DEPARTMENT OF HEALTH
RESEARCH INSTITUTE FOR TROPICAL MEDICINE
ANTIMICROBIAL RESISTANCE SURVEILLANCE REFERENCE LABORATORY

# ANNUAL REPORT SUMMARY 2020

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# Foreword

The whole world was taken aback at the COVID-19 pandemic which took millions of lives and has strained the health, economy, and general welfare in the Philippines and many other countries. Most, if not all, of the men and women of the Antimicrobial Resistance Surveillance Program (ARSP) played a big part in the response to this crisis. Despite the limitations brought about by the pandemic, the ARSP Annual Report 2020 is a proof of the unparalleled commitment of the staff involved in the program.

As expected, the number of isolates reported by the bacteriology laboratories were less than those reported in 2019. With statistical significance, rates of methicillin resistance in *S. aureus* continued to decrease from the past years. However, persistence of multi-drug resistant *E.coli*, *K. pneumoniae*, *A. baumanii*, and *P. aeruginosa* are still reported and remains a challenge in patient treatment. Penicillin resistance in *S. pneumoniae* continues to rise while vancomycin and linezolid resistance were still reported for enterococci.

AMR surveillance remains all the more relevant in the face of the ongoing pandemic. We anticipate to see the impact of the COVID-19 pandemic on AMR in the coming years and the mandate of DOH-ARSP of determining current status and trends of AMR in the country becomes all the more crucial to policy formulation and development of treatment guidelines. The Philippine National Action Plan to Combat Antimicrobial Resistance 2019-2023 continues to highlight the importance of AMR surveillance through the ARSP.

On-going efforts to integrate whole genome sequencing for AMR surveillance will prove useful in understanding the dynamics of the emergence and spread of emerging and high risk AMR pathogens and provide bases in undertaking measures for prevention and control. Likewise, there is an urgent need to adapt a One Health approach for controlling antimicrobial resistance in view of the close interplay of the drivers of antimicrobial resistance in the human, animal and environmental sectors.

**Celia C. Carlos, MD**
**Chair**
*Antimicrobial Resistance Surveillance Program*
*Department of Health*

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# Executive Summary

Resistance data for 61, 527 bacterial isolates coming from 24 hospital based bacteriology laboratories as sentinel sites, and 2 gonorrhoeae surveillance sites were analyzed for 2020.

### *Streptococcus pneumoniae*

Overall resistance rate of *S. pneumoniae* isolates against penicillin using meningitis breakpoint is 16.5% (n=139) and 0.7% (n=139) using non-meningitis breakpoint, erythromycin was at 10.4% (n=183), and 1.3% against levofloxacin (n=79). Resistance to ceftriaxone using meningitis breakpoint was at (4.3%n=70) and 2.9% for non- meningitis breakpoint.

### *Haemophilus influenzae*

Resistance rate of *H. influenzae* for 2020 ranged from zero for levofloxacin (n=31) and azithromycin (n=130) to 42.4 % for tetracycline (n=33).

### *Salmonella enterica* serotype Typhi

No resistance was detected among all antibiotics tested against *Salmonella enterica* serovar Typhi. The limited number of isolates is one of the contributing factor to the non-detection of resistance in this organism.

### Nontyphoidal *Salmonella*

Resistance against ampicillin was at 30.2% (n=162), 13.3% (n=158) for co-trimoxazole and 10.9% (n=156) for ceftriaxone. Chloramphenicol was at 11.1% in 2020.

### *Shigella* species

Ampicillin resistance was at 60.7% (n=61). Co-trimoxazole was at 61% (n=59) and ciprofloxacin at 5.2% (n=58).

### *Vibrio cholerae*

The combined resistance rates of *V. cholerae* from 2018-2020 showed that the resistance rate to ampicillin was highest at 28.9% (n=45) followed by co-trimoxazole (8.7%, n=46). Resistance to tetracycline at 6.5% (n=15) was based on few isolates thus should be interpreted with caution. No resistance was detected for azithromycin and chloramphenicol.

### *Neisseria gonorrhoeae*

Ciprofloxacin resistance increased from 79.4% in 2019 to 85.4% in 2020. No resistance was detected for ceftriaxone, cefixime and azithromycin.

### *Staphylococcus aureus*

Oxacillin resistance was highest at 47.6%, co-trimoxazole (34.3%), erythromycin (12.3%). Resistance rates to clindamycin (10.7%), vancomycin (1.2%) and ciprofloxacin (4.1%) from 2019 to 2020 slightly increased, but the changes were not significant.

### *Enterococcus* species

Vancomycin and linezolid resistant rates were at 11.9% and 2.6% respectively. Ampicillin resistance rate was at 43.8%.

### *E. coli*

E. coli rates of resistance against the fluoroquinolones and third generation cephalosporins are at 46.9% for ciproflox-acin (n=6, 076) and 40.3% for ceftriaxone (n=6,222). Resistance to carbapenems continue to rise with rates against ertapenem at 6.9% (n=5,595); imipenem at 8.7% (n=6,146) and meropenem at 8.9% (n=5,967). Colistin resistance was at 2.4% (n=2.289). E. coli extended-spectrum β –lactamase suspect rates for 2018 is at 25.28% (n=3,495).

### *Klebsiella pneumoniae*

Resistance to the carbapenems continue to rise with 2020 K. pneumoniae resistance rates as high as 14.3% for meropenem (n=9,333); 13.9% for imipenem (n=9,607) and 10.9% for ertapenem (n=8,647). Colistin resistance was at 5.4% (n=3,518). K. pneumoniae extended -spectrum β –lactamase suspect rates for 2020 is at 27.84% (n=5,803). When the subset of invasive blood culture K. pneumoniae isolates were analyzed, even higher carbapenem resistance rates are noted, with meropenem re-sistance rate as high at 19.4% (n=1,019).

### *Pseudomonas aeruginosa*

For 2020, carbapenem resistance is reported at 17.1% for imipenem (n=4,692) and 14.7% for meropenem (n=4,707). Colistin resistance was at 4% (n=2,946).

### *Acinetobacter baumannii*

As in the past years, more than 50% resistance were observed for many antibiotics in 2020: ampi-sulbactam at 56% (n=2,098), ceftazidime at 54.6% (n= 3,639), ciprofloxacin at 55.6% (n=3,584), imipenem at 56.8% (n=3,601), meropenem at 57.6% (n=3,518), piperacillin-tazobactam at 59.5% (n=3,442), cefepime at 56% (n=3,599), and cotrimoxazole at 50.5% (n=3,362). Resistance to amikacin was at 29.5% (n=1,304) and to colistin at 1.8% (n=2,438).

### Multidrug-resistant *Pseudomonas aeruginosa & Acinetobacter baumannii*

*P. aeruginosa* MDR and possible XDR rates for all isolates were at 23% and 17% respectively. *A. baumannii* MDR and possible XDR rates were at 64% and 54% respectively.

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# Introduction

Antimicrobial Resistance (AMR) is the change that occurs over time among bacteria, viruses, fungi and parasites where these organisms no longer respond to medicines making infections harder to treat and increasing the risk of disease spread, severe illness and death[1]. ***AMR is a serious public health threat*** because of its far reaching and serious implications in health care as well as economies. AMR hampers the control of infectious diseases because patients remain infectious for a longer time increasing the risk of spreading resistant microorganisms to others. AMR increases the cost of health care as more expensive therapies must be used when infections become resistant to first-line medicines. Infections due to resistant microorganisms increases economic burden to families and societies as it often results in longer duration of illness and treatment.

With the loss of antimicrobials to resistance, the achievements of modern medicine such as organ transplant, cancer chemotherapy and major surgery would be compromised as these would not be possible without effective antimicrobials for prevention and treatment of infections. Losing antimicrobials to resistance can result in many infectious diseases becoming untreatable and uncontrollable. This can bring us back to the pre-antibiotic era.

The Philippine Committee on Antimicrobial Resistance Surveillance Program was created in 1988 through the Department of Health's Department Order 339-J. The program aims to provide critical inputs to the Department of Health's effort to promote rational drug use by determining the status and developing trends of antimicrobial resistance of selected bacteria to specific antimicrobials.

AMR surveillance remains an essential component in the control of AMR in the country. Surveillance data enable correct decisions to be made about treatment options and guide policy recommendations. The Philippine National Action Plan on Antimicrobial Resistance 2019 -2023 [2] reiterates the importance of surveillance as it identifies the strengthening of surveillance and laboratory capacity as among its key strategy.

The COVID-19 pandemic had significant impact in the ARSP implementation for 2020. The necessary diversion of resources towards pandemic response resulted in the reduction in the operations and activities of the bacteriology of section sentinel sites as well as the reference laboratory. This resulted in significant decrease of culture and susceptibility reports submitted into the program as well as a decrease in the number of isolates referred to the reference laboratory for confirmation.

As the potential impact of the pandemic on AMR may manifest in the coming years, surveillance becomes all the more necessary to document changes in AMR trends and patterns. AMR surveillance therefore should be implement at various level of health care to inform patient care as well as policy formulation.

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# SURVEILLANCE, TESTING METHODS, DATA ANALYSIS & LIMITATIONS

## The Surveillance

The DOH-ARSP is a sentinel laboratory-based antimicrobial resistance surveillance on aerobic bacteria from clinical specimens.

Currently participating in the program are 24 sentinel sites and 2 gonorrhoeae surveillance sites representing 16 regions of the country (**Figure 1 & Table 1**).

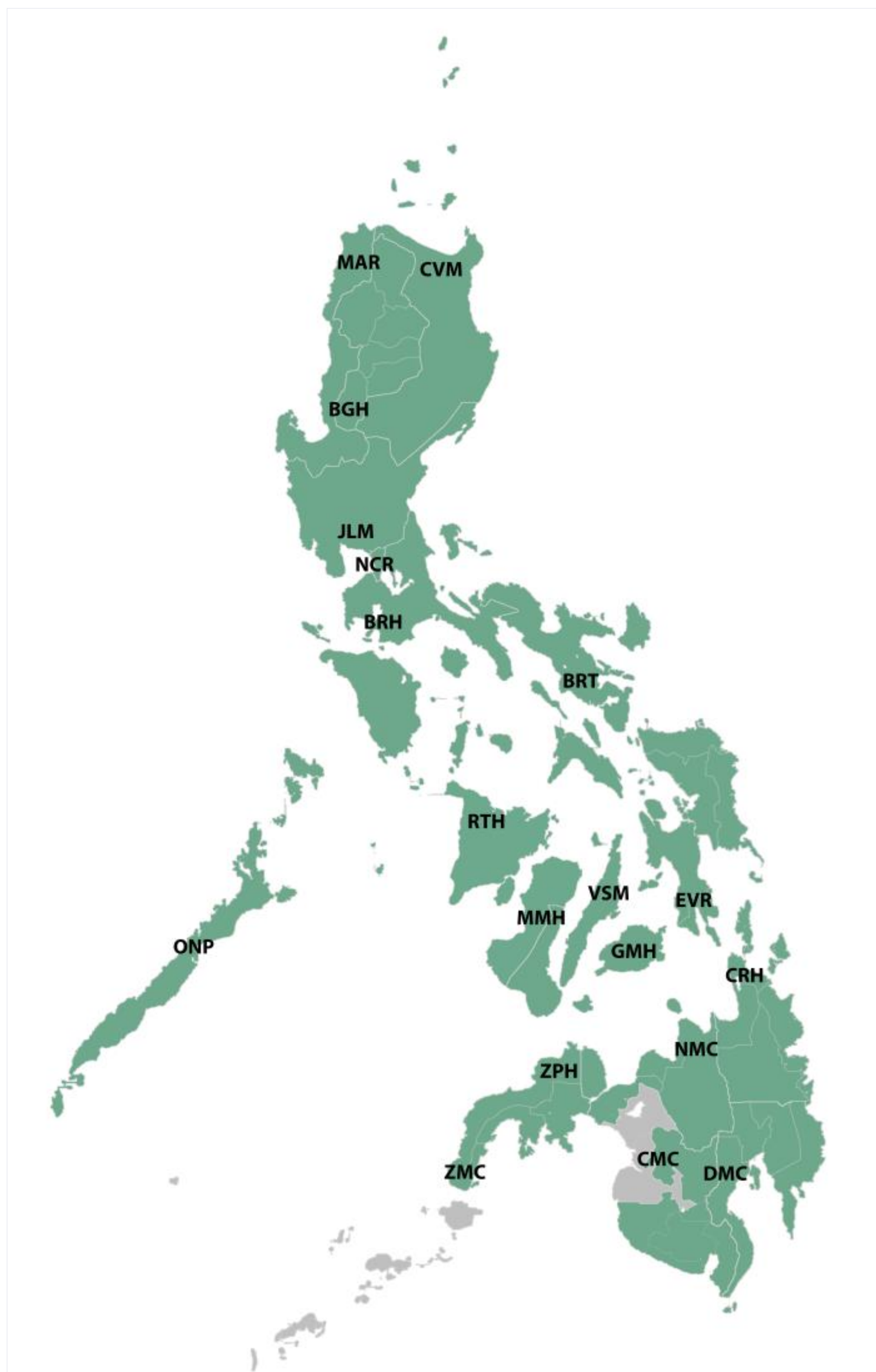


**Figure 1.** Regional representation in the ARSP 2020



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Table 1. ARSP 2020 sentinel sites by region

| Region | Sentinel Site |
|---|---|
| National Capital Region (NCR) | Far Eastern University Nicanor Reyes Medical Foundation Medical Center<br>Lung Center of the Philippines<br>National Kidney and Transplant Institute<br>Philippine General Hospital<br>Research Institute for Tropical Medicine<br>Rizal Medical Center<br>San Lazaro Hospital<br>University of Santo Tomas Hospital |
| Cordillera Administrative Region (CAR) | Baguio General Hospital and Medical Center |
| Region 1—Ilocos Region | Mariano Marcos Memorial Hospital and Medical Center |
| Region 2—Cagayan Valley | Cagayan Valley Medical Center |
| Region 3—Central Luzon | Jose B. Lingad Memorial Regional Hospital |
| Region 4-A—CALABARZON | Batangas Medical Center |
| Region 4-B—MIMAROPA | Ospital ng Palawan |
| Region 5—Bicol Region | Bicol Regional Training and Teaching Hospital |
| Region 6—Western Visayas | Corazon Locsin Montelibano Memorial Regional Hospital<br>Dr. Rafael S. Tumbokon Memorial Hospital |
| Region 7—Central Visayas | Celestino Gallares Memorial Hospital<br>Vicente Sotto Memorial Medical Center |
| Region 8—Eastern Visayas | Eastern Visayas Regional Medical Center |
| Region 9—Zamboanga Peninsula | Zamboanga City Medical Center<br>Zamboanga del Norte Medical Center |
| Region 10—Northern Mindanao | Northern Mindanao Medical Center |
| Region 11—Davao Region | Southern Philippines Medical Center |
| Region 12—SOCCSKSARGEN | Cotabato Regional Hospital and Medical Center |
| Region 13—CARAGA Region | Caraga Regional Hospital |
| *Legend: CALABARZON: Cavite, Laguna, Batangas, Rizal, Quezon; MIMAROPA: Mindoro, Marinduque, Romblon, Palawan; SOCCSKSARGEN: South Cotabato, Cotabato, Sultan Kudarat, Sarangani, General Santos City* | |

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The surveillance collects culture and antimicrobial susceptibility data from its ***24 sentinel sites and 2*** gonorrhoeae surveillance sites. Case finding is based on priority specimens sent routinely to sentinel sites laboratories for clinical purposes.

All sentinel sites implement standard methods for culture and susceptibility testing based on the WHO Manual for the Laboratory Identification and Antimicrobial Susceptibility Testing of Bacterial Pathogens of Public Health Importance in the Developing World [3] and updated Clinical Laboratory Standards Institute (CLSI) references for antibiotic susceptibility testing and quality control [4].

The culture and antimicrobial susceptibility test results are encoded using a database software called ***WHONET***. WHONET is Windows-based database software developed by the WHO Collaborating Centre for Surveillance of Antimicrobial Resistance based at the Brigham and Women's Hospital in Boston for the management and analysis of microbiology laboratory data with a special focus on the analysis of antimicrobial susceptibility test results.

Using a standard format, routine culture and antimicrobial susceptibility test results are sent monthly by the sentinel sites to the coordinating laboratory of the program – the ***Antimicrobial Resistance Surveillance Reference Laboratory (ARSRL) at the Research Institute for Tropical Medicine***. Beginning January 2018, sentinel sites transmit data daily to the reference laboratory. The automated data transfer facilitates prompt identification of resistant isolates of public health importance as well the identification of potential outbreaks among sentinel sites. The ARSRL's Data Management Unit manages the cleaning, analysis, storage and security of the program's surveillance data.

Sentinel sites likewise send isolates with unusual antimicrobial susceptibility patterns to ARSRL for phenotypic and genotypic confirmatory testing.

The program sentinel sites participate in an external quality assessment scheme (EQAS) conducted by the reference laboratory to ensure quality of laboratory results. Periodic monitoring visits to sentinel sites are likewise done.

## Testing Methods

At the reference laboratory, all referred isolates with unusual susceptibility patterns are re-identified using both automated (Vitek) and conventional methods. For antimicrobial susceptibility testing, minimum inhibition concentration (MIC) was determine using dilution method: automated via vitek machine, Gradient Etest, broth and agar dilution method were performed. Disk diffusion are also employed for those antibiotics which are not available in automated AST card and organisms which requires AST manual method (e.g. *N. gonorrhoeae*). Serotyping for *S. pneumoniae*, *H. influenzae*, Salmonellae, *Shigella* and *Vibrio cholera* were done for 2020.

Panel of antibiotics for testing are based on the latest CLSI recommendations. In the analysis of antimicrobial susceptibility testing, an isolate is considered resistant to an antimicrobial agent when tested and interpreted as resistant (R) in accordance with the clinical breakpoint criteria based on the most recent Clinical Laboratory Standards Institute (CLSI) references for antibiotic susceptibility testing.

## Data Analysis

Analysis is restricted to the first isolate received (per genus under surveillance) per patient in the calendar year. Data are expressed as a cumulative resistance percentage, i.e. the percentage of resistant isolates out of all isolates with antimicrobial susceptibility testing (AST) information on that specific organism–antimicrobial agent combination. For selected analyses, a 95% confidence interval is determined for the resistance percentage. Cumulative percentages of resistance are compared as proportions using the either Chi square of Fischer's test, using a $p$ value of $<0.05$ as statistically significant. Only species with testing data for 30 or more isolates are included in the analysis.

An annual report with a summary of the surveillance data focusing on aerobic bacterial pathogens of public health importance causing common infectious diseases with significant morbidity and mortality locally are disseminated to the program's stakeholders.

## Limitations

Interpretation of data in this annual report should be undertaken with caution taking into consideration that there may be several factors that could influence and introduce bias to the data resulting in over- or underestimation of resistance percentages. Potential sources of bias include population coverage, sampling, and laboratory capacity.

1) Most of the resistance data in the program come from regional hospitals which typically cater to patients from towns and cities within the vicinity of the hospital. Resistance variations in local areas not covered by regional hospitals are not represented in the program data.
2) Data for the National Capital Region come from 8 sentinel sites while data for other regions come from 1 or 2 sentinel sites.
3) Given that the program data are from routine clinical samples, differences in factors indicating need for microbiological cultures may introduce variations in the resistance data.
4) Performance of culture and susceptibility tests in the sentinel sites is dependent on the diagnostic habits of the clinicians as well as the financial capability of patients for such test. Differential sampling can occur if cultures are typically only performed after empirical treatment shows no adequate therapeutic response. Predictably, this will lead to a serious overestimation of the percentage resistance by not including susceptible isolates in the denominator.

5) Lastly, the ability of the laboratory to identify the microorganism and its associated antimicrobial susceptibility pattern may differ.

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# The 2020 ARSP Data

Resistance data for **61,527 isolates** were reported and analyzed for the year 2020. This was a 38.68% decrease when compared to the reported 100,334 isolates in 2019 (**Figure 2**). **Table 2** shows that 20 out of 24 sentinel sites had a decrease in data submission for 2020 with 2 sites not being able to submit any data. The sentinel sites have reported that, for 2020, huge part of laboratory resources had been directed towards COVID-19 pandemic response. Hospital census for cases other than COVID-19 also significantly decreased. These accounted for the significant decrease in the number of reports submitted to the surveillance program for 2020.

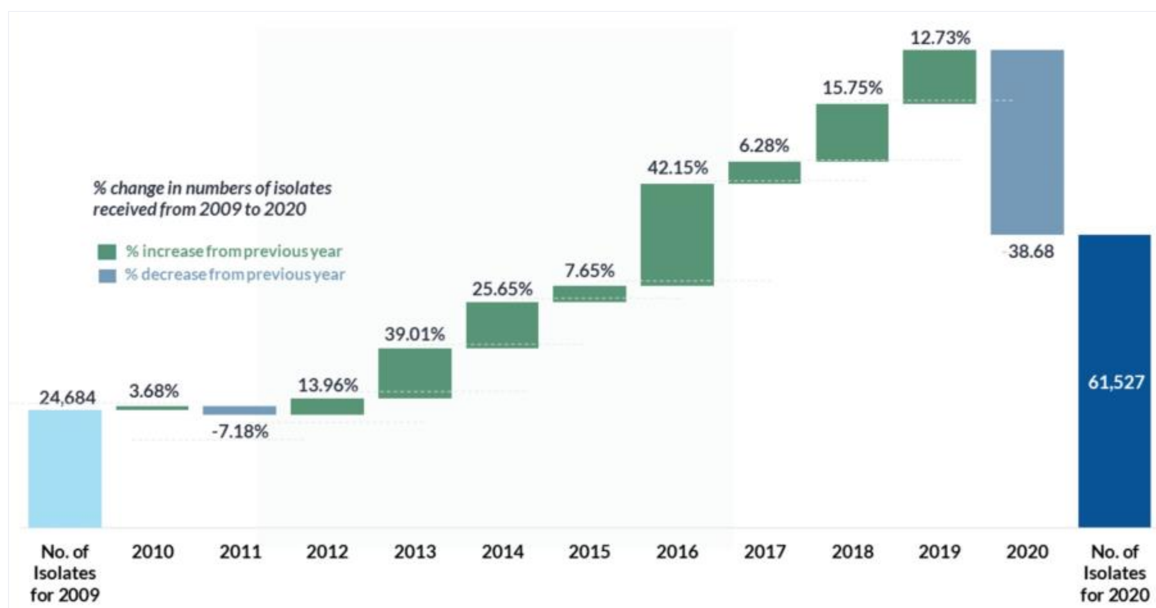


**Figure 2.** Number and the percentage difference of isolates received from 2009 to 2020

**Table 2.** Sentinel sites isolate contribution, DOH-ARSP, 2009 to 2020

| SENTINEL SITES | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Change % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PGH | - | - | - | - | 7093 | 12471 | 11710 | 12860 | 14572 | 12808 | 13895 | 6818 | -103.80 |
| RMC | 878 | 962 | 845 | 942 | 1207 | 320 | 1054 | 3252 | 3160 | 3241 | 2375 | 2027 | -17.17 |
| NKI | 3345 | 3681 | 2726 | 2403 | 2179 | 2918 | 1455 | 5894 | 627 | 2959 | 4358 | | |
| LCP | 2694 | 2 | 1233 | 2083 | 2253 | 2921 | 2905 | 3115 | 1367 | 3098 | 4433 | 2713 | -63.40 |
| RTM | 280 | 348 | 328 | 383 | 303 | 303 | 336 | 410 | 513 | 598 | 507 | 255 | -98.82 |
| SLH | 468 | 615 | 409 | 318 | 1132 | 575 | 824 | 1410 | 2460 | 2044 | 2371 | 1019 | -132.68 |
| GMH | 1151 | 936 | 1119 | 1521 | 1307 | 1351 | 1807 | 1669 | 3153 | 3258 | 3957 | 2624 | -50.80 |
| ZMC | 599 | 1060 | 686 | 721 | 822 | 819 | 841 | 1142 | 1222 | 1346 | 1644 | 1192 | -37.92 |
| FEU | 699 | 864 | 1064 | 931 | 1050 | 956 | 712 | 810 | 1201 | 1173 | 548 | | |
| STU | 1722 | 1470 | 752 | 1788 | 2050 | 2002 | 1923 | 2275 | 2088 | 2184 | 2722 | 1419 | -91.83 |
| EVR | 340 | 530 | 744 | 507 | 697 | 823 | 1514 | 1731 | 3303 | 3879 | 3874 | 4056 | 4.49 |
| MMH | 562 | 590 | 855 | 1153 | 1413 | 2289 | 2940 | 2886 | 3133 | 3026 | 2539 | 1425 | -78.18 |
| DMC | 2523 | 2870 | 2439 | 3332 | 3456 | 4062 | 5109 | 8058 | 8680 | 10762 | 12177 | 7412 | -64.29 |
| VSM | 1447 | 1931 | 2142 | 2450 | 3171 | 3951 | 3834 | 4803 | 6838 | 8714 | 10286 | 6886 | -49.38 |
| BGH | 2129 | 2199 | 1916 | 1972 | 2583 | 2625 | 3214 | 4628 | 4842 | 5775 | 5234 | 2968 | -76.35 |
| CMC | 459 | 600 | 595 | 639 | 796 | 833 | 1300 | 1599 | 1704 | 2642 | 3181 | 2076 | -53.23 |
| BRT | 618 | 486 | 537 | 677 | 611 | 1047 | 1251 | 1584 | 1640 | 1842 | 2521 | 1176 | -114.37 |
| RTH | - | - | - | - | - | - | - | 25 | 69 | 159 | 352 | 289 | -21.80 |
| ZPH | 38 | 11 | - | - | - | 9 | 8 | 4 | 7 | 3 | 69 | 129 | 46.51 |
| MAR | 2275 | 1898 | 1851 | 1928 | 1773 | 1706 | 1849 | 2759 | 3565 | 4293 | 4462 | 3581 | -24.60 |
| BRH | 1008 | 791 | 304 | 38 | - | 1022 | 1294 | 2075 | 2472 | 3133 | 3633 | 1569 | -131.55 |
| CVM | 248 | 907 | 790 | 944 | 1100 | 1223 | 1512 | 3473 | 4141 | 4276 | 5668 | 3782 | -49.87 |
| JLM | 387 | 1024 | 643 | 655 | 502 | 638 | 1266 | 2768 | 3261 | 3880 | 4824 | 3248 | -48.52 |
| NMC | 814 | 1817 | 1776 | 1684 | 2131 | 2416 | 2237 | 3105 | 2245 | 2961 | 3409 | 3735 | 8.73 |
| ONP | - | - | - | - | - | - | - | 2 | 5 | 68 | 90 | 13 | -592.31 |
| CRH | - | - | - | - | - | - | - | 10 | 624 | 879 | 1205 | 1115 | -8.07 |
| TOTAL | 24684 | 25592 | 23754 | 27069 | 37629 | 47280 | 50895 | 72347 | 76892 | 89001 | 100334 | 61527 | |

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**Table 3.** Most common isolates by specimen type, DOH-ARSP, 2020

| Specimen | Isolate | Specimen | Isolate |
|---|---|---|---|
| **Respiratory Specimens** | *Klebsiella pneumoniae* ss. *pneumoniae* | **Blood** | *Staphylococcus*, coagulase negative |
| | *Pseudomonas aeruginosa* | | *Staphylococcus aureus* ss. *aureus* |
| | *Acinetobacter baumannii* | | *Klebsiella pneumoniae* ss. *pneumoniae* |
| **Cutaneous or Wound** | *Staphylococcus aureus* ss. *aureus* | **Stool** | *Salmonella sp.* |
| | *Escherichia coli* | | *Vibrio cholerae* |
| | *Klebsiella pneumoniae* ss. *pneumoniae* | | *Shigella sp.* |
| **Cerobrospinal Fluid** | *Staphylococcus*, coagulase negative | **Urine** | *Escherichia coli* |
| | *Pseudomonas aeruginosa* | | *Klebsiella pneumoniae* ss. *pneumoniae* |
| | *Acinetobacter baumannii* | | *Enterococcus faecium* |

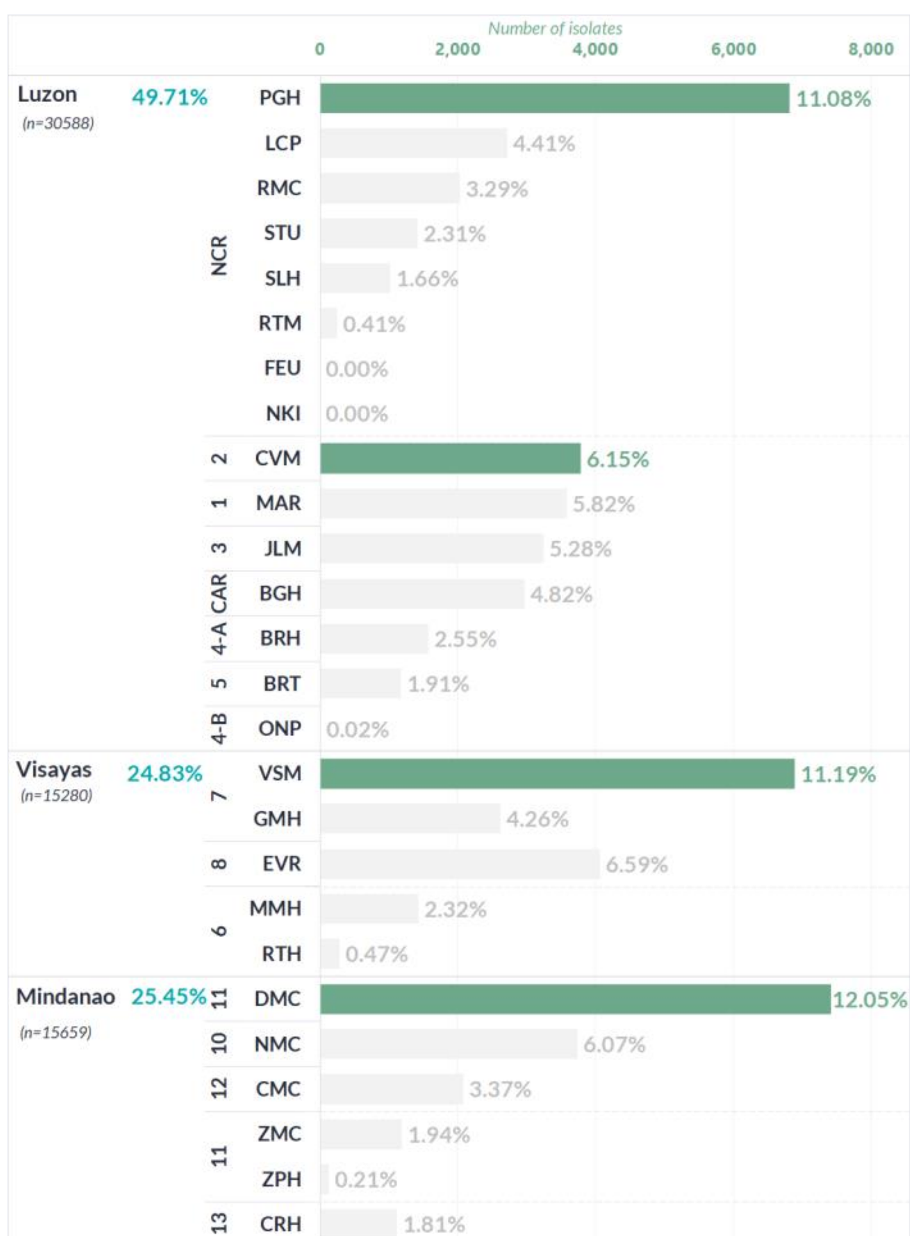


**Figure 3.** Sentinel sites isolate contribution, DOH-ARSP, 2020 (n=61,527)

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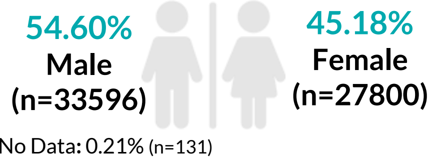
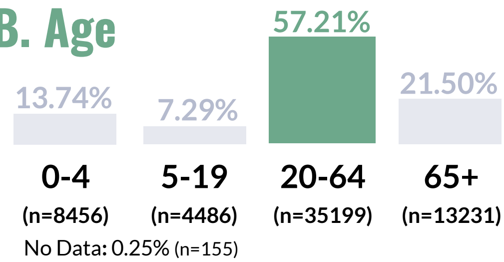
A. Sex




No Data: 0.21% (n=131)

B. Age




No Data: 0.25% (n=155)

C. Specimen Type

D. Hospital Department

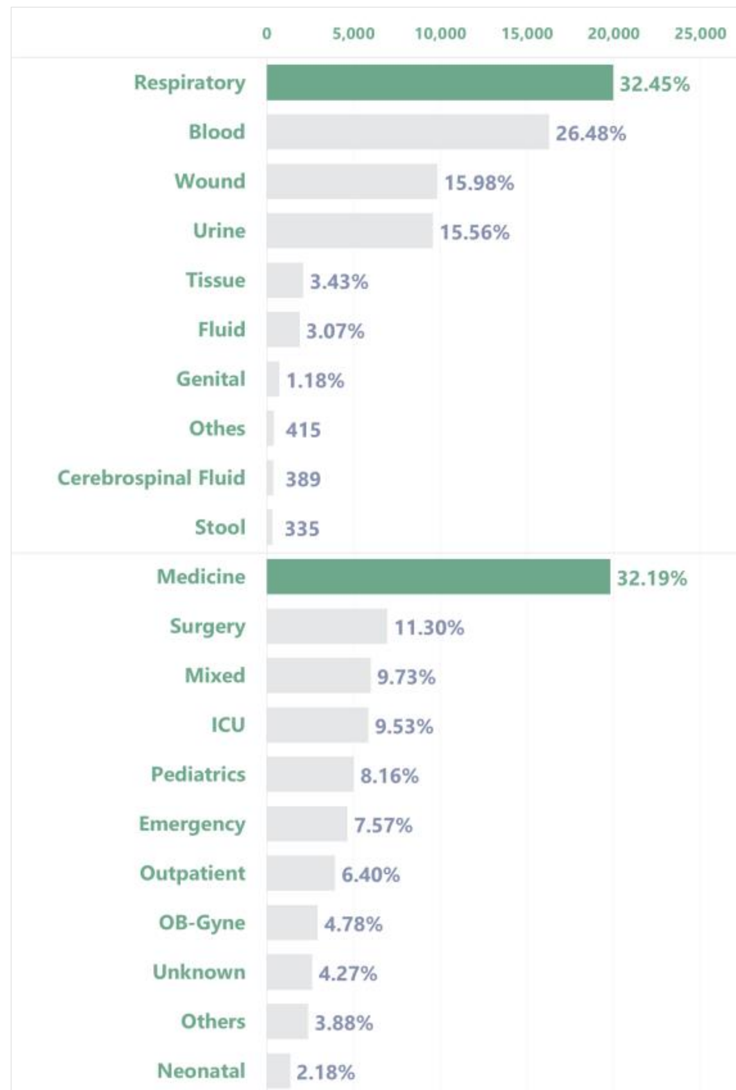



Figure 4. Patient characteristics of the 2020 ARSP isolates, DOH-ARSP, 2020 (n=61,527)

The 2020 ARSP data came from 22 sentinel sites and 2 *N. gonorrhoeae* surveillance sites of the program which represents 16 out of 17 regions in the Philippines. Of the total number of isolates for 2020, 49.71% were from Luzon, 24.8% were from Visayas and 25.5% were from Mindanao. The eight sentinel sites from the NCR region contributed 23.2% of the total 2020 data. Majority of the isolates were from male patients (54.60%) and from 20-64 years of age (57.20%). The most common specimen types were respiratory (32.45%), blood (26.48%) and wound (15.98%)(Figure 4).

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# *Streptococcus pneumoniae*

There were 210 reported *S. pneumoniae* isolates for 2020. This was 63.86% lower than the reported number of isolates for 2019 (n=581).

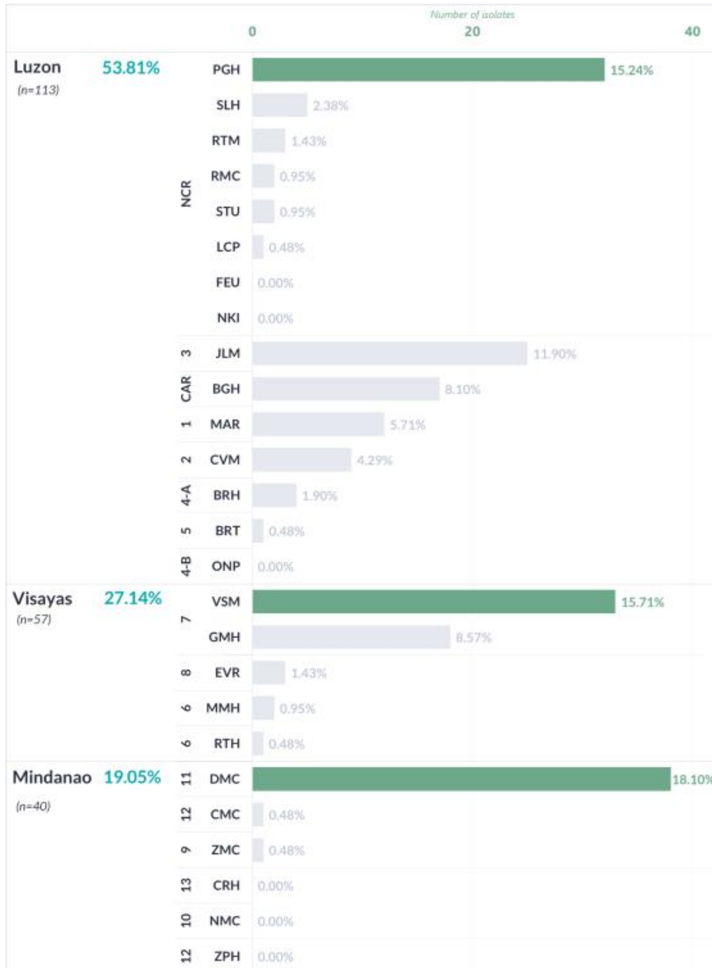
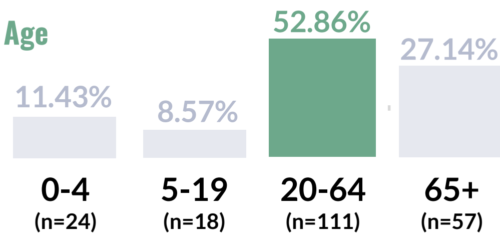


**Figure 5.** Isolate distribution of *Streptococcus pneumoniae* isolates, DOH-ARSP, 2020 (n =210)



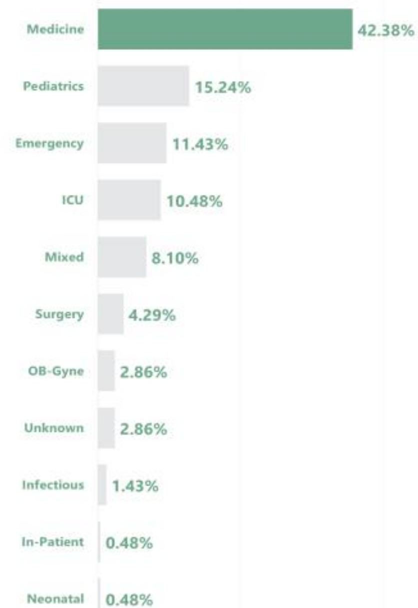



**Figure 6.** Patients characteristics of *Streptococcus pneumoniae*, DOH-ARSP, 2020 (n=210)

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In 2020, sentinel sites located in Luzon contributed most of the *S. pneumoniae* isolates (53.81%) with 21.43% coming from the NCR; 27.14% came from Visayas and 19.05% were from Mindanao (Figure 5). Many isolates came from patients 20-64 years of age (52.86%), and majority were males (60.00%). Most patients were from the medicine department of the hospital (42.38%). Majority of *S. pneumoniae* isolates were from respiratory specimens (70.48%), 26.67% from blood and 0.95% each from fluid tissue and wound (Figure 6).

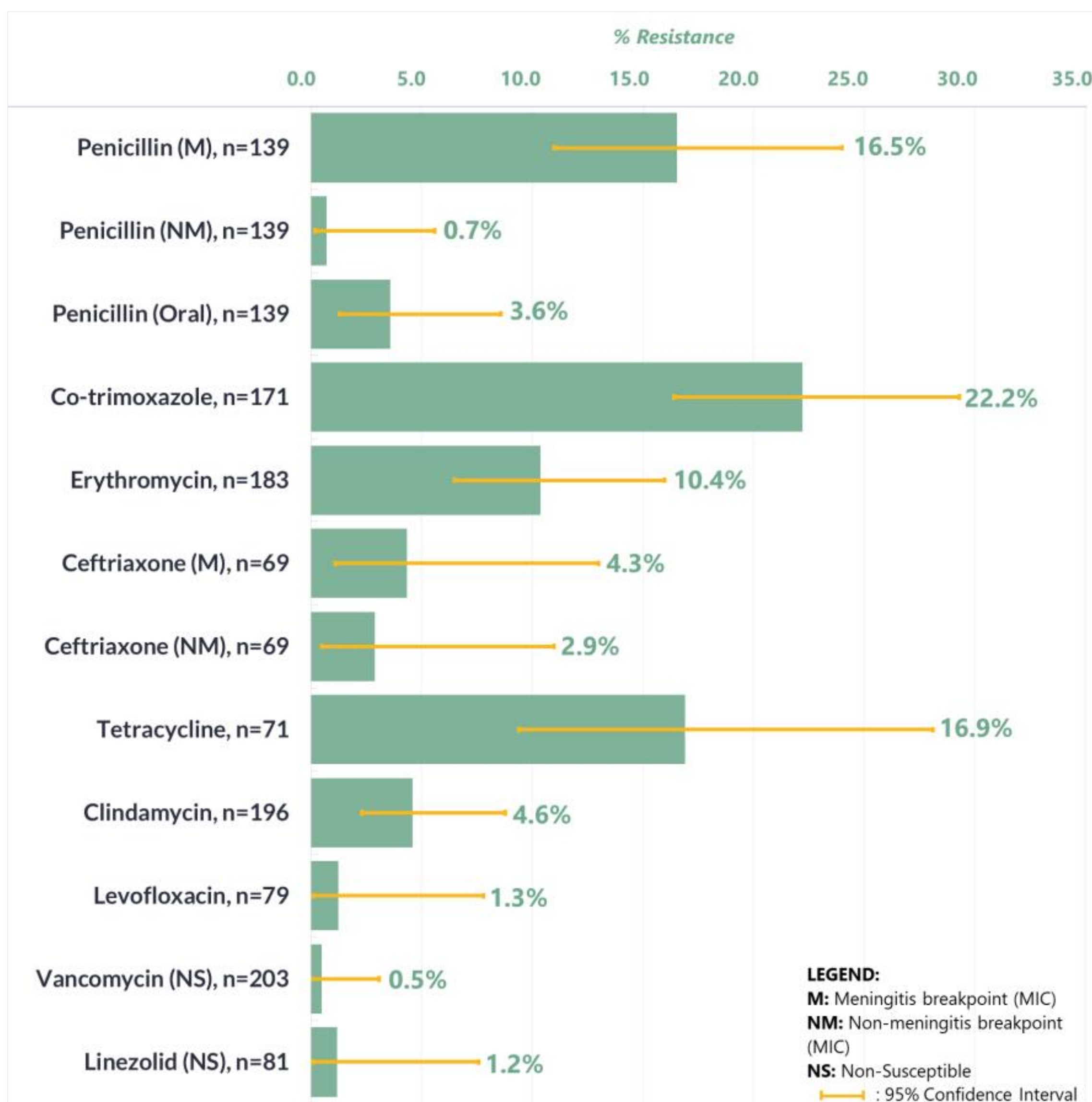


Figure 7. Percent resistance of *Streptococcus pneumoniae*, DOH-ARSP, 2020

For 2020, penicillin resistance in *S. pneumoniae* isolates (n=139) is at 16.5 % using meningitis (M) breakpoints, 0.7% (n=139) using non-meningitis (NM) breakpoints and 3.6% (n=139) for oral penicillin (Figure 7).Overall resistance rate of *S. pneumoniae* isolates against erythromycin was at 10.4% (n=183), and 22.2% against co-trimoxazole (n=171). Resistance to ceftriaxone (n=69) using meningitis breakpoints was at 4.3% and 2.9% for non-meningitis breakpoint. Tetracycline resistance was at 16.9% (n=71) and clindamycin at 4.6% (n=196). Resistance to levofloxacin, vancomycin and linezolid were at 1.3% (n=79), 0.5% (n=203) and 1.2% (n=81) respectively.

