Antibiogram of Bacteria Associated with Contact Surfaces of Public Transport Vehicles in Port Harcourt, Nigeria

Ordu, M. C*., L. P. Peekate and S. A. Wemedo
Department of Microbiology, Rivers State University,
Nkpolu-Oroworukwo, P.M.B. 5080, Port Harcourt, Nigeria.
*Corresponding Author: *marvisordu@gmail.com*

ABSTRACT

Public transport vehicles serve as a significant mode of daily commuting in urban centres. This study was carried out to appraise the population and antibiotic susceptibility of bacteria associated with contact surfaces of public transport vehicles in Port Harcourt metropolis, Nigeria. Motor-parks chosen for the study were; Mile-3 motor-park (M3MP), Rumuokoro motor-park (RMP), and Rivers State University motor-park (RSUMP). Samples were collected from the door-handles and dash-boards of some taxis with moistened sterile swab sticks and transported to the Microbiology laboratory, Rivers State University (RSU) for analysis using standard microbiological procedures. Results revealed that bacterial populations on door handles and dash-boards of taxis in M3MP plying Mile-3 to Iwofe were $2.16\pm3.25 \times 10^2$ and $1.42\pm1.06 \times 10^2$ CFU/cm^2 , Mile-3 to Choba; $2.56\pm1.15 \times 10^2$ and $1.05\pm1.02 \times 10^3$ CFU/cm^2, Rumuokoro to Choba; $2.79\pm1.65 \times 10^2$ and $5.47\pm6.72 \times 10^2$ CFU/cm^2, Rumuokoro to Rumudara; 66.4 ± 35.1 and 172 ± 89 CFU/cm^2 and RSUMP to RSU back-gate route; $1.68\pm1.34 \times 10^3$ and $2.63\pm1.72 \times 10^3$ CFU/cm^2 respectively. The highest bacterial population on door-handles and dashboards were observed in taxis in RSU motor-park plying the back-gate route. Bacteria types isolated were *Bacillus* spp., *Staphylococcus* spp., *Micrococcus* spp., *Serratia* spp., *Pseudomonas* sp., *Proteus* spp., *Klebsiella* spp., *Citrobacter sedlakii*, *Enterobacter* spp., *Edwardsiella ictaluri*, *Mixta theicola*, and *Yersinia kristensenii*. The bacteria from taxis of the different routes were all susceptible to gentamycin, except *Staphylococcus aureus* and *S. saprophyticus* from door-handles. M3MP; *Mixta theicola* from dashboards of vehicles in M3MP; *Bacillus megaterium* from door-handles of taxis in RMP; *Pseudomonas* sp. and *Mixta theicola* from dashboards of taxis in RSUMP. It is concluded that door-handles and dashboards of public transport vehicles in Port Harcourt metropolis are potential sources of dissemination of infections.

Keywords: Public transport taxis, dashboard, door handles, bacterial population, antibiotic susceptibility.

Introduction

Motor-parks are places where commuters board and/or transport goods to different destinations which could be intra city or intercity. It may comprise both indoor and outdoor spaces or exist singly to form public spaces used by a large number of people that commute in public transport systems (John and Adegoke, 2018).

In Port Harcourt and its environs, one of the major means of transportation is the use of service/commercial vehicles owned by private individuals that are found in different terminals or parks. These environments are not void of microorganisms as studies have shown that microorganisms are found in all environments including soil, air, and water and indoors of vehicles (Ikede *et al.,* 2022; Onwubiko *et al.,* 2023).

Rachael *et al.,* (2014) opined that the environments that humans encounter daily are sources of exposure to microbial communities and some of these microbial communities are of potential concern to human health.

One of the major ways of exposure to microorganisms in vehicles is via contact surfaces such as door handles and dashboards. Abdulwasiu *et al.,* (2022) reported that inanimate environmental surfaces such as door handles can become directly contaminated with microorganisms after frequent exposure to different people. Thus, exposed surfaces could be major terminals for picking up microorganisms especially when such surfaces (dashboards and door handles) are constantly assessed by different persons. The ability of inanimate objects to support viable microorganisms for a long period of time is well documented (Fierer *et al.,* 2008).

