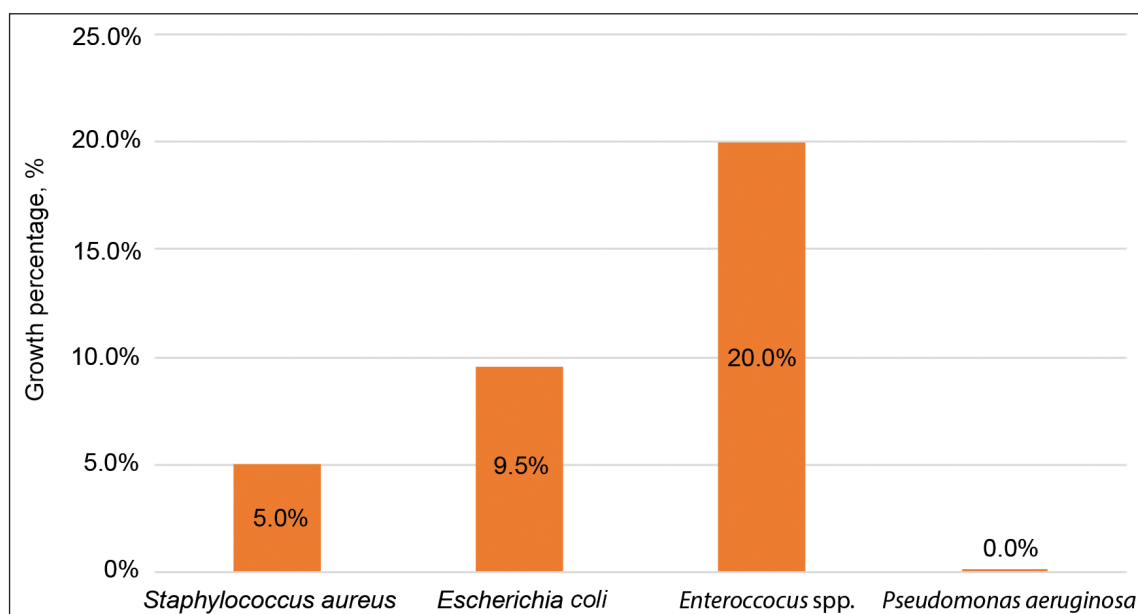


Figure. Detection of different microorganisms in samples (N = 200)

(55.6%). No statistically significant difference was detected ($p = 0.232$, $p > 0.05$). Such results could have been influenced by the lower amount of humidity and UV rays in the evening. Ultraviolet radiation (UV) is an effective bactericide. Therefore, the number of bacteria on surfaces decreases during daytime exposure to UV radiation. Comparing the growth of *E. coli* in the autumn and winter seasons revealed that the results differed insignificantly, but the number of bacteria found in the winter season (42.1%) was slightly lower than in the autumn season (57.9%). However, no significant difference was detected ($p = 0.667$, $p > 0.05$). According to Wei and Zhao (2018), the low temperature affects the change in the morphology of the bacteria. Bacteria are shortened at low temperatures, and this may have led to lower numbers of colonies in the samples of the winter season. Also, the results were affected by the intensive disinfection of the stairwells of apartment buildings and the mandatory wearing of protective masks during the winter season due to the global pandemic. Comparing the number of *S. aureus* found in the morning and evening samples, it was detected that a more abundant number of bacteria was found in the evening than in the morning. No statistically significant difference was detected ($p = 0.788$, $p > 0.05$). A larger number of *S. aureus* bacteria was found in autumn than in winter. No statistically significant difference was detected ($p = 0.435$, $p > 0.05$). In the study conducted by Valero et al. (2009), the results show that *S. aureus* cultures grew only in single colonies at low temperatures. Such results may have been influenced by low air temperature in the winter season and high humidity in the autumn season, as well as the use of personal protective equipment such as gloves and scarves, and the use of a protective mask. Also, more intensive disinfection of the stairwells of apartment buildings has started in winter due to the pandemic.

A recent study conducted by Mulongo et al. (2021) showed microbial colonisation of elevators and the staircase handrail in a hospital in Zambia. Elevators and the staircase handrail were contaminated with gram-positive

and gram-negative bacteria such as *S. aureus*, non-spore forming gram-positive bacilli, *Klebsiella* spp., coagulase-negative *Staphylococci*, and *Enterobacter* spp. This study showed that elevators and staircase handrails possess viable microorganisms. These microorganisms can cause infectious diseases. Therefore, it is essential to ensure effective infection control and prevention in order to reduce the population of microorganisms on surfaces.