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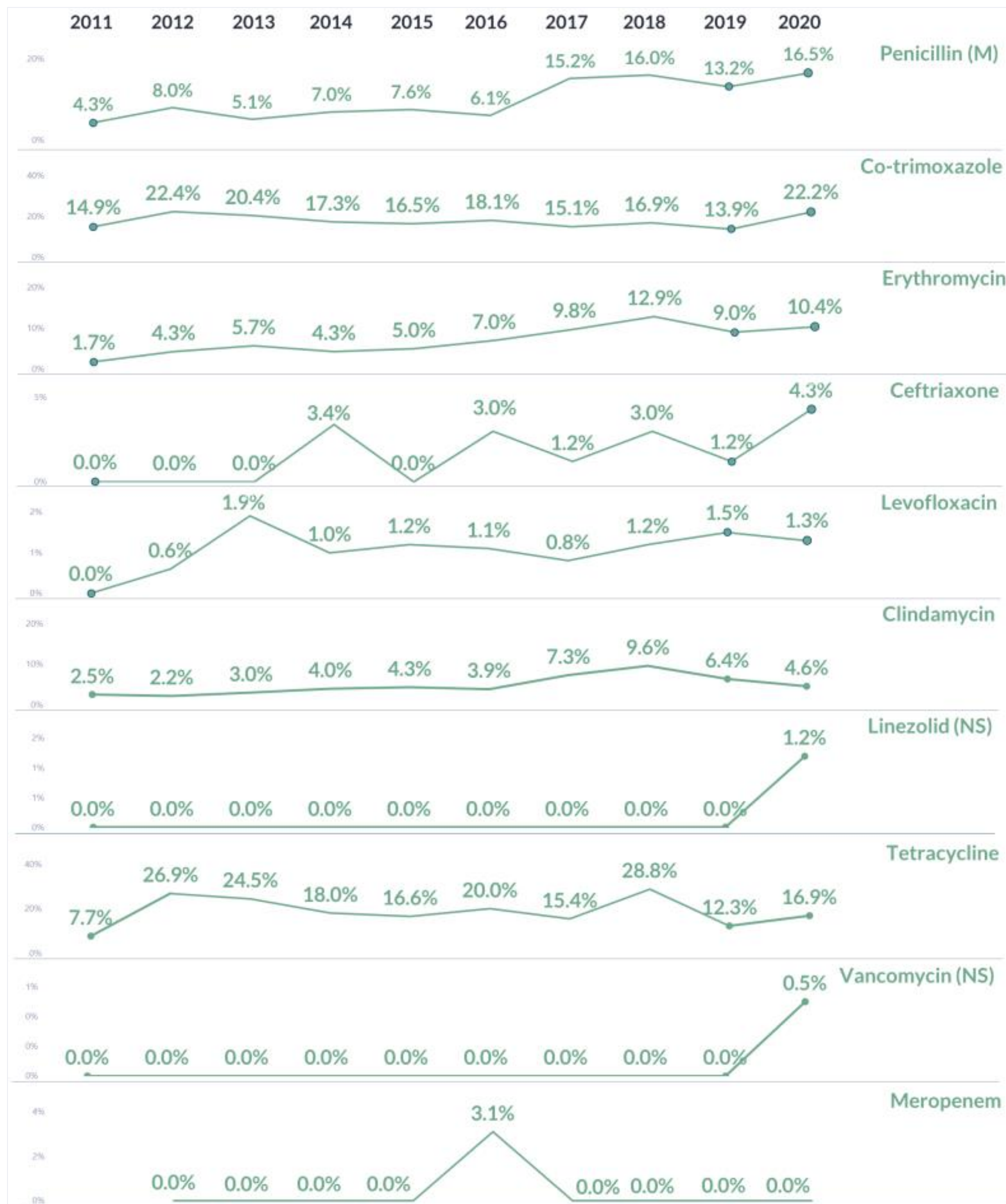


**Figure 8.** Yearly resistance rates of *S. pneumoniae*, DOH-ARSP, 2011-2020

The resistance of *S. pneumoniae* isolates to all antibiotics increased in 2020 from the resistance rates observed in 2019 except for levofloxacin and meropenem (Figure 8). However, all noted changes were not statistically significant.

Penicillin (M) increased from 13.2% in 2019 to 16.5% in 2020. Erythromycin showed fluctuating rates as seen over the past three years. An increase was also seen in ceftriaxone resistance at 4.3% (n=65) in 2020 from its previous rate of 1.2% in 2019.

### Penicillin-resistant *S. pneumoniae* isolates

There were 18 confirmed penicillin-resistant isolates of *S. pneumoniae*. Most (44.4%, n=8) of the isolates were from Luzon, and with equal population of males and females. Most (61.1%, n=11) of the isolates were from the 20-64 age group. Most (72.2%, n=13) resistant *S. pneumoniae* isolates were from respiratory specimens.

Among the 5 penicillin-resistant isolates from blood, two were from age group 0-4 years, two from 5-19 years and one from 20-64 years old. All were noted to be susceptible to erythromycin, ceftriaxone and clindamycin. Four of the isolates were intermediate to co-trimoxazole and one was resistant. The penicillin-resistant serotypes were 5, 14, 19 and 23.

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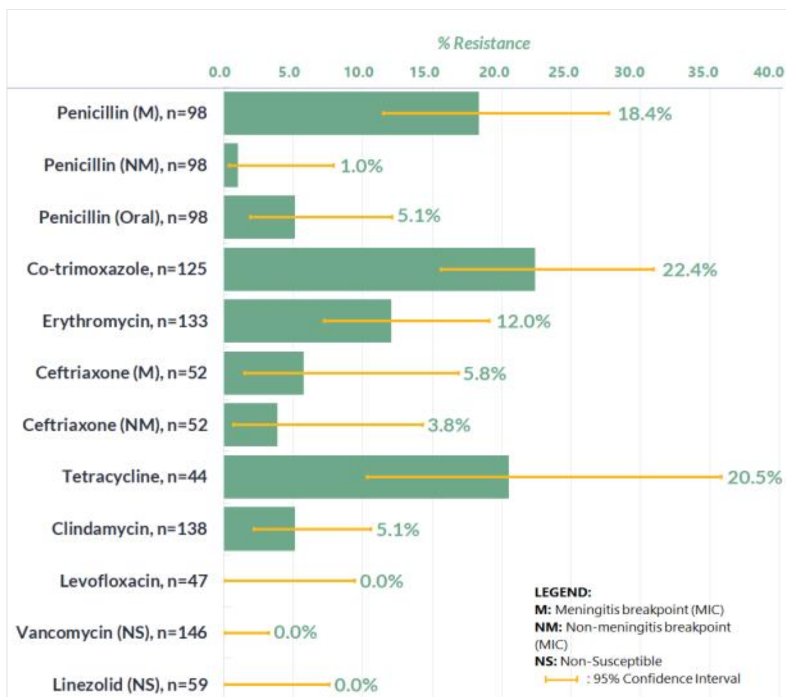


**Figure 9.** Percent resistance of *S. pneumoniae* respiratory isolates, DOH-ARSP, 2020

**Figure 9** shows the percent resistance of *S. pneumoniae* isolates from respiratory specimens. Co-trimoxazole resistance was at 22.4% (n=125), penicillin (M) at 18.4% (n=98), penicillin (NM) at 1.0% (n=98), penicillin (oral) at 5.1% (n=98) and erythromycin at 12.0% (n=133). Ceftriaxone (M) was at 5.8% while non-meningitis breakpoint for ceftriaxone was at 3.8% (n=52). Tetracycline resistance rate among respiratory isolates was at 20.5% (n=44) and 5.1% (n=138) for clindamycin. No *S. pneumoniae* isolate from respiratory specimens was found resistant against levofloxacin, vancomycin (NS) and linezolid (NS).

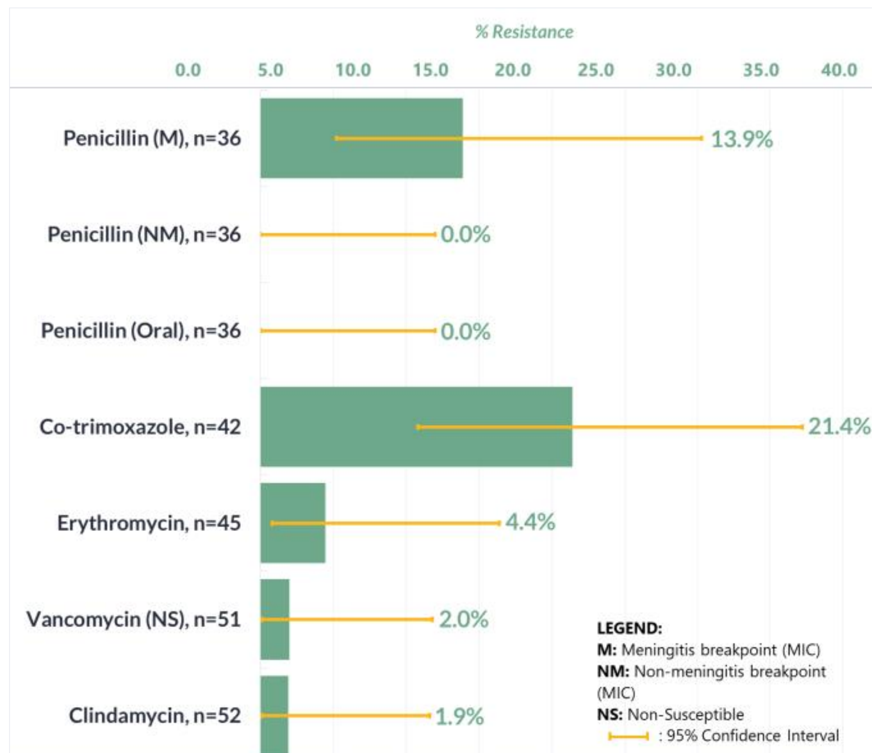


**Figure 10.** Percent resistance of *S. pneumoniae* blood isolates, DOH-ARSP, 2020

Among *S. pneumoniae* blood isolates, resistance to co-trimoxazole was at 21.4% (n=42) and penicillin (M) at 13.9% (n=36), while no resistance was reported using non meningitis and oral penicillin breakpoints (**Figure 10**). Erythromycin resistance was at 4.4% (n=45) and percent non-susceptible to vancomycin was 2.0% (n=51).

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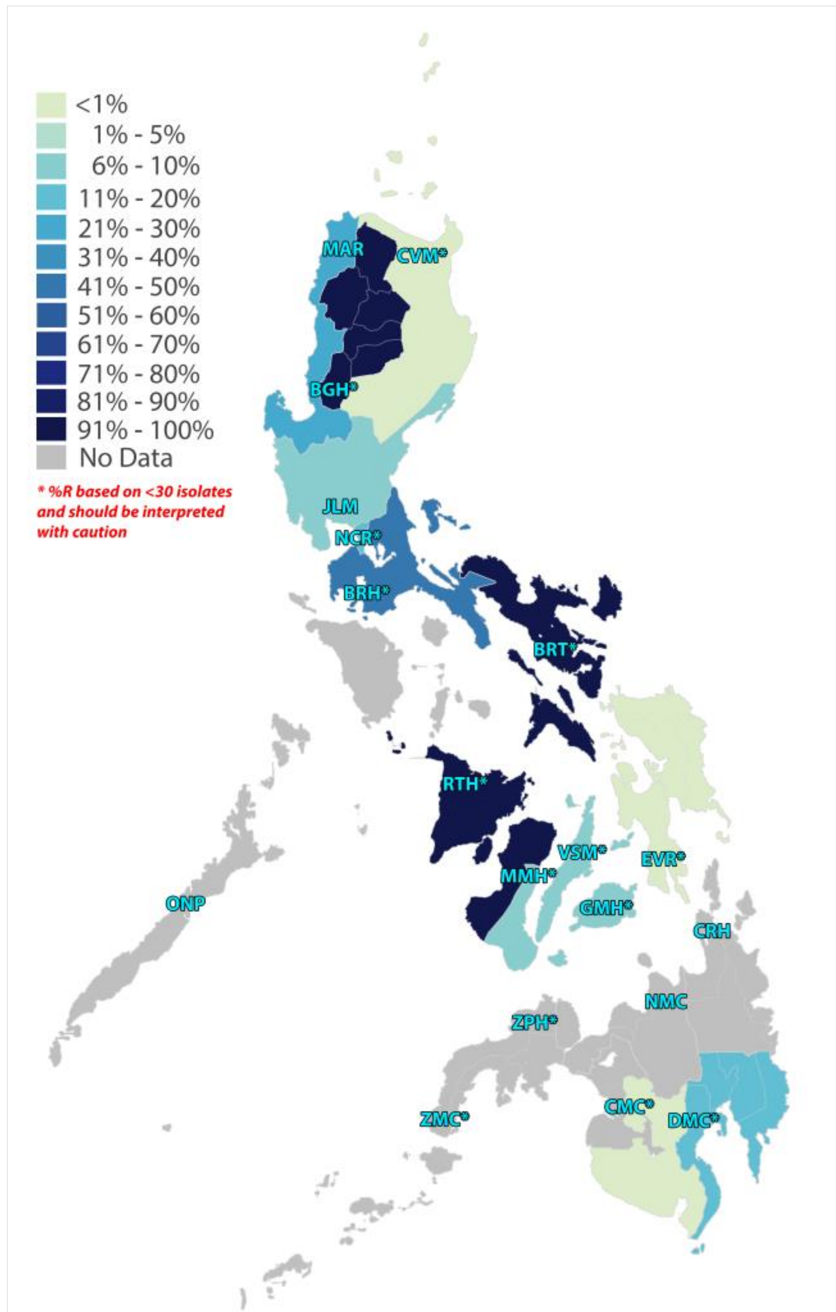


**Figure 11.** Geographic distribution of penicillin-resistant *S. pneumoniae* in the Philippines, DOH- ARSP, 2020

Overall penicillin resistance of *S. pneumoniae* isolates from 5 of the 22 sentinel sites (MAR, BGH, BRH, BRT and RTH) were more than 25%. *S. pneumoniae* isolates from two regions (NCR and DMC) on the other hand were in the 11-25% range and 4 (JLM, MMH, VSM and GMH) were in the 6-10% range. *S. pneumoniae* isolates from CVM and EVR were in the 1-5% penicillin resistance range.

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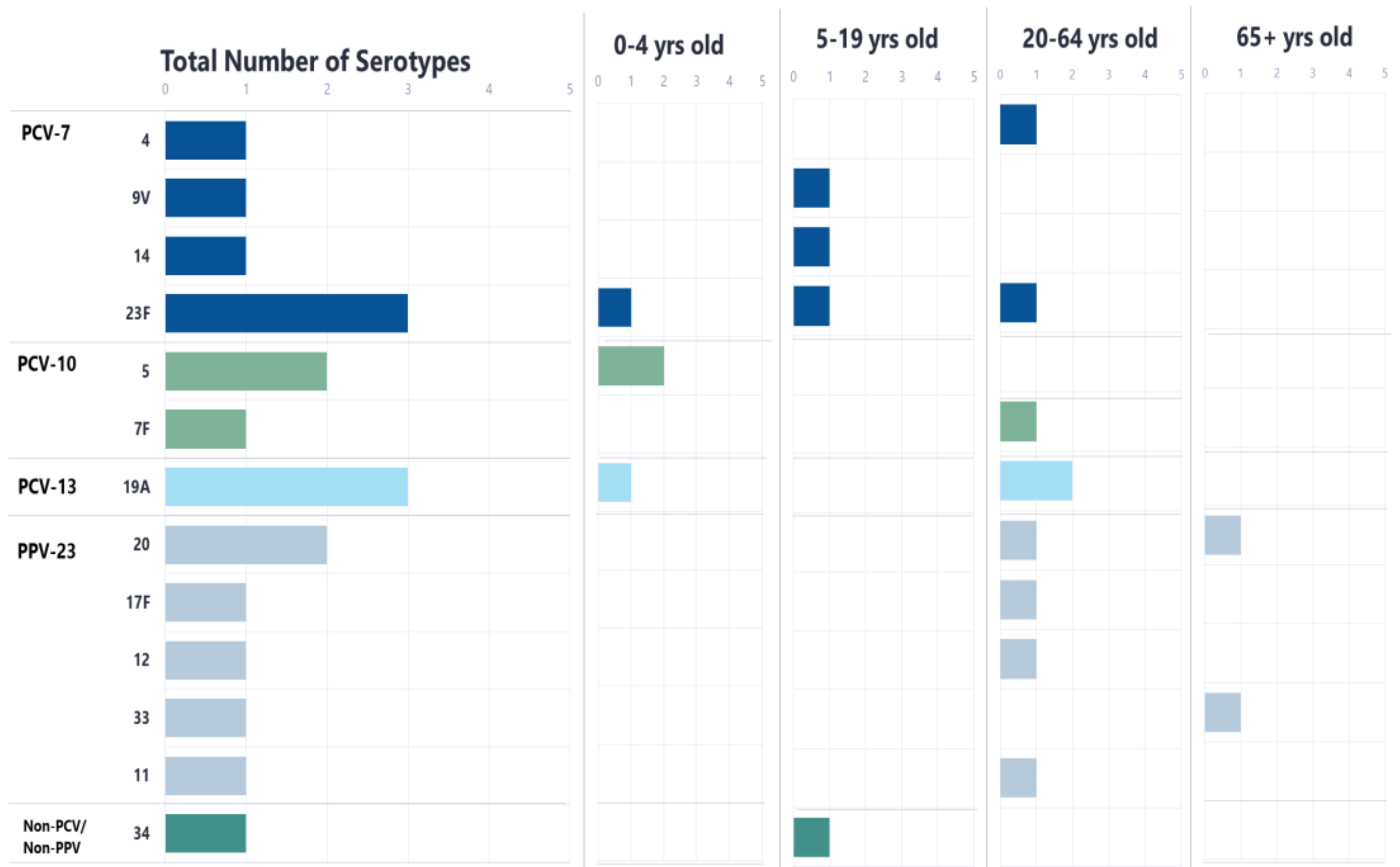


Figure 12. Invasive *S. pneumoniae* serotypes and PCV serotypes, DOH-ARSP, 2020

## Serotyping

To identify locally prevailing invasive serotypes, 22 *S. pneumoniae* isolates from blood samples received at the reference laboratory were serotyped following slide agglutination method using Denka Seiken antisera. The number of invasive *S. pneumoniae* isolates received by the reference laboratory for 2020 was much lower compared with number of isolates received in the past years. For 2020, there were 13 *S. pneumoniae* serotypes/serogroups identified with the most common being serotypes 23F, 19A and 20. Three isolates were non-serotypable. Serotypes identified per age group is shown in Figure 12.

Percent pneumococcal vaccine conjugate (PCV) coverage of invasive *S. pneumoniae* isolates was determined by dividing the number of isolates with serotypes included in PCVs over the total number of isolates with identified serotypes. The overall PCV7 coverage of 2020 invasive *S. pneumoniae* isolates was (27.3 %), 40.9% for PCV10 and 54.5% for PCV13. Based on the limited number of invasive *S. pneumoniae* isolates for 2020, PCV coverages of 2020 invasive *S. pneumoniae* isolates were higher compared to that of 2019 invasive *S. pneumoniae* isolates.

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# Haemophilus influenzae

There were 179 reported *H. influenzae* isolates for 2020. This was 62.86% lower than the 482 isolates reported for 2019. The biggest contributors for the 2020 *H. influenzae* data were DMC (28.49%, n= 51), VSM (25.14%, n= 45) and PGH (11.17%, n=20). Based on island group distribution, 43.02% (n= 77) came from Luzon, with 19.56% coming from NCR, 27.93% (n= 50) from Visayas and 29.05% (n=52) from Mindanao. (Figure 13)

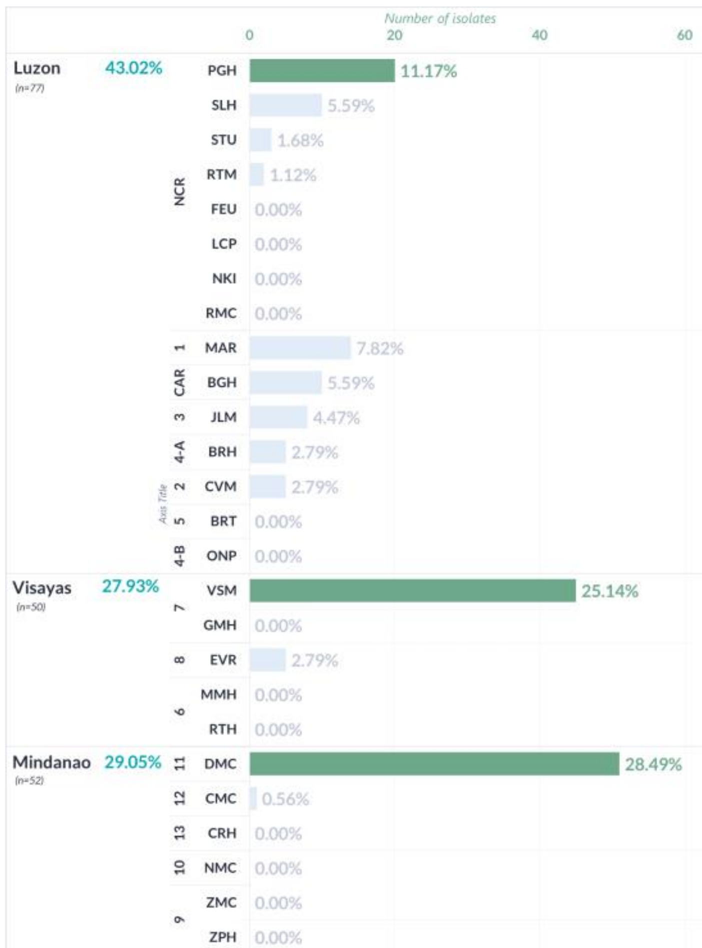
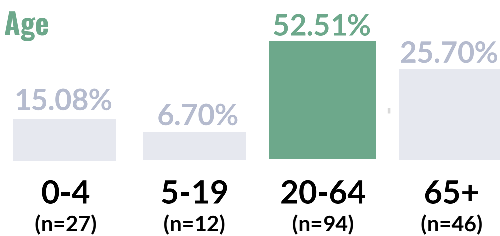



Figure 13. Isolate distribution of *H. influenzae* isolates, DOH-ARSP, 2020 (n=179)



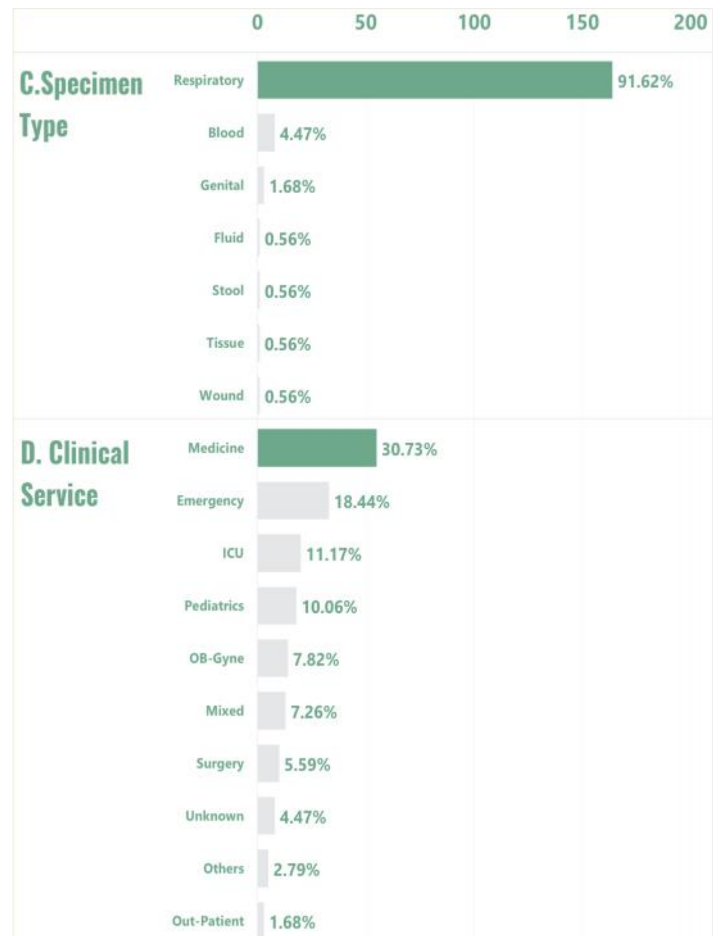




Figure 14. Patients characteristics of *H. influenzae* 2020 ARSP isolates, DOH-ARSP, 2020 (n=179)

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Majority (52.51%) of the isolates came from patients 20-64 years of age, and most were males (67.60%). Majority (91.62%) of the *H. influenzae* isolates were from respiratory specimens, with 4.47% from blood (Figure 14).

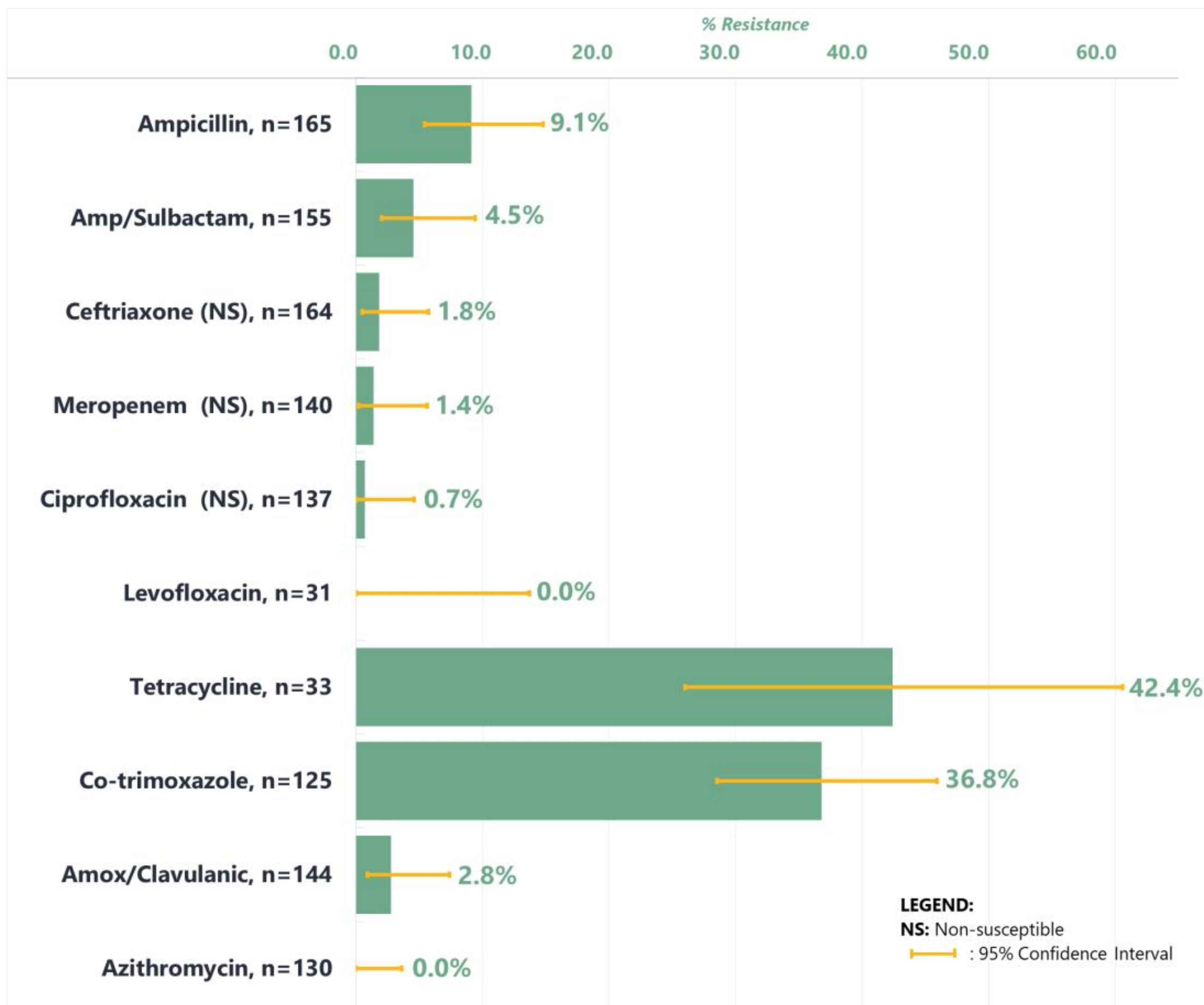


Figure 15. Percent resistance of *H. influenzae*, DOH-ARSP, 2020

Resistance rates of *H. influenzae* isolates against ampicillin was at 9.1% (n=165) and 4.5% (n=155) to ampicillin-sulbactam. Percent non-susceptible to ceftriaxone, meropenem, amoxicillin-clavulanic acid and ciprofloxacin were at 1.8%, 1.4%, 2.8% and 0.7% respectively. Tetracycline (42.4%) and co-trimoxazole (36.8%) resistance were both above 30%.

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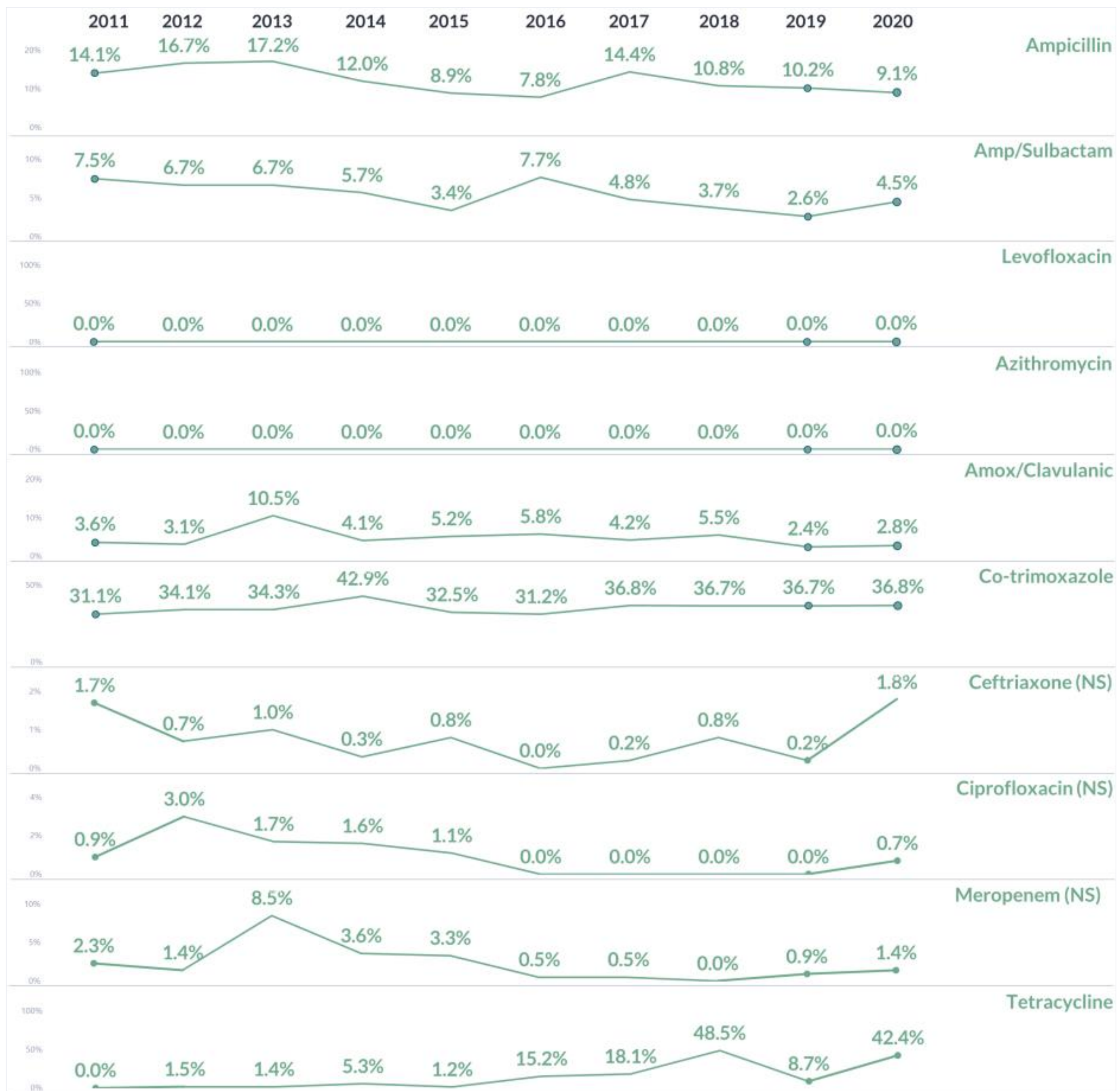


**Figure 16.** Yearly resistance rates of *H. influenzae* DOH-ARSP, 2011-2020

Resistance rates against ampicillin were noted to be decreasing in the last 3 years, while resistance to ampicillin-sulbactam increased to 4.5% from 2.6% in 2019 (p=0.2446). (Figure 16). Meropenem resistance increased in 2020 (p=0.6234) but not statistically significant. Tetracycline, on the other hand, increased by 33.7% in 2020, with statistical significance (p=0.0000).

### Meropenem Non-susceptible *H. influenzae*

There was one confirmed meropenem non-susceptible *H. influenzae* isolate from a 50—year old female 2020. The isolate was noted to be resistant to ampicillin but susceptible to ceftriaxone and ciprofloxacin.

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Resistance rates among respiratory isolates of *H. influenzae* are shown in **Figure 17**. Resistance to ampicillin and ampicillin- sulbactam were at 7.2% and 3.5%, respectively. Percent non-susceptible for ceftriaxone (2.0%), meropenem (1.5%) and ciprofloxacin (0.8%) were less than five percent. Co-trimoxazole resistance was at 34.8% (n=115). No *H. influenzae* respiratory isolate was detected to be resistant to azithromycin.

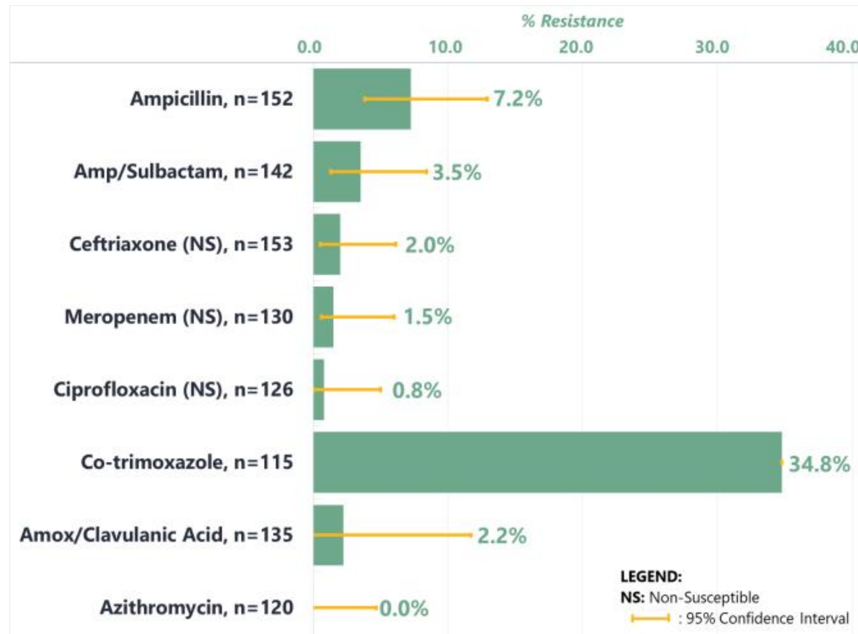


**Figure 17.** Percent resistance of *H. influenzae* respiratory isolates, DOH-ARSP, 2020

To obtain reasonable statistical estimate of the cumulative percentage resistance for *H. influenzae* from blood and CSF, data from 2018-2020 were combined. Ampicillin resistance was at 25.5% (n=55) while resistance to ampicillin–sulbactam was at 7.3%. Percent nonsusceptible to meropenem (3.8%) and ceftriaxone (4.1%) were less than 5% co-trimoxazole resistance was at 34.7%. No *H. influenzae* blood and CSF isolate was resistant to ciprofloxacin, levofloxacin and amoxicillin-clavulanic acid (**Figure 18**).

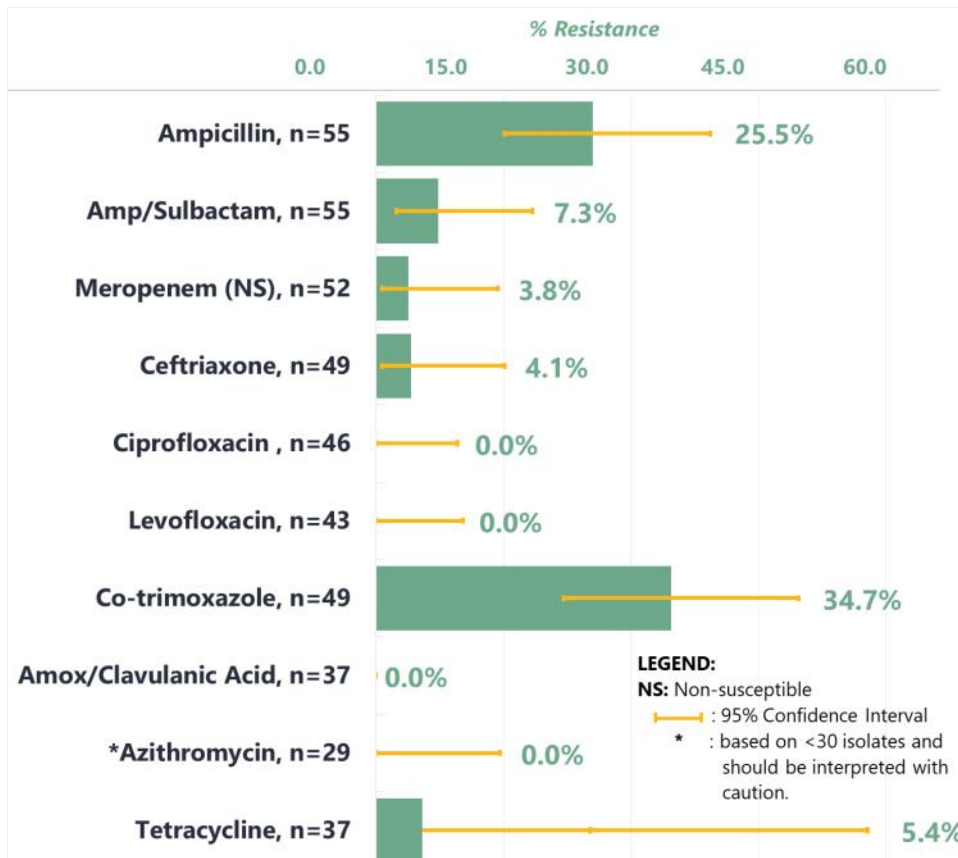


**Figure 18.** Percent resistance of blood and CSF *H. influenzae* isolates, DOH-ARSP, 2018-2020



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# *Salmonella enterica* serovar Typhi

There were 55 *Salmonella enterica* serovar Typhi reported and analyzed for 2020. This is 60.43% less than the 139 isolates reported for 2019. CMC contributed most to the number of *S*. Typhi isolates (30.91%). Based on island group distribution, 49.09% came from Mindanao, 29.09% from Luzon and 21.82% from Visayas (Figure 19).

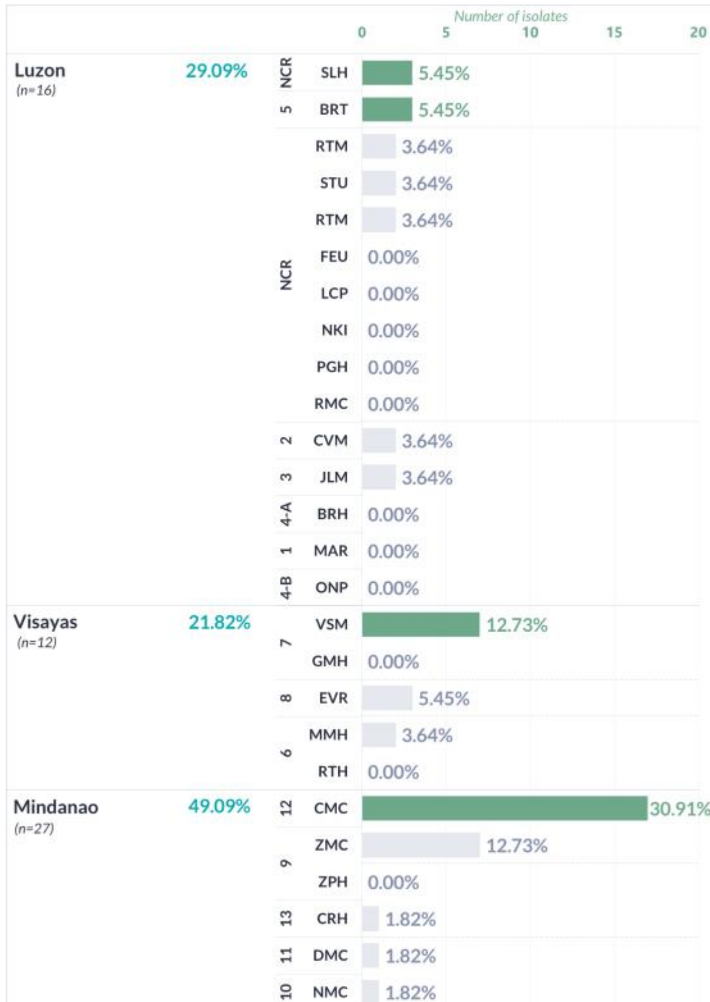
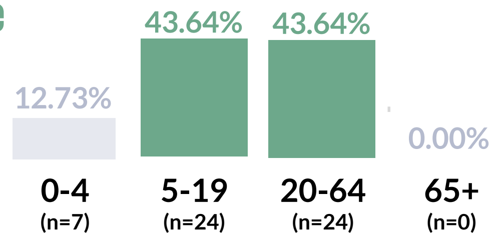



Figure 19. Isolate distribution of *S*. Typhi isolates, DOH-ARSP, 2020 (n=55)

## A. Sex

## B. Age



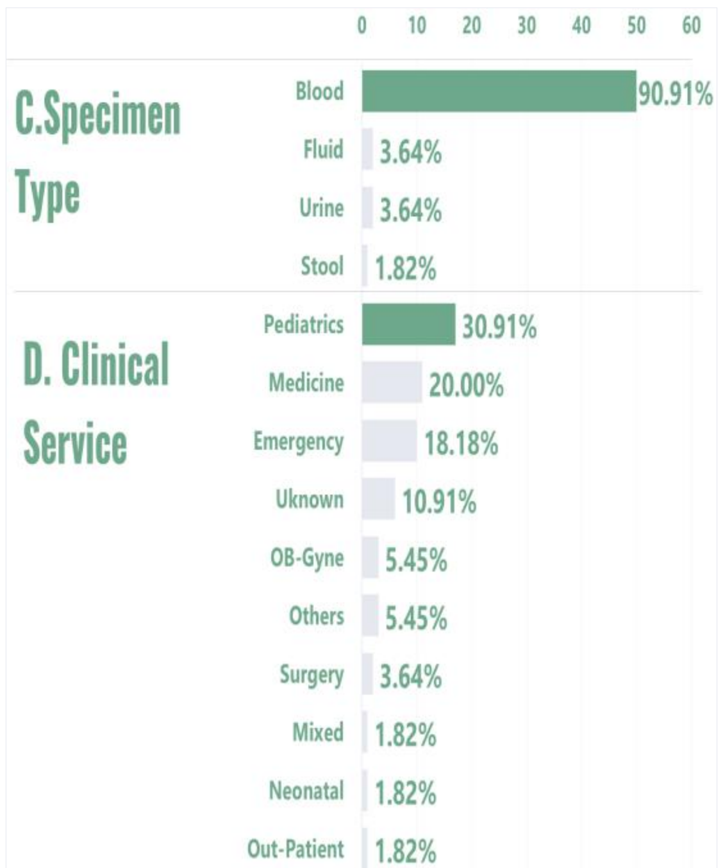




Figure 20. Patients characteristics of *S*. Typhi isolates, DOH-ARSP, 2020 (n=55)

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Many of the isolates came from the 5-19 (43.6%) and 20-64 (43.6%) age groups and more than half were males. Majority of the *S.* Typhi reported were from blood (90.9%). The rest of the isolates were from fluid (3.6%), urine (3.6%) and stool (1.8%)(Figure 20).