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Such environmental surfaces and objects especially those in proximity with persons and frequently touched pose a threat to human health (Onwubiko *et al.,* 2023). The human hand serves as a medium for the propagation of microorganisms from place to place, and from person to person. Although, it is nearly impossible for the hand to be free of microorganisms, as the presence of pathogenic bacteria may lead to chronic or acute illness (Oranusi *et al.,* 2013).

Human hands usually harbour microorganisms both as part of body normal flora as well as transient microbes contacted from the environment (Lindberg *et al.,* 2004).

In a city like Port Harcourt were people move around from one place to another in public taxis and given that the door handles are not routinely disinfected, the opportunity for the transmission of contaminating microorganisms is inevitable; although it is accepted that the infection risk in general community is less than those associated with patients in hospital (Abdulwasiu *et al.,* 2022).

The increasing incidence of epidemic outbreaks of certain diseases and its rate of spread from one community to the other has become a major public health concern (Nworie *et al.,* 2012). Thus, this study was carried out to investigate the antibiogram of bacteria associated with contact surfaces of public transport vehicles as to ascertain the health hazards associated with public vehicles and provide insights for resistant pattern to help guide the selection of appropriate drug options in Port Harcourt, Rivers State, Nigeria.

Materials and Methods

Study area

The study area was Port Harcourt metropolis in Nigeria. Within the study area, three motor-parks were chosen for the study: Mile-3 motor-park, Rumuokoro (RM) motor-park, and Rivers State University (RSU) motor-park. The GPS coordinates of the motor-parks, and the sampled routes are presented in Table 1.

Table 1: Geo-References of the Sampling Routes within the Investigated Communities

Motor parks	GPS coordinates	No. of routes Plied	Estimate of Taxis operated	Route plied	Taxis sampled
Mile-3	4°48'13.4"N 6°59'25.5"E	13	97	To Iwofe	5
				To Choba	5
Rumuokoro	4°52'02.7"N 6°59'39.8"E	17	132	To Choba	5
				To Rumudara	5
RSU Campus	4°48'13.1"N 6°59'09.8"E	4	35	To back-gate	5

GPS: Global Positioning system, ETO: Estimate of Taxis operated, RTS: Route Taxis sampled, RSU: Rivers State University.

Sample Collection and Ethical consideration, and Inclusion and Exclusion Criteria

Vehicle surface samples were collected from 5 randomly selected taxis plying selected routes in each of the motor-park. An estimated surface area of 3 cm × 3 cm (i.e. 9 cm^2) of the dash-boards and door-handles of the selected taxis were swabbed with moistened sterile swab sticks. Collected samples were transported, within 24 hours, to the Microbiology laboratory of Rivers State University for isolation of bacteria. A total of 50 samples were randomly collected and analyzed during this study for a period of 4 months (June – September, 2023).

The consent and permission of the commercial drivers were sought and obtained before sample collection. The consenting drivers were assured of the confidentiality of the information obtained during the study.

Only commercial cabs within the study area were included in the study while private cars were not used for the study.

Isolation of bacteria

The used swab sticks were agitated in 10 ml sterile normal saline, separately, and the resulting suspensions were subjected to ten-fold serial dilution using sterile normal saline to a dilution of 10^{-2}. Aliquots of 0.1 ml of the dilutions were spread inoculated on nutrient agar (NA) plates in duplicates. Inoculated NA plates were incubated 35 °C for 24 hours. After incubation, ensuing colonies were selected based on difference in colonial characteristics, and sub-cultured onto nutrient agar to obtained pure bacterial isolates. Pure isolates were subjected to physicochemical and biochemical tests so as to identify them, their stock cultures were also prepared.

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Identification of bacterial isolates

The bacterial isolates were subjected to Gram staining and microscopic examination, and the following biochemical tests: catalase, oxidase, coagulase, motility, citrate utilization, indole production, Methyl Red-Vogues Proskauer (MRVP), 7% salt (NaCl) tolerance, starch hydrolysis, and fermentation tests using glucose, lactose, mannitol, and xylose tests were carried out as described by Peekate (2022). Results obtained from the tests were keyed into the search dialogue of the online bio-database software "Advanced Bacterial Identification Software (ABIS)" available at https://www.tgw1916. net/bacteria_logare.html, to reveal the possible identity of the isolates.