The results of the study show *Enterococcus* spp. grew mostly in single and moderately abundant colonies in the samples taken in the morning, while most abundant and moderately abundant – some very abundant – colonies prevailed in the evening samples (10%). The total number of bacteria detected in the evening and in the morning was similar. *Enterococcus* spp. were found in 47.5% of morning samples and 52.5% in the evening samples. No statistically significant difference was observed ($p = 0.162$, $p > 0.05$). It was noticed during the research that the number of enterococci differed strongly in the winter and autumn seasons. *Enterococcus* spp. were detected in 67.5% of samples in autumn, and in 32.5% in winter. A statistically significant difference ($p = 0.001$, $p < 0.05$) was detected between the amount of *Enterococcus* spp. in the autumn and winter seasons. Such results can be associated with the membrane structure of *Enterococcus* and the content of lipids and fatty acids, which allow enterococci to survive at various temperatures (Kumariya et al., 2015). The bacteria have a lipid membrane which may change according to environmental conditions. This plasticity is critical for cell survival in the environment. *Enterococcus* has been shown to alter its membrane fatty acid content in response to environmental conditions. Therefore, these bacteria can survive in the environment and on surfaces more easily (Woodall et al., 2021).

A previous study compared bacteria contamination from samples collected from the handrails of Delta state polytechnic, Ozoro, in the morning and afternoon. The results showed that contamination was higher in the morning sample than in the afternoon sample. However,

Enterococcus spp. were detected in much lower numbers than *Streptococcus* bacteria in the test samples (Orogu et al., 2018)

Handrails and handles are commonly touched by hands. Various microorganisms can be found on them, which can be transferred from one person to another. Microorganisms and fungi are potential pathogens and can cause infectious diseases in humans (Mulongo et al., 2021).

CONCLUSIONS

The stairwell door handles in blocks of flats were contaminated with *Enterococcus* spp. the most and with *S. aureus* the least. Slightly higher microbial contamination of multi-apartment stairwell door handles was observed in the evening. Microbial contamination of these door handles was observed to be higher in autumn than in winter. It is necessary to ensure effective infection control and prevention strategies.

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DAUGIABUČIŲ LAIPTINIŲ DURŲ RANKE- NŲ MIKROBINĖS TARŠOS VERTINIMAS

Santrauka

Daugiabučių laiptinių durų rankenos per dieną paliečiamos daugybę kartų. Dėl šios priežasties ant jų kaupiasi mikroorganizmai, kurie gali sukelti įvairias infekcijas. Todėl labai svarbu laikytis tinkamos rankų higienos ir atlikti daugiabučių laiptinėse dažnai liečiamų paviršių dezinfekciją. Tyrimo tikslas – įvertinti daugiabučių laiptinių durų rankenų mikrobine taršą. Tyrimo mėginiai nuo Kauno miesto daugiabučių laiptinių durų rankenų imti spalio–lapkričio mėnesiais ir gruodžio–sausio mėnesiais ryte (7–8 val.) ir vakare (19–20 val.). Buvo paimta po 100 mėginių rudens ir žiemos sezono metu (50 ryte ir 50 vakare). Tyrimo imtį sudarė 200 mėginių, kiekvieno iš jų tirtos 4 analitės: *Enterococcus* spp., *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*.

Visi mėginiai tirti Kauno kolegijos Medicinos technologijų ir dietetikos katedros mikrobiologijos laboratorijoje vadovaujantis LST EN ISO 14698-1 standartu. Daugiabučių laiptinių durų rankenos labiausiai užterštos *Enterococcus* spp., o mažiausiai – *Staphylococcus aureus* bakterijomis. Šiek tiek didesnis rankenų mikrobinis užterštumas nustatytas vakare. Minėtas mikrobinis užterštumas rudenį buvo didesnis nei žiemą. Tokiems rezultatams įtakos galėjo turėti pirštinių ir šalikų, apsauginių kaukių dėvėjimas, daugiabučių laiptinių dezinfekcija žiemos sezono metu, taip pat žema oro temperatūra žiemą ir didelis drėgmės lygis rudenį.

Raktažodžiai: *Enterococcus* spp., *Escherichia coli*, *Staphylococcus aureus*, laiptinių durų rankenos, daugiabučiai