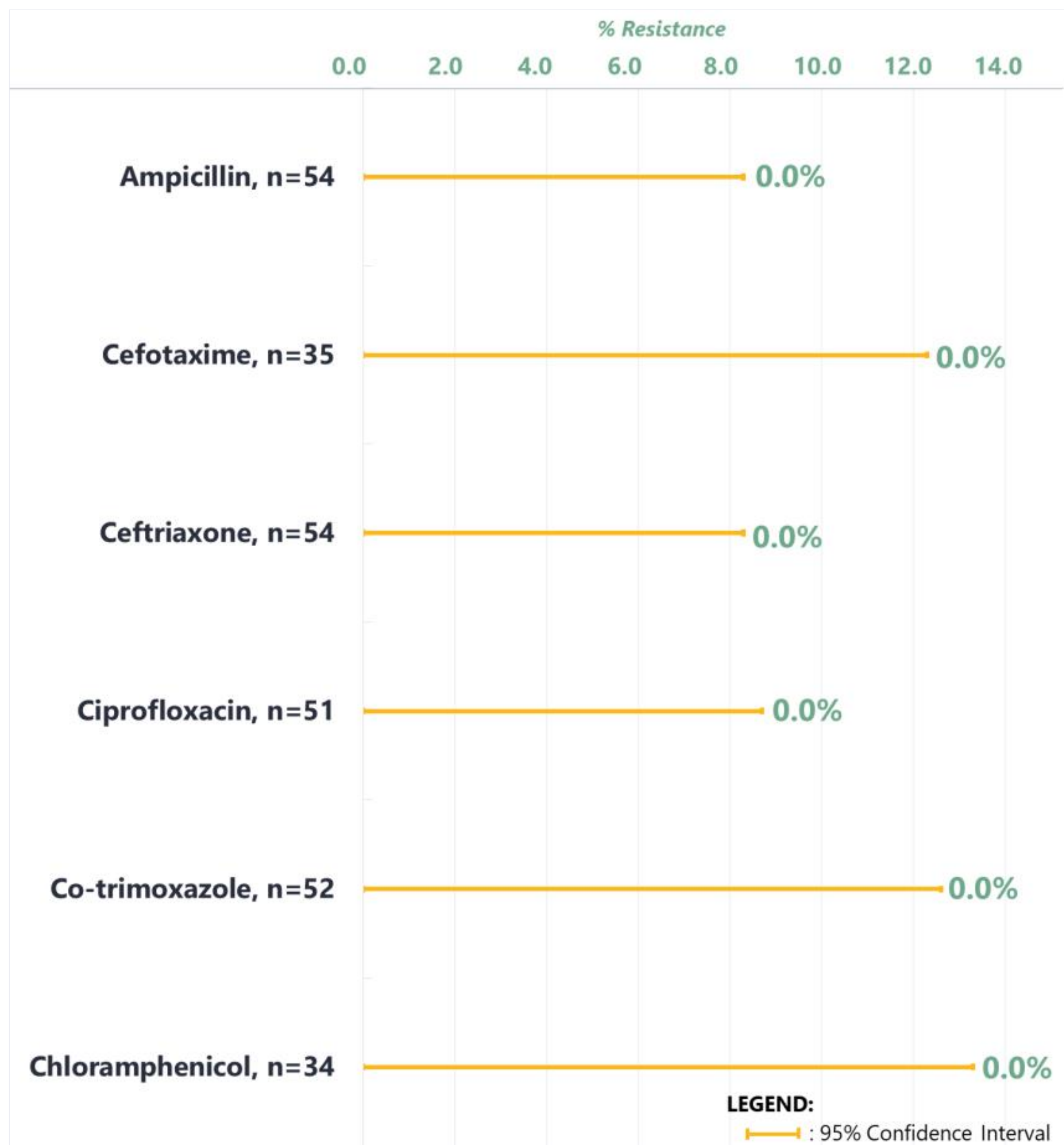


**Figure 21.** Percent resistance of *S.* Typhi , DOH-ARSP, 2020

For 2020 *Salmonella enterica* serovar Typhi isolates, no resistance was observed against ampicillin, ciprofloxacin, co-trimoxazole and chloramphenicol. As there were very few *S.* Typhi isolates reported for 2020, continued surveillance of antibiotic resistance among these pathogens has to be done.

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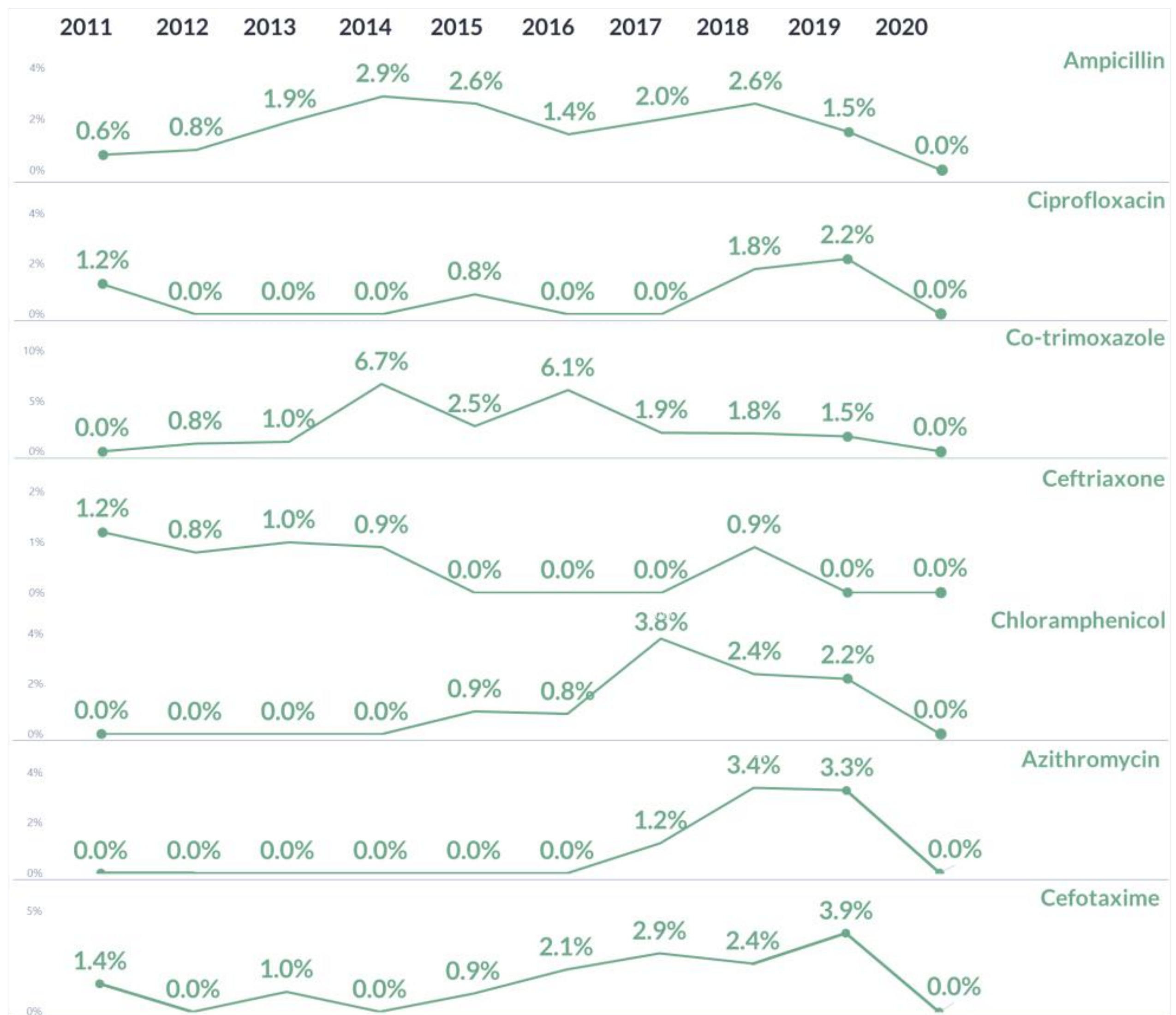


**Figure 22.** Yearly resistance rates of *S.* Typhi DOH-ARSP, 2011-2020

Yearly resistance rates of *S.* Typhi remained low in the past ten years and isolates remained susceptible to antibiotics used against them including ampicillin, chloramphenicol, cefotaxime, ciprofloxacin, ceftriaxone, co-trimoxazole and azithromycin (Figure 22).

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# Non-typhoidal *Salmonella*

There were 167 reported non-typhoidal *Salmonella* (NTS) isolates for 2020. This was 31.84% less than the reported 245 NTS isolates in 2019. PGH (14.37%) contributed most to the number of NTS isolates. Most of the isolates came from Luzon (66.47%, n=111) with 32.34% coming from NCR, 22.16% coming from Mindanao and 11.38% from Visayas (Figure 23).

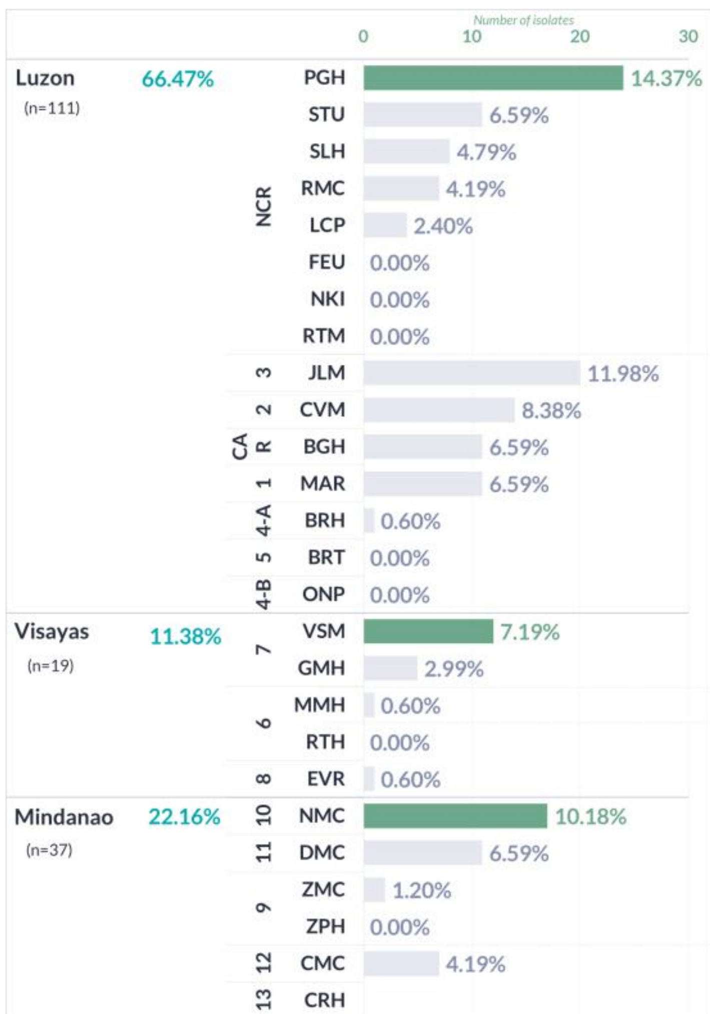
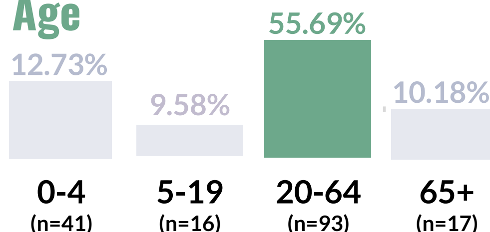



Figure 23. Isolate distribution of Non-typhoidal *Salmonella* isolates, DOH-ARSP, 2020 (n =167)

## A. Sex

## B. Age



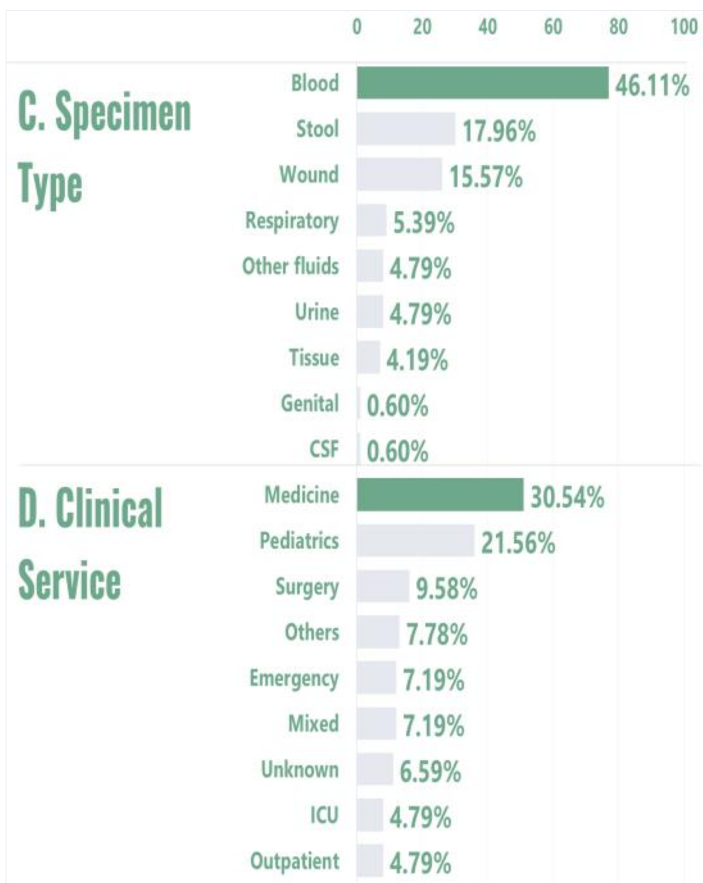




Figure 24. Patients characteristics of of Non-typhoidal *Salmonella* isolates, DOH-ARSP, 2020 (n=55)

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Majority (55.69%) of the isolates came from the 20-64 age group, and most were males (59.28%). Many of the reported NTS isolates were from blood (46.11%), stool (17.96%) and wound (15.57%). The rest of the isolates were from respiratory, urine, tissue, CSF and other body fluids (Figure 24).

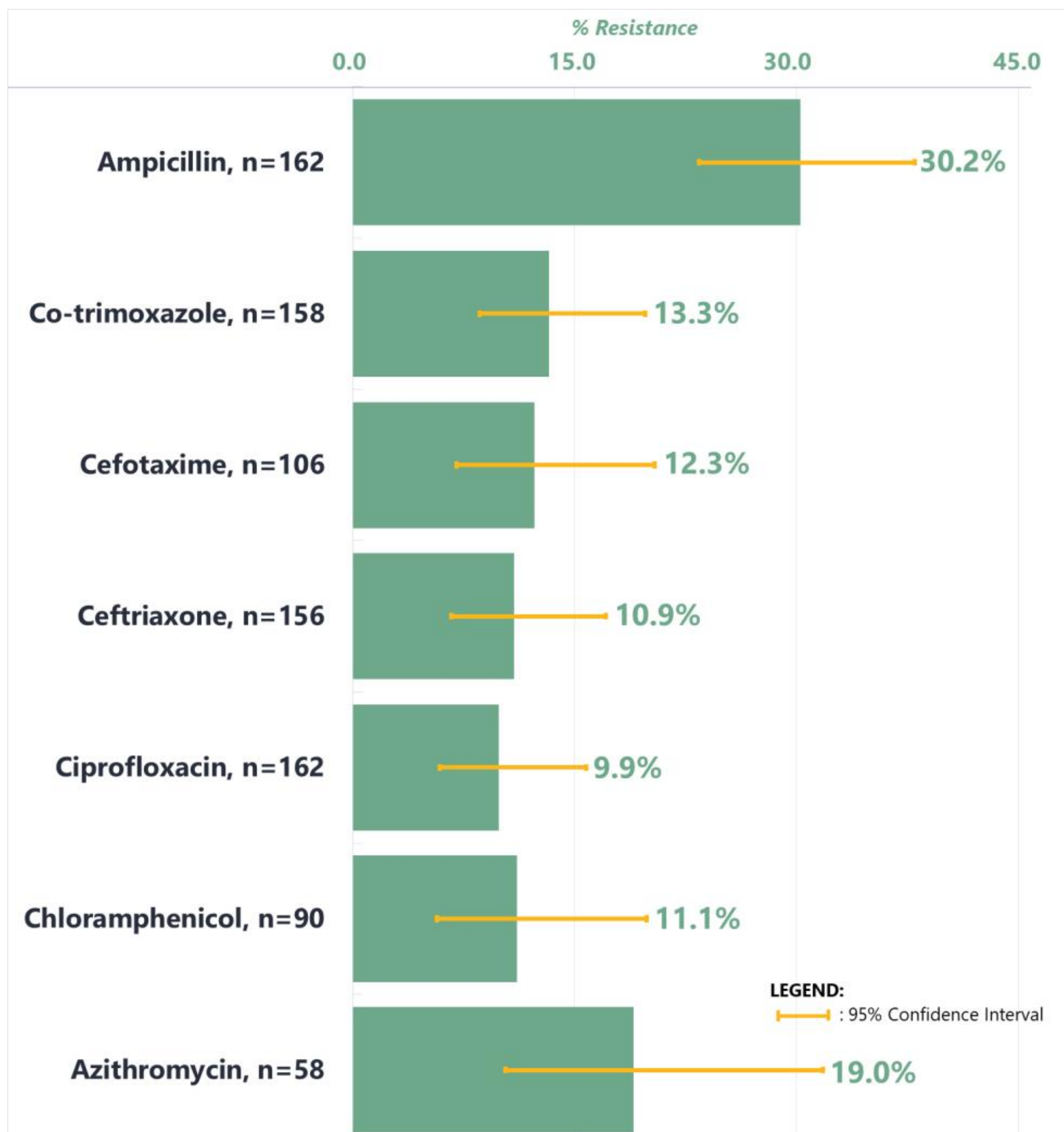


Figure 25. Percent resistance of Non-typhoidal *Salmonella*, DOH-ARSP, 2020

Resistance against ampicillin was at 30.2% (n=162), 13.3% (n=158) to co-trimoxazole and 10.9% (n=156) to ceftriaxone. Ciprofloxacin resistance was at 9.9%, 11.1% to chloramphenicol and 19% to azithromycin (Figure 25).

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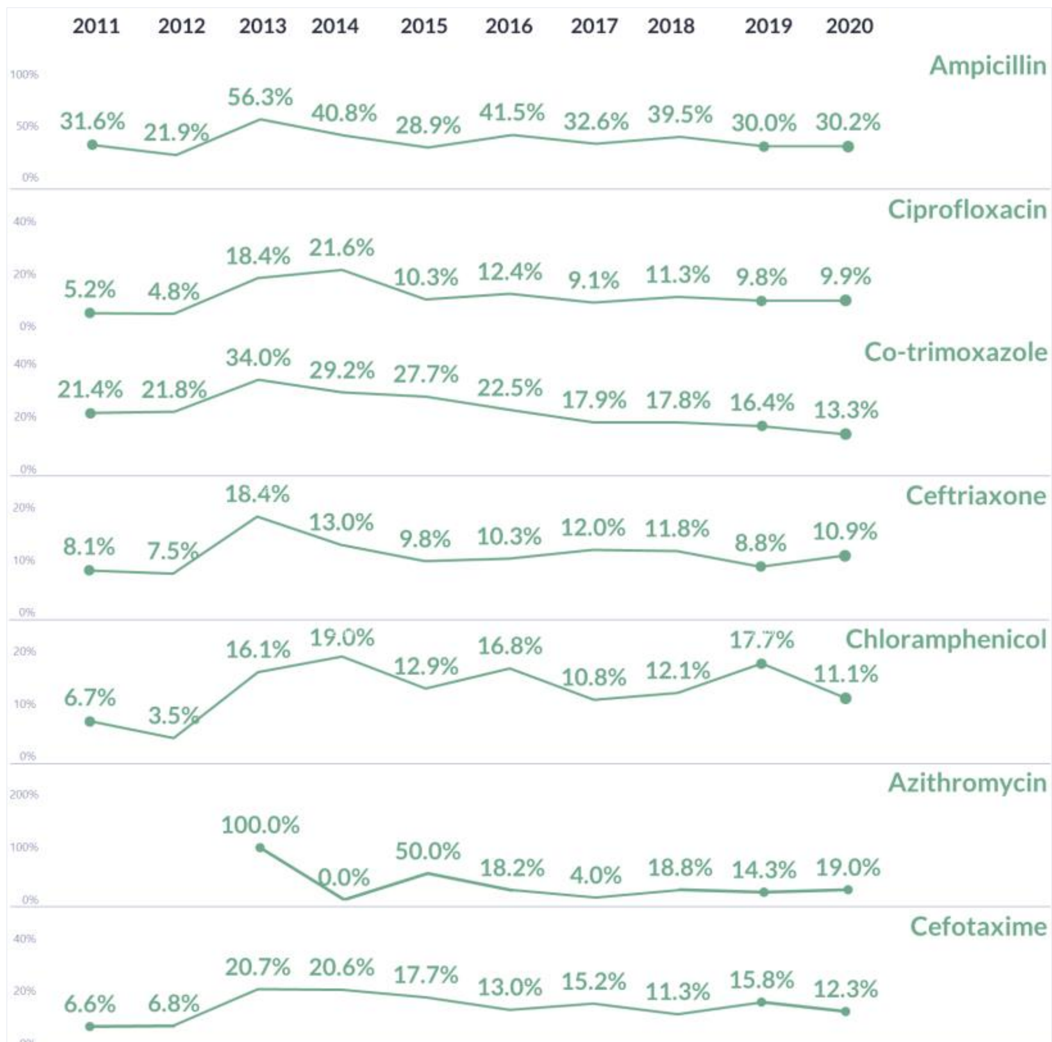


**Figure 26.** Yearly resistance rates of Non-typhoidal *Salmonella*, DOH-ARSP, 2011-2020

Yearly resistance rates among NTS isolates are shown in **Figure 26**. Ampicillin and ciprofloxacin resistance slightly increased by 0.2% in 2020 from their value in 2019 but the changes were not statistically significant. Ceftriaxone also increased from 8.8% in 2019 to 10.9% in 2020 (p=0.4950). The decrease in resistance rate in co-trimoxazole, cefotaxime and chloramphenicol were not statistically significant. Resistance to azithromycin increased among 2020 NTS isolates but the increase was not significant (p=0.2464).

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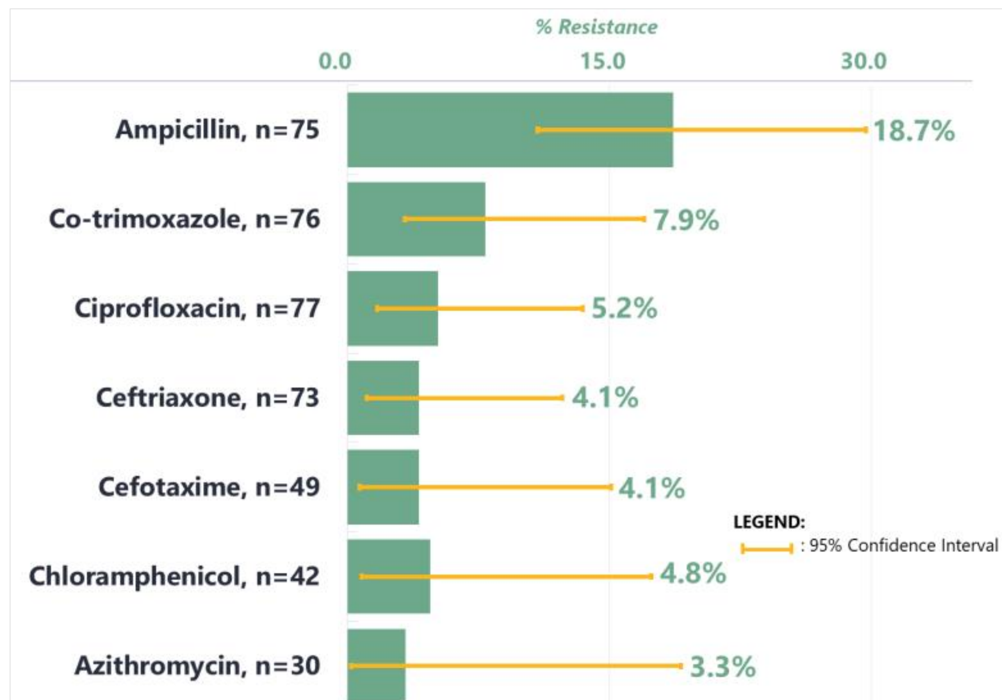


**Figure 27.** Percent resistance of Non-typhoidal *Salmonella*, blood isolates DOH-ARSP, 2020

Ampicillin resistance was at 18.7% among NTS blood isolates. Co-trimoxazole, ciprofloxacin and ceftriaxone resistance were at 7.9%, 5.2% and 4.1% respectively. Resistance to cefotaxime was at 4.1% and 4.8% for chloramphenicol. Azithromycin resistance was at 3.3%.

**Table 4.** List of confirmed *Salmonella* serotypes, DOH-ARSP 2020

| Serotype | Number of isolates | Percentage |
|---|---|---|
| *Salmonella* Enteritidis | 32 | 33.33 |
| *Salmonella* Typhi | 30 | 31.25 |
| *Salmonella* Typhimurium | 7 | 7.29 |
| *Salmonella* Weltevreden | 6 | 6.25 |
| *Salmonella* Bardo | 2 | 2.08 |
| *Salmonella* Group B | 2 | 2.08 |
| *Salmonella* Montevideo | 2 | 2.08 |
| *Salmonella* Schleissheim | 2 | 2.08 |
| *Salmonella* Virchow | 2 | 2.08 |
| *Salmonella* Berta | 1 | 1.04 |
| *Salmonella* Braenderup | 1 | 1.04 |
| *Salmonella* Dublin | 1 | 1.04 |
| *Salmonella* Kentucky | 1 | 1.04 |
| *Salmonella* Lamphun | 1 | 1.04 |
| *Salmonella* Newport | 1 | 1.04 |
| *Salmonella* Nitra | 1 | 1.04 |
| *Salmonella* Paratyphi A | 1 | 1.04 |
| *Salmonella* Paratyphi B | 1 | 1.04 |
| *Salmonella* Stanley | 1 | 1.04 |
| Salmonella *enterica* ss. Farmingdale | 1 | 1.04 |
| **Total** | **96** | **100** |

## Serotyping of *Salmonella*

There were 96 confirmed Salmonellae at the reference laboratory. Most of these isolates were *Salmonella enterica* serovar Enteritidis (33.33%) and *Salmonella enterica* serovar Typhi (31.25%). Among the 66 confirmed non-typhoidal *Salmonella*, the most common serotypes identified were *Salmonella enterica* serovar Enteritidis (32 isolates) and *Salmonella enterica* serovar Typhimurium (7 isolates). Antimicrobial resistance for NTS varies by serotype. Overall changes in resistance among NTS reflects variations in serotypes, its distribution, or both.

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# *Shigella* species

For 2020, there were 20 *Shigella* species reported. VSM (30.00%) contributed 30% of isolates and 10% were from ZMC. Based from island group distribution, 30% were from Luzon and 35% were from Visayas and Mindanao (Figure 28).

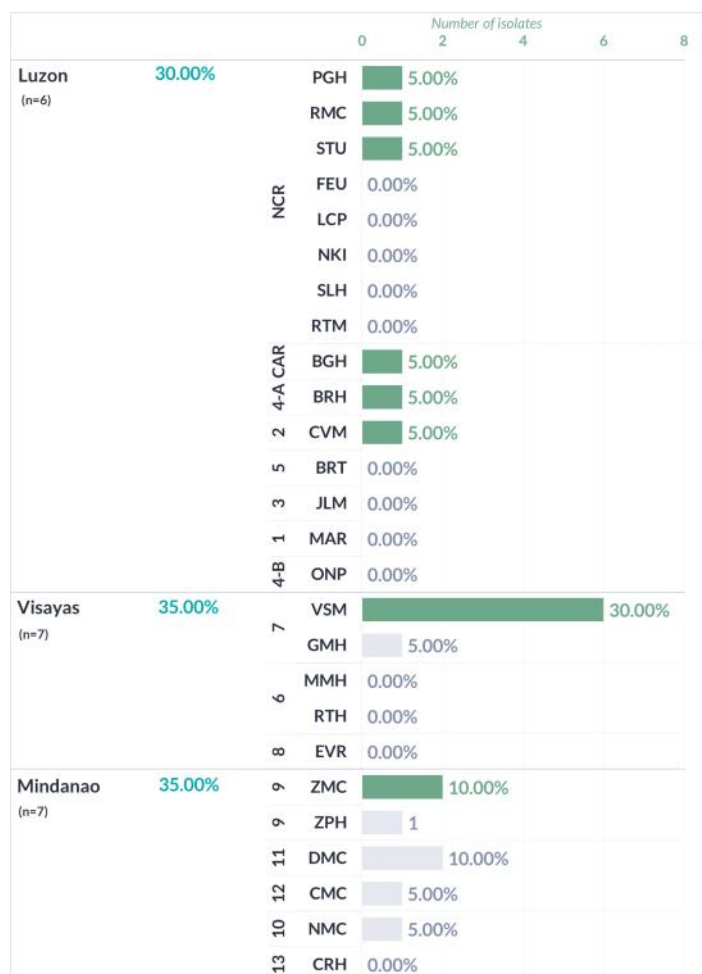
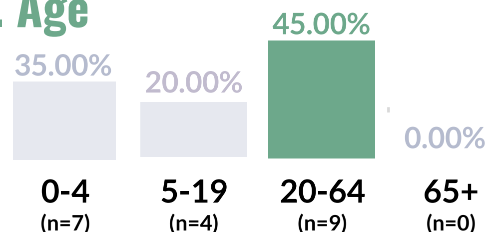



Figure 28. Isolate distribution of *Shigella* species isolates, DOH-ARSP, 2020 (n =20)

## A. Sex

## B. Age



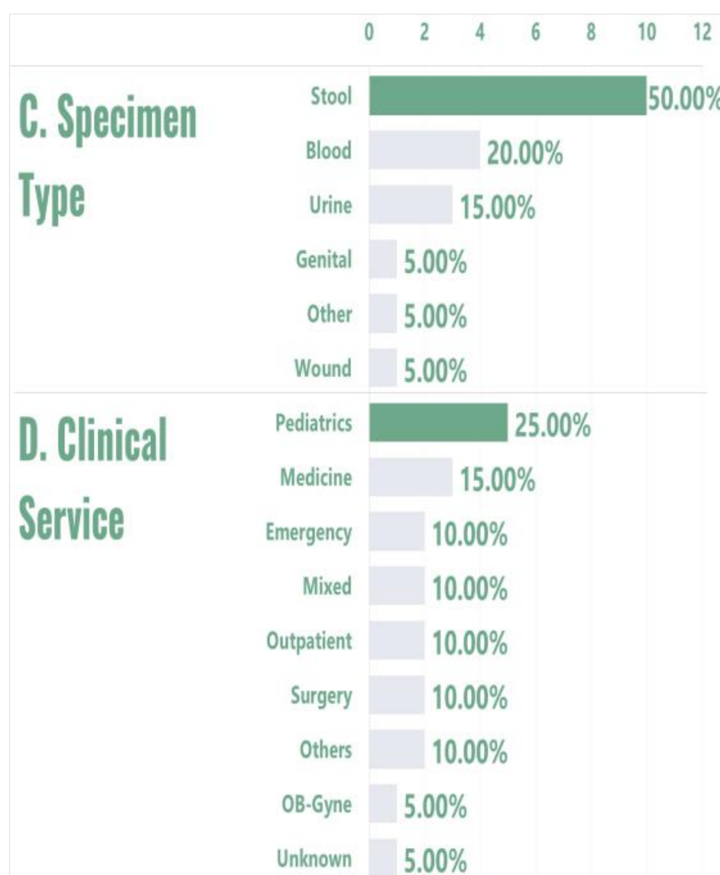




Figure 29. Patients characteristics of *Shigella* species isolates, DOH-ARSP, 2020 (n=20)

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Many of the isolates came from the 20-64 age group (45.0%) and most were females (55.0%). Half of the isolates were from stool specimens, 20% from blood and 15% were from urine (Figure 29).

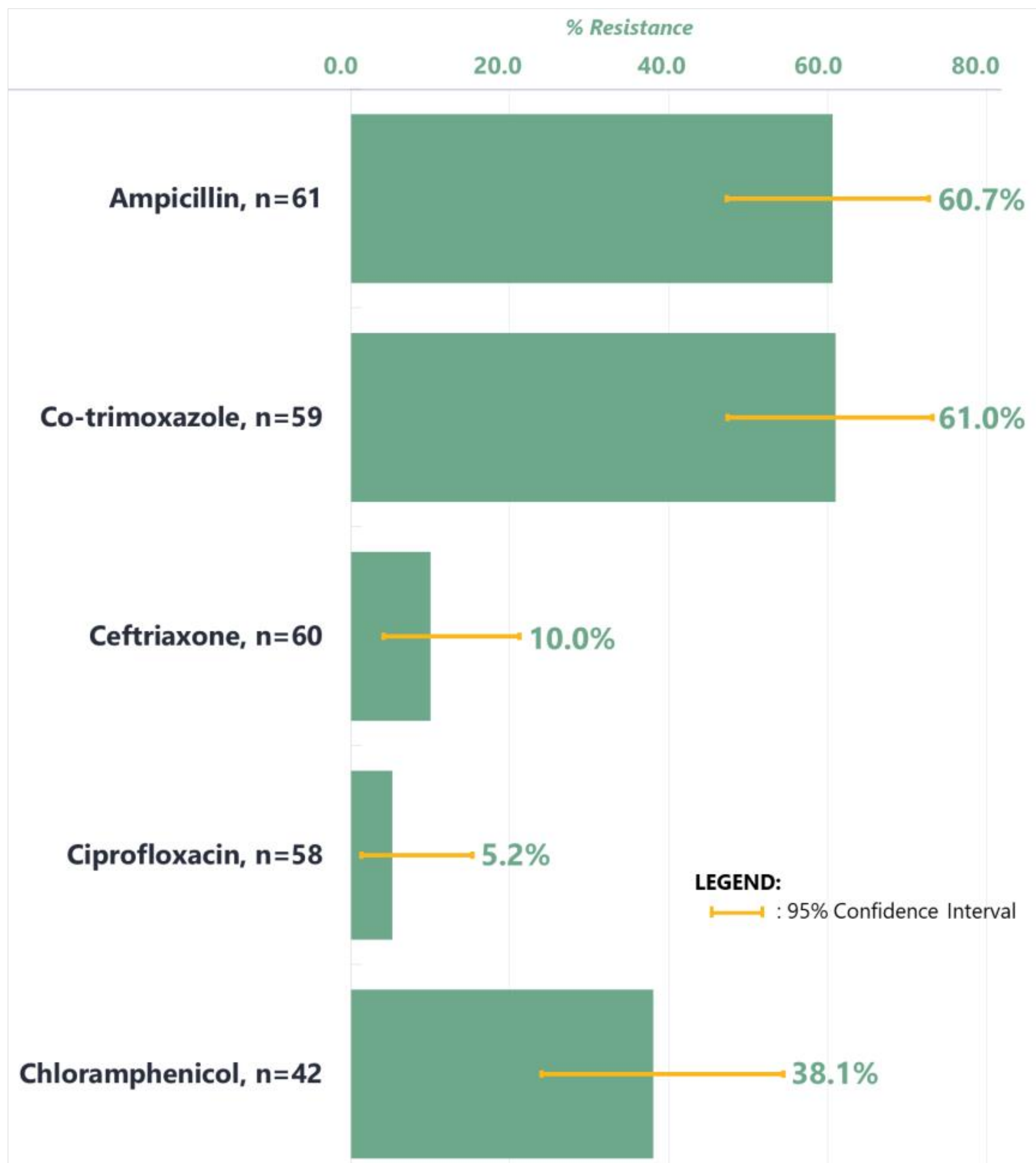


Figure 30. Percent resistance of *Shigella* species, DOH-ARSP, 2019-2020

Figure 30 shows the antimicrobial resistance rate of *Shigella* species for 2019-2020. Ampicillin resistance was at 60.7% (n=61), co-trimoxazole, at 61% (n=59) and chloramphenicol at 38.1% (n=42). Resistance rates to ceftriaxone was at 10.0% and to ciprofloxacin at 5.2%.

There were two confirmed azithromycin-resistant *Shigella* sp isolates for 2020. Both came from 4-year-old females and were susceptible to ceftriaxone, cefotaxime and ciprofloxacin.

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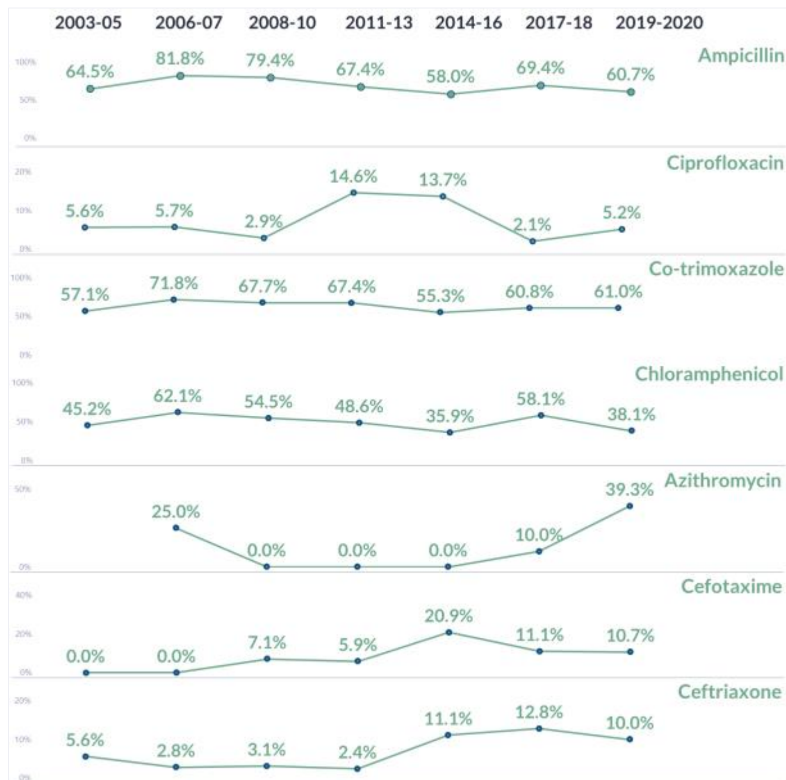


**Figure 31.** Yearly resistance rates of *Shigella* species, DOH-ARSP, 2011-2020

Cumulative percent resistance for every 2 years were analyzed and shown in Figure 31. The changes in resistance rates computed in 2019-2020 from 2017-2018 was not statistically significant.

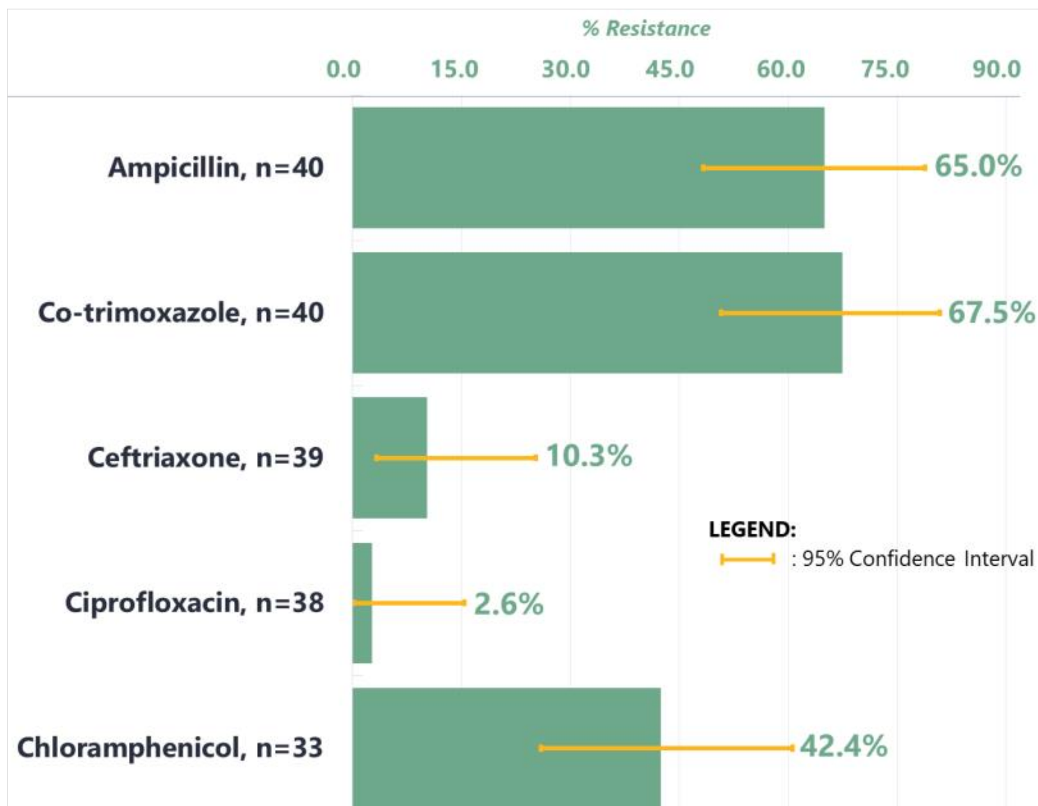


**Figure 32.** Percent resistance of *Shigella* species stool isolates, DOH-ARSP, 2019-2020

Figure 32 shows the resistance rates of *Shigella* stool isolates from 2019-2020. Ampicillin and co-trimoxazole resistance rates were at 65.0% and 67.5%, respectively. Chloramphenicol resistance was at 42.4%, ceftriaxone at 10.3% and ciprofloxacin at 2.6%.

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# *Vibrio cholerae*

There were 20 isolates of *Vibrio cholerae* reported for 2020. This is 30% higher in reported isolates in 2019 (n=14). Most isolates were from Visayas (60%), with majority from VSM (50%). No *V. cholerae* was reported from Luzon.

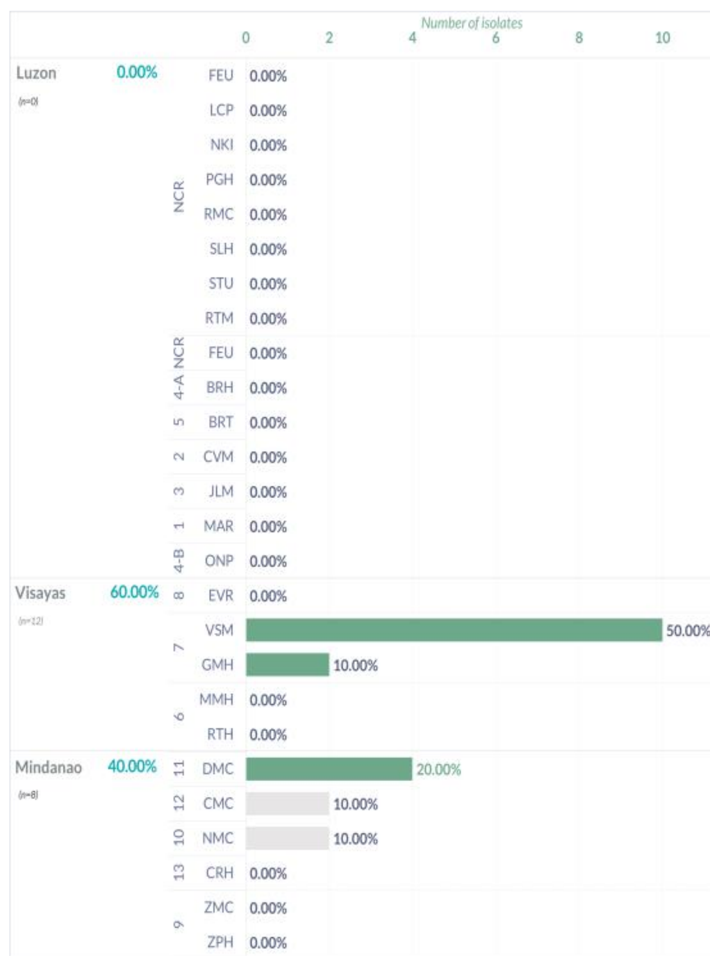
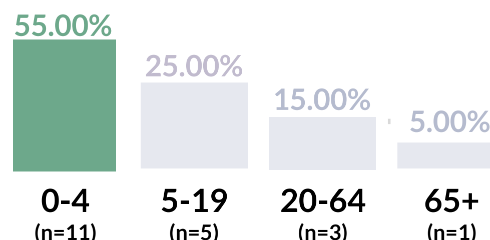



**Figure 33.** Isolate distribution of *V. cholerae* isolates, DOH-ARSP, 2020 (n=20)



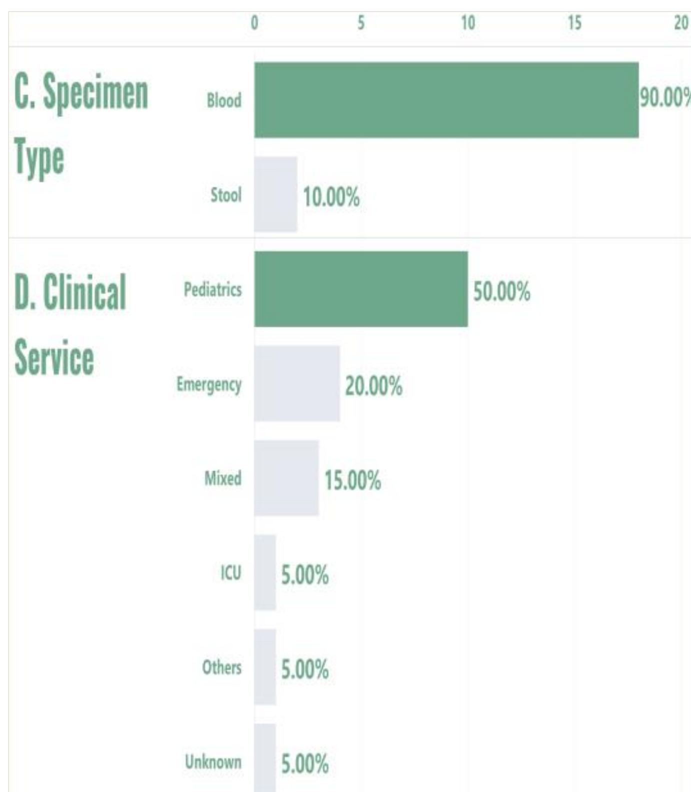




**Figure 34.** Patients characteristics of *V. cholerae* isolates, DOH-ARSP, 2020 (n=20)

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More than half of the isolates were from 0-4 years old (55%) and mostly from male patients (70%). Ninety percent of the isolates were detected in blood specimens (Figure 34).