Antibiotic Susceptibility Testing of Isolates

Identified bacterial isolates were subjected to antibiotic susceptibility testing using the well in agar method (Balouiri *et al*., 2016). The antibiotics used include Ampicilin, Ampiclox, Ciprofloxacin, Chloramphenicol, Erythromycin, Gentamycin, Ofloxacin, Penicillin, Streptomycin, and Tetracycline. Solutions of the antibiotics were prepared for use in the well in agar method, and the volumes of antibiotic solutions to be delivered into agar wells were chosen to be 40 μL. Initial and final stock solutions of the antibiotics were prepared so as to obtain in the chosen volume (40 μL) the quantity of the corresponding antibiotics as prescribed by the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

Broth cultures of the bacteria were prepared by inoculating bacterial colonies into 7 ml sterile nutrient broth. The inoculated broths were incubated at 35 °C for about 18 hours. After incubation, sterile normal saline were added to the broth cultures so as to adjust the turbidity to the turbidity of a prepared 0.5 McFarland standard (prepared as outlined in the Clinical and Laboratory Standards Institute manual; CLSI, 2012). Turbidity measurement was achieved with the aid of a spectrophotometer (721 VIS, Spectrophotometer, Huanghua Faithful Instrument Co. Ltd, China) set at 600 nm. The adjusted broth culture were then spread, inoculated, in duplicates, onto sterile Mueller-Hinton agar (MHA) plates with the aid of sterile swab sticks. The MHA plates were prepared such that the agar thickness was about 7 – 8 mm. Equidistant wells of about 6 mm in diameter were bored into inoculated MHA with the aid of a sterile cork borer.

Aliquots of 40 μL of the different antibiotic solutions were placed separately into the wells with the aid of an automatic micro-pipette. The plates were allowed in the upright position for about 30 minutes for adsorption of the antibiotic solutions into the agar. Afterwards, the plates were incubated in inverted position at 35 °C for 24 hours. After incubation, zones of inhibitions around the wells were measured and recorded.

Statistical Analysis

The mean and standard deviations of the bacterial load of the contact surfaces were determined using descriptive statistics on the statistical package for social science (SPSS version 27). The Analysis of Variance was used to check for significant differences between the various contact surfaces of the vehicles. Duncan multiple range test was used in separation of means were there was significant difference. The significant level adopted was $P<0.05$.

Results

The bacterial population on door-handles presented in Table 2 are as follows; Mile-3 to iwofe it can be seen that the bacterial population on door handles ranged from 0.50 to 7.70 10^2 CFU/cm^2, with an average of $2.16\pm3.25 \times 10^2$ CFU/cm^2 . Mile-3 to choba ranged form 1.37 to 3.91 10^2 CFU/cm^2, with an average of $2.56\pm1.15 \times 10^2$ CFU/cm^2 . Rumuokoro to choba ranged from 1.53 to 5.52×10^2 CFU/cm^2, with an average of $2.79\pm1.65 \times 10^2$ CFU/cm^2. Rumuokoro to Rumuodara ranged from 1.31 to 8.50 CFU/cm^2 , with an average of 4.40 ± 3.13 CFU/cm^2 . RSU motor-park to RSU back-gate ranged from 2.31×10^2 to 2.95×10^3 CFU/cm^2, with an average of $1.68\pm1.34 \times 10^3$ CFU/cm^2.

Bacterial population on Dash-boards presented in Table 3 are as follows; Mile-3 to iwofe it can be seen that the bacterial population on dash-boards ranged from 1.80×10^2 to 3.59 CFU/cm^2, with an average of $1.42\pm1.06 \times 10^2$ CFU/cm^2. Mile-3 to choba ranged from 1.81×10^3 to 4.29×10^2 CFU/cm^2, with an average of $1.05\pm1.02 \times 10^3$ CFU/cm^2. Rumuokoro to Choba ranged from 1.51×10^2 to 1.74×10^3 CFU/cm^2, with an average of $5.47\pm6.72 \times 10^2$ CFU/cm^2. Rumuokoro to Rumuodara ranged from 1.14×10^2 to 3.91 CFU/cm^2, with an average of $2.62\pm1.02 \times 10^2$ CFU/cm^2. RSU motor-park to RSU back-gate ranged from 2.25 to 4.81×10^3 CFU/cm^2, with an average of $2.63\pm1.72 \times 10^3$ CFU/cm^2.

