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Identifying The Rate Of S. Pneumonia Isolates Resistant To Penicillin In European Countries From 2015 To 2024

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Abstract: ***Antimicrobial resistance (AMR) is a serious threat to public health in the WHO European region. This research was aimed at comparing the rate of S. pneumonia resistance to penicillin in European countries from 2015 to 2024. Data was obtained from the atlas on the site of the European Centre for Disease Prevention and Control (ECDC) surveillance atlas of infectious diseases. Results show the highest rate of S. pneumonia resistance to penicillin in Spain. All other countries had fewer than 100 isolates from 2015 to 2024, with the exception of 2021; Spain had over 100 isolates, spanning as high as over 250 isolates. Estonia, Iceland, Malta, and Slovenia had zero resistant isolates in some years and did not go over 5 resistant isolates reported for the 10 years analysed. The increase in isolates in 2024 compared to 2015 was observed in over 50% (n=17) of the European countries analysed. Belgium had over an 8-fold increase, Germany and the Netherlands had over 5- fold increase, and Iceland had 73 fold increase from 2015 to 2024. Spain, though having the highest number of isolates for both years, did not have up to 2-fold increase.***

The High and increasing number of resistant isolates observed in Spain, and the extreme rate of increase observed in Iceland, Belgium, Germany, and Netherlands within the 10 years studied pose a therapeutic threat. Thus, these countries should be specifically targeted in deploying therapeutic initiatives to Europe by global bodies like the WHO with respect to S. pneumonia resistance to penicillin. This research has also identified countries that maintained zero or a negligible number of isolates across the 10 years, thus sending these initiatives to such countries like Estonia could easily be a waste of effort. Therefore, this research aids country-specific directed therapy.

It is also worth noting that Croatia and Sweden had over 3-folds decrease from 2015 to 2024, thus identifying strategies used by these countries could be adapted as therapeutic interventions for Spain, Iceland, Belgium, Germany, and Netherlands.

Keywords: S. pneumonia, resistance, Penicillin, European

I. INTRODUCTION

Though new antimicrobial agents have been approved, it has been reported that these new agents do not have innovative features e.g. new mechanism of actions. Thus, there is a need to incentivize research with respect to the development of antibiotics both within Europe and LMIC countries. This initiative is aimed at combating the ongoing prevalence of antibiotic resistance (AMR) (Anderson et al, 2023). The comprehensive set of regional and country-level estimates of AMR burden in the WHO European region was reported in a 2022 publication, results show that AMR is a serious threat to public health in the WHO European region, thus targeted efforts and investments with continuous outcome-based research endeavors is required (Mestrovic et al, 2022) AMR is known not just to be a European problem

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but a global problem. Twenty-five *E. coli* isolates obtained from the water samples analyzed for suitability for household use, in Nigeria, an African country, were observed to be resistant to most of the antibacteria agents used, confirming not only the globalization of this health threat but the source being household water shows the importance of targeting a one health approach in developing measures to handle it (Mestrovic et al, 2022).

An European study identified the resistance rates of *K. pneumoniae* to fluoroquinolones in 2021, its European age distribution, and its resistance rates compared to carbapenems. An over 50% resistance of *K. pneumoniae* isolates for 19years and above was identified. The about 2 fold fluoroquinolone resistance increase observed over a duration of 16 years poses a high therapeutic threat to Europeans above the age of 19 over the next decade, as *K. pneumoniae* has shown tendencies to increase in their resistance rates (Mohammed et al, 2025).

Thirty fluoroquinolone-resistant clinical isolates of *Escherichia coli* producing extended-spectrum β-lactamases were observed and mutations in the quinolone resistance-determining regions of *gyrA*, *gyrB*, *parC*, and *parE* were studied. Ten isolates showed a mutation in *parE* that was significantly associated with an increase in the MIC for fluoroquinolones (Sorlozano et al, 2007). This fluoroquinolone resistance has been observed in *Enterobacteriaceae*, (Dalhoff, 2012), in Flaviviruses such as Dengue and Zika virus (Scroggs et al, 2021)

Penicillin resistance is also a global issue as was observed in a Vitenemese research which concluded that Penicillin should not be the first-line antibiotic of choice, and ceftriaxone at an enhanced dose should be used instead (Tran-Quang et al, 2023).