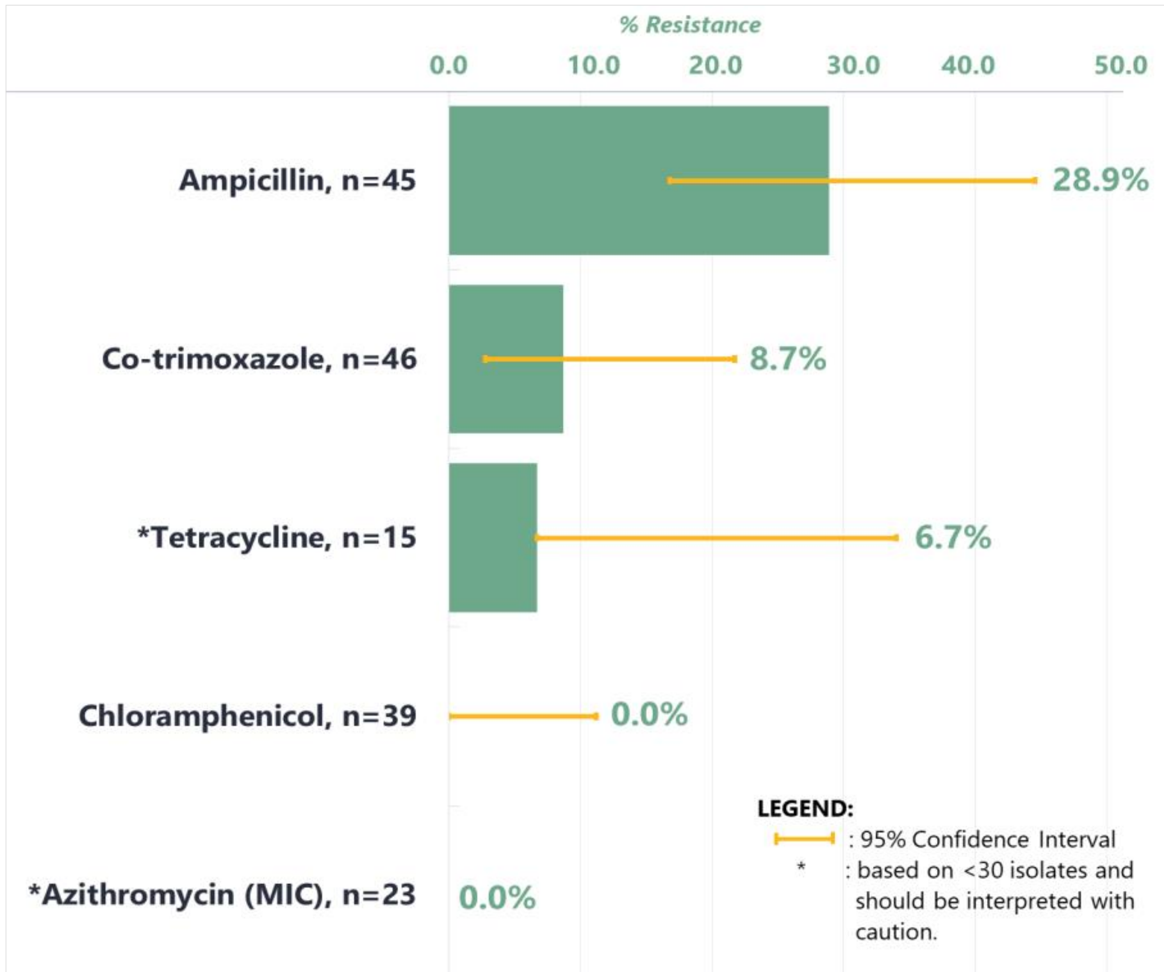


Figure 35. Percent resistance of *V. cholerae*, DOH-ARSP, 2018-2020

Figure 35 shows the combined resistance rates of *V. cholerae* from 2018-2020. Resistance rate to ampicillin was highest at 28.9% (n=45) followed by co-trimoxazole (8.7%, n= 46). Tetracycline resistance rate was at 6.7% (n=15). No resistance was detected for azithromycin and chloramphenicol. The three ampicillin resistant *V. cholerae* isolates were from the pediatric population. All of these isolates were from stool and from the sentinel sites in Mindanao (NMC=1, CMC=2).

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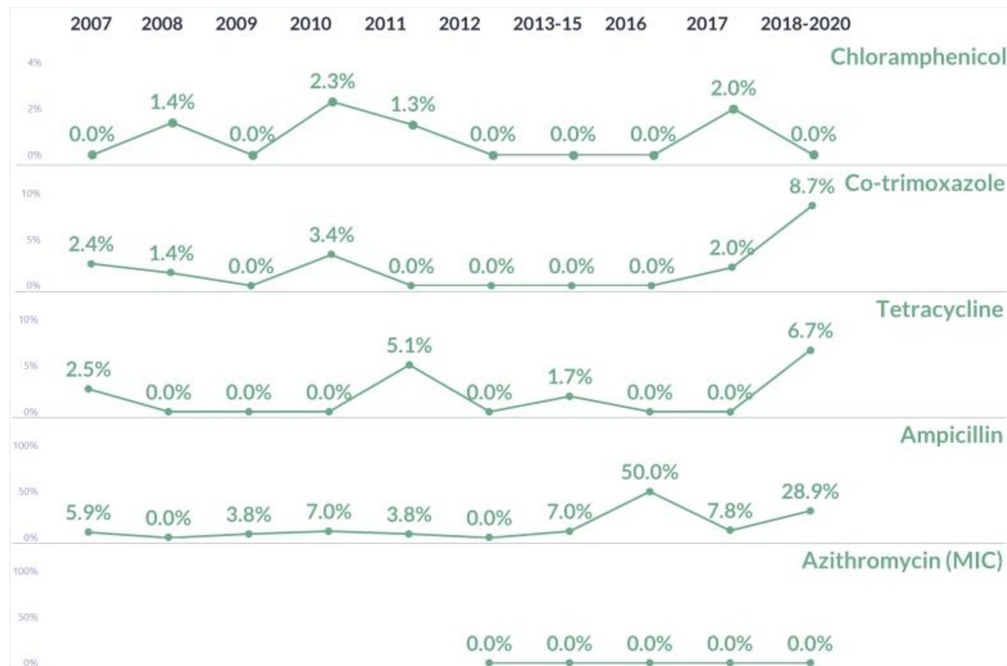


**Figure 36.** Yearly resistance rates of *V. cholerae*, DOH-ARSP, 2011-2020

Co-trimoxazole resistance showed increasing trend (p=0.3029) between 2017 and combined 2018-2020 analysis periods. There was likewise an increase in ampicillin resistance (p= 0.03259) for these periods. Chloramphenicol and tetracycline resistance showed fluctuating values, however differences were not significant. *V. cholerae* isolates remained susceptible to azithromycin in the last ten years.

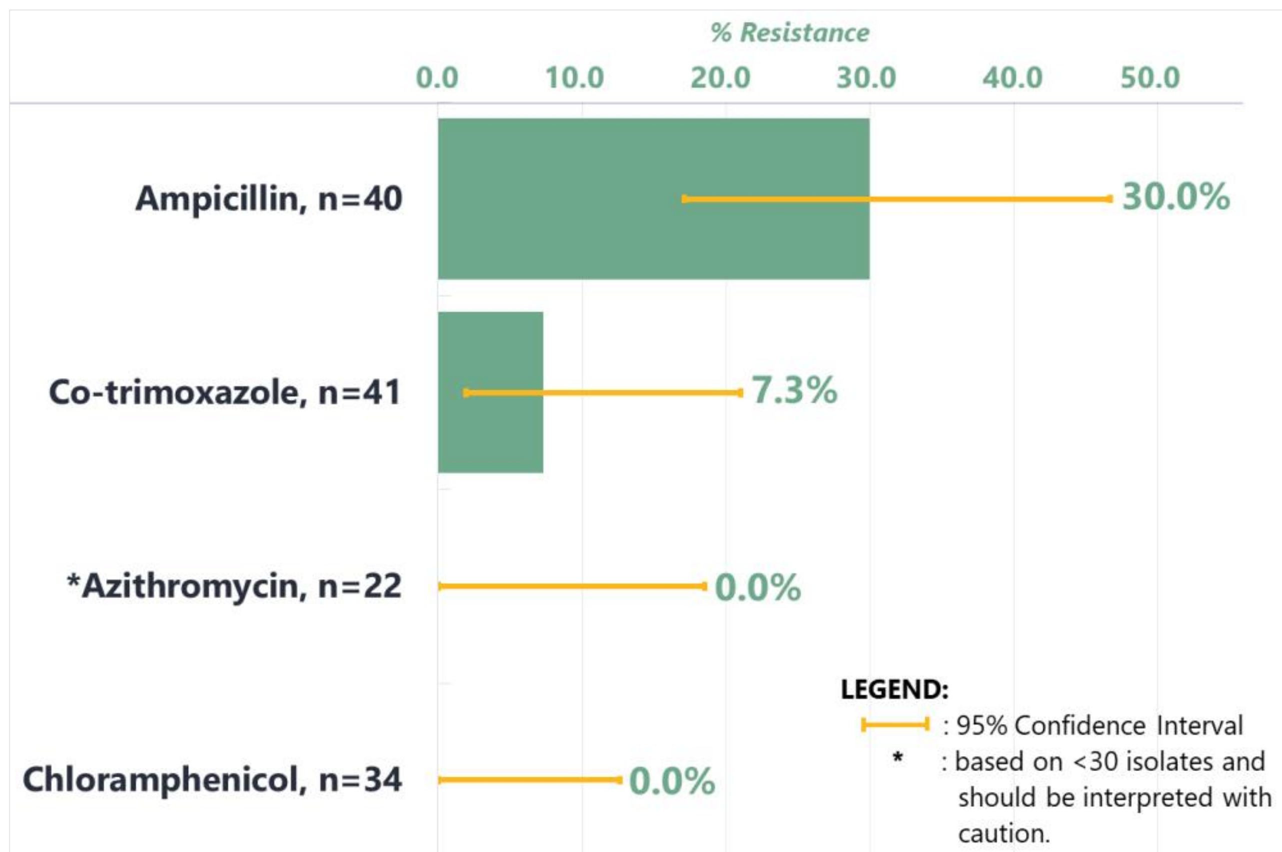


**Figure 37.** Percent resistance of *V. cholerae* from stool, DOH-ARSP, 2018-2020

Combined 2018-2020 *V. cholerae* resistance rates from stool are shown in **Figure 37**. Ampicillin resistance was at 30.0% and 7.3% against co-trimoxazole. No resistance to chloramphenicol was detected.



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# *Neisseria gonorrhoeae*

There were 46 *Neisseria gonorrhoeae* isolates reported for 2020. This was 67.61% lower than the number reported in 2019 (n=142). The largest contributors of data were VSM (50%) and RTM (28.26%). Based on island group distribution, the number of isolates reported in Visayas was at 58.70% (n=27), 39.13% in Luzon and 2.17% in Mindanao (Figure 38).

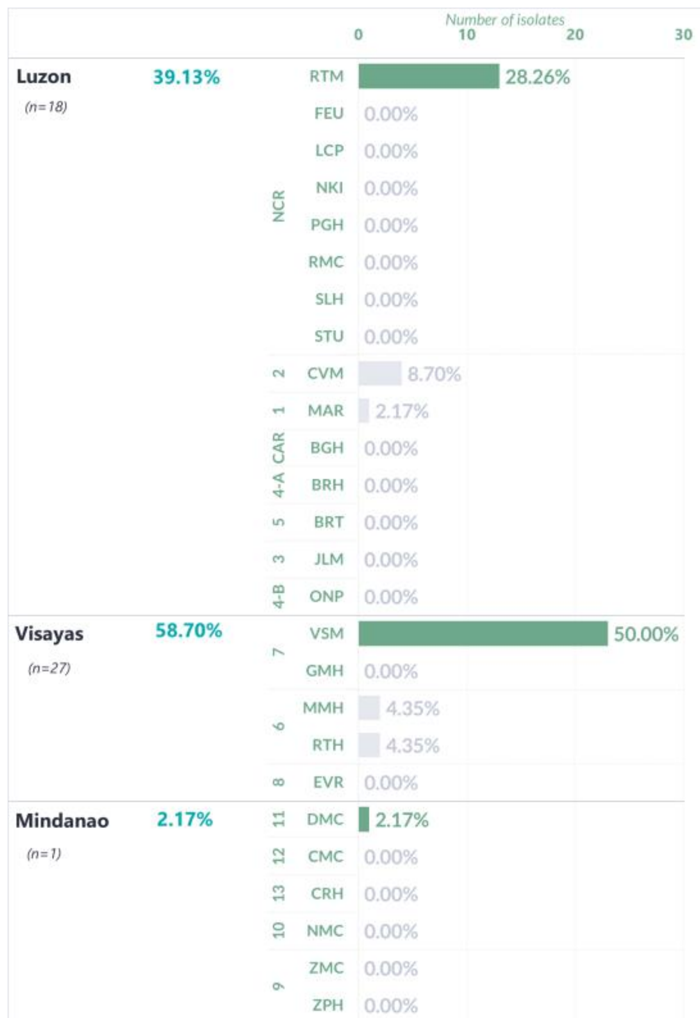
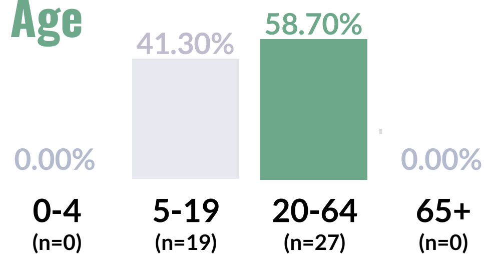



Figure 38. Isolate distribution of *N. gonorrhoeae* isolates, DOH-ARSP, 2020 (n =46)

## A. Sex

## B. Age



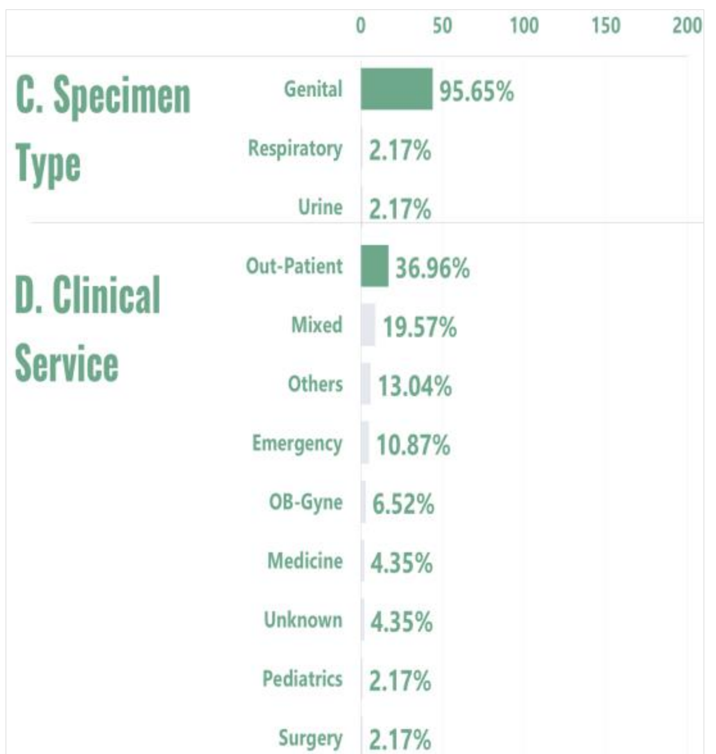




Figure 39. Patients characteristics of *N. gonorrhoeae*, DOH-ARSP, 2020 (n=46)

Majority of the isolates were from patients aged 20-64 years old (58.70%) and mostly were males (69.57%)(Figure 39).

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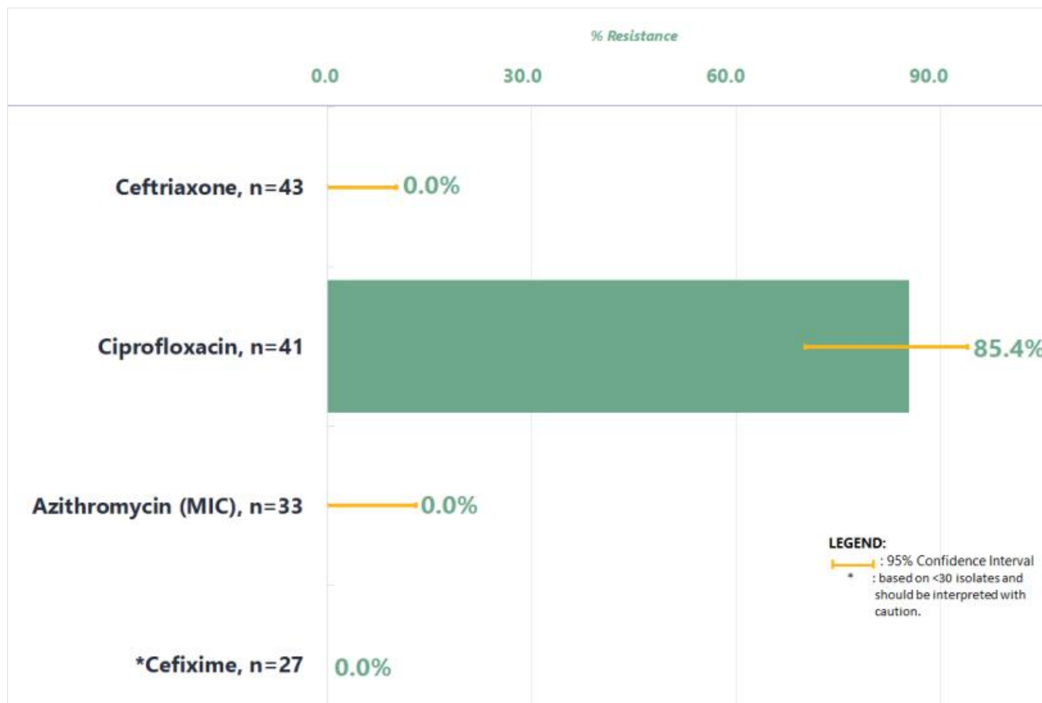


**Figure 40.** Percent resistance of *N. gonorrhoeae*, DOH-ARSP, 2020

**Figure 40** shows the resistance rates of *N. gonorrhoeae* in 2020. Ciprofloxacin resistance increased from 79.4% in 2019 to 85.4% in 2020 (p= 0.3955). As in the past years, no resistance to ceftriaxone, cefixime and azithromycin was seen in 2020.

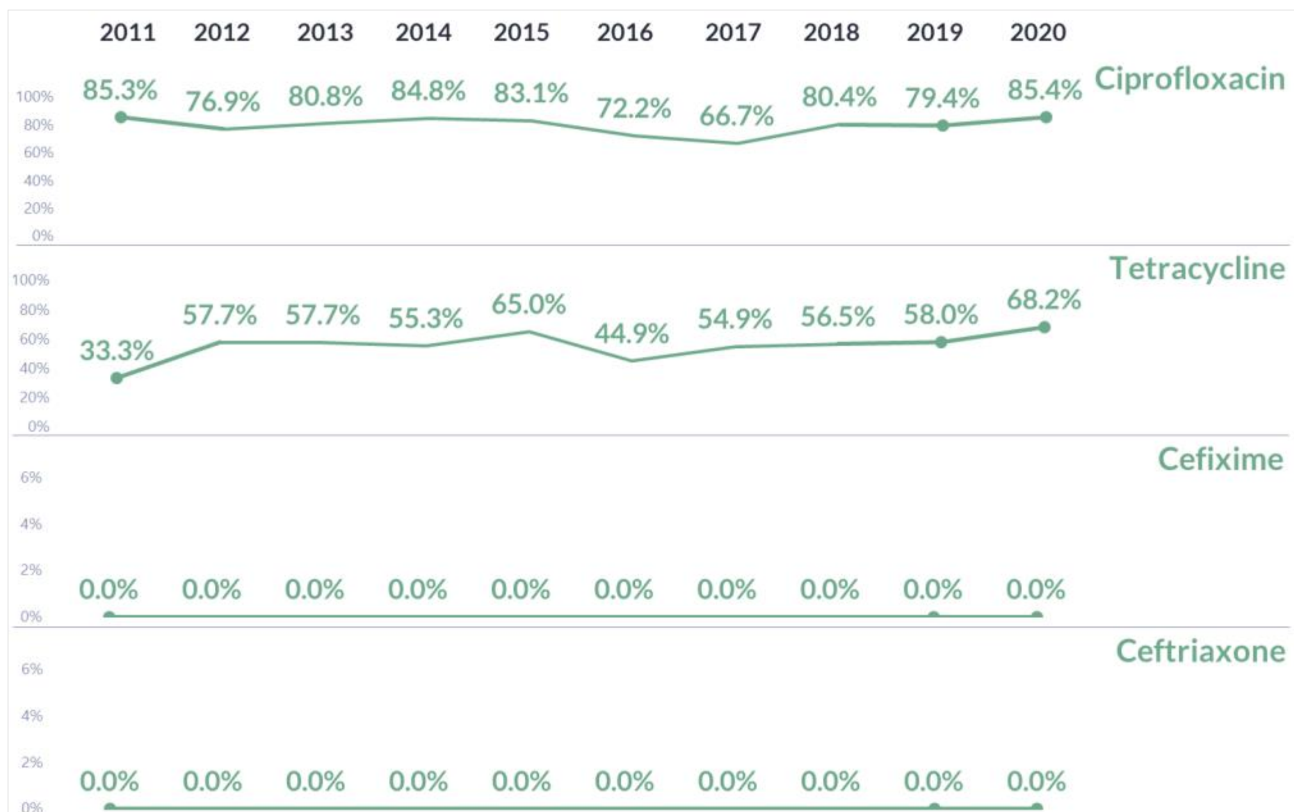


**Figure 41.** Yearly resistance rates of *N. gonorrhoeae*, DOH-ARSP, 2011-2020

**Figure 41** shows the yearly resistance rate of *N. gonorrhoeae*. Resistance rate to ciprofloxacin decreased in 2017 at 66.7% but an increase in rate were noted in the last two years but were not statistically significant. Tetracycline resistance followed an increasing trend in the last four years (p= 0.3687). Fluctuations on yearly resistance rates were seen for nalidixic acid.

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# *Staphylococcus aureus*

A total of 3,989 *S. aureus* isolates were reported in 2020. This was 47.63% less than the 7,617 isolates reported in 2019. The largest contributor of *S. aureus* isolates in 2020 were VSM (13.24%), DMC (12.01%) and JLM (10.55%). Luzon showed the highest number of reported isolates at 52.22% with 17.76% coming from NCR, Visayas at 25.29% and Mindanao at 22.49% (Figure 42).

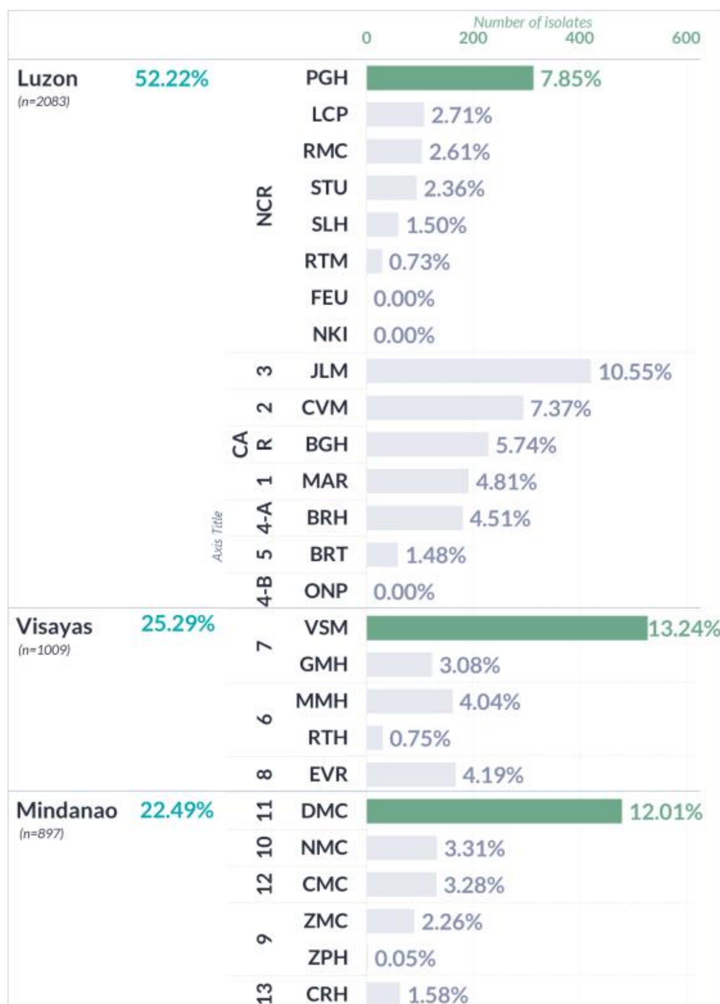


Figure 42. Isolate distribution of *S. aureus*, DOH-ARSP, 2020 (n =3,989)

## A. Sex

58.81% Male (n=2346)

41.06% Female (n=1638)

No Data: 0.13% (n=5)

## B. Age

| 0-4 (n=467) | 5-19 (n=478) | 20-64 (n=2484) | 65+ (n=557) |
|---|---|---|---|
| 11.71% | 11.98% | 62.27% | 13.96% |

No Data: 0.08% (n=3)

## C. Infection Type

80.52% Community Acquired (n=3212)

13.61% Hospital Acquired (n=543)

Unknown: 5.87% (n=234)

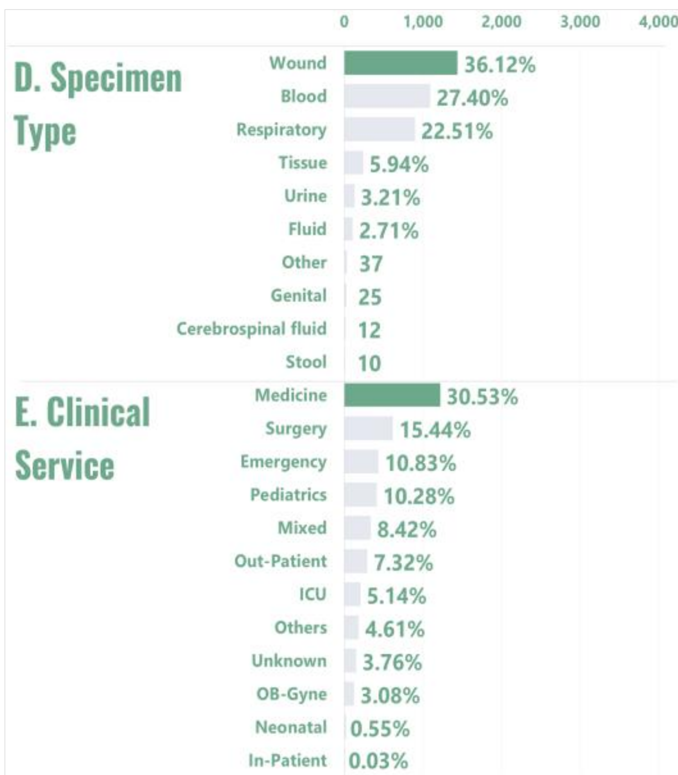


Figure 43. Patients characteristics of *S. aureus*, DOH-ARSP, 2020 (n=3,989)

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More than half (62.27%) of the *S. aureus* isolates were from patients age 20-64 years old, and most were from males (58.81%). Most (36.12%) *S. aureus* were isolated from wound and were community acquired (80.52%)(Figure 43).

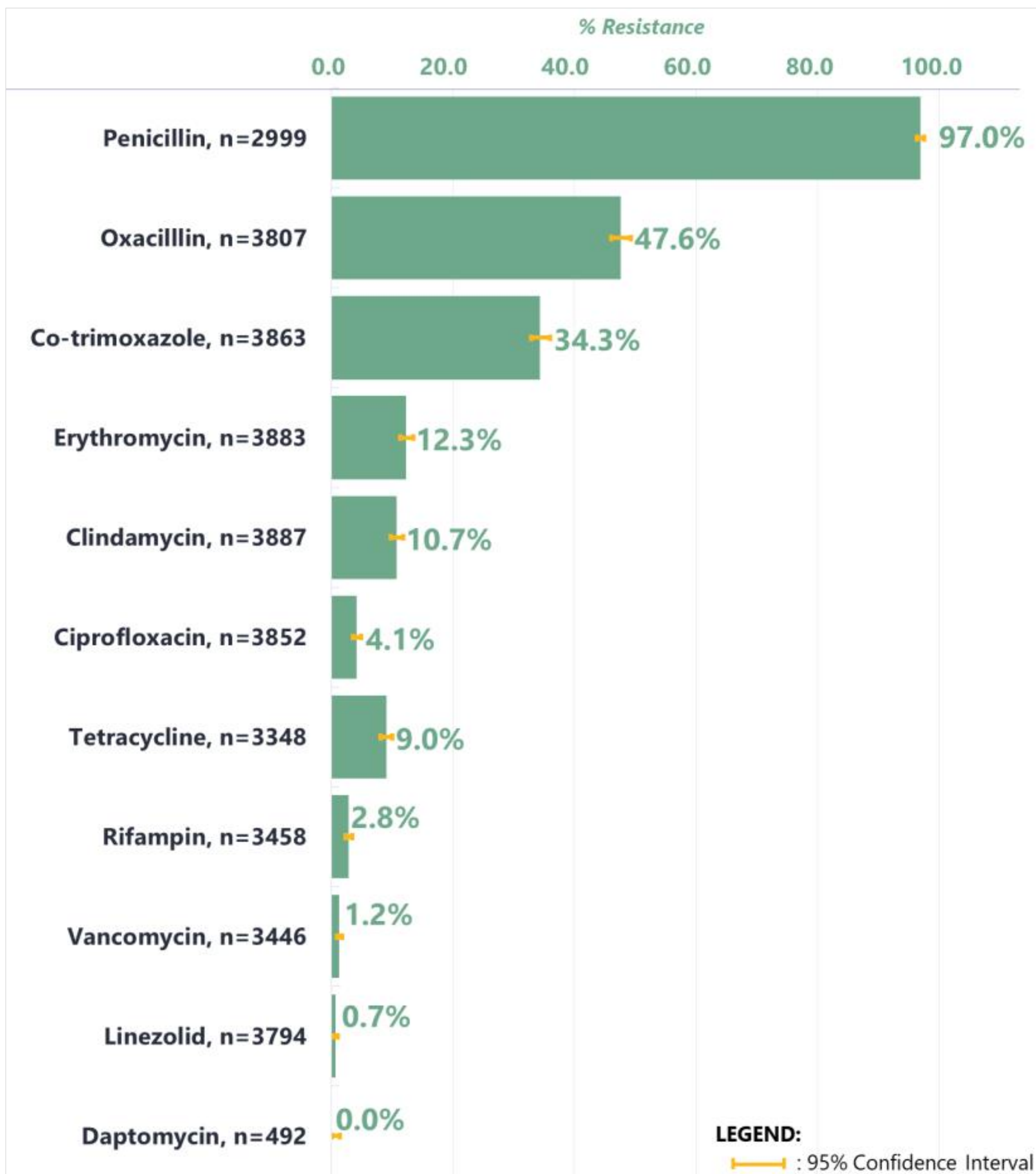


Figure 44. Percent resistance of *S. aureus*, DOH-ARSP, 2020

The overall cumulative resistance rates of *S. aureus* reported for 2020 are shown in Figure 44. Oxacillin resistance was at 47.6% (n=3,807) and co-trimoxazole at 34.3% (n=3,863). Erythromycin resistance was at 12.3% (n=3,883) and clindamycin at 10.7% (n=3,887). Resistance to ciprofloxacin, tetracycline, and rifampin were less than 10%. Resistance to vancomycin was at 1.2% (n=3,446) and 0.7% to linezolid (n=3,794). No daptomycin resistance was recorded for 2020.

There was one isolate confirmed to be non-susceptible to daptomycin. This was isolated from a wound of 51—year old male. The isolate was resistant to oxacillin and ciprofloxacin but susceptible to co-trimoxazole, erythromycin, linezolid, and vancomycin.

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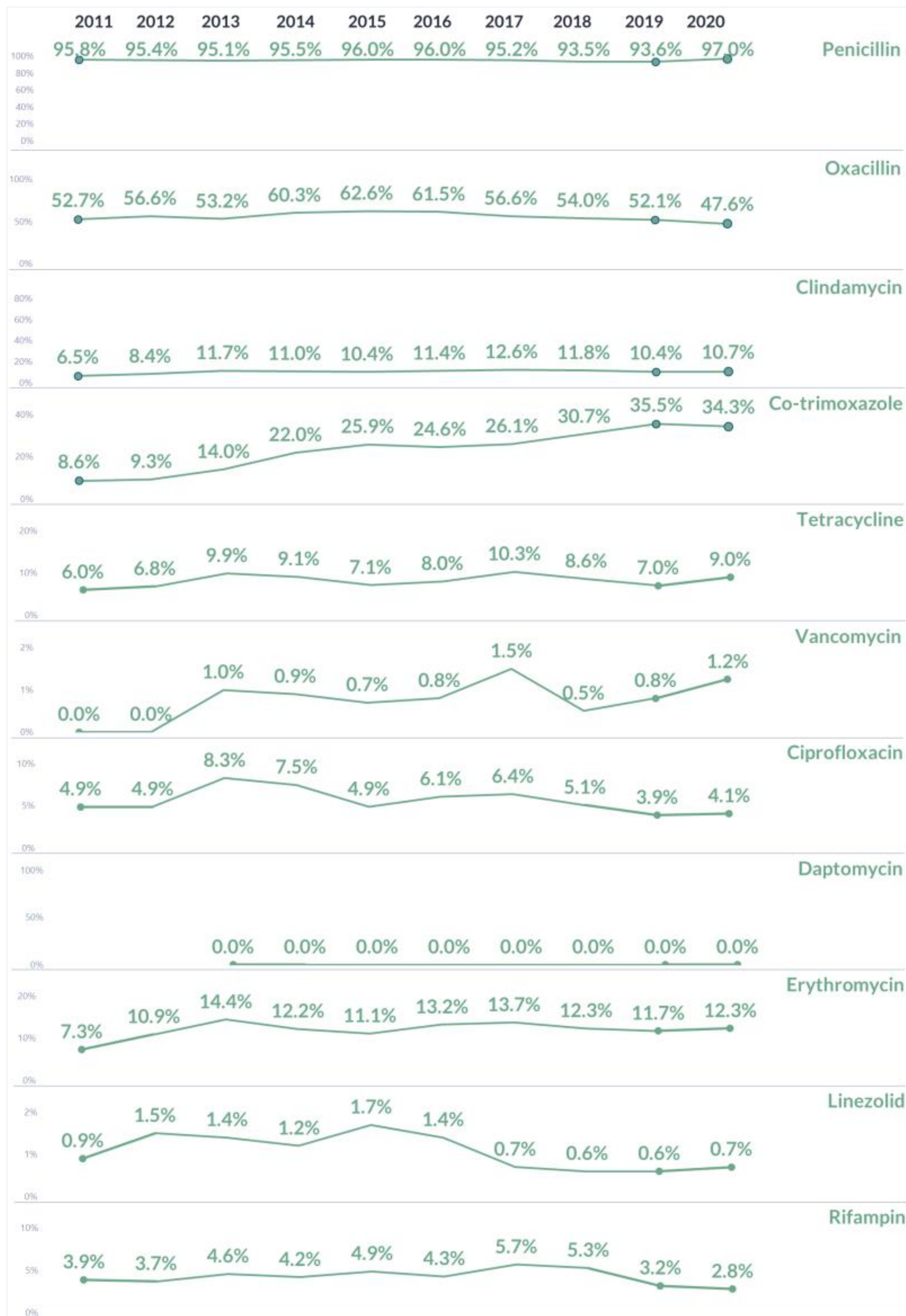


**Figure 45.** Yearly resistance rates of *S. aureus*, DOH-ARSP, 2011-2020

Yearly resistance rates for *S. aureus* are shown in **Figure 45**. Oxacillin resistance continued to decrease to 47.6% from 52.1% in 2019 and the change was noted to be statistically significant. Decrease in rates for 2020 were also seen for co-trimoxazole and rifampin but were not statistically significant. The increase in the resistance rates for vancomycin and linezolid were not statistically significant.

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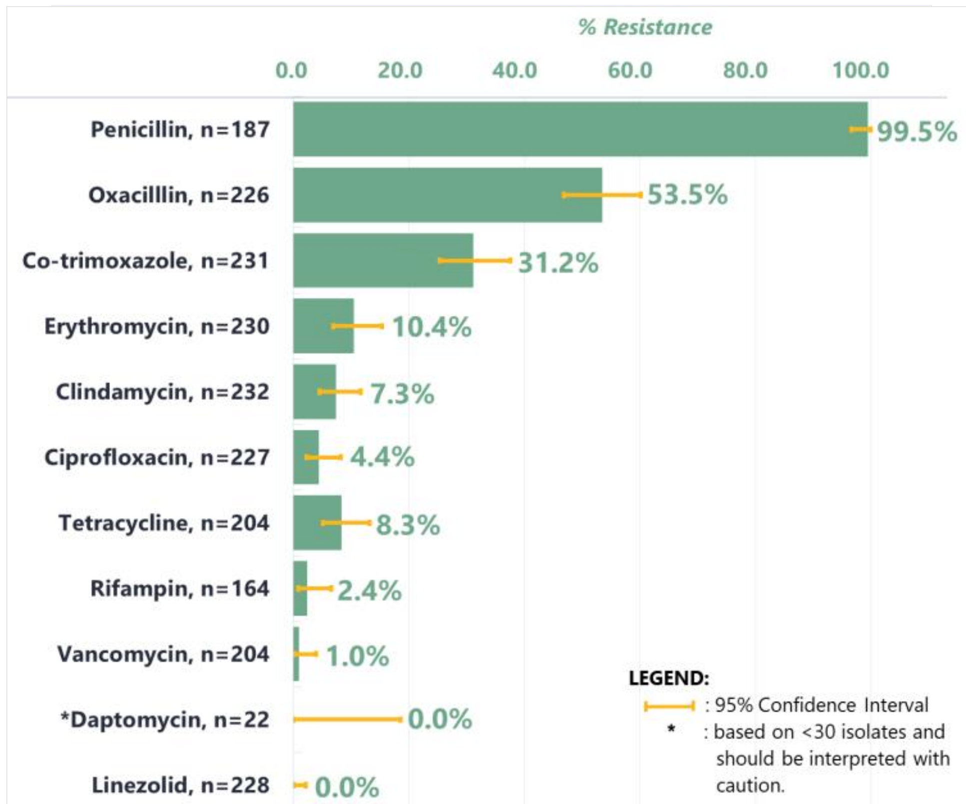


Figure 46. Percent resistance of *S. aureus* skin and soft tissues isolates, DOH-ARSP, 2020

Figure 46 shows the resistance rates of *S. aureus* isolates from skin and soft tissues. Penicillin resistance was high at 99.5% (n=187) followed by oxacillin at 53.5% (n=226) and co-trimoxazole at 31.2% (n=231). Resistance to the following antibiotics were less than 15%: erythromycin (10.4%), clindamycin (7.3%), ciprofloxacin (4.4%), tetracycline (8.3%), and rifampin (2.4%). Resistance to vancomycin was at 1.0%. No *S. aureus* soft tissue isolates was found to be resistant against linezolid.

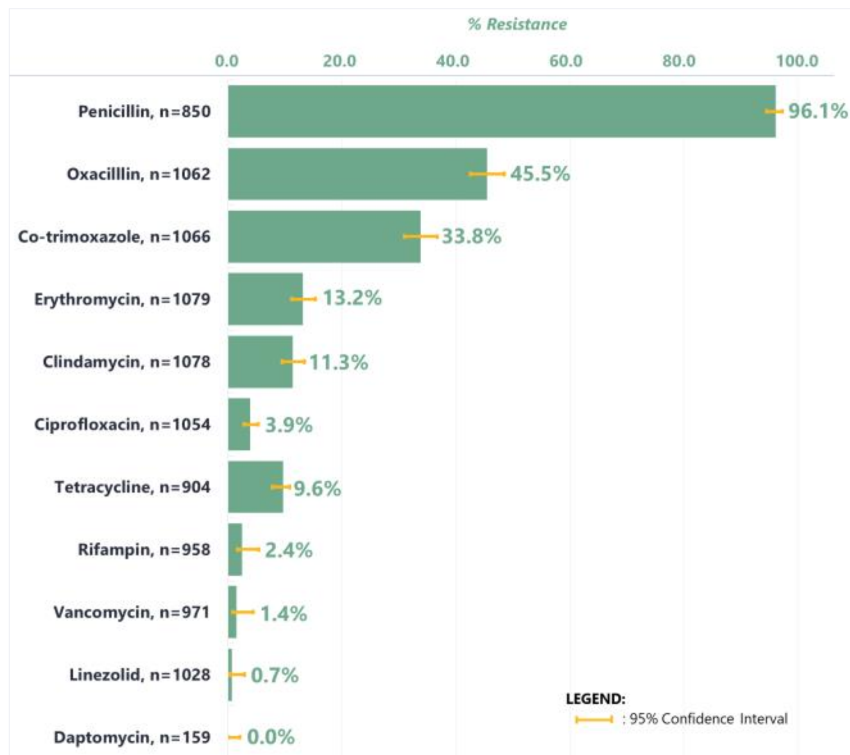


Figure 47. Percent resistance of *S. aureus* blood isolates, DOH-ARSP, 2020

Figure 47 shows the resistance rates of *S. aureus* from blood isolates. Highest resistance rate was detected for penicillin at 96.1% (n=850), followed by oxacillin at 45.5% (n=1,062) and co-trimoxazole at 33.8% (n=1,066). Resistance to ciprofloxacin was at 3.9%, 2.4% to rifampin, 1.4% to vancomycin and 0.7% to linezolid. No resistance to daptomycin was noted among the *S. aureus* blood isolates.