Table 2: Total Heterotrophic Bacteria Population (CFU/cm^2) on Door-Handles of Sampled Taxis in Port Harcourt

Sample code	Total heterotrophic bacteria population (CFU/cm^2) on Door-handles of Sampled Taxis				
	Mile-3 to Iwofe	Mile-3 to Choba	Rumuokoro to Choba	Rumuokoro to Rumudara	RSU Park toRSU Back-Gate
1DH	0.50×10	3.68×10^2	5.52×10^2	3.40×10	2.34×10^3
2DH	2.51×10^2	1.79×10^2	1.53×10^2	8.50×10	2.31×10^2
3DH	7.70×10^2	2.06×10^2	3.13×10^2	6.80×10	2.40×10^2
4DH	3.05×10	3.91×10^2	1.96×10^2	1.95×10^2	2.95×10^3
5DH	2.57×10	1.37×10^2	1.80×10^2	1.31×10^2	2.66×10^3
Mean ± SD	$2.16 \pm 3.25 \times 10^2$	$2.56 \pm 1.15 \times 10^2$	$2.79 \pm 1.65 \times 10^2$	$4.40 \pm 3.13 \times 10$	$1.68 \pm 1.34 \times 10^3$

*SD: Standard deviation.   *Means that do not share a letter down the group are significantly different (P<0.05)

Table 3: Total Heterotrophic Bacteria Population (CFU/cm^2) on Dash-Boards of Sampled Taxis in Port Harcourt

Sample code	Viable Total heterotrophic bacteria population (CFU/cm^2) on Dash-boards of Sampled Taxis				
	Mile-3 to Iwofe	Mile-3 to Choba	Rumuokoro to Choba	Rumuokoro to Rumudara	RSU Park to RSU Back-Gate
1DB	2.73×10^2	4.29×10^2	2.85×10^2	1.14×10^2	2.25×10
2DB	1.80×10^2	3.16×10^2	3.69×10^2	3.08×10	3.03×10^3
3DB	3.59×10	2.46×10^3	1.90×10^2	2.63×10^2	4.81×10^3
4DB	1.94×10^2	1.81×10^3	1.74×10^3	3.91×10	2.89×10^3
5DB	2.87×10	2.18×10^2	1.51×10^2	2.33×10^2	2.38×10^3
Mean ± SD	$1.42 \pm 1.06 \times 10^2$	$1.05 \pm 1.02 \times 10^3$	$5.47 \pm 6.72 \times 10^2$	$2.62 \pm 1.02 \times 10^2$	$2.63 \pm 1.72 \times 10^3$

*SD: Standard deviation.   *Means that do not share a letter down the group are significantly different (P<0.05)

The colonial characteristics of bacteria isolated from door handles and dash boards of vehicles in the sampled motor-parks and the results of the physicochemical and biochemical tests carried out on them revealed the identity of the isolated bacteria as *Bacillus* spp., *Staphylococcus* spp., *Micrococcus* spp., *Serratia* spp., *Pseudomonas* sp., *Proteus* spp., *Klebsiella* spp., *Citrobacter sedlakii*, *Enterobacter* spp., *Edwardsiella ictaluri*, *Mixta theicola*, and *Yersinia kristensenii*. *Staphylococcus* and *Serratia* species were present in all the samples.

Antibiotic susceptibility results of identified bacterial isolates are presented in Table 4 – 8. In Table 4, results showed that three of the bacterial isolates from the vehicles in Mile-3 motor-park plying from Mile-3 to Iwofe were susceptible to all the antibiotics; the others were resistant to between 1-5 antibiotics.

Results in Table 5, showed that only one bacterial isolate from the vehicles in Mile-3 motor-park plying from Mile-3 to Choba was susceptible to all the antibiotics; the others were resistant to between 3-9 antibiotics.

Results in Table 6 showed that all the bacterial isolates from the vehicles in Rumuokoro motor-park plying from Rumuokoro to Choba were resistant to between 1-6 antibiotics.