Penicillin resistance rates in *S. pneumoniae* have also been observed in Argentina and have remained stable in Argentina in recent years. The expansion of resistant clones was reported to differ with regions and is influenced by the use of antibiotics, vaccines, particularly conjugated ones, and population density. Parenteral treatment with high doses of penicillin G continues to be an effective therapy for pneumonia and bacteremia, while oral are aminopenicillins are effective for otitis media and sinusitis, and third-generation cephalosporins for meningitis (Specht et al 2021). It was also concluded that the continuous surveillance of *S. pneumoniae* is necessary to aid new discovery that aids the exploration of alternative treatments and preventive strategies (Specht et al 2021). 2022 study emphasized that vaccination is the best preventive measure for *S. pneumoniae* infection, considering its resistance to commonly used antibiotics (Zhou et al, 2022).

Following the introduction of pneumococcal conjugate vaccines, PCV7 (2006) and PCV13 (2010), major shifts occurred in serotype prevalence for community-associated lower respiratory tract infections (CA-LRTI) & bacteremia. PCV7 types and most PCV13 types (but not 3 and 19A) were largely or wholly displaced. Many of which were internationally prevalent and associated with antibiotic resistance. Other serotypes expanded into the space, with serotype 8 becoming especially prominent in bacteraemia, though not in respiratory infections. Serotype 15A, often multi-resistant, rose then fell in relative importance after deployment of PCV13. Among the currently most prevalent types, serotype 3 is rarely resistant to agents besides tetracyclines, and bloodstream serotype 8 isolates have mostly been reported to be fully susceptible (Horner et al, 2025).

This research is aimed at identifying the comprehensive set of regional and country-level estimates of *S. pneumonia* resistance to penicillin amongst European Countries.

II. METHOD

Data analysed in this paper were obtained and analysed from the atlas on the site of the European Centre for Disease Prevention and Control (ECDC) surveillance atlas of infectious diseases. On the atlas, the following selection was made- Health Topic: Antimicrobial resistance, Subpopulation: Streptococcus pneumonia, Subpopulation 2: Penicillin, Indicator: Resistant isolates, Selection using these parameters were made for the years 2015 – 2024 (10-year duration), and data obtained and analysed using Excel

RESULTS

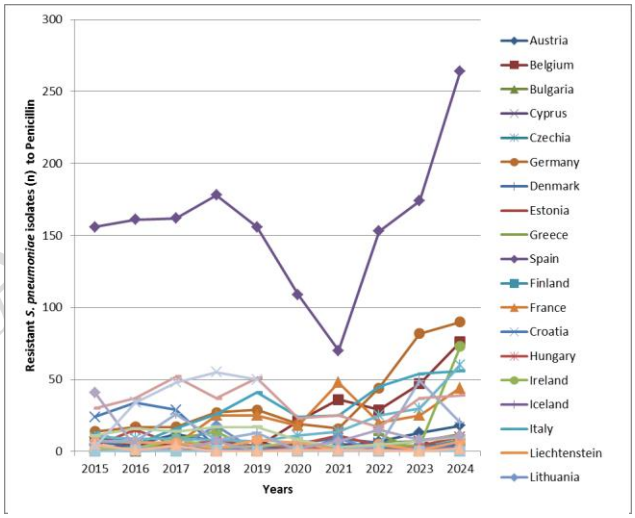

Figure 1: Rate of S. pneumonia resistance to penicillin in European countries from 2015 to 2024

Above results show the highest rate of *S. pneumonia* resistance to penicillin in Spain. All other countries had less than 100 isolates from 2015 to2024 but order than year 2021Spain had over 100 isolates spanning as high as over 250 isolates. Some countries had zero resistant isolates in some years and did not go over 5 resistant isolates reported for the 10 years analysed which were Estonia, Iceland, Malta, Slovenia

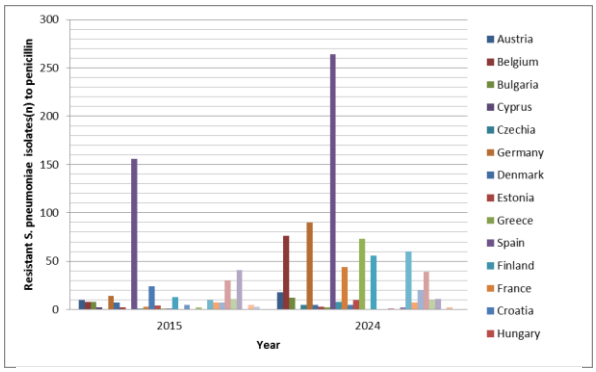

Figure 2: Rate S. pneumonia resistance to penicillin compared between 2015 and 2024