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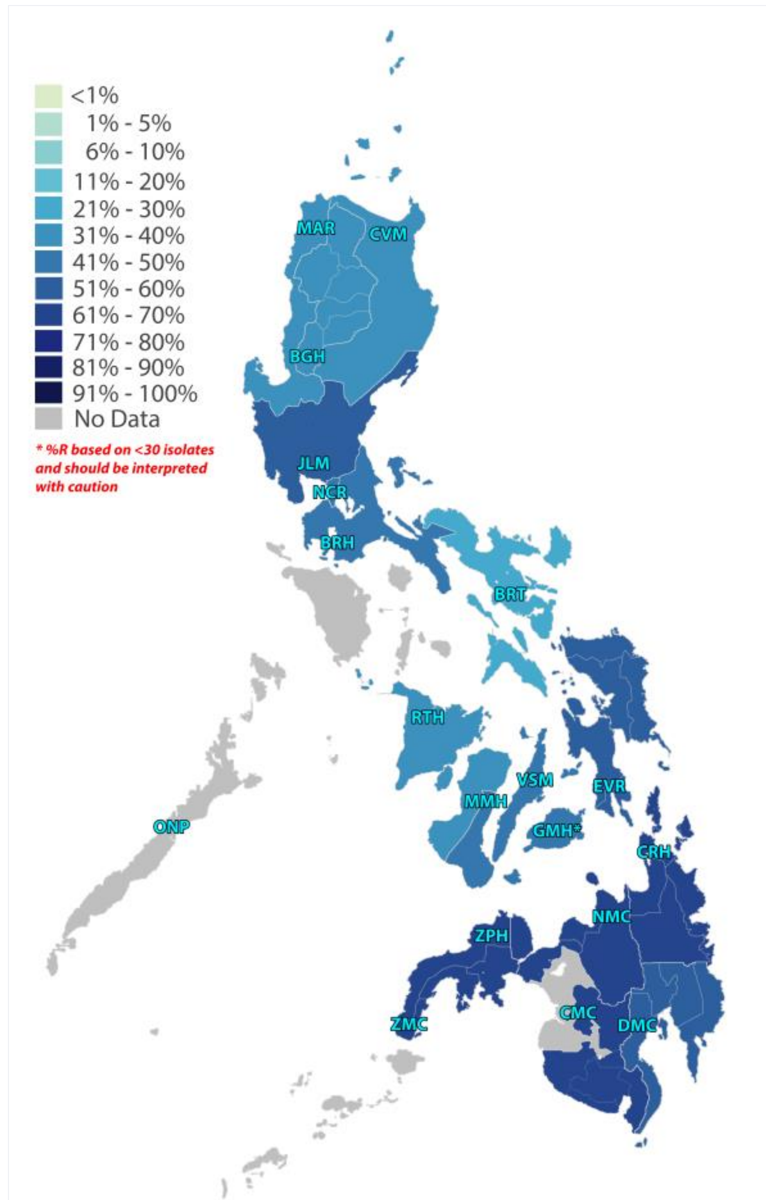


**Figure 48.** Geographic distribution of oxacillin-resistant *S. aureus* in the Philippines, DOH-ARSP, 2020

**Figure 48** shows the oxacillin resistance rates across the different regions in the country. Most sentinel sites from Mindanao have MRSA rates in the range of 61-85% while most sentinel sites from the Visayas have MRSA rates in the range of 46-60%. Most of the sites from northern Luzon have MRSA rates in the range of 31-45%.

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# Methicillin Resistant *Staphylococcus aureus*

There were 1,662 methicillin resistant *Staphylococcus aureus* (MRSA) isolates reported for 2020. Largest contributors for MRSA isolates include VSM (15.88%), DMC (13.90%) and JLM (13.0%) (Figure 49).

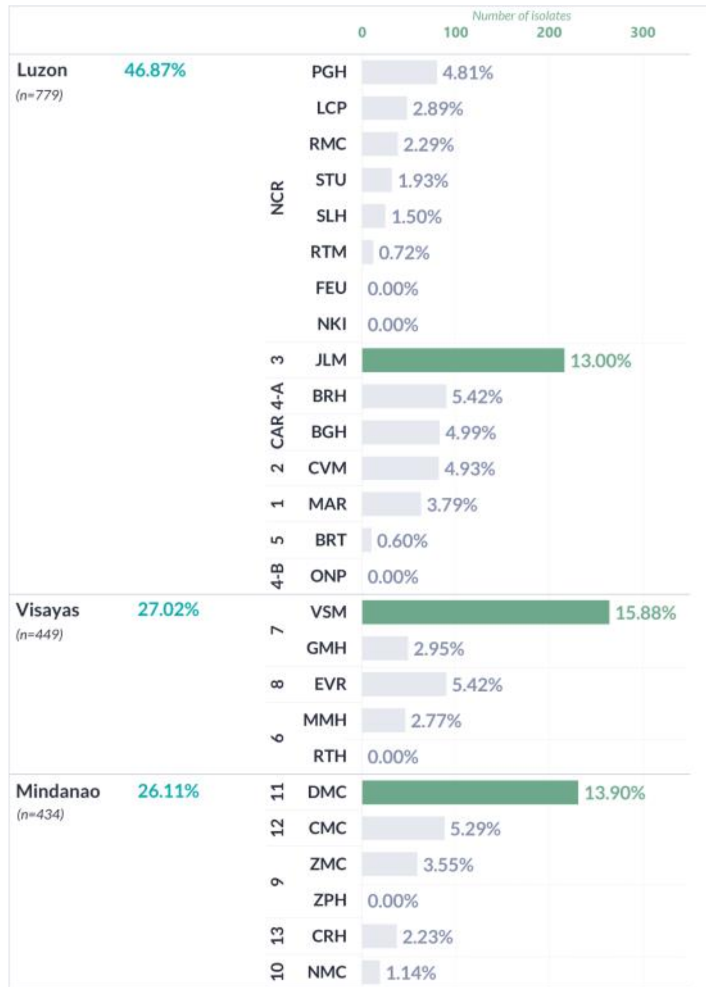
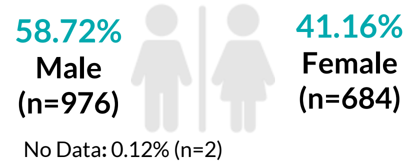


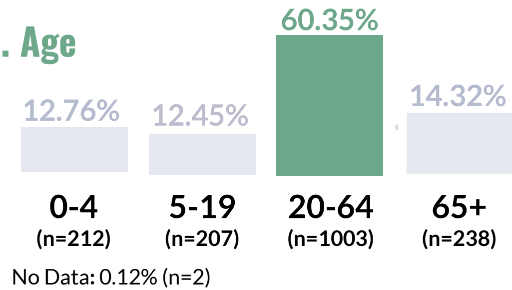

Figure 49. Isolate distribution of MRSA isolates, DOH-ARSP, 2020 (n =1,662)

## A. Sex



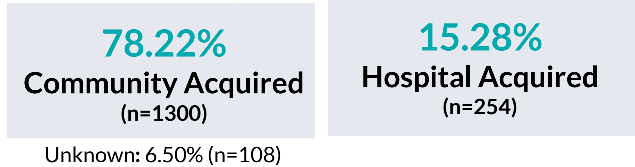

No Data: 0.12% (n=2)

## B. Age




No Data: 0.12% (n=2)

## C. Infection Type




Unknown: 6.50% (n=108)

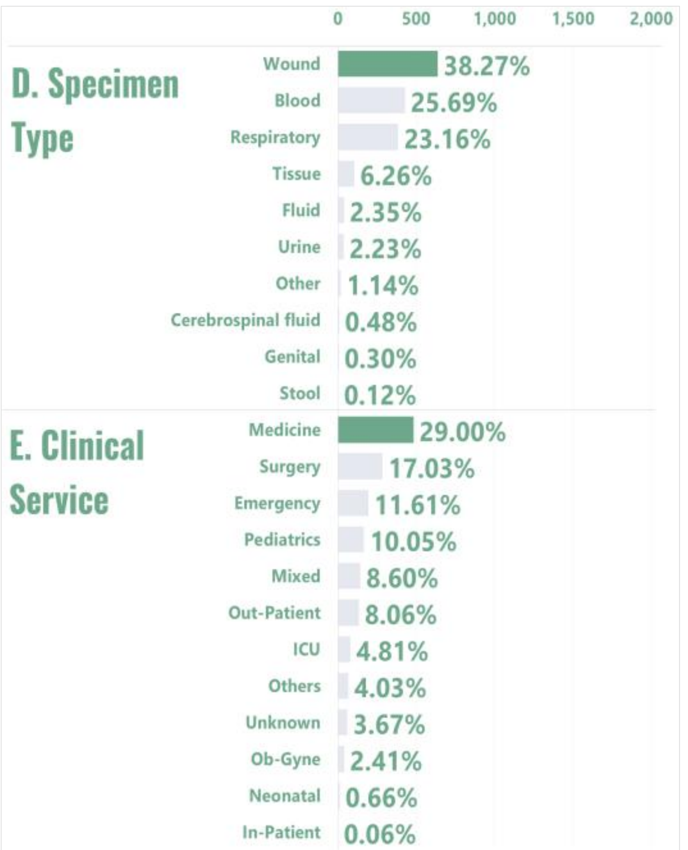



Figure 50. Patients characteristics of MRSA isolates, DOH-ARSP, 2020 (n=1,662)

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Majority (60.35%) of the isolates were from 20-64 years old, and most (58.72%) were from males. Many (38.27%) of MRSA isolates were from wound specimens, others were from blood (25.69%) and respiratory (23.16%) specimens. Majority (78.22%) of the cases were community acquired (Figure 50).

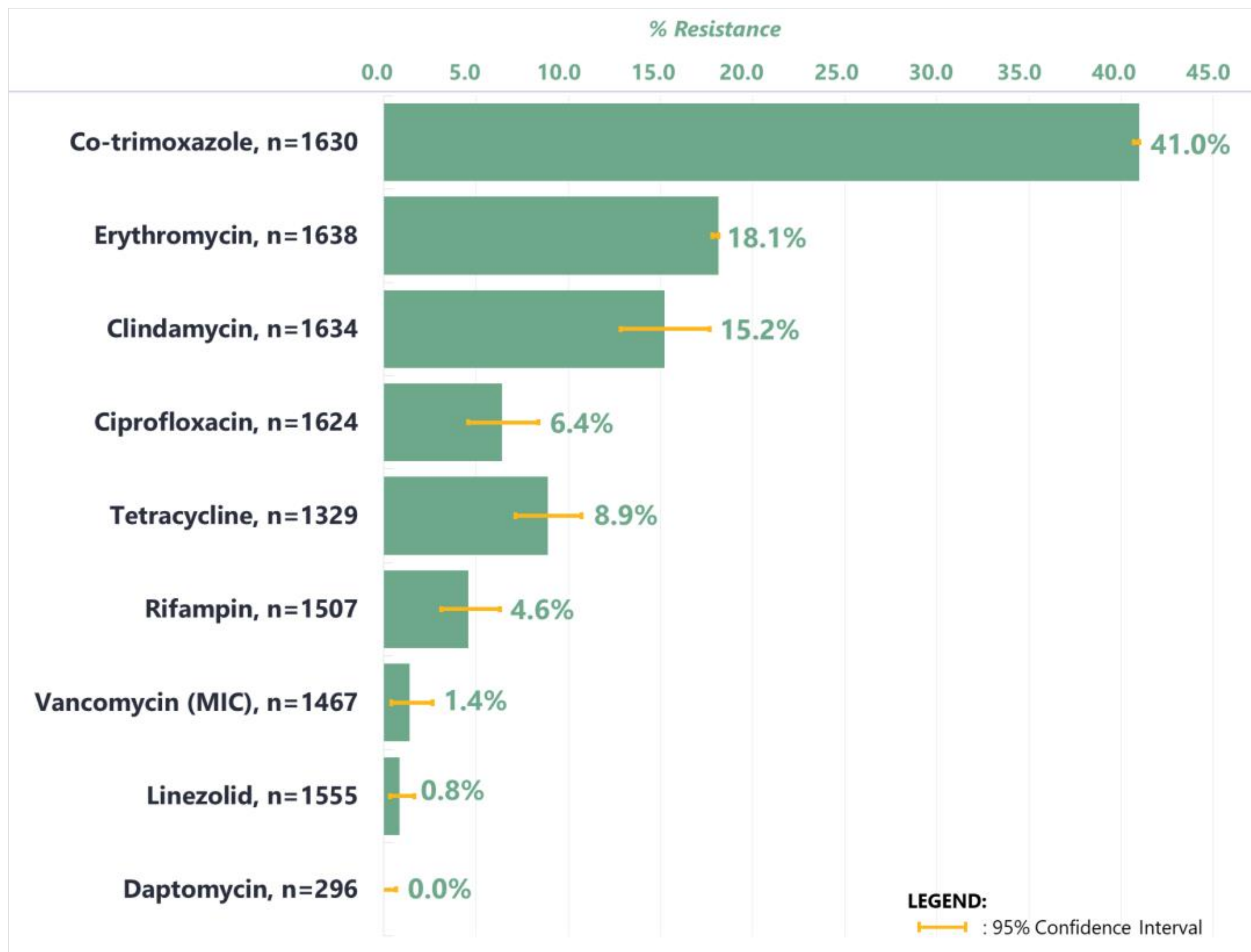


Figure 51. Percent resistance of MRSA, DOH-ARSP, 2020

The cumulative resistance rates of MRSA isolates from all specimens are shown in Figure 51. Co-trimoxazole resistance was at 41.0% (n=1,630), a slight increase in the rate from 2019 at 39.5% (n=3,402). Resistance to erythromycin was at 18.1%, to clindamycin at 15.2% and to tetracycline at 8.9%. Resistance to rifampin was at 4.6%, vancomycin at 1.4% and linezolid at 0.8%.

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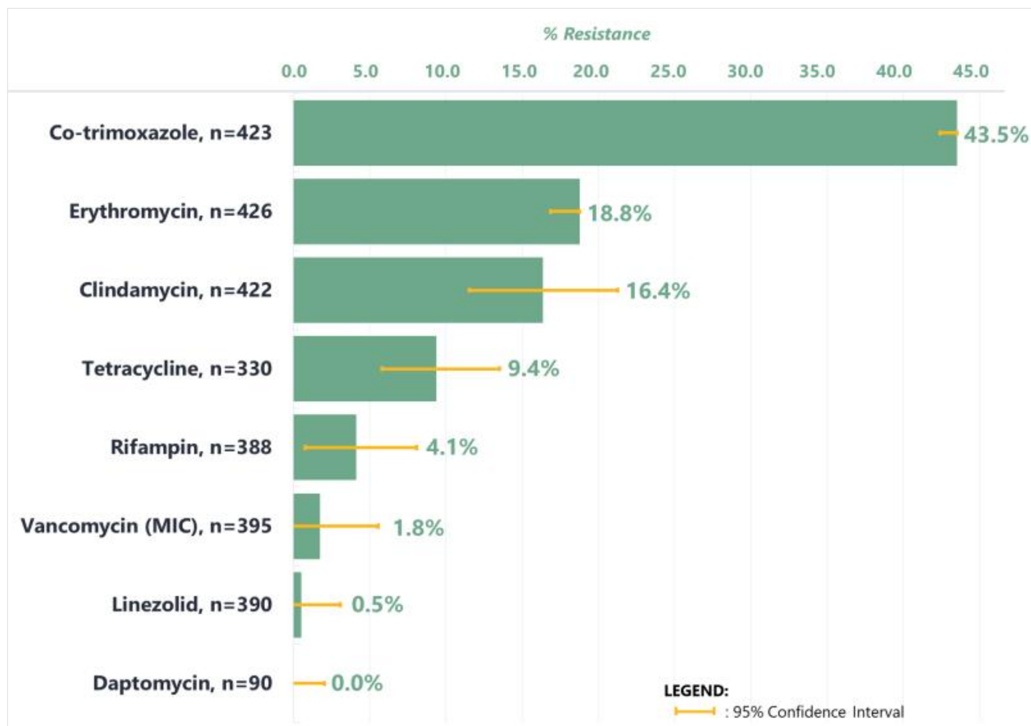


Figure 52. Percent resistance of MRSA blood isolates, DOH-ARSP, 2020

Figure 52 shows the resistance rates of MRSA isolates from blood specimens. Co-trimoxazole was at 43.5% (n=423), 18.8% for erythromycin and 9.4% for tetracycline. The resistance to following antibiotics remained low: rifampin (4.1%), vancomycin (1.8%), linezolid (0.5%). No daptomycin-resistant MRSA isolate was detected in blood.

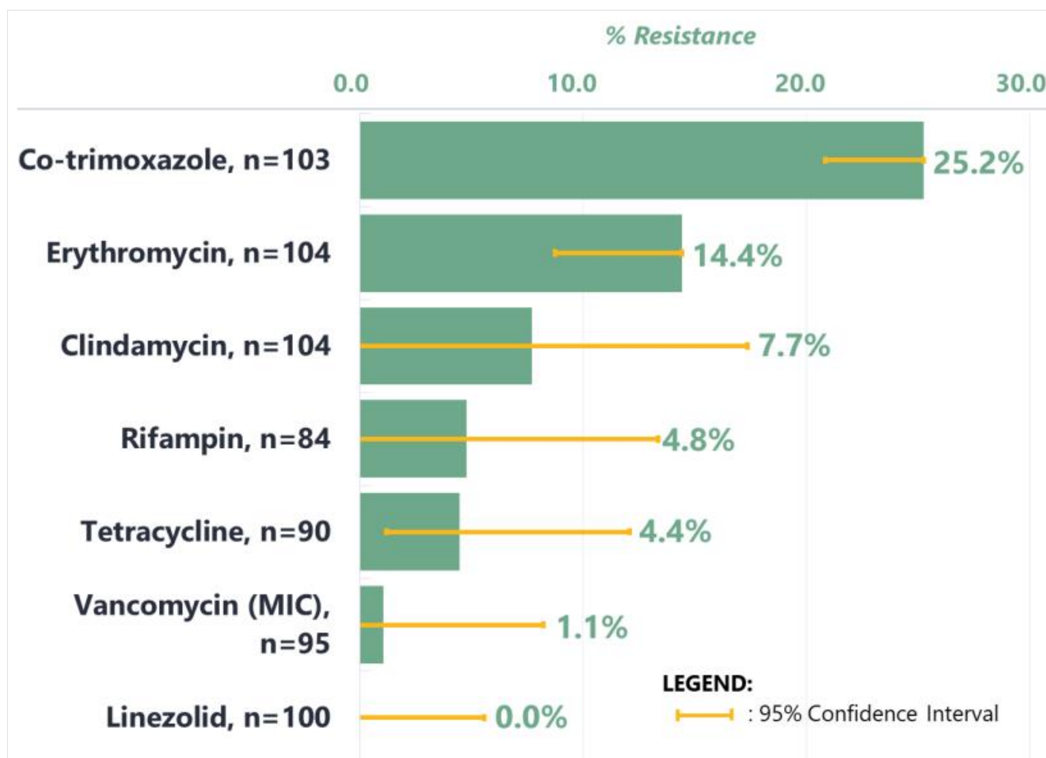


Figure 53. Percent resistance of MRSA tissue isolates, DOH-ARSP, 2020

Figure 53 shows the resistance rates of MRSA isolates from skin and soft tissue sample. Co-trimoxazole resistance was at 25.2% (n=103) and 14.4% for erythromycin. Resistance to rifampin was at 4.8%. Tetracycline resistance was at 4.4% and vancomycin at 1.1%. No linezolid-resistant MRSA isolate from tissue specimens was detected.

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# *Enterococcus species*

For 2020, there were a total of 2,866 isolates of *Enterococcus* species reported of which the most common were *Enterococcus faecalis* (n=51.5%) and *Enterococcus faecium* (39.1%).

# *Enterococcus faecalis*

There were 1,476 isolates of *Enterococcus faecalis* in 2020. DMC contributed most of the data in *E. faecalis* (21.41%) followed by PGH (10.84%) and MAR (10.57%). Most (55.76%) of the isolates were from Luzon (Figure 54).

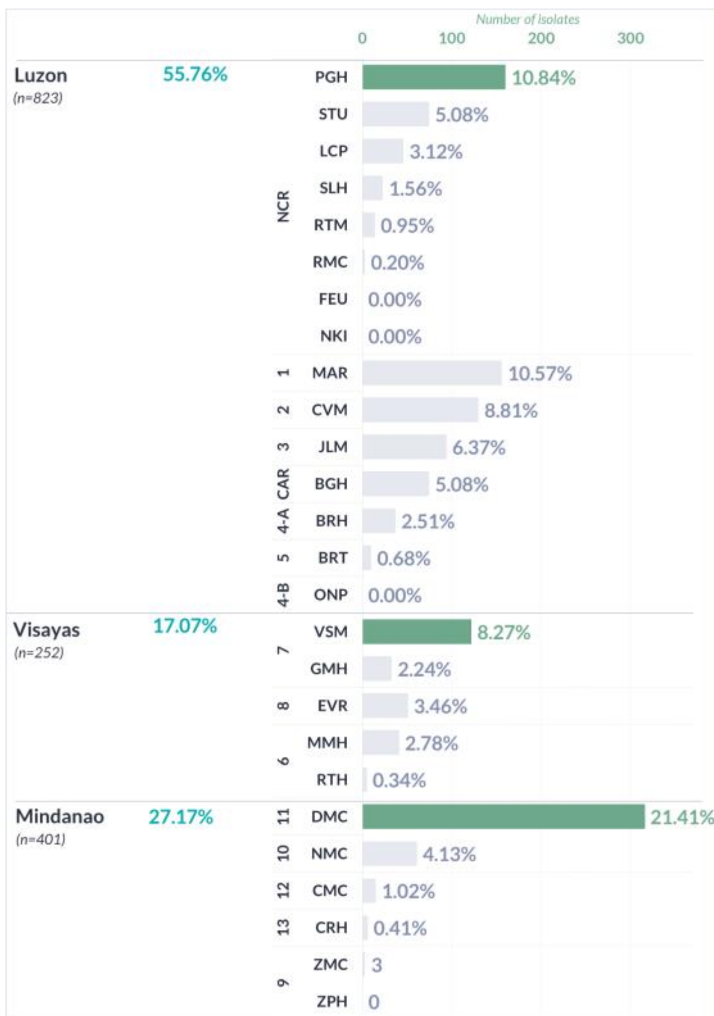
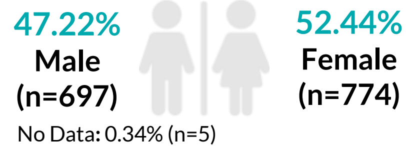
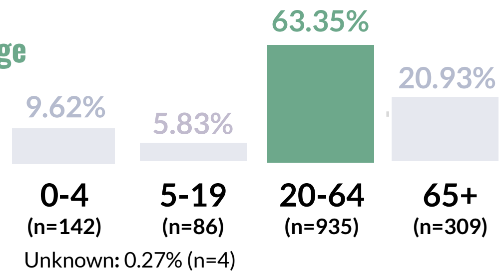



Figure 54. Isolate distribution of *E. faecalis*, DOH-ARSP, 2020 (n = 1,476)

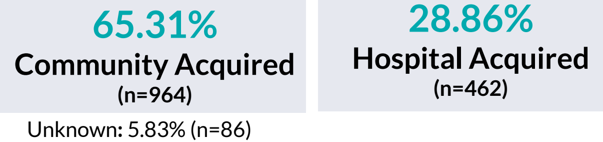
## A. Sex




## B. Age




## C. Infection Type



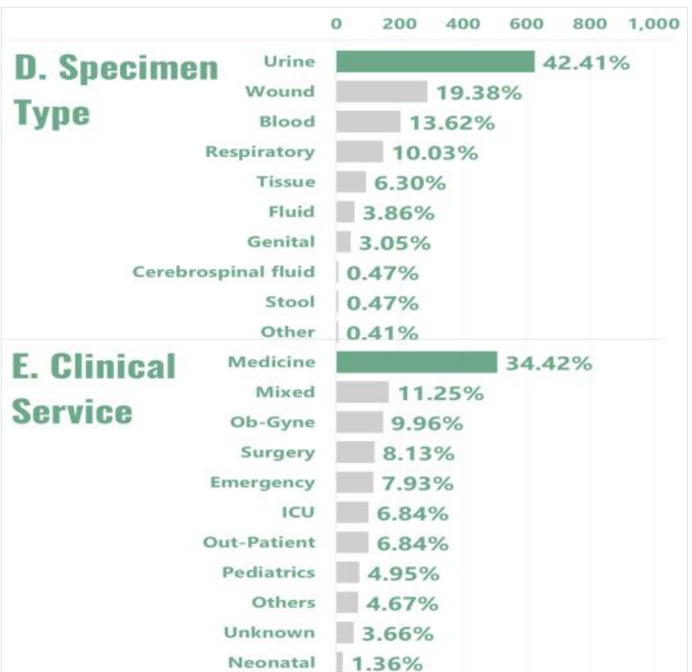




Figure 55. Patients characteristics of *E. faecalis*, DOH-ARSP, 2020 (n=1,476)

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Majority (63.35%) of the *E. faecalis* isolates were from 20-64 age group, and mostly (52.44%) from females. *E. faecalis* was mostly isolated from urine (42.41%) and most of the cases were community acquired (65.31%) (Figure 55).

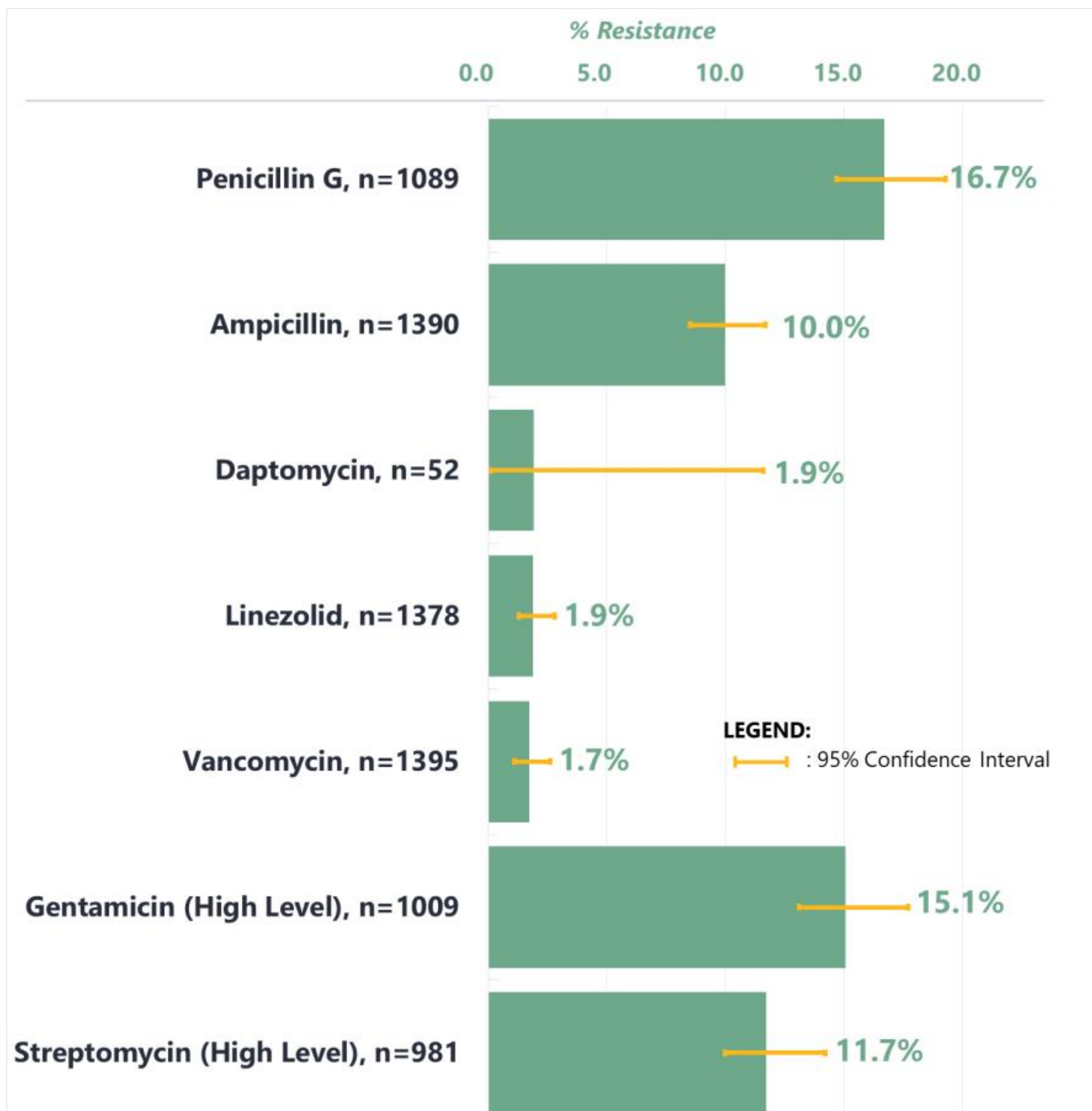


Figure 56. Percent resistance of *E. faecalis*, DOH-ARSP, 2020

Penicillin resistance among *E. faecalis* was at 16.7% (n=1089) while ampicillin resistance was at 10% (n=1390) (Figure 56). Daptomycin resistance was at 1.9%, vancomycin resistance at 1.7% (p=0.8198), and linezolid resistance at 1.9% (p=0.8384). High level resistance to gentamicin was at 15.1% and to streptomycin at 11.7%.

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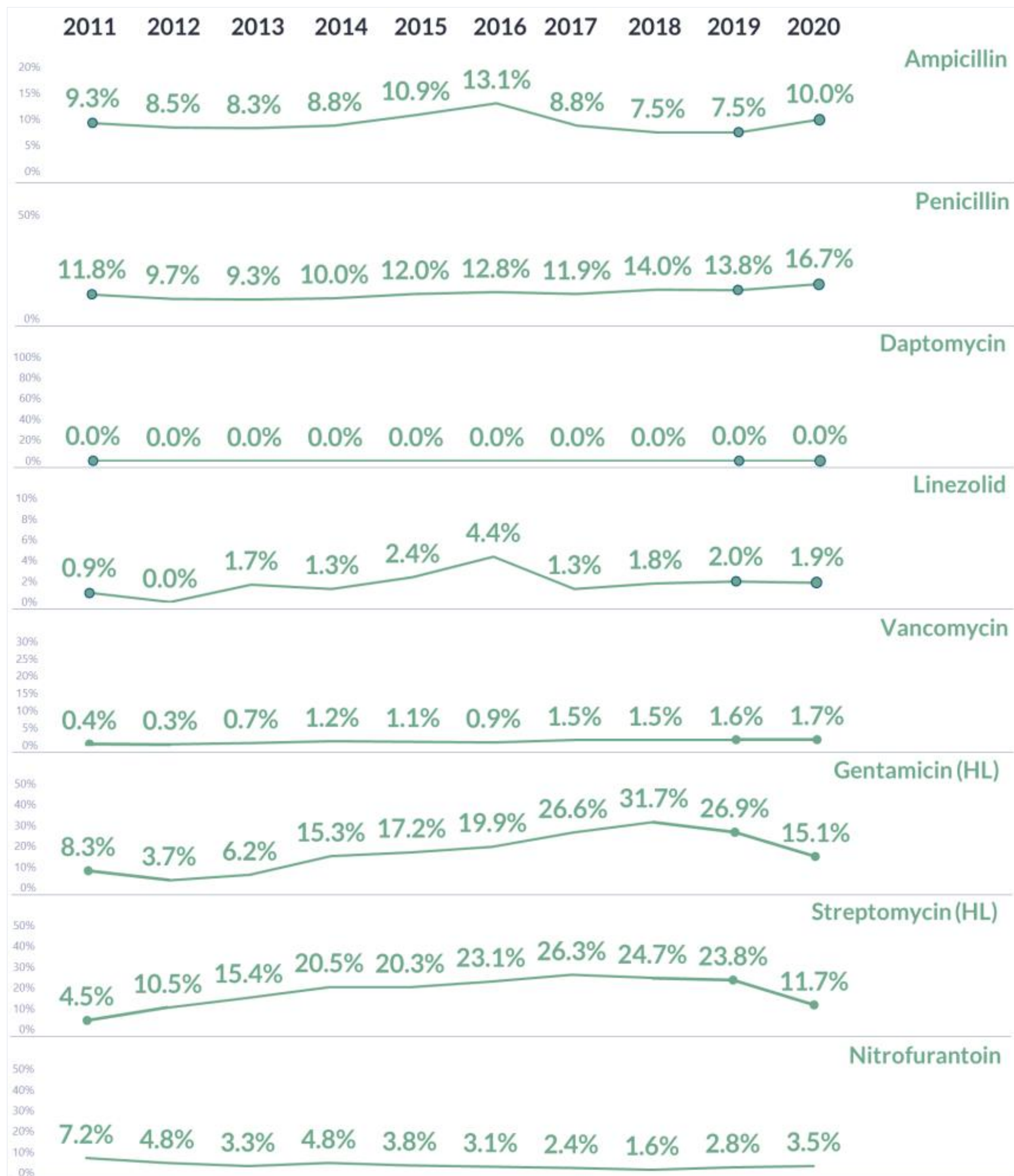


**Figure 57.** Yearly resistance rates of *E. faecalis*, DOH-ARSP, 2011-2020

**Figure 57** shows the yearly resistance rate of *E. faecalis* isolates. Ampicillin resistance started to increase to 10% in 2020 from its previous resistant rates in the last two years and the change was statistically significant. Resistance rates for linezolid, and gentamicin (high level) and streptomycin (high level) showed decreasing trend. Penicillin, linezolid and streptomycin (high level) showed fluctuating levels over the past ten years. Linezolid resistance remained below 5% for the past 10 years.

Resistance to gentamicin (High Level) decreased from 26.9% (n=1,580) in 2019 to 15.1% (n=1,009) in 2020, the difference was noted to be significant (p=0.0001). This was also seen in the resistance pattern of *E. faecalis* against streptomycin (High Level) (11.7%) in 2020 compared from the previous year.

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There were two confirmed linezolid-resistant *E. faecalis* in 2020. These were from blood samples of two elderly males. One was susceptible to ampicillin, daptomycin, high level aminoglycosides and vancomycin. The other isolate was susceptible to ampicillin, daptomycin, high level gentamycin and vancomycin but intermediate to daptomycin and resistant to high level gentamicin

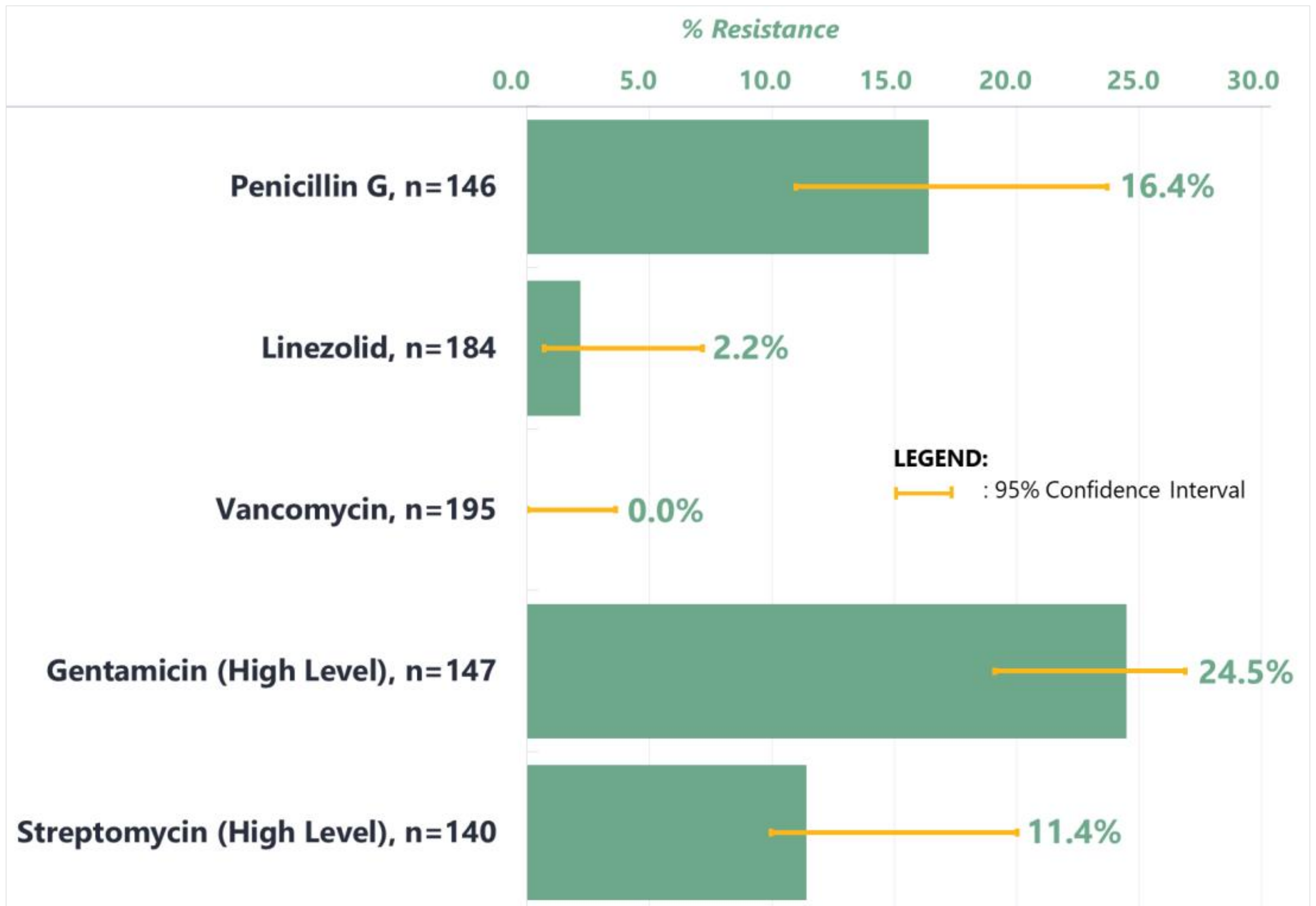


**Figure 58.** Percent resistance of *E. faecalis* blood isolates, DOH-ARSP, 2020

**Figure 58** shows the resistance rates of *E. faecalis* isolates from blood specimens. Penicillin resistance was at 16.4% and linezolid at 2.2% . Resistance rate for streptomycin (High Level) was at 11.4% in 2020 from 22.7% in 2019 with the decrease noted to be statistically significant (p=0.0140). Gentamicin (high level) resistance rate was at 24.5%. No resistance was detected for vancomycin among blood isolates.

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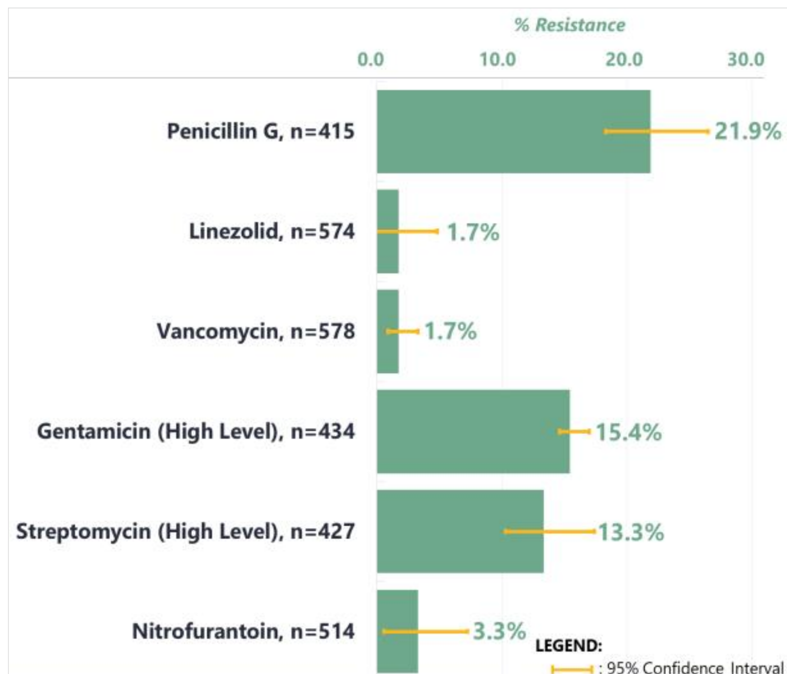


**Figure 59.** Percent resistance of *E. faecalis* urine isolates, DOH-ARSP, 2020

Penicillin resistance of *E. faecalis* urine isolates was at 21.9% (n=415), gentamicin (high level) at 15.4% (n=434) and streptomycin high level at 13.3% (n=427). Resistance to linezolid (1.7%), vancomycin (1.7%) and nitrofurantoin (3.3%) were all less than five percent.

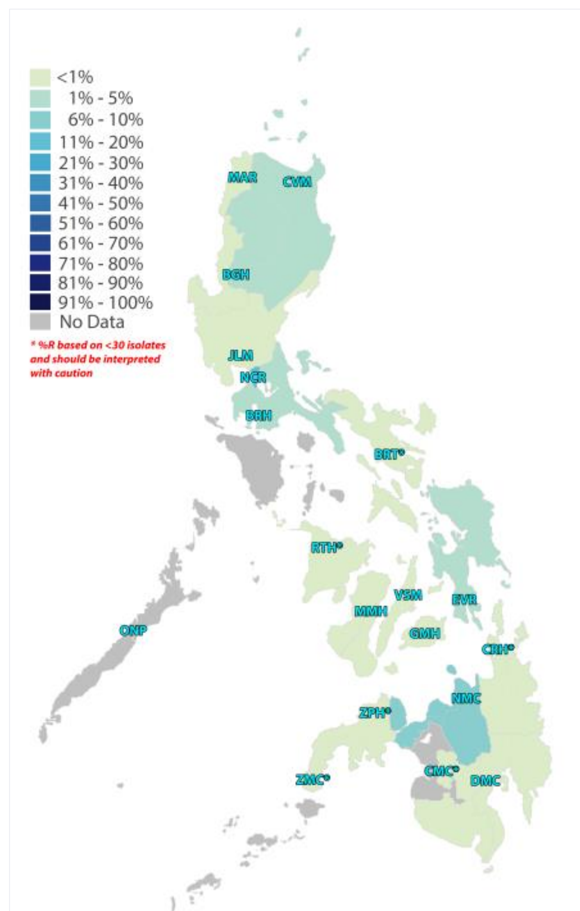


**Figure 60.** Geographic distribution of vancomycin-resistant *E. faecalis* in the Philippines, DOH-ARSP, 2020

**Figure 60** shows the geographical distribution of vancomycin-resistant *E. faecalis* isolates across the country. Most sentinel sites reported vancomycin resistance among *E. faecalis* to be less than 5% except for NMC which is at 6-10% range.



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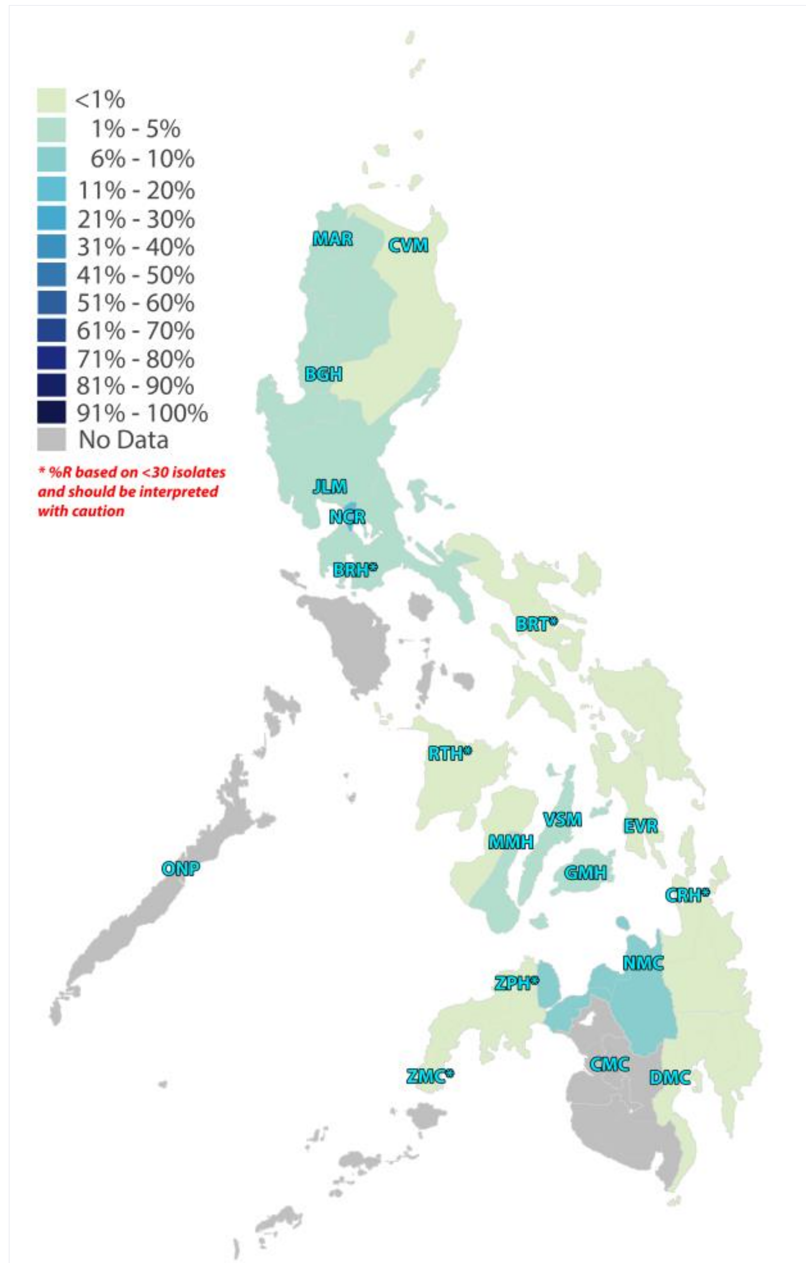


**Figure 61.** Geographic distribution of linezolid resistant *E. faecalis* in the Philippines, DOH-ARSP, 2020

**Figure 61** shows the geographical distribution of linezolid resistant *E. faecalis* isolates across the country. Most sentinel sites reported linezolid resistance among *E. faecalis* to be less than 5% except for NMC which is at 6-10% range.