Results in Table 7 showed that all the bacterial isolates from the vehicles in Rumuokoro motor-park plying from Rumuokoro to Rumudara were resistant to between 1-9 antibiotics. Results in Table 8 showed that all the bacterial isolates from the vehicles in RSU motor-park plying the RSU back-gate route were resistant to between 4-9 antibiotics.

Table 4: Antibiotic Susceptibility of Bacteria from Door-Handles and Dash-Boards of Vehicles in Mile-3 Motor-Park plying Mile-3 to Iwofe

Antibiotics	*Bacillus* sp (n=4)			*Staphylococcus* sp n=7			*Micrococcus* sp n=3			*Serratia* sp n=1		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
CP	3 (75)	0	1 (25)	6 (85.7)	0	1 (14.3)	3 (100)	0	0	1 (100)	0	0
GT	4 (100)	0	0	6 (85.7)	1 (14.3)	0	3 (100)	0	0	1 (100)	0	0
CH	4 (100)	0	0	6 (85.7)	0	1 (14.3)	3 (100)	0	0	1 (100)	0	0
SM	4 (100)	0	0	6 (85.7)	0	1 (14.3)	1 (33.3)	0	2 (66.7)	0	1 (100)	0
AM	1 (25)	1 (25)	2 (50)	3 (42.9)	0	4 (57.1)	1 (33.3)	1 (33.3)	1 (33.3)	0	0	1 (100)
AP	2 (50)	0	2 (50)	2 (28.6)	0	5 (71.4)	1 (33.3)	0	2 (66.7)	0	0	1 (100)
TC	1 (25)	0	3 (75)	4 (57.1)	0	3 (42.9)	3 (100)	0	0	0	0	1 (100)
ER	4 (100)	0	0	4 (57.1)	0	3 (42.9)	1 (33.3)	0	2 (66.7)	0	0	1 (100)
OF	4 (100)	0	0	5 (71.4)	0	2 (28.6)	3 (100)	0	0	0	1 (100)	0
PN	4 (100)	0	0	4 (57.1)	0	3 (42.9)	0	0	3 (100)	0	0	1 (100)

Key: CP: Ciprofloxacin (5 µg), GT: Gentamycin (10 µg), CH: Chloramphenicol (30 µg), SM: Streptomycin (10 µg), AM: Ampicilin (10 µg), AP: Ampiclox (30 µg), TC: Tetracycline (30 µg), ER: Erythromycin (15 µg), OF: Ofloxacin (5 µg), PN: Penicillin (10µg).

Table 5: Antibiotic susceptibility of bacteria from door-handles and dash-boards of vehicles in Mile-3 motor-park plying Mile-3 to Choba

Antibiotics	*Bacillus* sp (n=4)			*Staphylococcus* sp n=7			*Micrococcus* sp n=3			*Serratia* sp n=1		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
CP	3 (75)	0	1 (25)	6 (85.7)	0	1 (14.3)	3 (100)	0	0	1 (100)	0	0
GT	4 (100)	0	0	6 (85.7)	1 (14.3)	0	3 (100)	0	0	1 (100)	0	0
CH	4 (100)	0	0	6 (85.7)	0	1 (14.3)	3 (100)	0	0	1 (100)	0	0
SM	4 (100)	0	0	6 (85.7)	0	1 (14.3)	1 (33.3)	0	2 (66.7)	0	1 (100)	0
AM	1 (25)	1 (25)	2 (50)	3 (42.9)	0	4 (57.1)	1 (33.3)	1 (33.3)	1 (33.3)	0	0	1 (100)
AP	2 (50)	0	2 (50)	2 (28.6)	0	5 (71.4)	1 (33.3)	0	2 (66.7)	0	0	1 (100)
TC	1 (25)	0	3 (75)	4 (57.1)	0	3 (42.9)	3 (100)	0	0	0	0	1 (100)
ER	4 (100)	0	0	4 (57.1)	0	3 (42.9)	1 (33.3)	0	2 (66.7)	0	0	1 (100)
OF	4 (100)	0	0	5 (71.4)	0	2 (28.6)	3 (100)	0	0	0	1 (100)	0
PN	4 (100)	0	0	4 (57.1)	0	3 (42.9)	0	0	3 (100)	0	0	1 (100)

Key: CP: Ciprofloxacin (5 µg), GT: Gentamycin (10 µg), CH: Chloramphenicol (30 µg), SM: Streptomycin (10 µg), AM: Ampicilin (10 µg), AP: Ampiclox (30 µg), TC: Tetracycline (30 µg), ER: Erythromycin (15 µg), OF: Ofloxacin (5 µg), PN: Penicillin (10µg).