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2024 was observed to have more *S. pneumonia* isolates resistant to penicillin compared to year 2015. The increase in isolates at 2024 compared to 2015 was observed in over 50% (n=17) of the European countries analysed

Belgium had over 8 folds increase, Germany and Netherlands had over 5 folds increase and Iceland had 73 fold increase from 2015 to 2024. Spain though having the highest number of isolates for both years did not have up to 2 fold increase

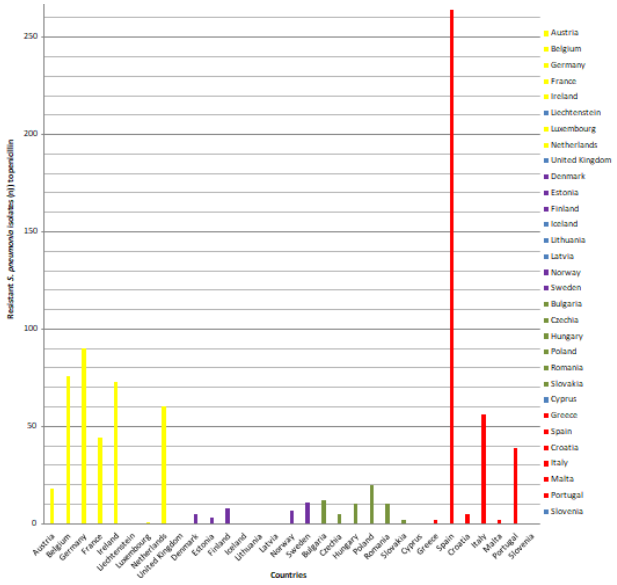

Figure 3: Rate of S. pneumonia resistance to penicillin compared in North(blue) West(Yellow) South (green) and Eastern Europe (red)

Northern and Southern European region were observed to have lesser resistant isolates to Penicillin compared to Western and eastern region of Europe.

III. DISCUSSION

Though Penicillin resistance is a global issue, as observed in other countries like Vietnamese, and Argentina (Tran-Quang et al, 2023, Specht et al, 2021). This research aimed at identifying the comprehensive set of regional and country-level estimates of *S. pneumonia* resistance to penicillin amongst European Countries.

Western and Eastern regions of Europe would have to understudy countries like Estonia and Iceland, etc with almost negligible *S. pneumonia* isolates resistant to penicillin. Though Spain has an alarming number of resistant isolates and it's also increasing, Iceland, Belgium, Germany, and the Netherlands also pose a therapeutic threat as their rate of increase within the 10 years studied was extreme. It is also worth noting that Croatia and Sweden had over 3 folds decrease from 2015 to 2024. Thus, they may have effective strategies that led to this reduction, which can be easily adapted, rather than studying countries that have had consistently a negligible number of resistant isolates. The use of vaccination in Spain and these countries with high folds of increase could eliminate resistant isolates, leaving susceptible ones.

Introduction of pneumococcal conjugate vaccines, PCV7 and PCV13, as earlier stated, led to major shifts in the displacement of elated serotypes. Many of which were internationally prevalent and associated with antibiotic resistance. Other serotypes expanded into the space, with serotype 8 becoming especially prominent in bacteraemia, and these blood serotypes have been reported to be fully susceptible (Horner et al, 2025). Thus, applying a similar strategy in Spain could lead to a decrease in resistant isolates. Also, a 2022 study emphasized that vaccination is the best preventive measure for *S. pneumoniae* infection considering, its resistance to commonly used antibiotics. (Zhou et al, 2022))

The results obtained from this research aid regional and Country specificity in deploying therapeutic initiatives to Europe by global bodies like the WHO with respect to *S. pneumonia* resistance to penicillin. Sending these initiatives to Estonia could easily be a waste of effort. Thus, as much as a comprehensive set of regional and country-level estimates of AMR burden in the WHO European region (Mestrovic et al, 2022) is required, research specific to a pathogen-resistant isolate distribution to a specific antibiotic could aid in increasing efficacy of deployed therapeutic initiatives.

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