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# Enterococcus faecium

There were 1,120 isolates of *E. faecium* in 2020. Highest contribution of *E. faecium* isolates came from PGH (23.39%), DMC (21.07%) and VSM (9.29%). Based on island group distribution, Luzon (57.77%) contributed most to the number of *E. faecium* isolates, with 33.5% coming from NCR (Figure 62).

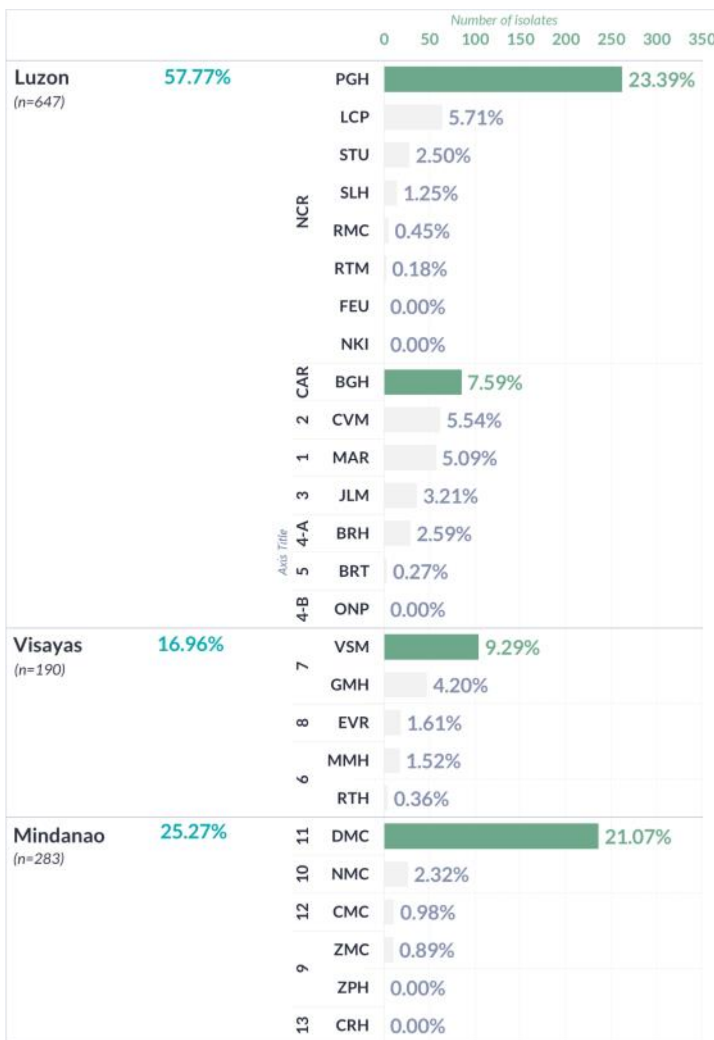
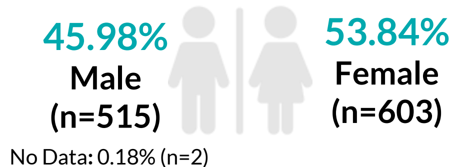


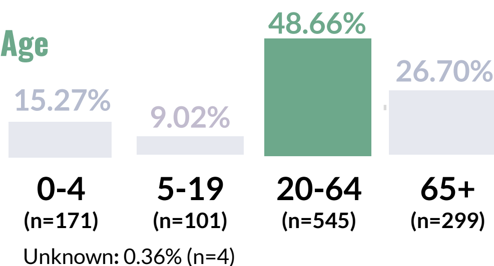

Figure 62. Isolate distribution of *E. faecium* isolates, DOH-ARSP, 2020 (n = 1,120)

## A. Sex



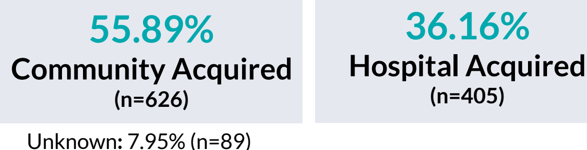

No Data: 0.18% (n=2)

## B. Age




Unknown: 0.36% (n=4)

## C. Infection Type




Unknown: 7.95% (n=89)

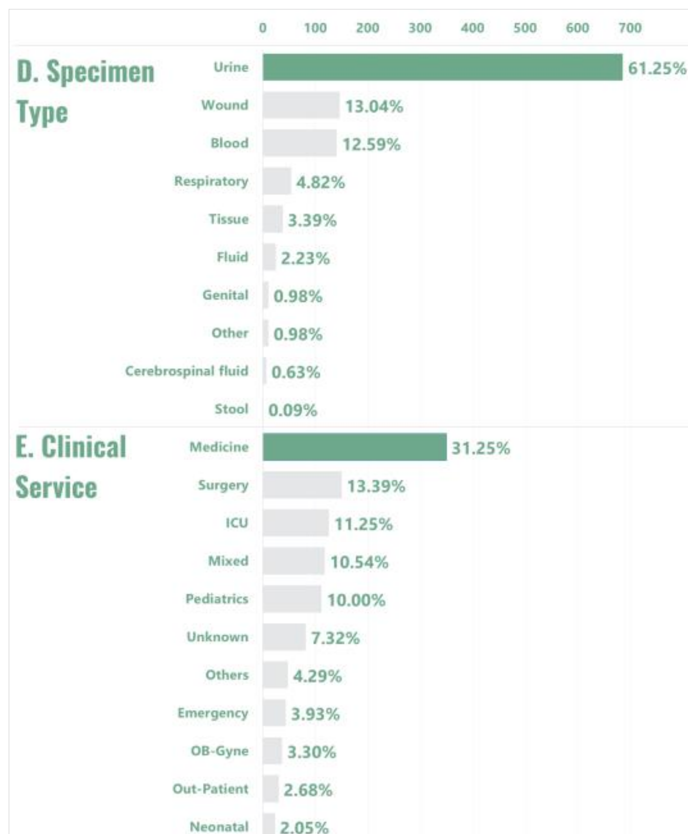



Figure 63. Patients characteristics of *E. faecium* isolates, DOH-ARSP, 2020 (n=1,120)

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Many (48.66%) of the isolates were from the 20-64 age group, and mostly from females (53.84%). Majority (61.25%) of *E. faecium* isolates were from urine specimens followed by wound (13.04%) and blood (12.59%). Most (55.89%) cases were community acquired (Figure 63).

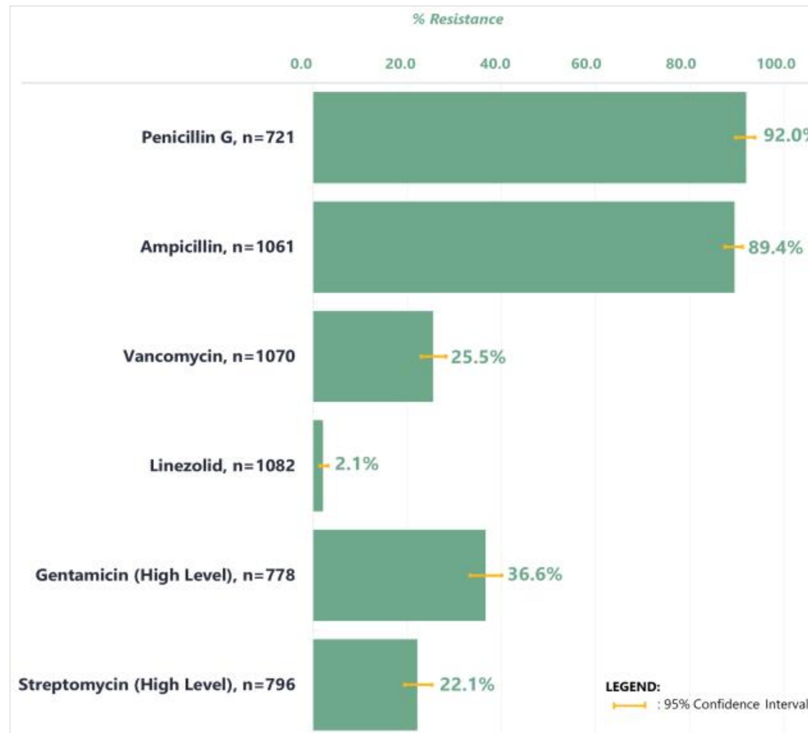


Figure 64. Percent resistance of *E. faecium*, DOH-ARSP, 2020

The cumulative resistance rates of *E. faecium* are shown in Figure 64. Ampicillin resistance rate was at 89.4% and linezolid at 2.1%. Gentamicin (High Level) decreased from 65.2% in 2019 to 36.6% in 2020 and the change was statistically significant (p=0.0000). Streptomycin (High Level) also decreased from 45.2% in 2019 to 22.1% in 2020 (p=0.0000). Vancomycin and linezolid resistance rates were 25.5% and 2.1% respectively.

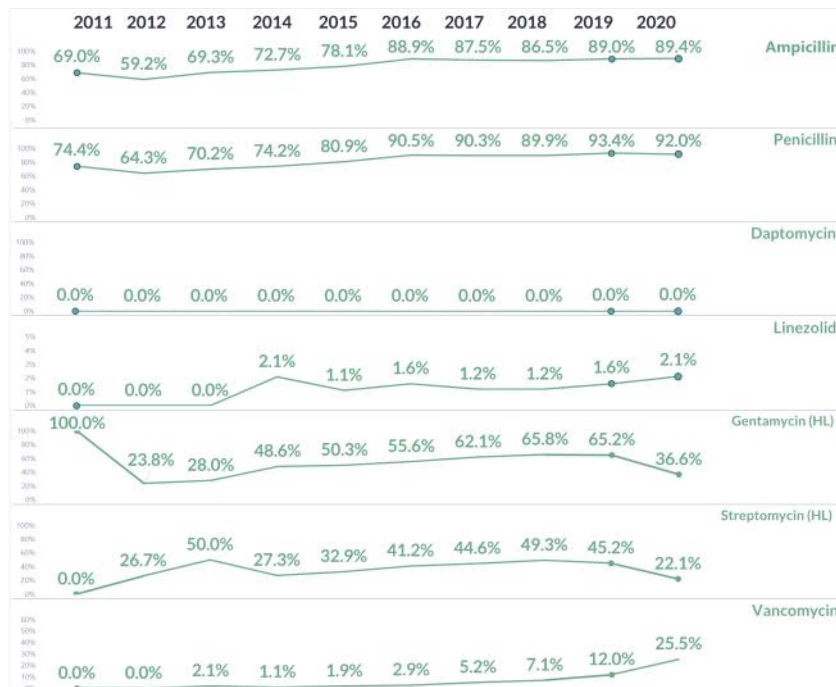


Figure 65. Yearly resistance rates of *E. faecium*, DOH-ARSP, 2011-2020

Penicillin resistance was at high level in the past ten years (Figure 65). Linezolid and vancomycin resistance showed increasing trend from 2011-2020. High resistance rates patterns in gentamicin (HL) decreased by 28.6%. Streptomycin (HL) resistance also decreased by 1.4%. Decrease for both gentamicin (HL) and streptomycin (HL) is statistically significant.

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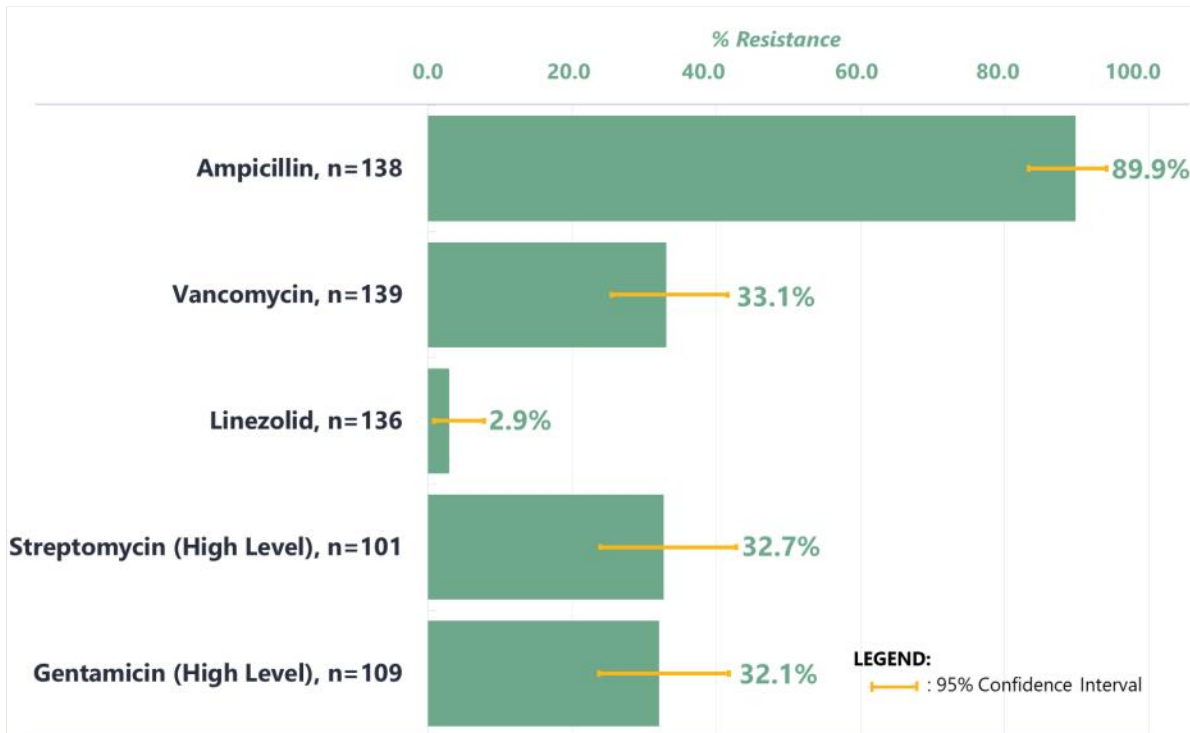


**Figure 66.** Percent resistance of *E. faecium* blood isolates, DOH-ARSP, 2020

**Figure 66** shows the antimicrobial resistance rate of *E. faecium* isolates from blood. Ampicillin resistance was at 89.9% (n=138) followed by vancomycin at 33.1% (n=139) and streptomycin (HL) at 32.7% (n=101).

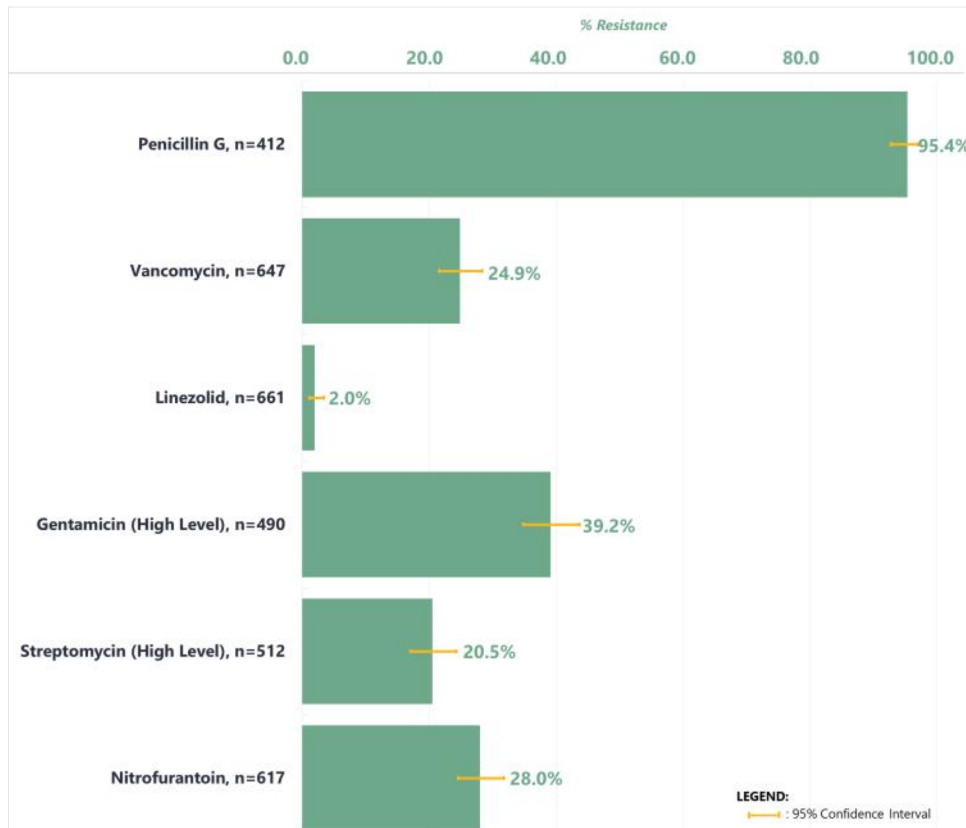


**Figure 67.** Percent resistance of *E. faecium* urine isolates, DOH-ARSP, 2020

**Figure 67** shows the resistance rates of *E. faecium* isolates from urine samples. Penicillin resistance was at 95.4% (n=412). Resistance rates to gentamicin(HL), streptomycin (HL) and nitrofurantoin were at 39.2%, 20.5% and 28.0% respectively.

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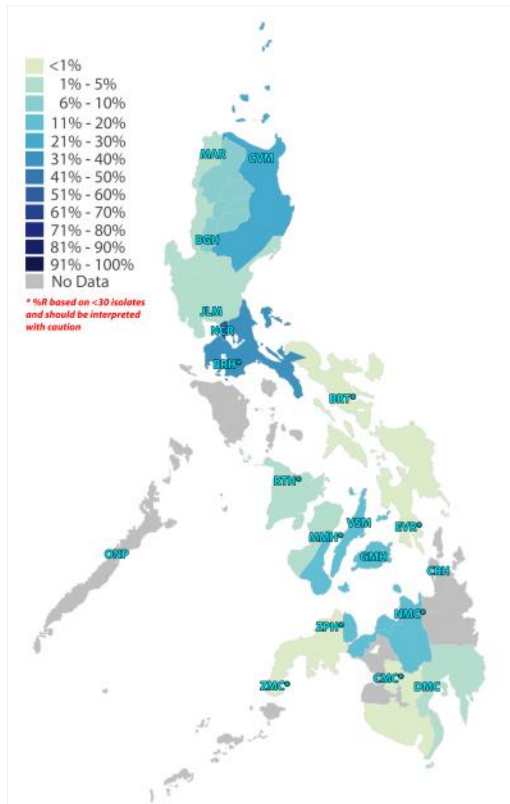


Figure 68. Geographic distribution of vancomycin-resistant *E. faecium* in the Philippines, DOH-ARSP, 2020

Figure 68 shows the distribution across the country of vancomycin-resistant *E. faecium*. It was noted that sentinel sites from Regions II, VII, X and XIII reported the highest resistance to vancomycin.

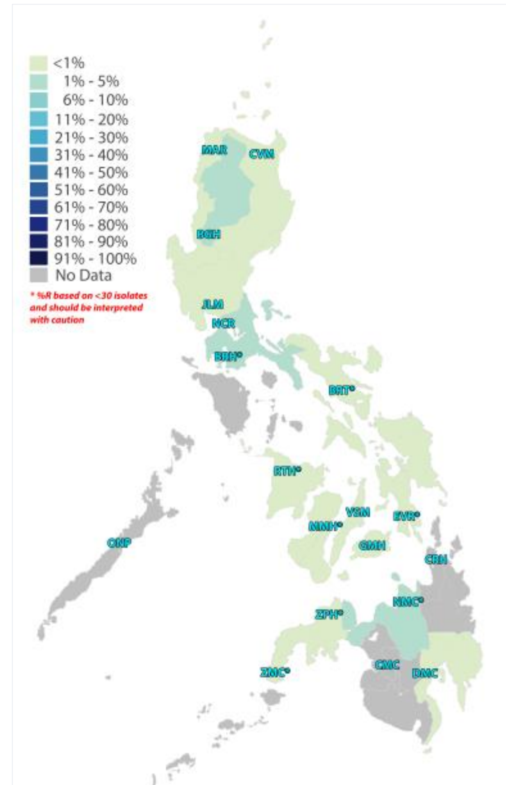


Figure 69. Geographic distribution of linezolid-resistant *E. faecium* in the Philippines, DOH-ARSP, 2020

Figure 69 shows the distribution across the country of linezolid resistant *E. faecium*. Most of the sentinel sites reported less than 5% linezolid resistance.

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# *Escherichia coli*

A total of 6,432 isolates of *E. coli* were reported for 2020. PGH (14.1%) contributed most to the number of *E. coli* isolates followed by DMC (9.75%) and VSM (9.56%). Based on island group distribution, 53.48% were from Luzon, with 25.08% from NCR (Figure 70).

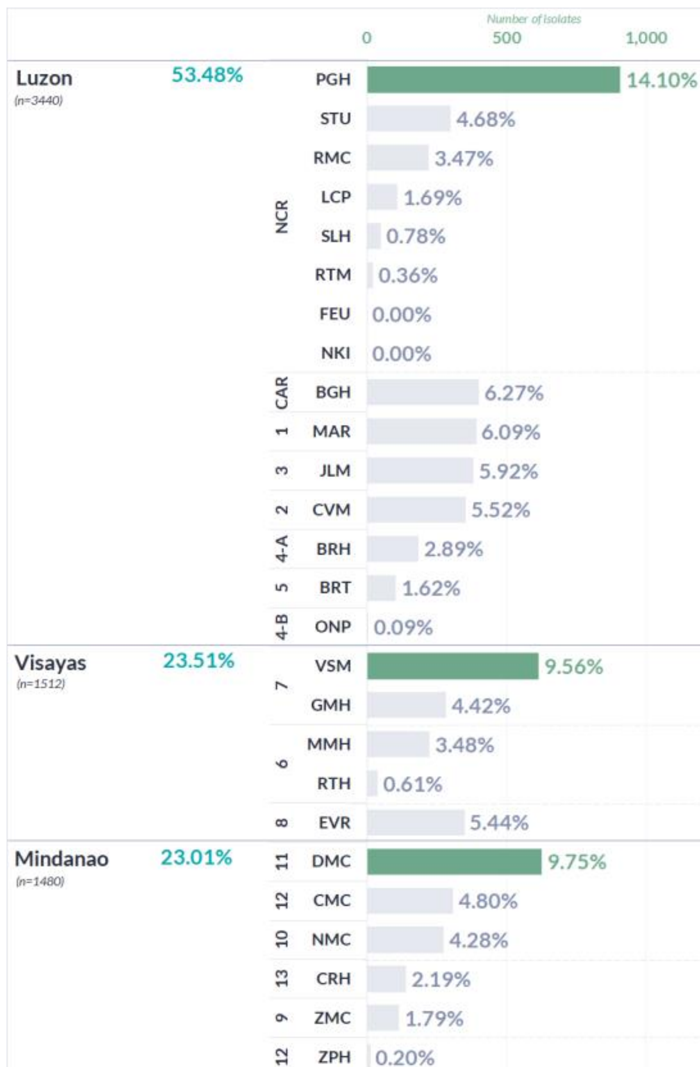
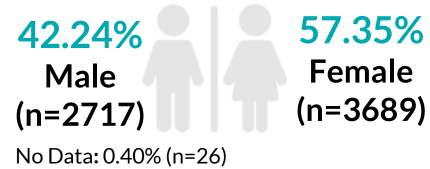


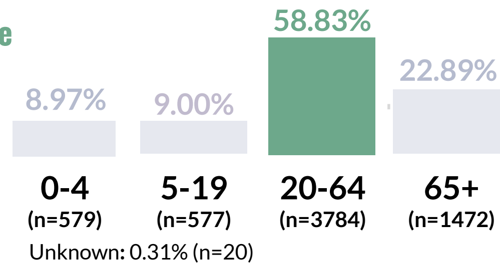

Figure 70. Isolate distribution of *E. coli* 2020 ARSP isolates, DOH-ARSP, 2020 (n = 6,432)

A. Sex



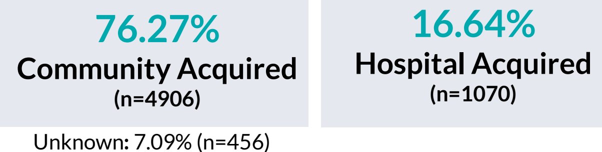

No Data: 0.40% (n=26)

B. Age




Unknown: 0.31% (n=20)

C. Infection Type




Unknown: 7.09% (n=456)

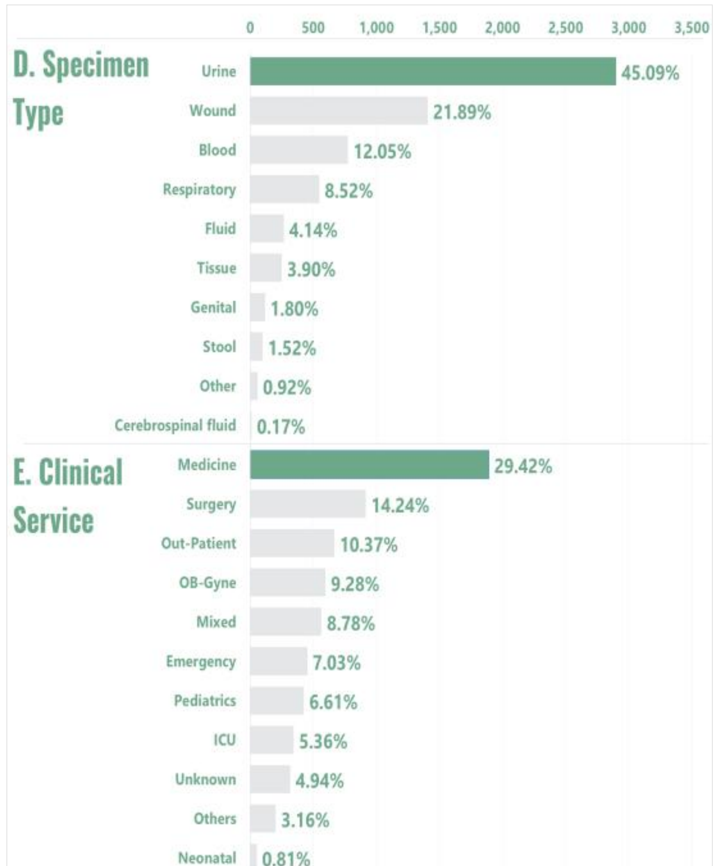



Figure 71. Patients characteristics of *E. coli* isolates, DOH-ARSP, 2020 (n=1,476)

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Majority (58.83%) of the isolates were from patients aged 20-64 years old and most (57.35%) were females. Many (45.09%) of *E. coli* isolates were from urine and wound (21.89%). Most (76.27%) cases were identified as community acquired infections (CAIs).

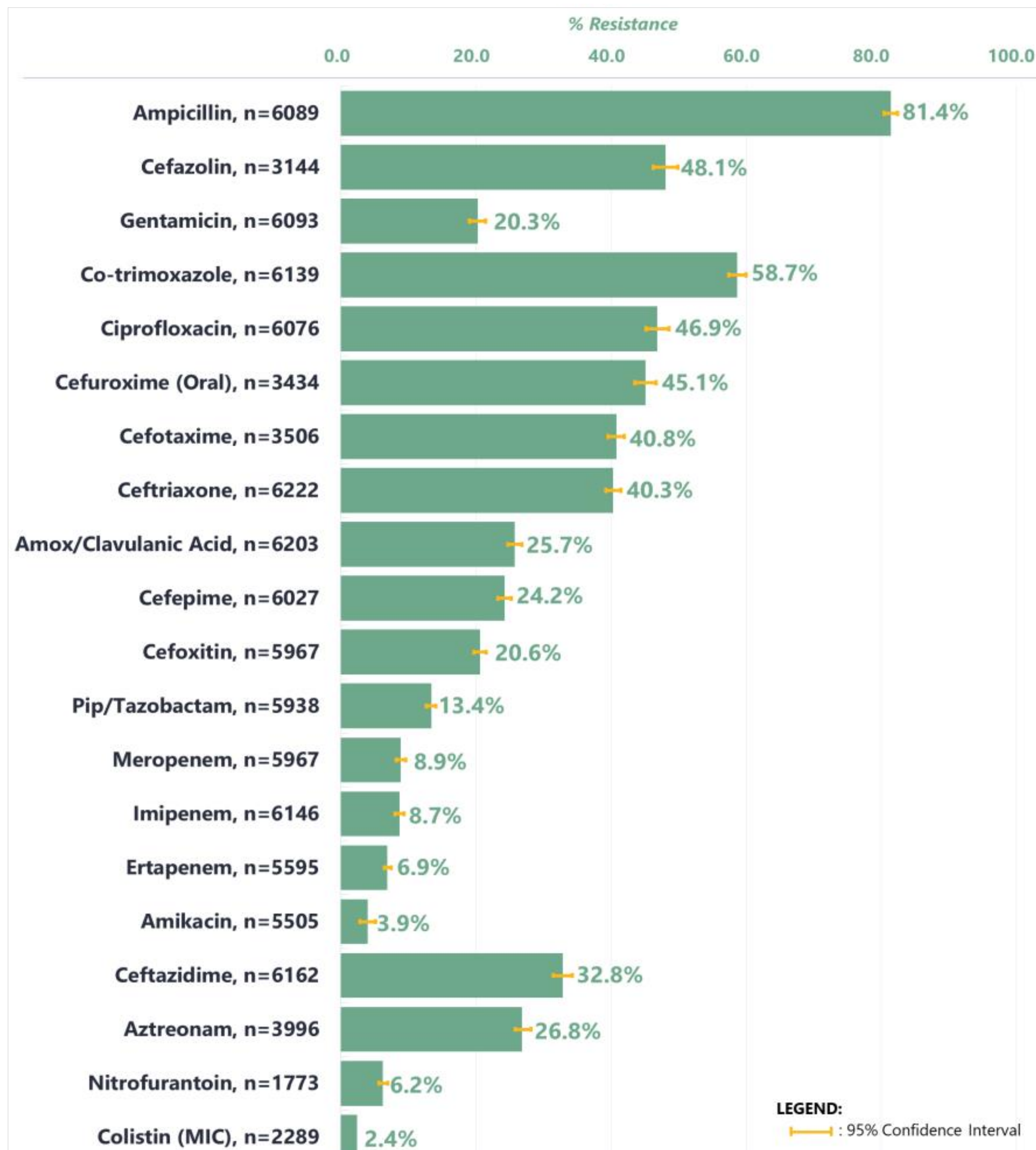


**Figure 72.** Percent resistance of *E. coli*, DOH-ARSP, 2020

**Figure 72** shows the cumulative antibiotic resistance rates of *E. coli* in 2020. For 2020, we continue to see that resistance rates of *E. coli* to most antibiotics are above 20%. Resistance to piperacillin/tazobactam was at 13.4% while resistance to the carbapenems was 6.9% for ertapenem and 8.9% for meropenem. Resistance to amikacin was at 3.9% and colistin at 2.4%.

There was one confirmed colistin-resistant *E. coli* isolate from urine sample of a 63-year-old female. The isolate was resistant to most of the antibiotics but was susceptible to the carbapenems and to cefoxitin, gentamicin and piperacillin-tazobactam.

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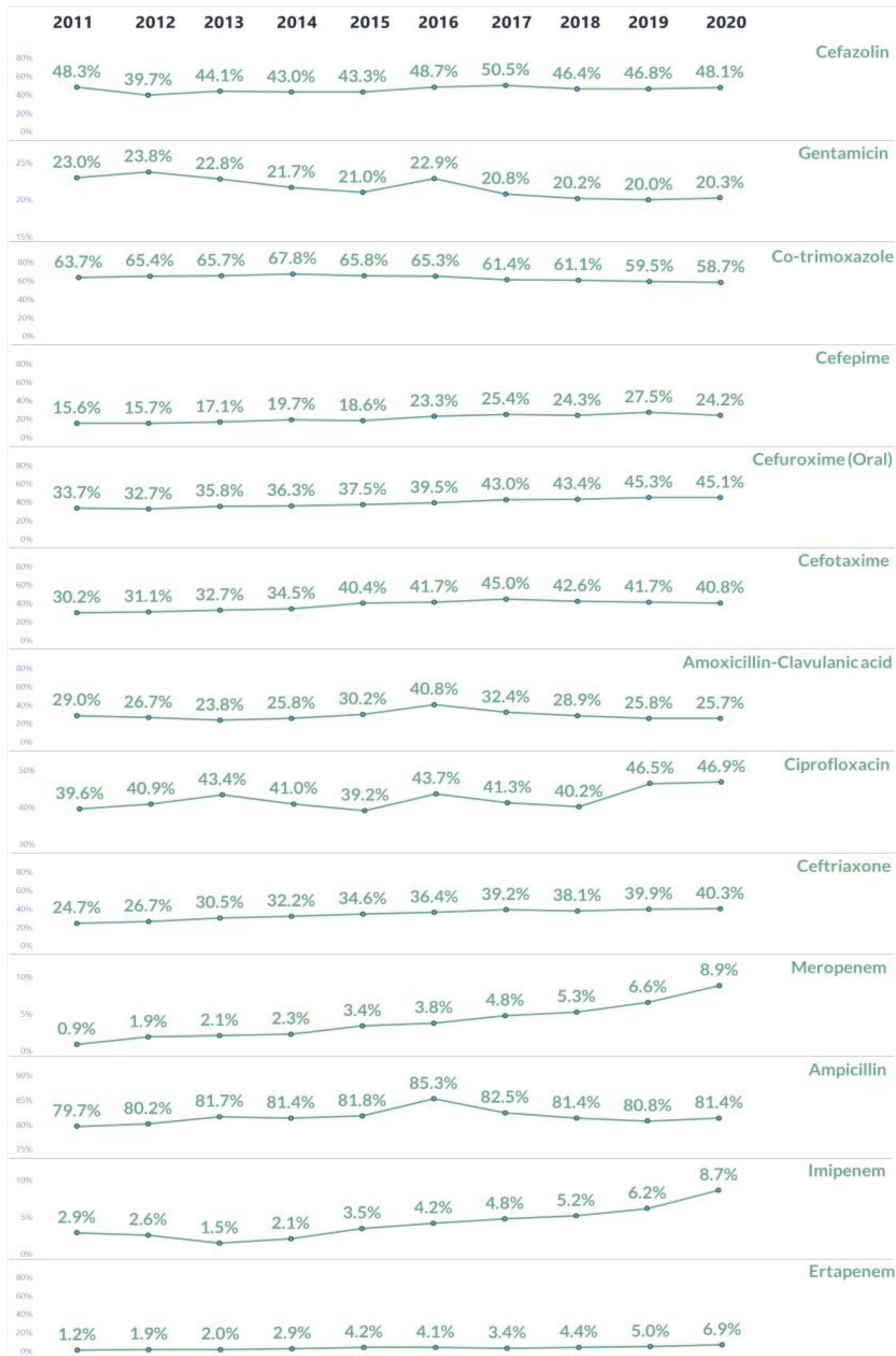


**Figure 73.** Yearly resistance rates of *E. coli* , DOH-ARSP, 2011-2020

Resistance rates to ampicillin, ceftriaxone and gentamicin increased from 2019 to 2020 (Figure 73), however, these changes were not statistically significant (Figure 73). Cefuroxime decreased in resistance rates from the previous year but was not statistically significant. The decrease in resistance rate of cefepime to 24.2% in 2020 from 27.5% in 2019 was statistically significant (p=0.0000). The increases in resistance rates to carbapenems (meropenem, imipenem,and ertapenem) in 2020 from rates in 2019 were all statistically significant (p=0.0000).

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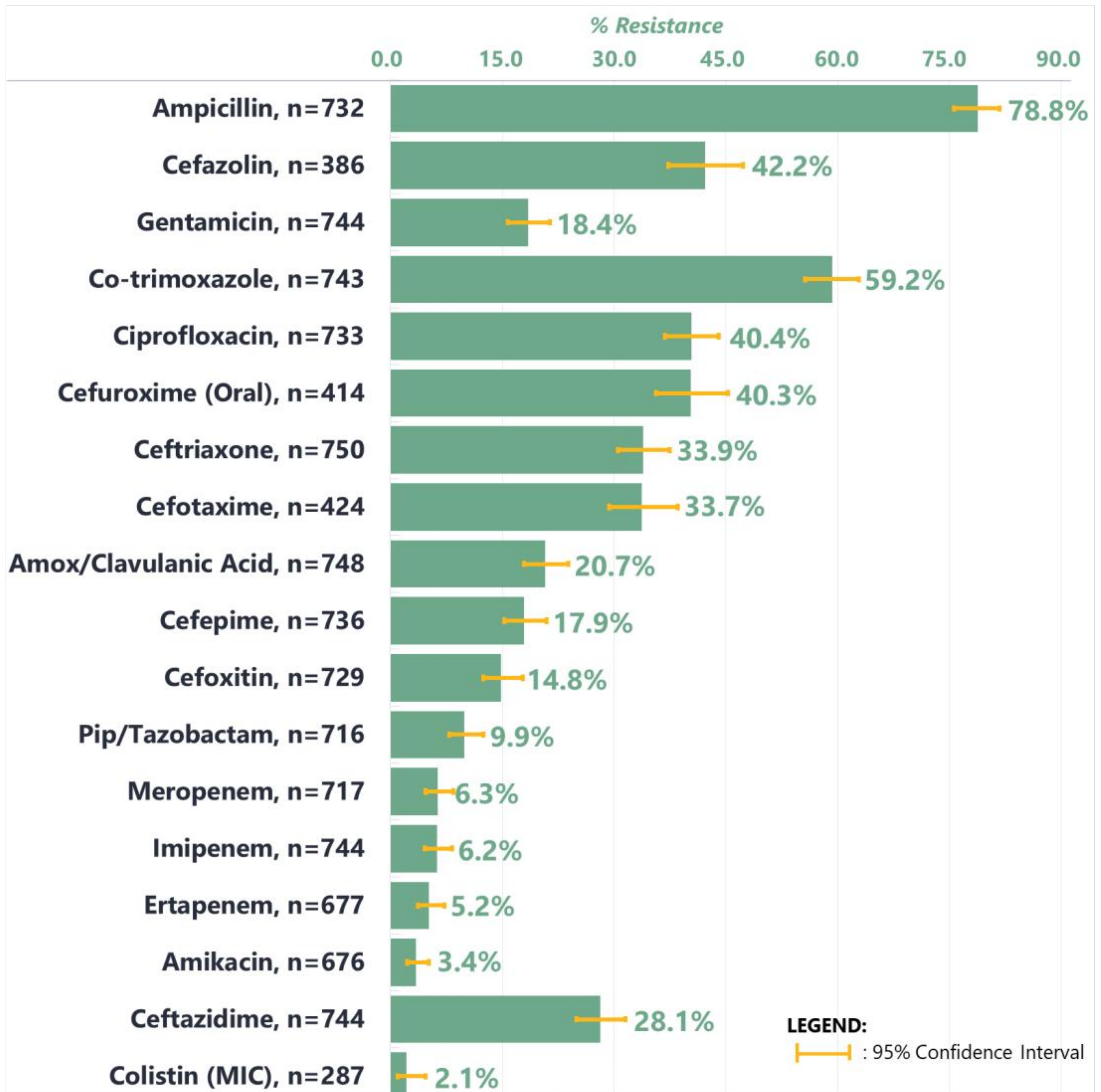


Figure 74. Percent resistance of *E. coli* blood isolates, DOH-ARSP, 2020

Figure 74 shows the resistance rates of *E. coli* isolates from blood. Resistance to most antibiotics were above 20%. Resistance to carbapenem antibiotics were less than 10%. Resistance to amikacin was at 3.4% and 2.1% to colistin.

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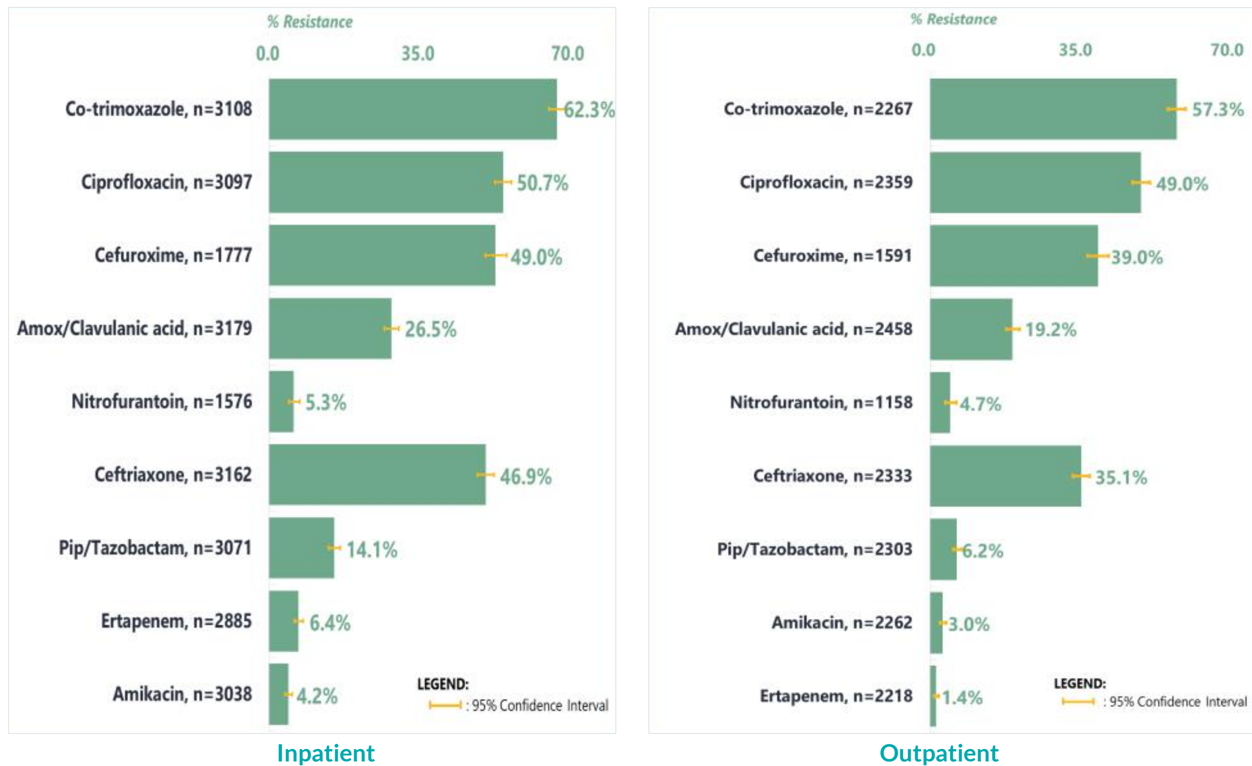


**Figure 75.** Percent resistance of *E. coli* urine isolates from outpatients and in-patients, DOH-ARSP, 2020

Resistance rates of outpatient and inpatient urinary *E. coli* isolates against commonly used antibiotics are shown in Figure 75. Among urinary *E. coli* from out- patients, co-trimoxazole resistance was high at 57.3% while resistance to nitrofurantoin was at 4.7%. Among urinary *E. coli* from in- patients lowest resistance was for amikacin at 4.2%.