Table 6: Antibiotic Susceptibility of Bacteria from Door-Handles and Dash-Boards of Vehicles in Rumuokoro Motor-Park plying Rumuokoro to Choba

Antibiotics	*Bacillus* sp		*Staphylococcus* sp		*Citrobacter* sp		*Serratia* sp		*Mixta theicola*		*Klebsiella* sp		*Proteus* sp	
	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)
CP	0	1 (100)	4 (80)	1 (20)	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0
GT	1 (100)	0	5 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0
CH	1 (100)	0	5 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0
SM	1 (100)	0	5 (100)	0	1 (100)	0	0	1 (100)	1 (100)	0	0	1 (100)	0	1 (100)
AM	1 (100)	0	1 (20)	4 (80)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
AP	1 (100)	0	1 (20)	4 (80)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
TC	1 (100)	0	4 (80)	1 (20)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
ER	1 (100)	0	1 (20)	4 (80)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
OF	1 (100)	0	3 (60)	2 (40)	1 (100)	0	1 (100)	0	0	1 (100)	0	1 (100)	0	1 (100)
PN	0	1 (100)	0	5 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)

Key: Isolate code, CP: Ciprofloxacin (5 µg), GT: Gentamycin (10 µg), CH: Chloramphenicol (30 µg), SM: Streptomycin (10 µg), AM: Ampicilin (10 µg), AP: Ampiclox (30 µg), TC: Tetracycline (30 µg), ER: Erythromycin (15 µg), OF: Ofloxacin (5 µg), PN: Penicillin (10 µg).

Table 7: Antibiotic Susceptibility of Bacteria from Door-Handles and Dash-Boards of Vehicles in Rumuokoro Motor-Park plying from Rumuokoro to Rumudara

Antibiotics	*Bacillus* sp		*Staphylococcus* sp		*Serratia* sp		*Klebsiella* sp		*Proteus* sp	
	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)
CP	1 (50)	1 (50)	1 (50)	1 (50)	1 (100)	0	0	1 (100)	0	1 (100)
GT	1 (50)	1 (50)	1 (50)	1 (50)	1 (100)	0	1 (100)	0	1 (100)	0
CH	1 (50)	1 (50)	1 (50)	1 (50)	1 (100)	0	1 (100)	0	1 (100)	0
SM	1 (50)	1 (50)	1 (50)	1 (50)	1 (100)	0	0	1 (100)	1 (100)	0
AM	1 (50)	1 (50)	0	2 (100)	0	1 (100)	0	1 (100)	1 (100)	0
AP	0	1 (50)	0	2 (100)	0	1 (100)	0	1 (100)	1 (100)	0
TC	1 (50)	1 (50)	0	1 (50)	0	1 (100)	0	1 (100)	1 (100)	0
ER	1 (50)	1 (50)	1 (50)	1 (50)	0	1 (100)	0	1 (100)	0	0
OF	1 (50)	1 (50)	1 (50)	1 (50)	0	1 (100)	0	1 (100)	1 (100)	0
PN	0	2 (100)	0	2 (100)	0	1 (100)	0	1 (100)	0	1 (100)

Key: CP: Ciprofloxacin (5 µg), GT: Gentamycin (10 µg), CH: Chloramphenicol (30 µg), SM: Streptomycin (10 µg), AM: Ampicilin (10 µg), AP: Ampiclox (30 µg), TC: Tetracycline (30 µg), ER: Erythromycin (15 µg), OF: Ofloxacin (5 µg), PN: Penicillin (10µg).

Table 8: Antibiotic Susceptibility of Bacteria from Door-Handles and Dash-Boards of Vehicles in RSU Motor-Park plying the RSU Back-Gate Route

Antibiotics	*Bacillus* sp		*Staphylococcus* sp		*Citrobacter* sp		*Serratia* sp		*Enterobacter* sp		*Pseudomonas* sp		*Proteus* sp	
	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)
CP	1 (50)	1 (50)	2 (100)	0	0	1 (100)	1 (100)	0	0	1 (100)	1 (100)	0	0	1 (100)
GT	1 (50)	0	2 (100)	0	0	1 (100)	1 (100)	0	0	1 (100)	0	1 (100)	1 (100)	0
CH	1 (50)	1 (50)	2 (100)	0	1 (100)	0	1 (100)	0	0	1 (100)	1 (100)	0	0	1 (100)
SM	0	0	1 (50)	0	0	0	0	0	0	1 (100)	1 (100)	0	1 (100)	0
AM	0	2 (100)	2 (100)	0	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
AP	0	2 (100)	2 (100)	0	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
TC	0	2 (100)	2 (100)	0	0	1 (100)	0	1 (100)	0	0	0	1 (100)	0	1 (100)
ER	0	2 (100)	2 (100)	0	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)
OF	0	2 (100)	1 (50)	1 (50)	1 (100)	0	0	1 (100)	0	1 (100)	1 (100)	0	1 (100)	0
PN	0	2 (100)	2 (100)	0	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)	0	1 (100)

Key: CP: Ciprofloxacin (5 µg), GT: Gentamycin (10 µg), CH: Chloramphenicol (30 µg), SM: Streptomycin (10 µg), AM: Ampicilin (10 µg), AP: Ampiclox (30 µg), TC: Tetracycline (30 µg), ER: Erythromycin (15 µg), OF: Ofloxacin (5 µg), PN: Penicillin (10 µg).

Discussion

The bacterial population in public transport taxis in port Harcourt metropolis showed high bacterial load across the locations. Although John and Adegoke (2018) reported bacteria load ($\log_{10}$ 6.3 ± 0.7CFU/cm^2) of hand contact surfaces in bus terminals in Uyo metropolis, Nigeria. Furthermore, the bacterial load in the present study were higher than those reported by Onwubiko *et al.* (2015) of door handles and contact surfaces of commercial vehicles in Umuahia, Abia State, Nigeria. The bacteria on the vehicles contact surfaces could have found their way either due to dusts from the outside environment or through contaminated towels used in cleaning the surfaces. This statement corroborates the response offered by the commuters during the period of sample collection where most drivers that had the time to answer indicated they only clean their taxis when they were very dirty. The higher bacteria populations on taxis were associated with the fact that most of the taxis were highly dilapidated and were infrequently cleaned. This realization could also be due to the higher patronage of commercial vehicles and the high bacterial load could be attributed to the level of activities surrounding the motor parks, the type of people entering the vehicles as well as the various activities like sneezing, talking, touching of door handles by different users, and so on. Another study reported that microorganisms could spread from one person to another and from one location to another through the human hand.

However, it is nearly impossible for the hand to be free of microbes because the existence of these dangerous bacteria could result to some illness (Oranusi *et al.,* 2013). The bacterial isolates identified in this study includes; *Staphylococcus aureus, Staphylococcus* sp, *Serratia,* sp, *Bacillus* sp, *Micrococcus* sp, *Mixta* sp, *Enterobacter* sp, *Klebsiella* sp, *Pseudomonas* sp, *Proteus* sp, and *Citrobacter* sp. Sleiman *et al.* (2018) isolated coagulase positive and negative *Staphylococcus* sp and *Klebsiella* sp from car handles of commercial vehicles while Emmanuel *et al.,* (2022) isolated *E. coli, Staphylococcus, Bacillus, Pseudomonas, Enterobacter, Proteus, Micrococcus* and *Streptococcus* sp from door and contact surfaces of commercial vehicles in Umuahia, Abia State, Nigeria. Raad *et al.,* (2018) in their study reported that the presence of bacterial isolates such as *Klebsiella, Enterobacter, E. coli, Proteus, Staphylococcus Salmonella* and *Streptococcus* spp could be via contamination of handles with faeces.

This implied that the level of hygiene (hand washing) practiced by individuals who use these commercial vehicles could influence the bacterial isolates. Users who must have touched surfaces contaminated with these isolates or who had previously used the rest room without properly washing their hands could deposit these isolates on new surfaces they touch. This could also be the reason the bacterial isolates varied in the respective doors especially as some isolates which were isolated in some car handles were not isolated in others.