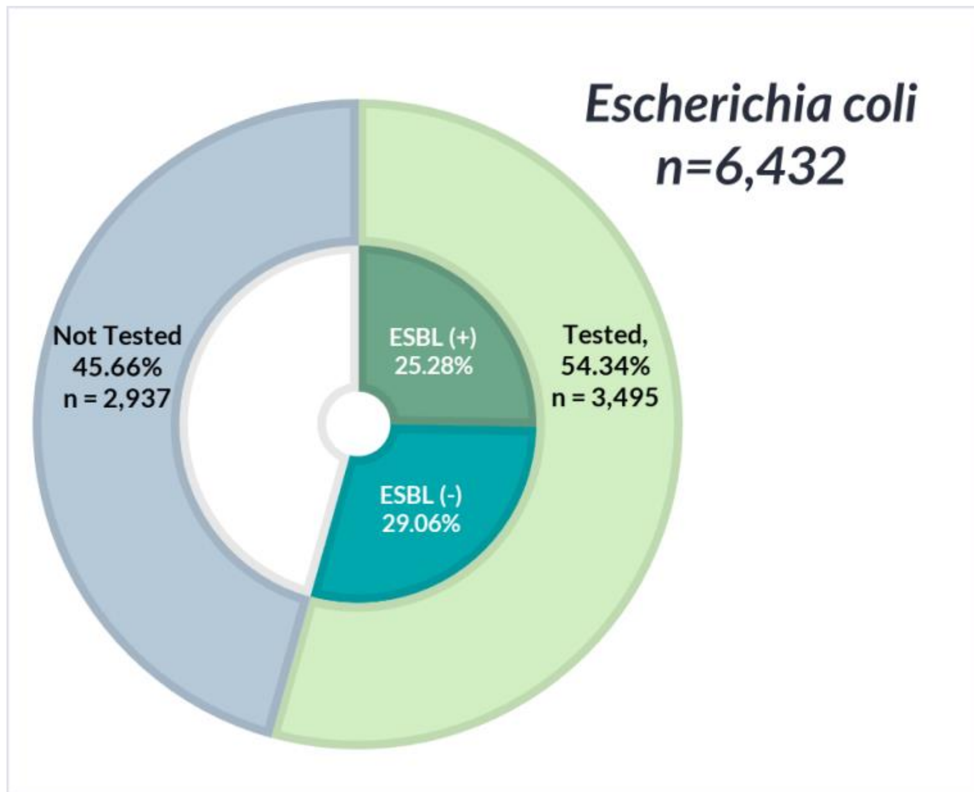


**Figure 76.** Percentage of ESBL- producing *E. coli* in the Philippines, DOH-ARSP, 2020

From the subset of the 2020 *E. coli* isolates screened phenotypically for ESBL production, positivity rate was at 25.28% (n=1,595).

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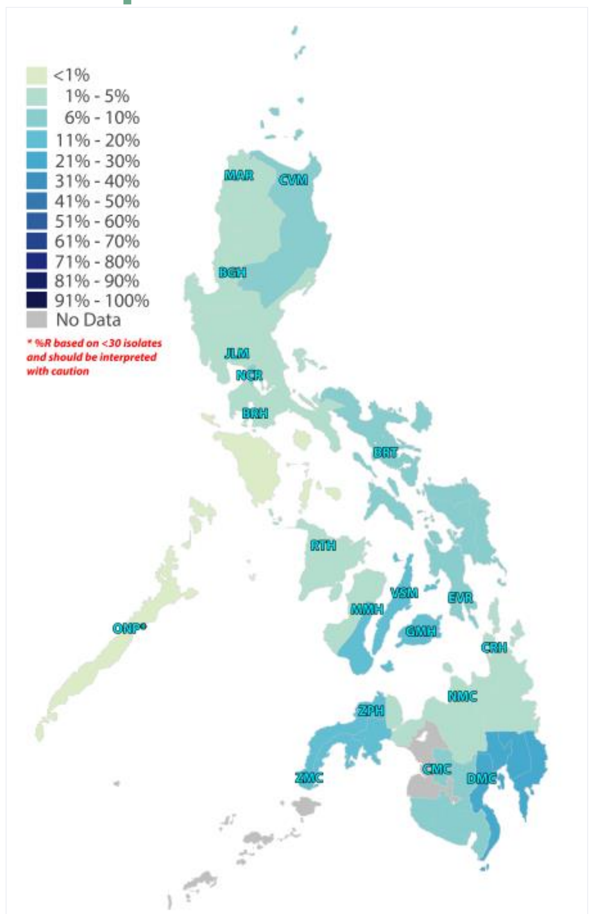
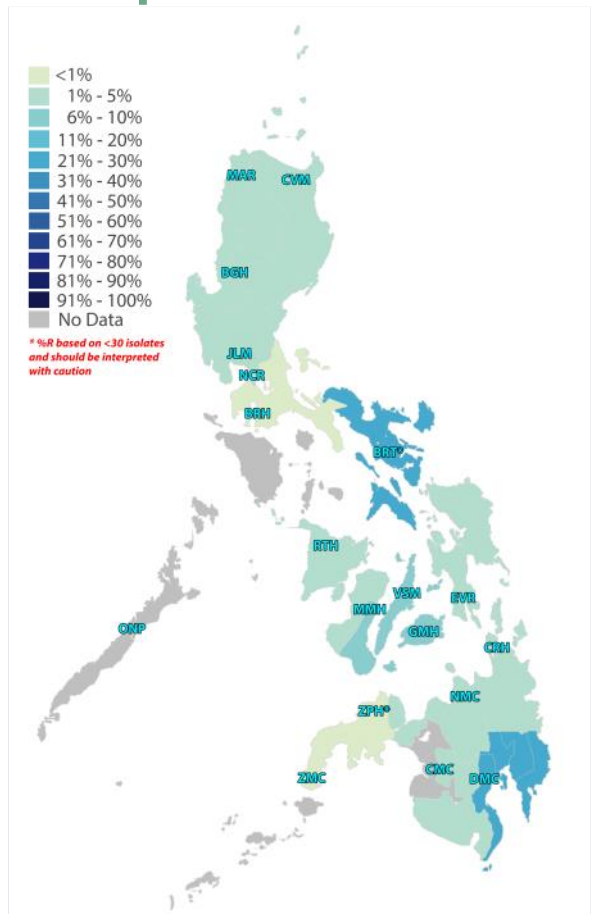
## A. Imipinem




## B. Ertapenem




## C. Meropenem

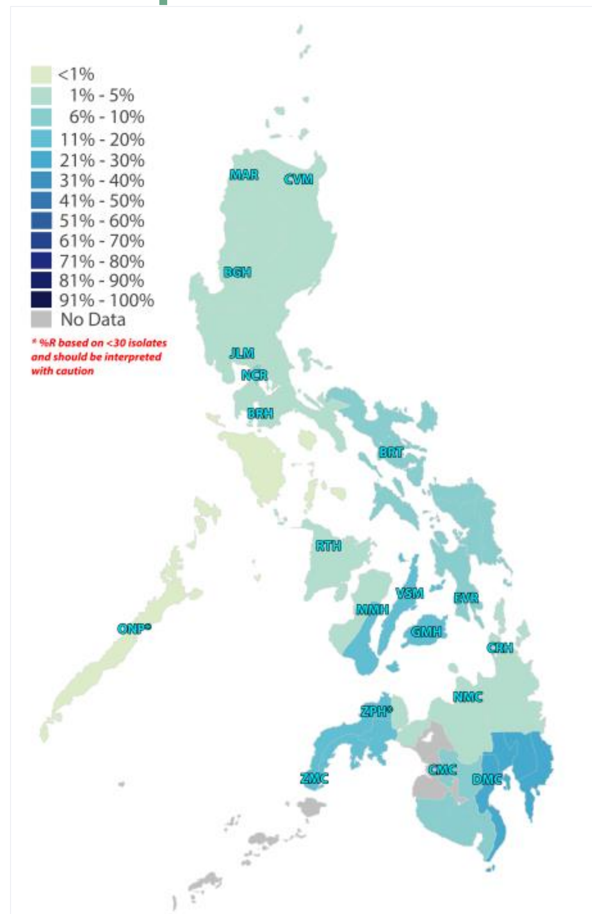


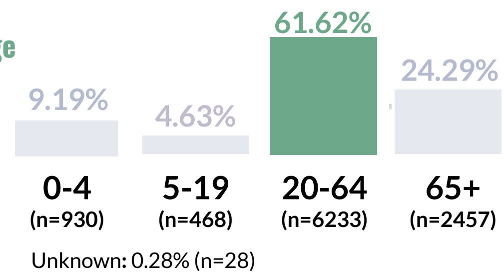

**Figure 77.** Resistance maps of *E. coli* for (A) imipenem, (B) ertapenem and (C) meropenem, DOH-ARSP, 2020

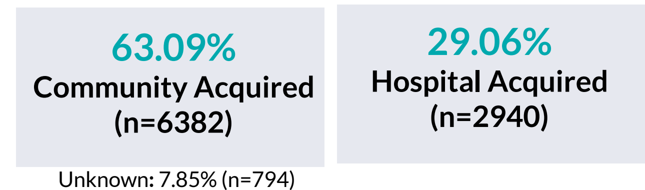
Figure 77 shows the carbapenem resistance rates across the different regions represented by the sentinel sites. The *E. coli* isolates from most of the regions have carbapenem resistance rates of less than 5%. It appears however that DMC has relatively higher resistance to the carbapenems.

# *Klebsiella pneumoniae*

There were 10,116 *Klebsiella pneumoniae* isolates reported for 2020. VSM (16.32%) contributed most to the number of *K. pneumoniae* isolates followed by DMC (10.89%) and PGH (10.72%). Based on island group distribution, 44.12% were from Luzon with 20.5% of that proportion coming from NCR, 34.03% from Visayas and 21.86% from Mindanao (Figure 78).

Figure 78. Isolate distribution of *K. pneumoniae* isolates, DOH-ARSP, 2020 (n =10,116)



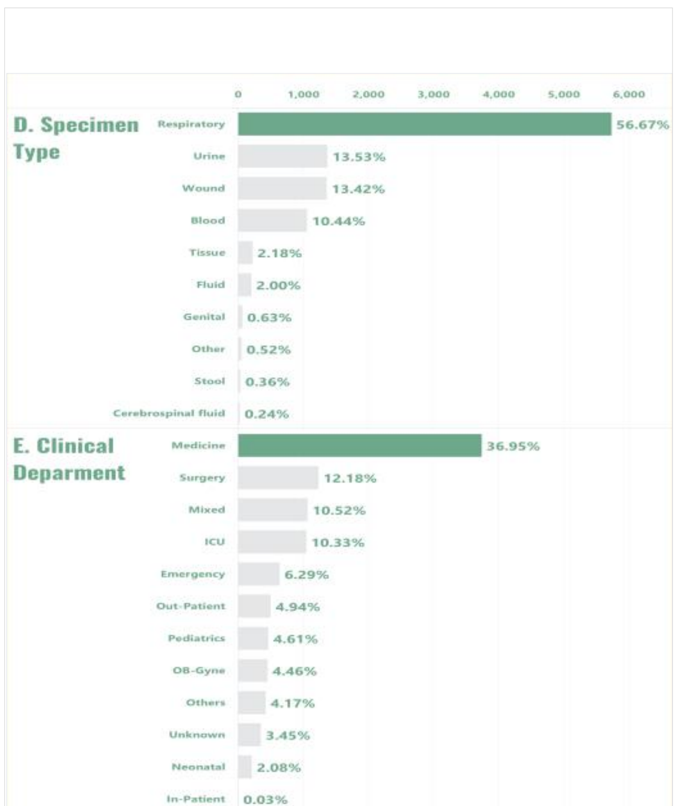




Figure 79. Patients characteristics of *K. pneumoniae* isolates, DOH-ARSP, 2020 (n=10,116)

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Majority (61.62%) of the isolates were from 20-64 years old, and most (57.33%) were males. Most of *K. pneumoniae* were from respiratory (56.67%), urine (13.53%) and wound (13.42%) specimens. Majority (63.09%) of the cases were community acquired infections (Figure 79).

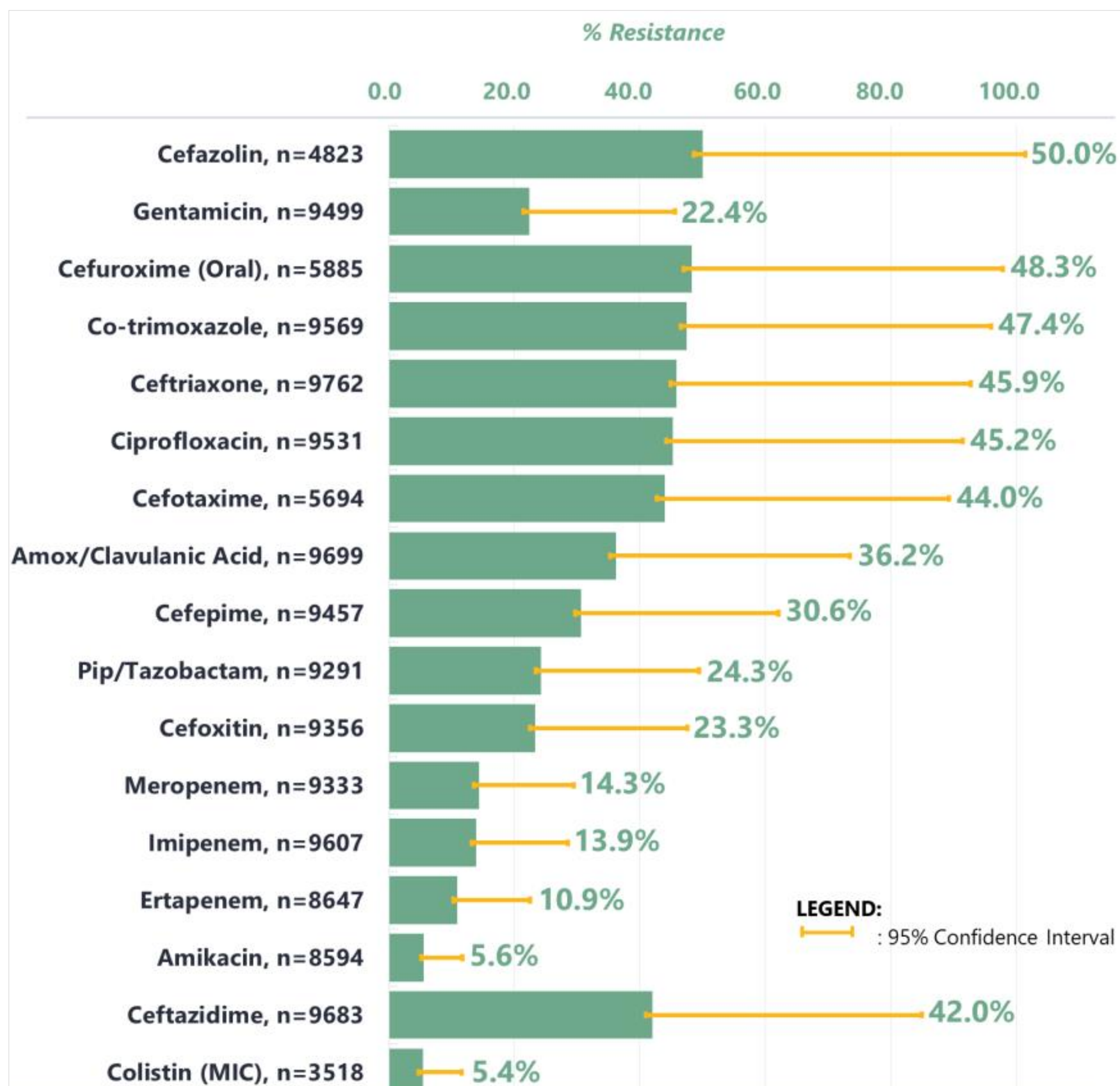


Figure 80. Percent resistance of *K. pneumoniae*, DOH-ARSP, 2020

Cumulative resistance rates of *K. pneumoniae* from all specimens are shown in Figure 80. As known to be commonly resistant to multiple classes of antibiotics, *K. pneumoniae* antimicrobial rates to most of the antibiotics were above 20%. Among the antibiotics for which *K. pneumoniae* resistance was relatively low were amikacin (5.6%) and the carbapenems: meropenem (14.3%), imipenem (13.9%) and ertapenem (10.9%). Colistin resistance was reported to be at 5.4%.

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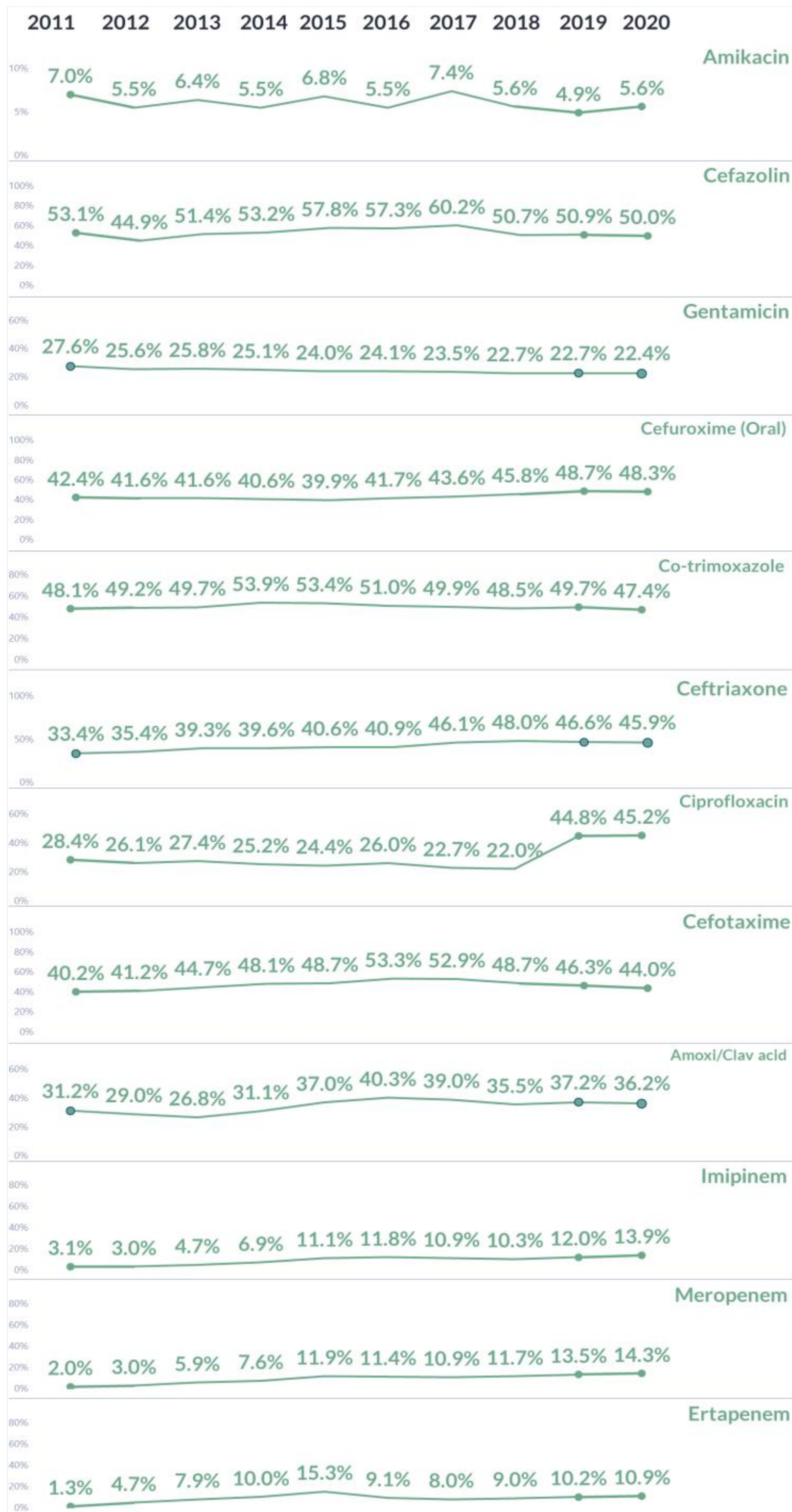


**Figure 81.** Yearly resistance rates of *K. pneumoniae*, DOH-ARSP, 2011-2020



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**Figure 81** shows the yearly resistance trend of *K. pneumoniae*. Cefazolin, gentamicin, cefuroxime(oral) and co-trimoxazole showed relatively constant rates over the years. Carbapenem antibiotics showed increasing rates in the last five years. Ciprofloxacin resistance rate doubled in 2019 and continued to increase in 2020. Resistance to ceftriaxone and nitrofurantoin have been observed to be decreasing.

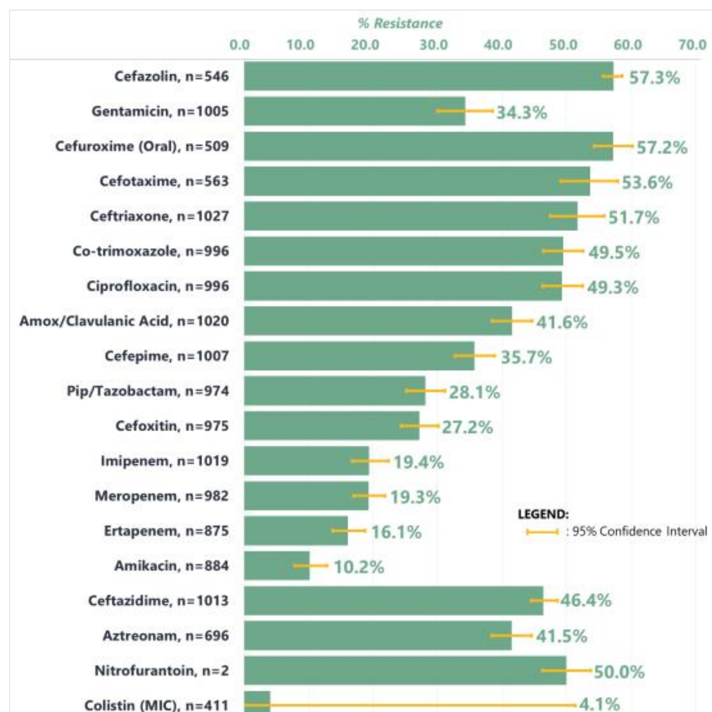


**Figure 82.** Percent resistance of *K. pneumoniae* blood isolates, DOH-ARSP, 2020

**Figure 82** shows the resistance rates of *K. pneumoniae* isolates from blood specimens. Resistance rates for most of the antibiotics were above 20%. Resistance to the carbapenems ranged from 16-19.4%. Colistin resistance was at 4.1%.

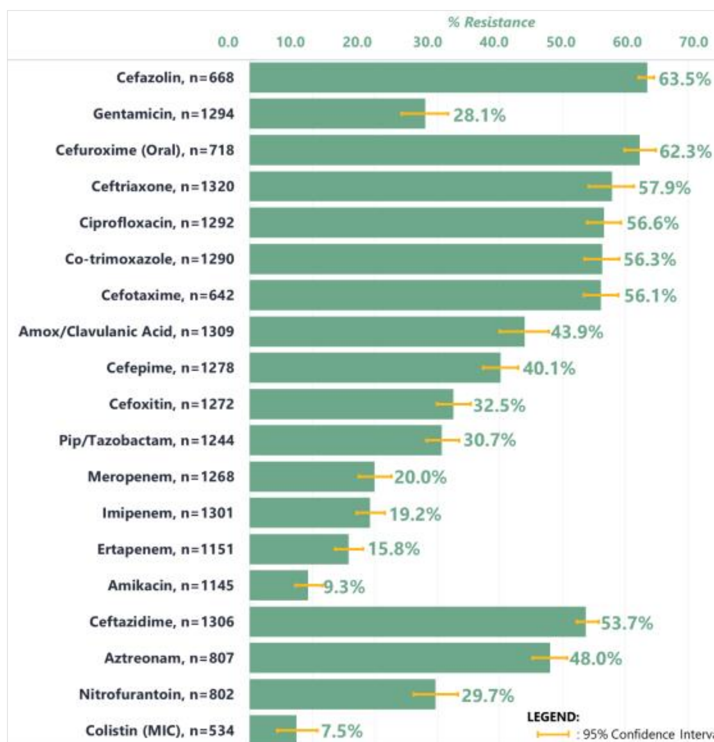


**Figure 83.** Percent resistance of *K. pneumoniae* urine isolates, DOH-ARSP, 2020

**Figure 83** shows the antibiotic resistance rates of *K. pneumoniae* isolates from urine specimens. Resistance rates to most antibiotics were noted to be very high. Resistance to carbapenems ranged from 15.8% to 20.0%. Colistin resistance was reported to be at 7.5%.

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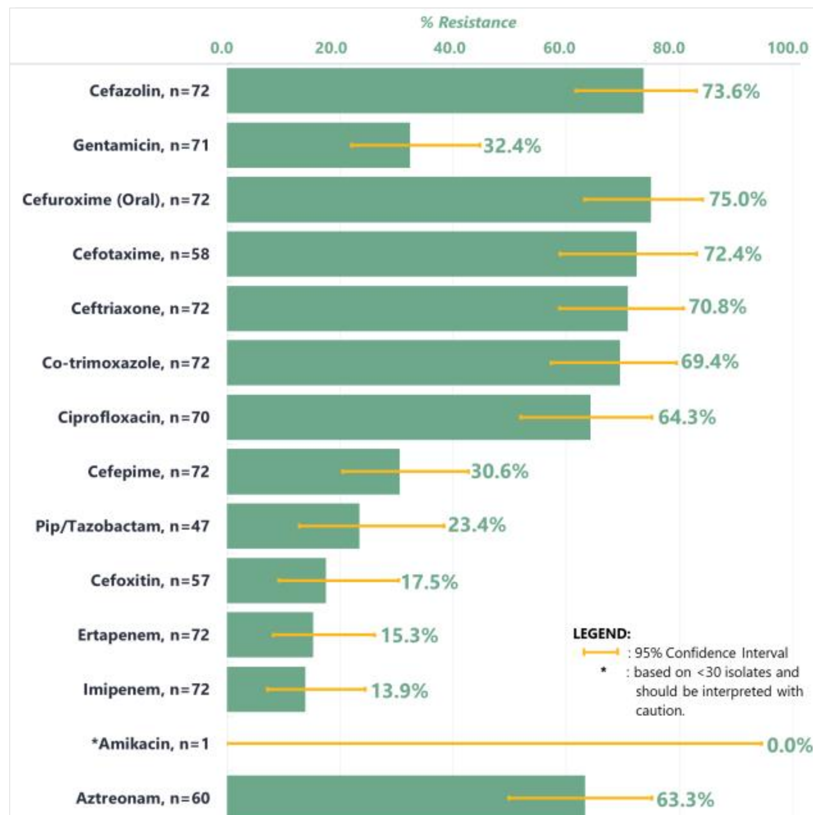


**Figure 84.** Antibiogram of colistin-resistant *K. pneumoniae* isolates, DOH-ARSP, 2020

There were 72 confirmed colistin-resistant *K. pneumoniae* isolates in 2020 (**Figure 84**). Lowest percent resistance to this group of isolates was recorded for imipenem (13.9%) followed by ertapenem at 15.3%. Resistance to the following antibiotics were more than 60%: ciprofloxacin (64.3%), co-trimoxazole (69.4%), ceftriaxone (70.8%), cefotaxime (72.4%), cefazolin (73.6%) and cefuroxime (75.0%).

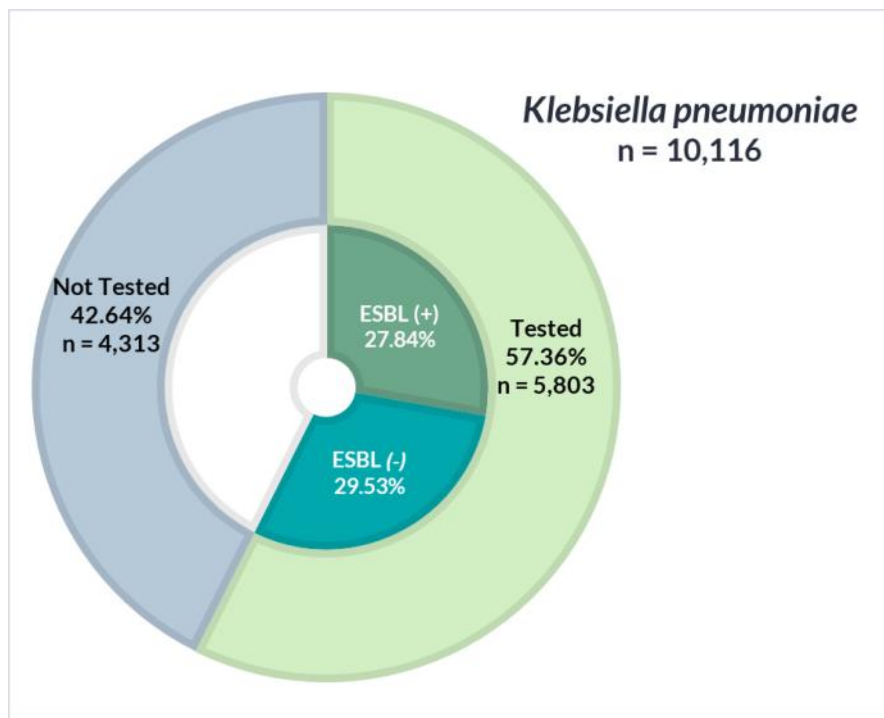


**Figure 85.** Percentage of ESBL- producing *K. pneumoniae* in the Philippines, DOH-ARSP, 2020

From the subset of 2020 *K. pneumoniae* isolates screened phenotypically for ESBL production, ESBL positivity rate was 27.8% (**Figure 85**).

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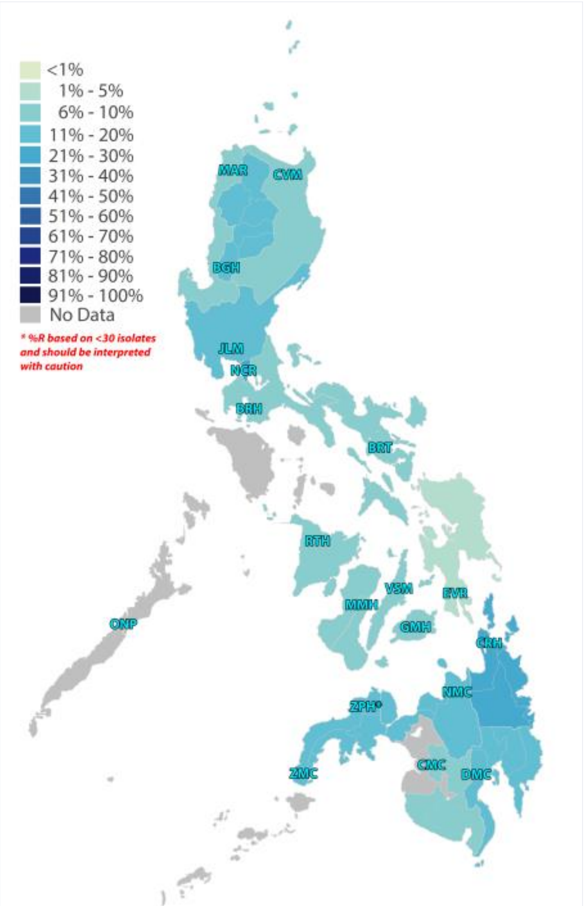
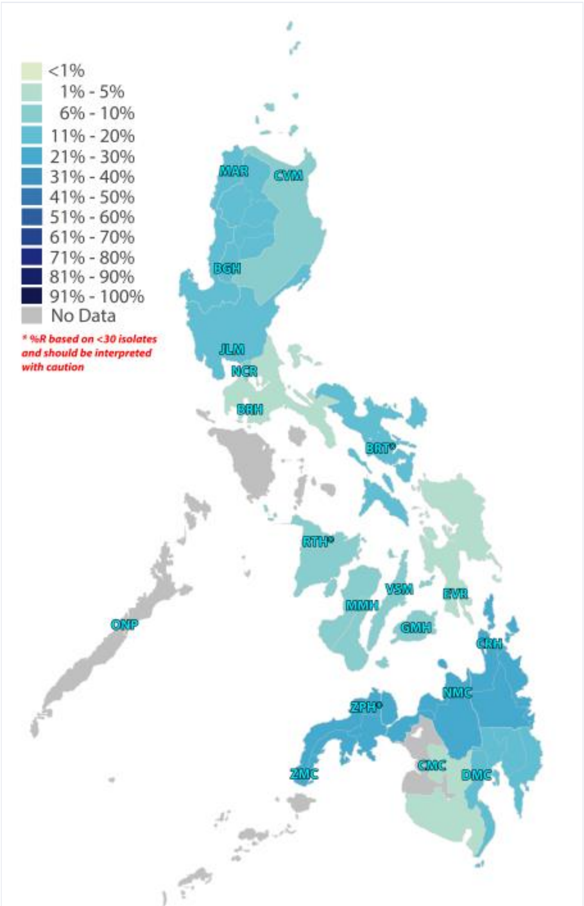
## A. Imipinem




## B. Ertapenem




## C. Meropenem

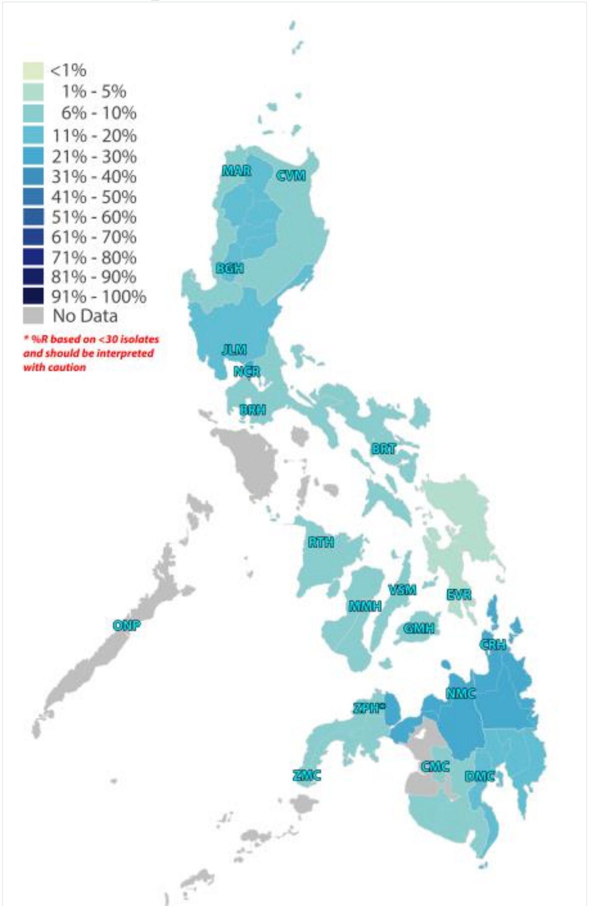



**Figure 86.** Resistance maps of *K. pneumoniae* for (A) imipenem, (B) ertapenem and (C) meropenem, DOH-ARSP, 2020

**Figure 86** shows the carbapenem resistance rates of *K. pneumoniae* across the different regions represented by the sentinel sites. The *K. pneumoniae* isolates from most of the regions have carbapenem resistance rates in the range of 6-10% or 11-25%. CRH has relatively higher resistance to the carbapenems with rates higher than 25%.

# *Pseudomonas aeruginosa*

There were 5,063 *Pseudomonas aeruginosa* isolates for 2020. Large contributors of *P. aeruginosa* isolates were DMC (15.09%), VSM (12.96%) and PGH (11.36%). Based on island group distribution, Luzon contributed 49.16% of the isolates, 26.33% from Visayas and 24.51% from Mindanao (Figure 87).

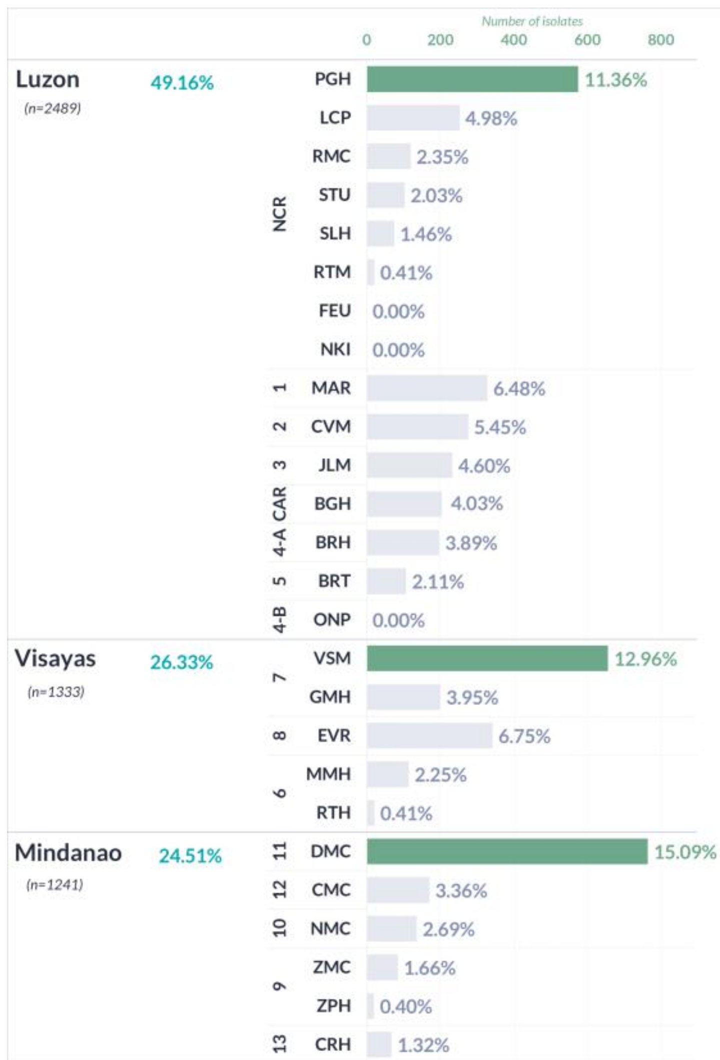
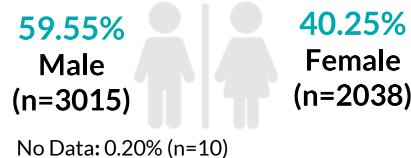


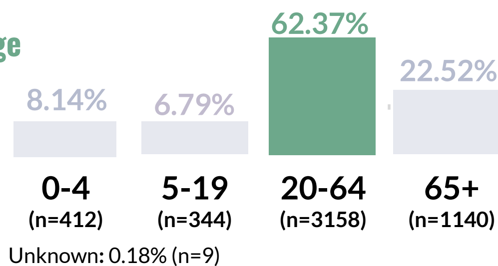

Figure 87. Isolate distribution of *P. aeruginosa* isolates, DOH-ARSP, 2020 (n =5,063)

A. Sex



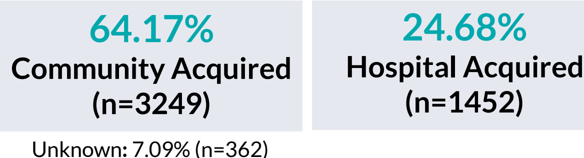

No Data: 0.20% (n=10)

B. Age




Unknown: 0.18% (n=9)

C. Infection Type




Unknown: 7.09% (n=362)

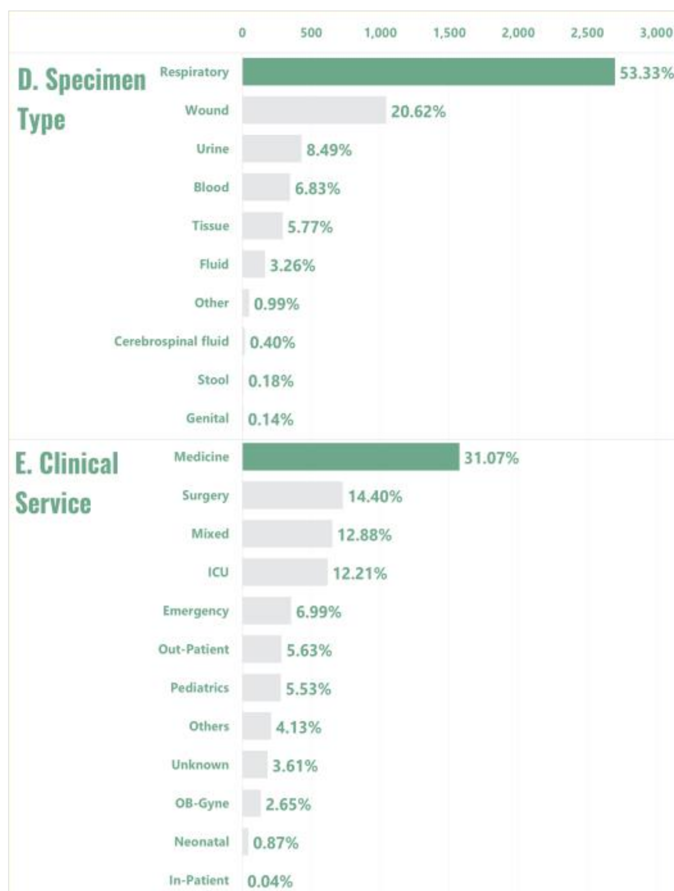



Figure 88. Patients characteristics of *P. aeruginosa* 2020 ARSP isolates, DOH-ARSP, 2020 (n=5,063)

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Majority (62.37%) of the isolates were from patients within 20-64 age group, and mostly were from males (59.55%) (Figure 88). Most (53.33%) of the *P. aeruginosa* isolates were from respiratory specimens followed by wound (20.62%) and urine (8.49%). Most (64.17%) cases were presumptive community acquired infections.

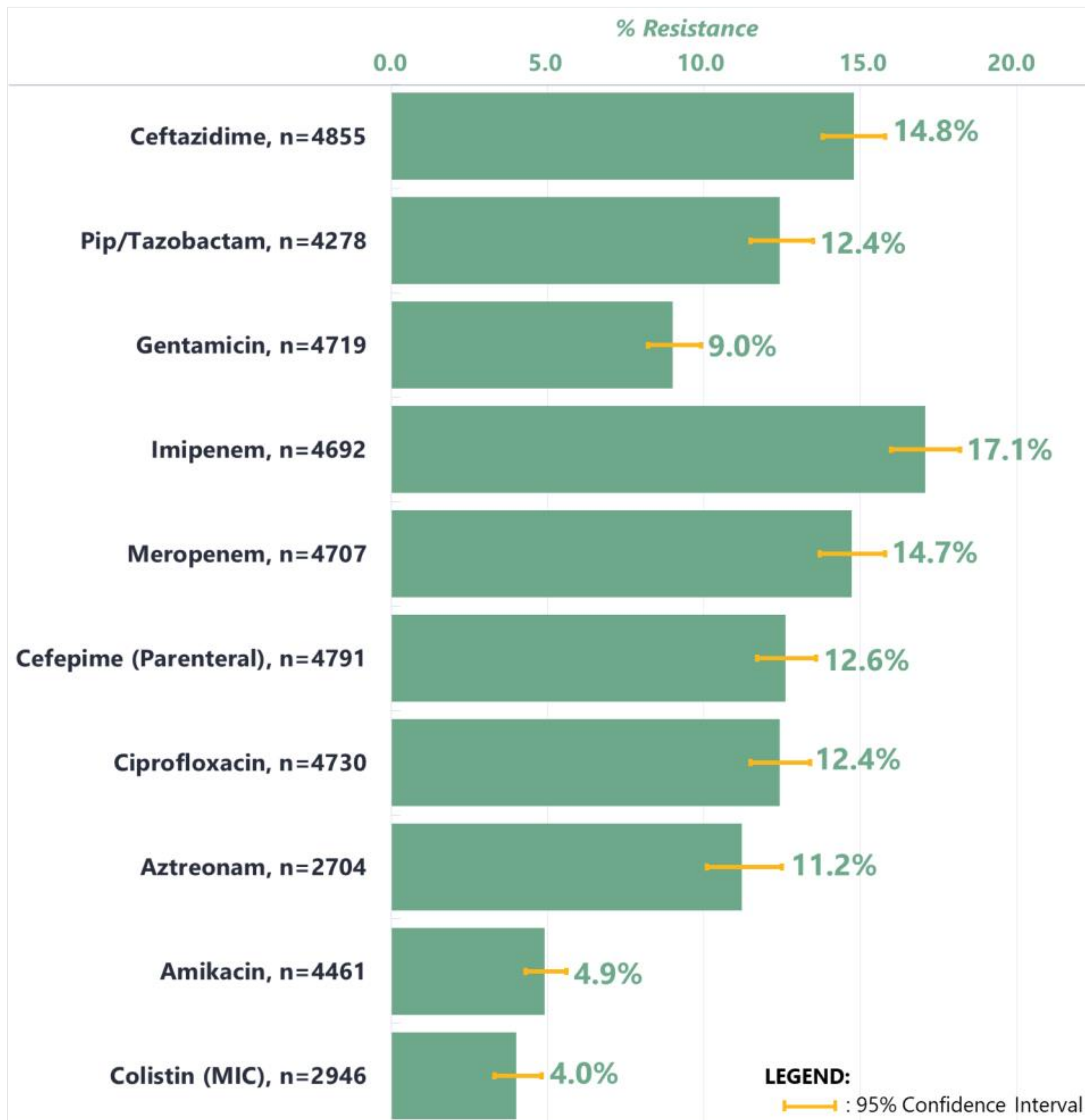


Figure 89. Percent resistance of *P. aeruginosa*, DOH-ARSP, 2020

Figure 89 shows the cumulative resistance rates of *P. aeruginosa* in 2020. Resistance to ceftazidime, cefepime(Parenteral) and piperacillin-tazobactam were at 14.8%, 12.6% and 12.4%, respectively. Imipenem and meropenem resistance were at 17.1% and 14.7%, respectively. Amikacin resistance was at 4.9%, aztreonam at 11.2% and colistin resistance was at 4%. Gentamicin decreased from 10.3% in 2019 to 9% in 2020 (p=0.0186). The noted decrease in resistance rate from 2019 to 2020 for aztreonam (p= 0.0001), ciprofloxacin (p=0.0045) and amikacin (p= 0.1116) were all significant.