Research has shown that the microflora on hands is ephemeral and can change with the environment (Willey *et al*., 2008). The widespread occurrence of *Staphylococcus aureus* and other *Staphylococcus* spp as normal flora of human skin and hands, which frequently come into contact with external objects, could be the cause of their isolation. *Micrococcus* sp, which are frequently found in fine dust particles, have the ability to colonize human skin and mucous membranes. In soil, opportunistic pathogens such as *Pseudomonas* spp. are also present. More so *Staphylococcus* species suggest that there may have been an aerosol discharge from the mouth and nose, thus, implying that passengers may have left body flora on those surfaces (Adegoke and Komolafe, 2008; Komolafe). Furthermore, significant to public health is the existence of isolates of *Pseudomonas aeruginosa*. According to reports, *Pseudomonas aeruginosa* is a significant opportunistic pathogen and one of the main factors contributing to infection-related mortality in critically ill and immunocompromised individuals (Baadhaim *et al.,* 2011).

The Antibiotics susceptibility pattern showed that Multi drug resistant was recorded for most of the bacterial isolates in the study. Thus, very high resistance was reported in the commonly used antibiotics against the bacterial isolates. This study corroborates previous studies that have demonstrated the presence of multi drug resistant isolates from contact surfaces and door handles of contact surfaces (Boma and Olime, 2011). Nonetheless, the current investigation differs from the findings of John and Adegoke, (2018), who reported that gram-negative bacteria isolates from contact surfaces were highly susceptible (92.3%) to ofloxacin, although they reported higher susceptibility (93%) of the isolates to gentamycin which agreed with the present study. Also, 100% susceptibility of *Serratia* isolates to gentamycin reported in their study corroborates the present study.

More so, despite the level of susceptibility recorded for gentamycin, ciprofloxacin, chloramphenicol and tetracycline against both the Gram positive and Gram negative bacteria isolates in the present study, some of these isolates were not completely susceptible to the commonly used antibiotics.

This agreed with Emmanuel *et al.,* (2022) who reported that the isolates in their study showed a pattern of resistance to commonly used antibiotics such as Trimethoprim, Ampicillin and Gentamicin. This is in agreement with the reports of Onwubiko and Chinyeaka (2015), and Nwankwo and Offiah (2016) who reported that antibiotic resistant microorganism contaminate environmental surfaces such as door handles. Resistance to these commonly used antibiotics could be attributed to the presence of antibiotics resistant genes in the plasmids of these isolates. For instance, *Klebsiella aerogenes*, *Mixta theicola*, and *Cronobacter sakakazii* possessed the Oxa-48 antibiotics resistant genes which are known to confer resistance against beta-lactam antibiotics including third generation cephalosporin antibiotics.

More so, the presence of qnrB genes codes for the resistance of quinolones (Woravit *et al.,* 2013). Thus, this could be the reason why the isolates developed resistance to fluoroquinolones antibiotics such as ciprofloxacin and ofloxacin. In a previous study, it was reported that the accumulation and expression of several genes, each of which codes for resistance to a single drug, on resistance (R) plasmids or increased expression of genes encoding multidrug efflux pumps are the causes of drug resistance to multiple drugs (Nikaido, 2009). Furthermore, the genes that encode the β-lactamase enzymes are frequently linked to agents that are not β-lactams, such as aminoglycosides and fluoroquinolones.

Thus, complex multidrug resistant phenotypes and occasionally pan-resistance are caused by bacterial resistance determinants (Livermore, 2009). The present study agreed with previous studies which have also identified the gene in enterobacteriaceae and *Klebsiella pneuoniae* (Gottig *et al.,* 2015). They also opined that the transfer of the gene to other enterobacteriaceae is due to the high conjugation rate of pOXA-48a.

In conclusion, this study showed that the hand-contact surfaces of commercial vehicles are home to different species of bacteria. This revelation is an impulsion for emphasis on regular washing of hands and good hygiene practice procedures at every possible instance.

This will help to reduce any possible health hazards that may lead to an epidemic. On the other hand the outcome of the study suggests that gentamycin could be a drug of choice in the case of outbreak of bacterial infection resulting from contact surfaces of public transport taxis.

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