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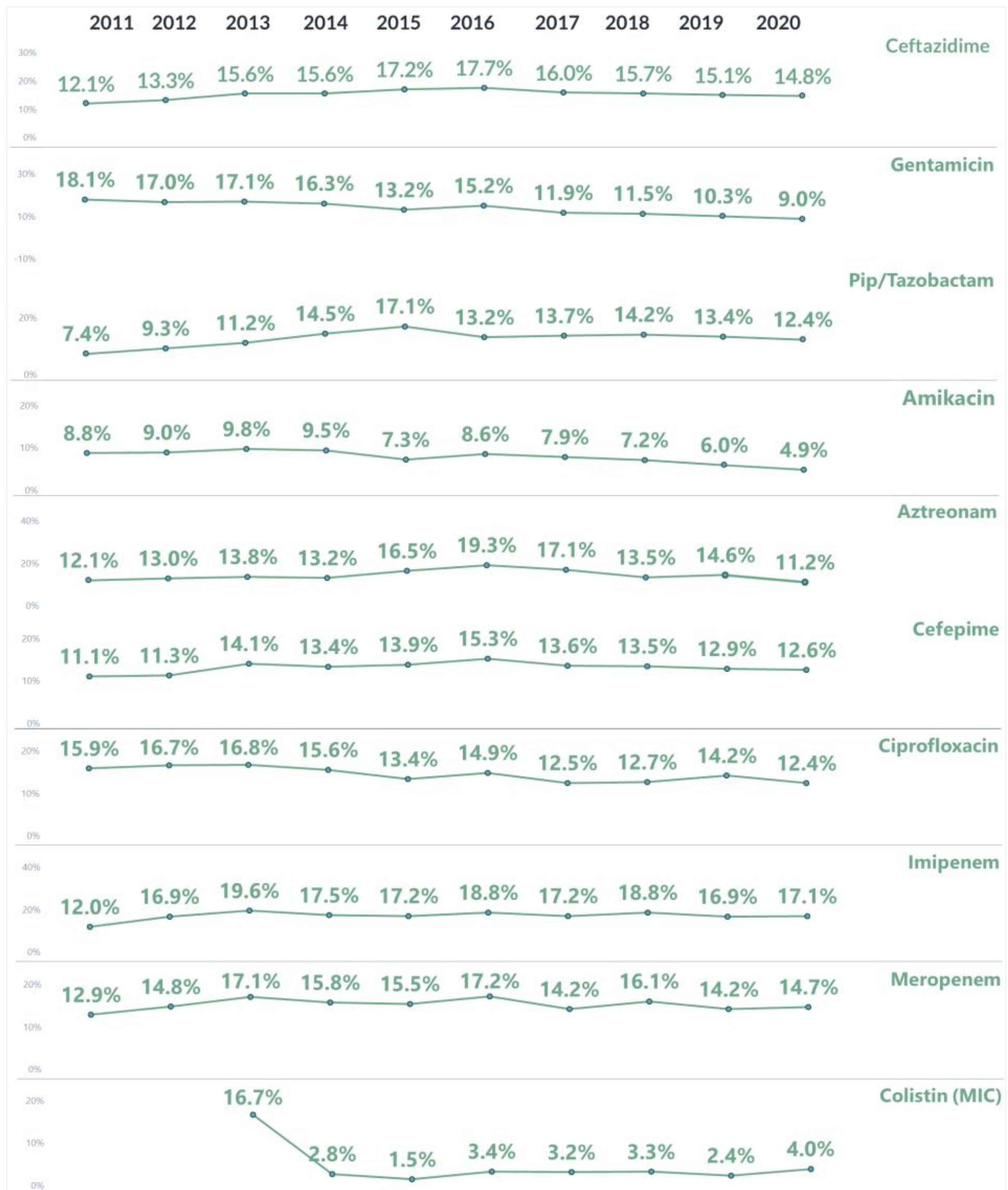


Figure 90. Yearly resistance rates of *P. aeruginosa*, DOH-ARSP, 2011-2020

The yearly resistance rate of *P. aeruginosa* is shown in Figure 90. Ceftazidime, amikacin and cefepime resistance rates showed decreasing trend in the last four years. Aztreonam and ciprofloxacin resistance showed fluctuating trends over the last four years. The same trend was noted for imipenem and meropenem.

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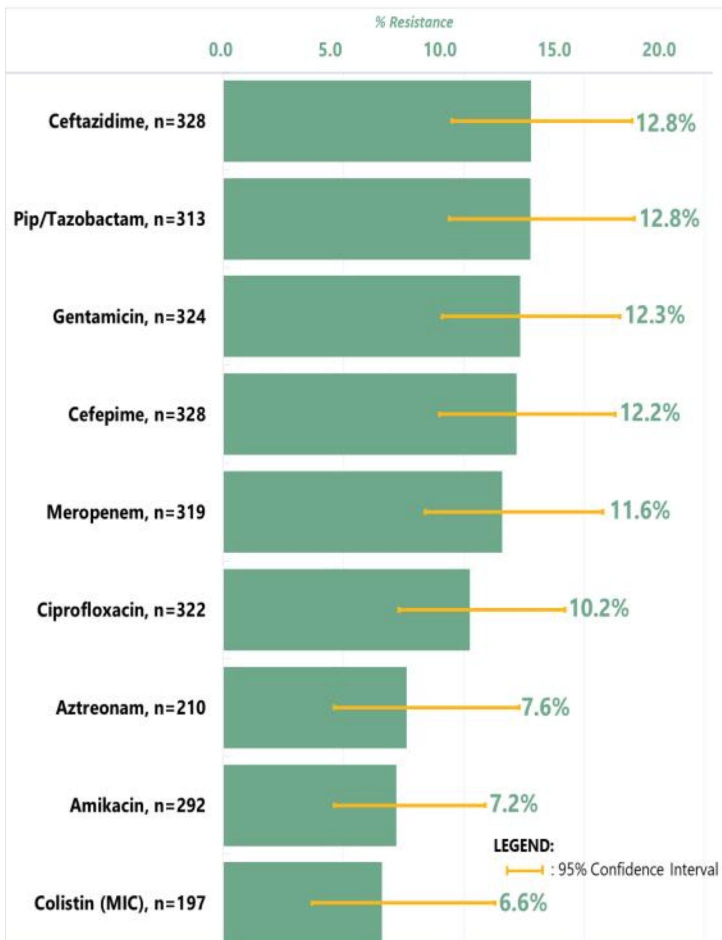
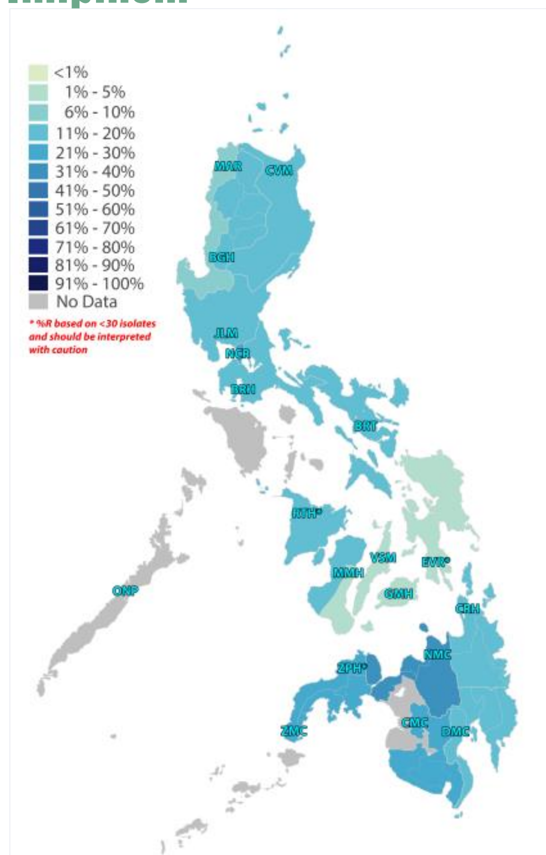



**Figure 91.** Percent resistance of *P. aeruginosa* blood isolates, DOH -ARSP, 2020

**Figure 91** shows the antibiotic resistance rates of *P. aeruginosa* isolates from blood specimens. Highest resistance rates were for ceftazidime and piperacillin- tazobactam at 12.8% for both. Resistance to gentamicin and cefipime were at 12.3% and 12.2%, respectively. Resistance to aztreonam, amikacin, and colistin was all below 10%.

**Figure 92** shows the carbapenem resistance rates of *P. aeruginosa* across the different regions represented by the sentinel sites. The *P. aeruginosa* isolates from most of the regions have imipenem and meropenem resistance rates in the range of 11-20%. NMC has relatively higher resistance to the carbapenems with rates higher than 25%

## A. Imipinem




## B. Meropenem

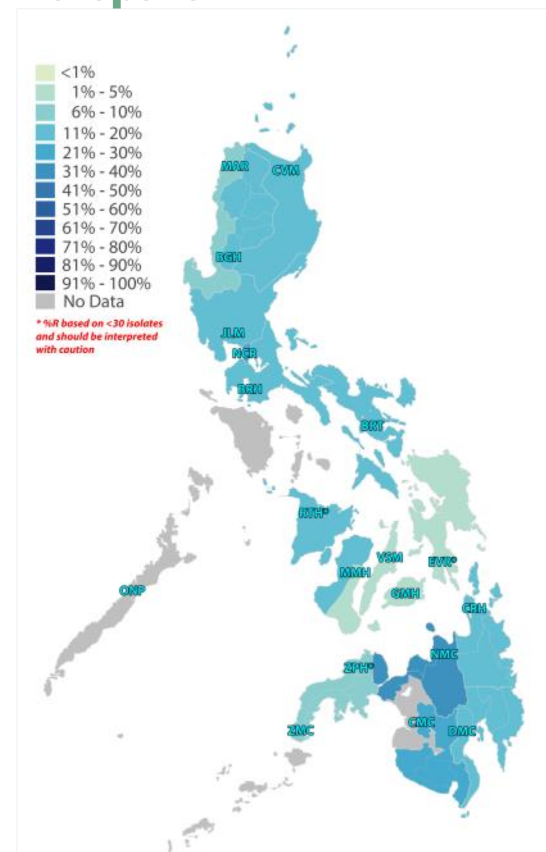



**Figure 92.** Resistance maps of *P. aeruginosa* for (A) imipenem and (B) meropenem, DOH-ARSP, 2020

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# *Acinetobacter baumannii*

There were 3,845 isolates of *Acinetobacter baumannii* for 2020, which is lower than the reported isolates in 2019. Largest contributors of *A. baumannii* isolates were PGH (17.48%), DMC (14.69%) and VSM (9.54%) (Figure 93).

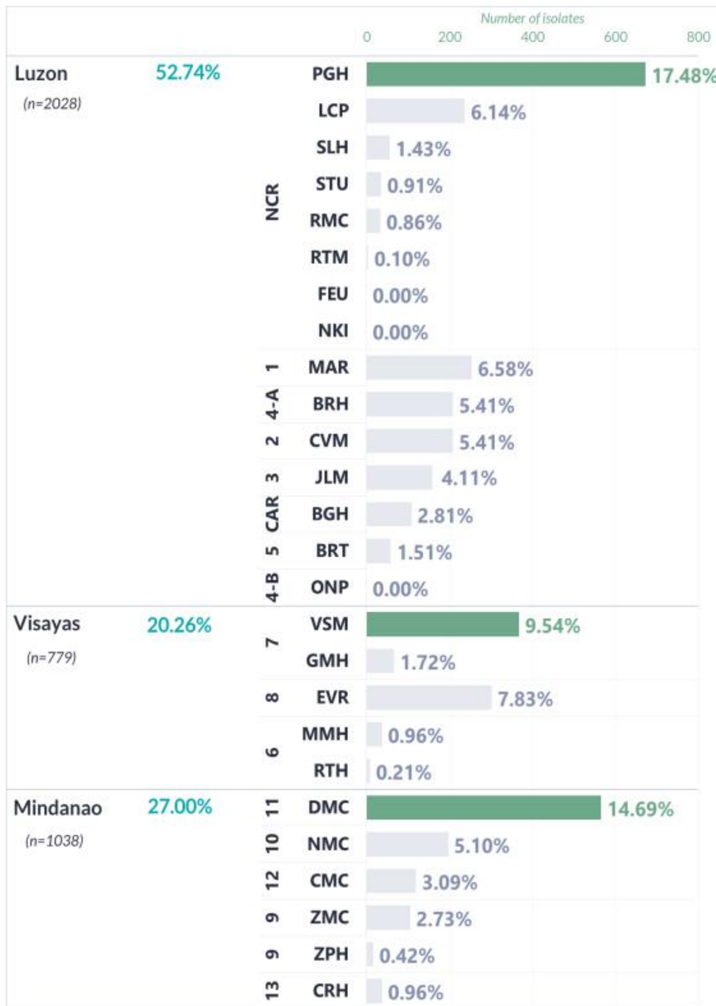
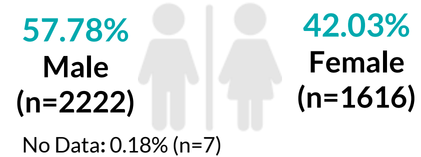


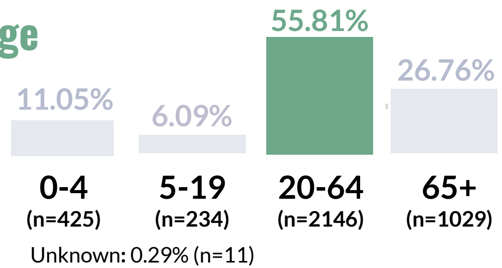

Figure 93. Isolate distribution of *A. baumannii* isolates, DOH-ARSP, 2020 (n =3,845)

## A. Sex



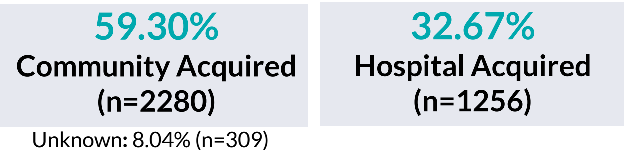

No Data: 0.18% (n=7)

## B. Age




Unknown: 0.29% (n=11)

## C. Infection Type




Unknown: 8.04% (n=309)

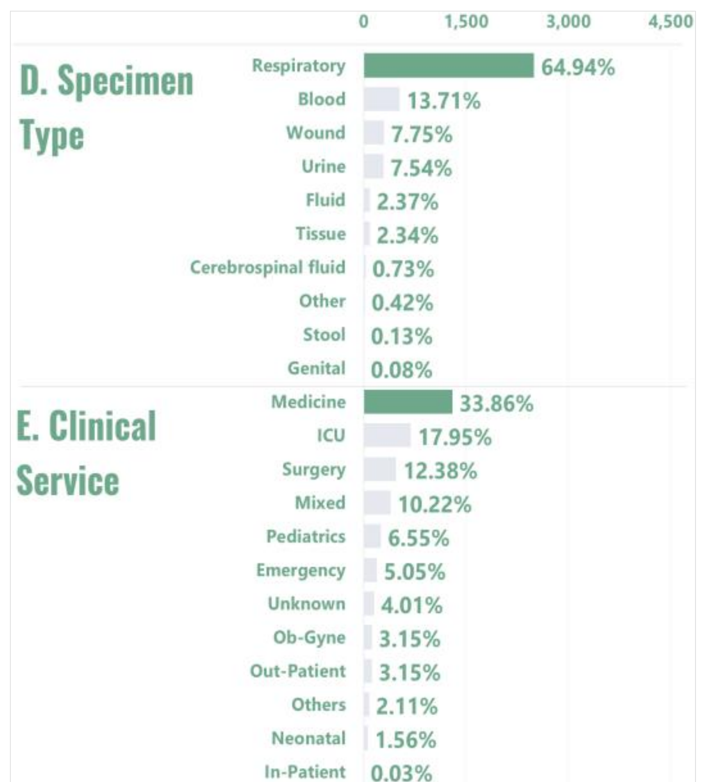



Figure 94. Patients characteristics of *A. baumannii*, DOH-ARSP, 2020 (n=3,845)

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Majority (55.81%) of the isolates were from 20-64 years old group and most were males (57.78%). Most (64.94%) of the isolates were from respiratory specimens and most (59.30%) cases were community acquired infections.

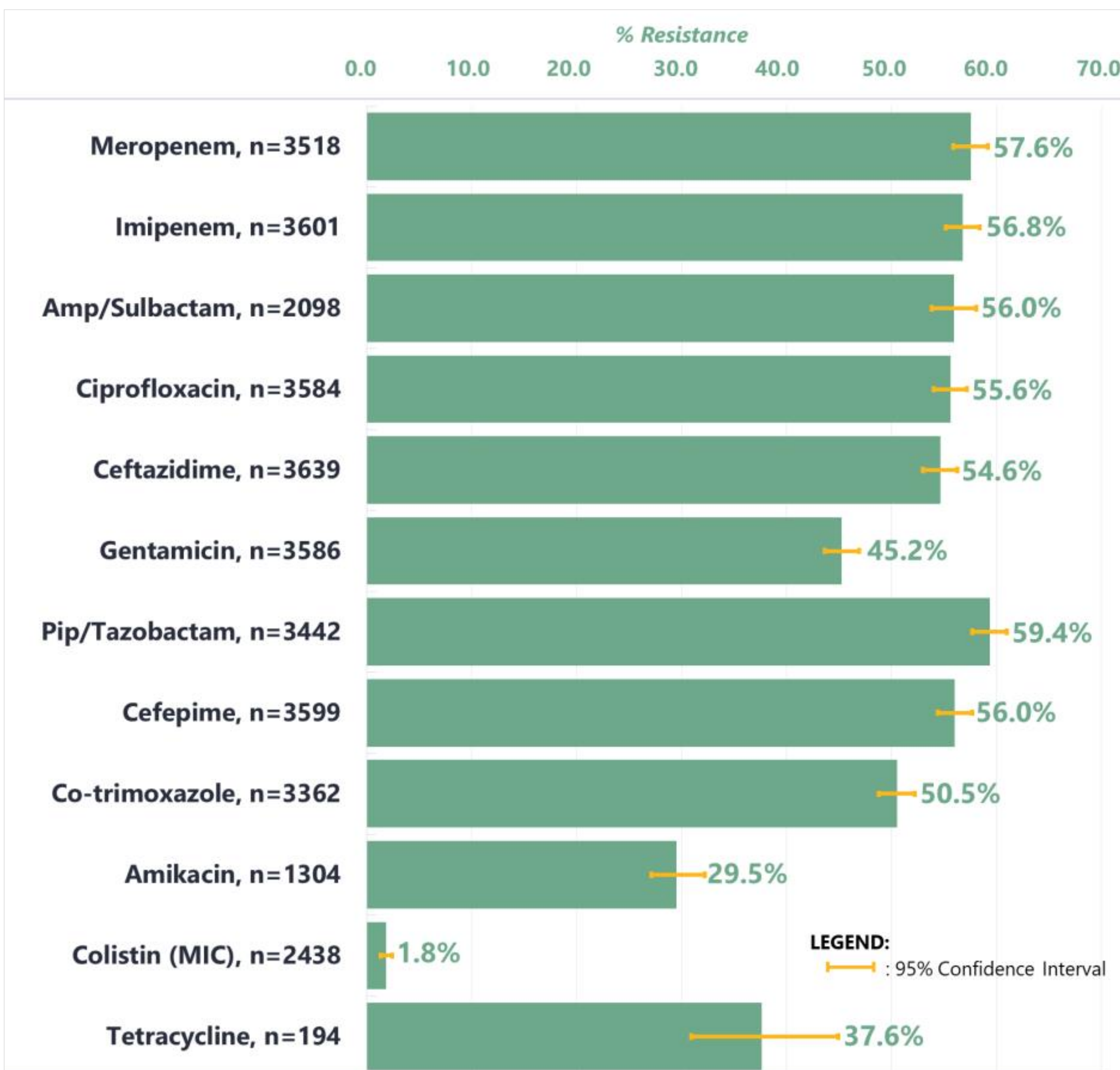


Figure 95. Percent resistance of *A. baumannii* , DOH-ARSP, 2020

Figure 95 shows the cumulative resistance rates of *A. baumannii* in 2020. Most of the resistance rates were more than 50% with the highest for meropenem (57.6%), followed by imipenem (56.8%) and ceftazidime (54.6%). Lowest resistance was for the reserved drug colistin (1.8%).

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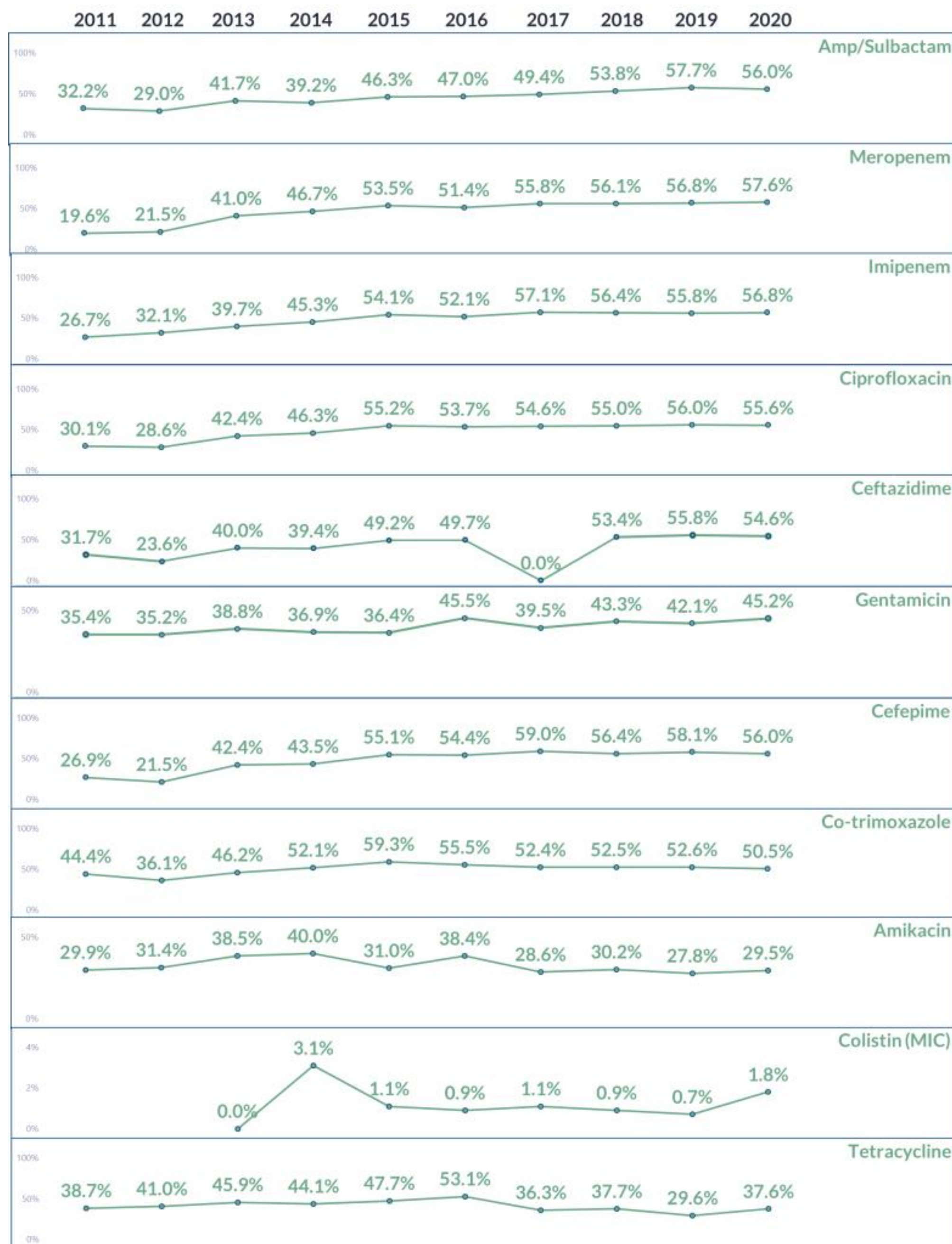


**Figure 96.** Yearly resistance rates of *A. baumannii*, DOH-ARSP, 2011-2020

**Figure 96** shows the yearly resistance rates of *A. baumannii* isolates. Resistance to most antibiotics continued to increase. There was likewise an increase in colistin resistance for 2020 compared with 2019 resistance rate and the change was noted to be statistically significant (p -value = 0.0000).

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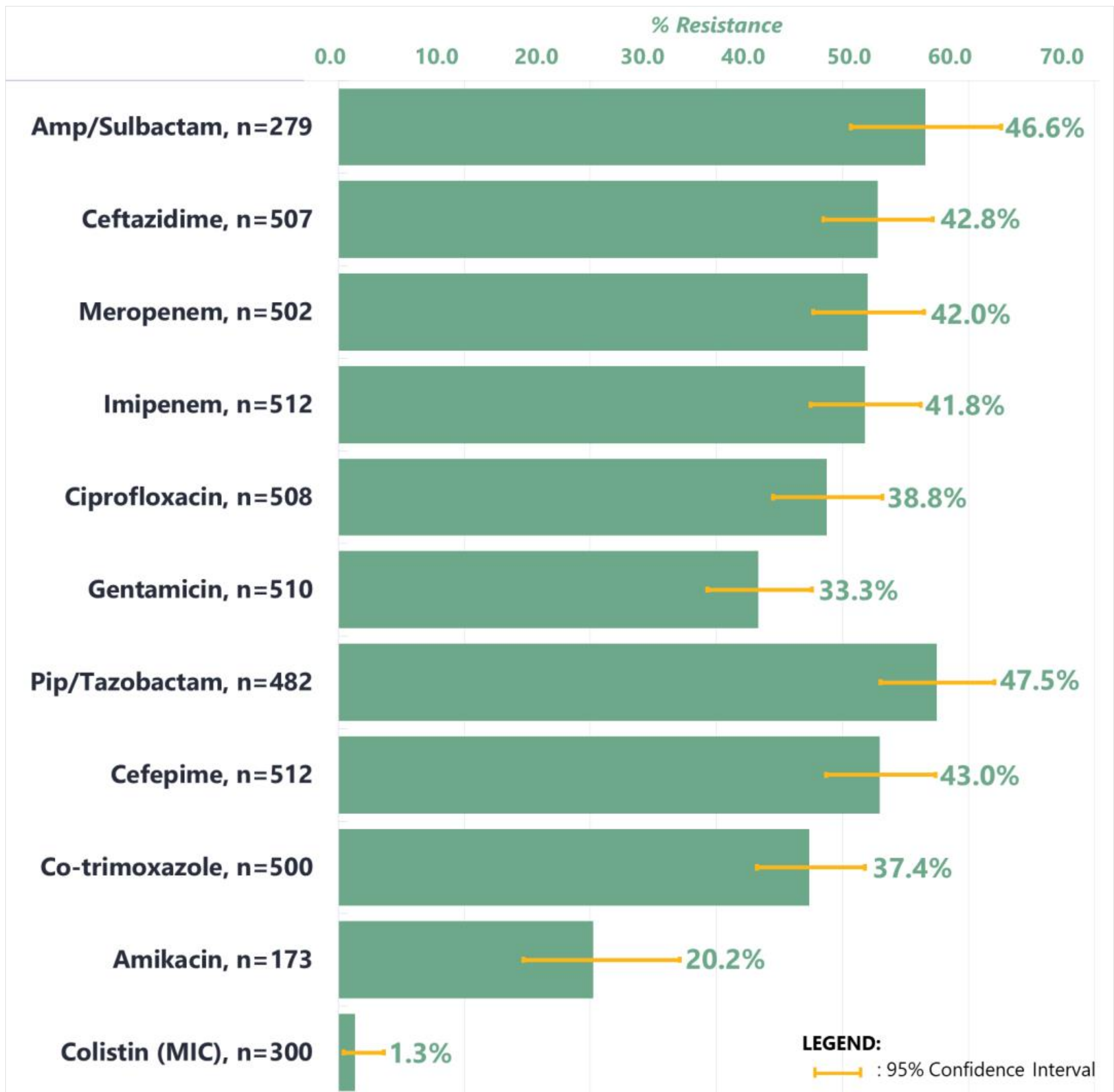


Figure 97. Percent resistance of *A. baumannii* blood isolates, DOH-ARSP, 2020

Figure 97 shows the resistance rates of *A. baumannii from* blood samples for 2020 Most of the resistance rates were above 40%. Resistance to amikacin was at 20.2% and 1.3% to the reserved drug colistin.

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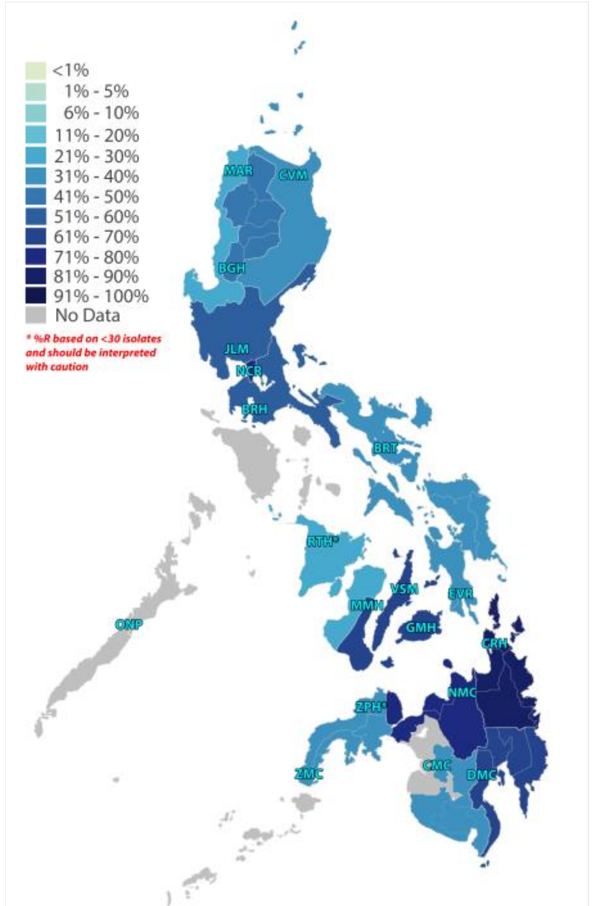
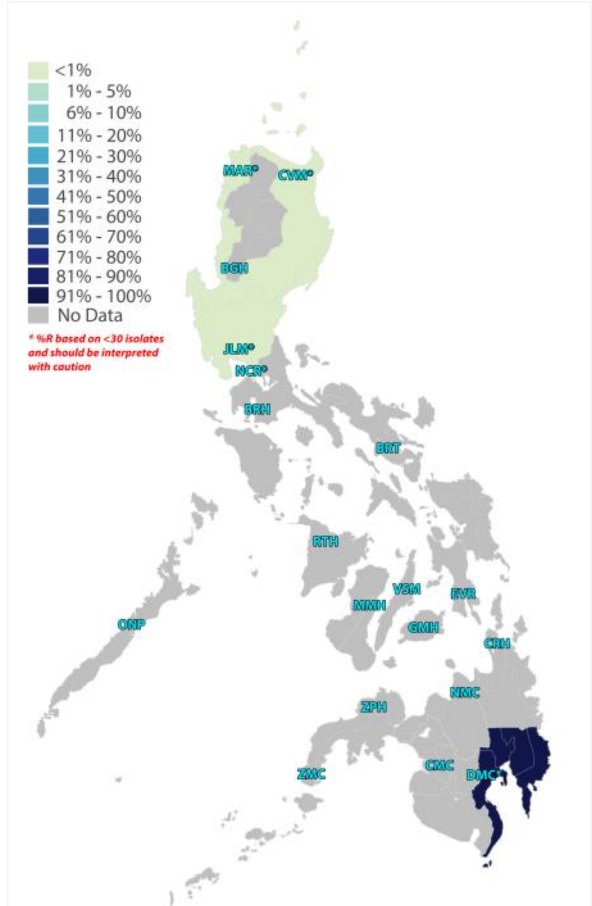
## A. Imipinem




## B. Ertapenem




## C. Meropenem

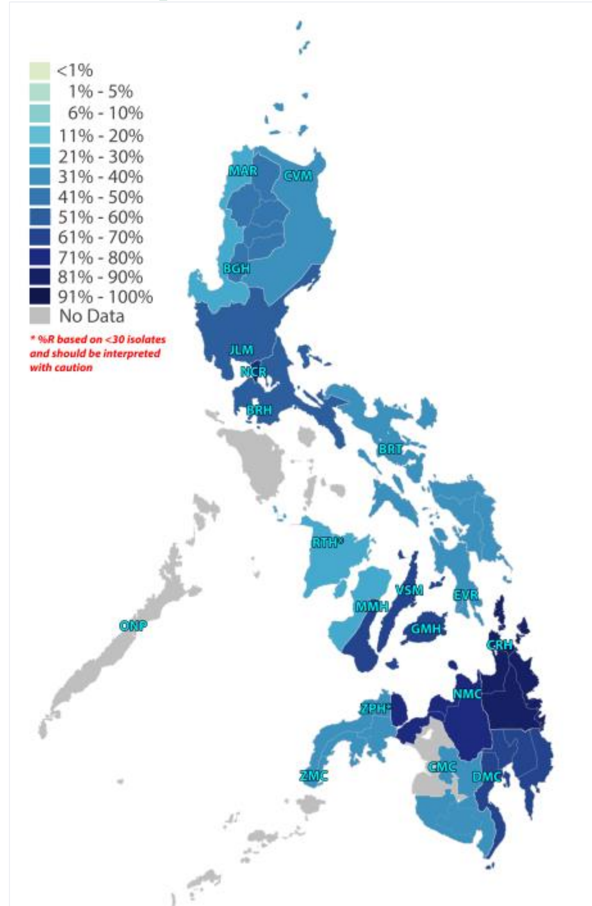



**Figure 98.** Resistance maps of *A. baumannii* for (A) imipenem, (B) ertapenem and (C) meropenem, DOH-ARSP, 2020

**Figure 98** shows the carbapenem resistance rates of *A. baumannii* across the different regions represented by the sentinel sites. The *A. baumannii* isolates from most of the regions have imipenem and meropenem resistance rates of more than 20%.

# Multidrug Resistant *Pseudomonas aeruginosa* and *Acinetobacter baumannii*

Multidrug- resistant pathogens are increasingly recognized globally. Terminologies are summarized in Table 5.

Among the 2020 *P. aeruginosa* isolates from all types of samples, 23% were MDR and 17% were possible XDR (Table 6). Among *P. aeruginosa* isolates from blood samples, 21% were MDR and 15% were possible XDR. Among the 2020 *A baumannii* isolates from all types of samples, 64% were MDR and 54% were possible XDR.

Among *A baumannii* isolates from blood samples, 50% are MDR and 35% are possible XDR.

**Table 5.** Multidrug-resistant, extensively drug resistant and pan-drug resistant bacteria – an international expert proposal interim standard definitions for acquired resistance

| Term | Definition |
|---|---|
| MDR<br>Multidrug-resistant | Acquired non-susceptibility to at least one agent in three or more antimicrobial categories |
| XDR<br>Extensively drug-resistant | Non-susceptibility to at least one agent in all but two or fewer antimicrobial categories |
| PDR<br>Pandrug-resistant | Non-susceptibility to all agents in all antimicrobial categories |

**Table 6.** MDR and Possible XDR *P. aeruginosa* and *A. baumannii*, DOH-ARSP, 2020

| | Number of isolates tested | Percentage MDR | Percentage Possible XDR |
|---|---|---|---|
| ***Pseudomonas aeruginosa*** | | | |
| All isolates | 5,063 | 23% | 17% |
| Blood isolates | 346 | 21% | 15% |
| ***Acinetobacter baumannii*** | | | |
| All isolates | 3,845 | 64% | 54% |
| Blood isolates | 527 | 50% | 35% |

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**Figure 99.** Yearly MDR and XDR trends of *A. baumannii* for all isolates and blood subsets, DOH-ARSP, 2016-2020

Percent MDR of all *A. baumannii* isolates (p= 0.0000) and blood isolates (p=0.0699) showed increasing trend in the last two years. The difference between percent XDR of *A. baumannii* (all isolates) in 2019 and 2020 is significant (p= 0.0000).

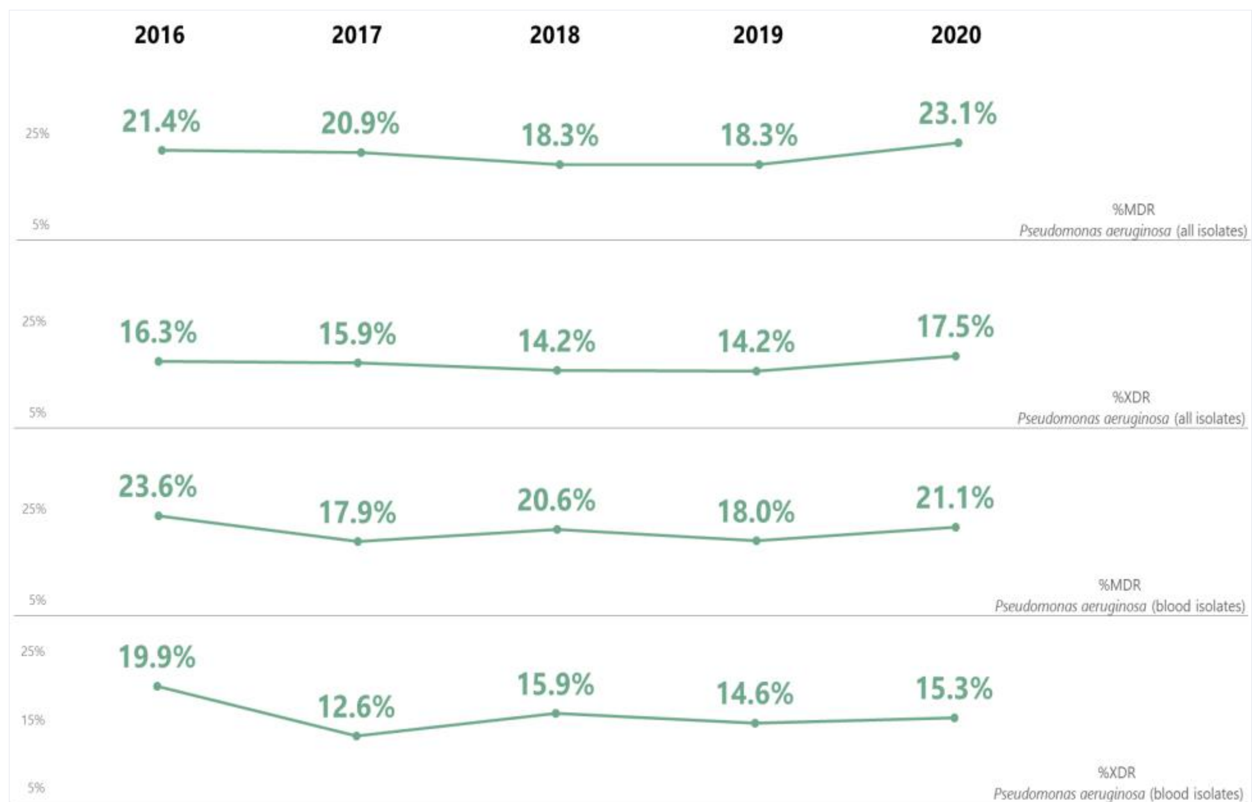


**Figure 100.** Yearly MDR and XDR trends of *P. aeruginosa* for all isolates and blood subsets, DOH-ARSP, 2016-2020

The difference between the percent MDR and XDR of *P. aeruginosa* (all isolates) in 2019 and 2020 are both significant at p= 0.0000. Percent MDR for *P. aeruginosa* blood isolates increased from 18% in 2019 to 21% in 2020, however the difference was not significant.

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# Conclusions, Recommendations and Future Directions

Antimicrobial resistance continue to increase for most of the bacterial pathogens considered of public health importance included in this surveillance.

### Recommendations based on the reported the 2020 data:

Infections secondary to *Streptococcus pneumoniae* can still be covered with penicillin even as the changing trends of resistance among pneumococci has to be closely monitored. Improving the surveillance to include clinical outcomes data for invasive isolates as well as routine pneumococcal serotyping will allow for better monitoring and evaluation of the government's vaccination strategy for this vaccine preventable pathogen.

Due to high resistance rate of *Haemophilus influenzae* to ampicillin, recommended empiric treatment for suspected *H. influenzae* infections may consist of beta-lactam-beta-lactamase inhibitor combinations and extended spectrum oral cephalosporins.

Empiric treatment for suspected uncomplicated typhoid fever could still consist of either chloramphenicol or co-trimoxazole or amoxicillin/ampicillin. Microbiological data is recommended to aid in pathogen directed therapy in view of increasing reports of nalidixic acid resistant and ciprofloxacin non-susceptibility of *S.* Typhi which may result to clinical treatment failures.

Increasing rates of ciprofloxacin resistance should remind clinicians to use antibiotics judiciously in Salmonella gastroenteritis, as this is usually a self-limited disease.

In view of the emerging resistance of *Shigella* to the quinolones and limited data available, more vigilant surveillance of the resistance pattern of this organism should be pursued by encouraging clinicians to send specimens for culture.

Tetracycline, chloramphenicol and co-trimoxazole remain good treatment options for cholera cases.

With the limited available data on *Neisseria gonorrhoeae*, ceftriaxone remains as empiric antibiotic of choice for gonococcal infections. More vigilant surveillance of the resistance patterns of this organism should be pursued by encouraging clinicians to send specimens for culture and confirmatory testing at the reference laboratory.

Statistically significant decrease in MRSA rates continue to be noted beginning in 2017 until 2020. Linking laboratory information with clinical data as well as genotyping to identify strains of prevalent MRSA isolates will allow for targeted and comprehensive strategies in MRSA containment.

Multidrug resistance among the bacterial organisms *Escherichia coli, Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* continues to be a public health concern because of the limited treatment options and infection control challenge in containment. Real time data analysis, genotyping to establish linkages will allow for timely isolation and infection control interventions. Stratified, institute specific antibiograms will allow clinicians to identify the best empiric antibiotic options for suspected infections.

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## Program Future Direction

Continued efforts to improve quality of data by sentinel site and reference laboratory capacity building thru training, efforts to improve facilities, equipment and services.

Improve data management, security and sharing by personnel capacity building of the reference laboratory data management unit and equipment upgrade.

Pursue continuous integration of whole genome sequencing into ARSP through cultivation of the technical expertise and skills in molecular diagnostics of the reference laboratory as well as advocacy for requisite fund and resource requirements.

Strengthen and expand the gonorrhoeae surveillance network and harmonize with available clinical data by working with the Bureau of Epidemiology.

Actively contribute and participate in the implementation of the Philippine Action Plan to Combat Antimicrobial Resistance.

Harmonize with the national antibiotic use data and antimicrobial resistance surveillance data on animal specimens with ARSP data by collaborating with the Pharmaceutical Division of the Department of Health and the Department of Agriculture to enhance the relevance and significance of the surveillance information generated and present a more cohesive picture of the local state of AMR.

Incorporate the technology of geographic information system and mapping in the surveillance.

Work with Epidemiology Bureau to develop a protocol for notification of reportable drug-resistant pathogens

Pursue ISO 15189 accreditation for the reference laboratory.

Generate more relevant collaborative and investigator initiated researches.

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# References

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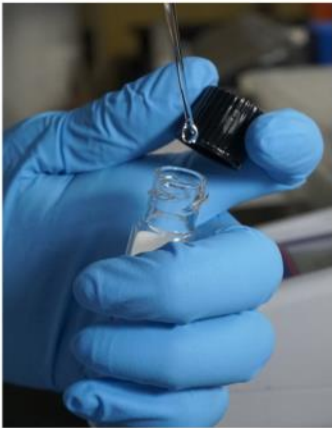

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