Antimicrobial resistance of *Salmonella* Typhi and Paratyphi isolates in Portugal, January 1994 - June 2025

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1 Introduction

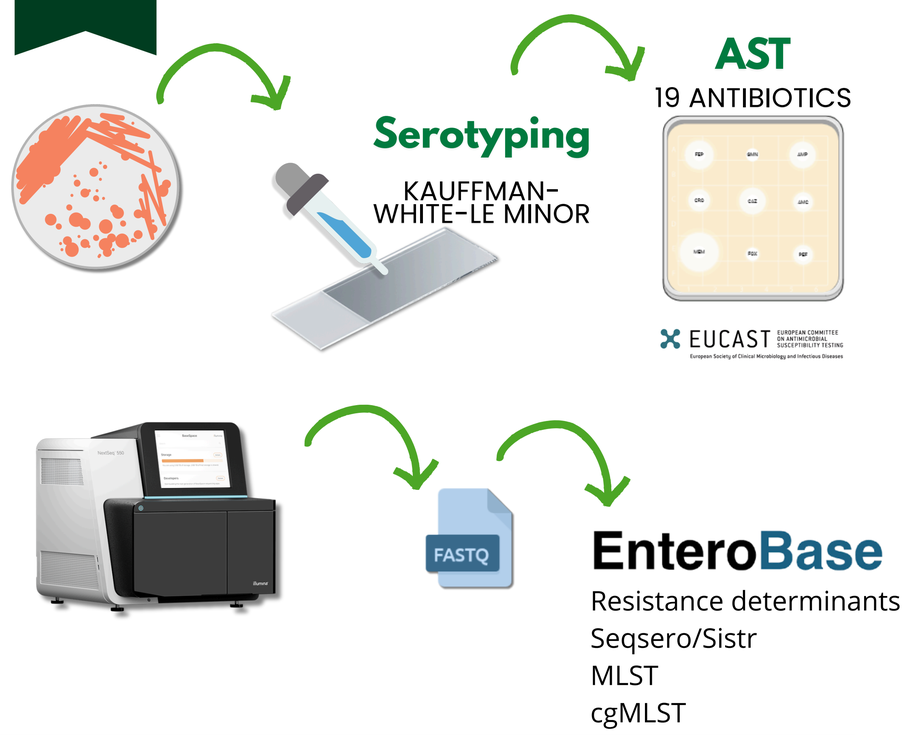
Typhoid and paratyphoid fever are severe systemic infections caused by *Salmonella* (*S.*) *enterica* subspecies enterica serovars Typhi and Paratyphi A, B and C.

Transmission occurs primarily through ingestion of food or water contamined with faeces from infected individuals or via direct person-to person contact. In Europe, enteric fever is rare and mainly associated with travel to endemic countries.

The increasing prevalence of multidrug resistance (MDR), particularly in *S.* Typhi, poses significant therapeutic challenges.

Characterization of antibiotic resistance profiles of *S.* Typhi and Paratyphi A, B, and C isolates received in Jan 94-Jun 25

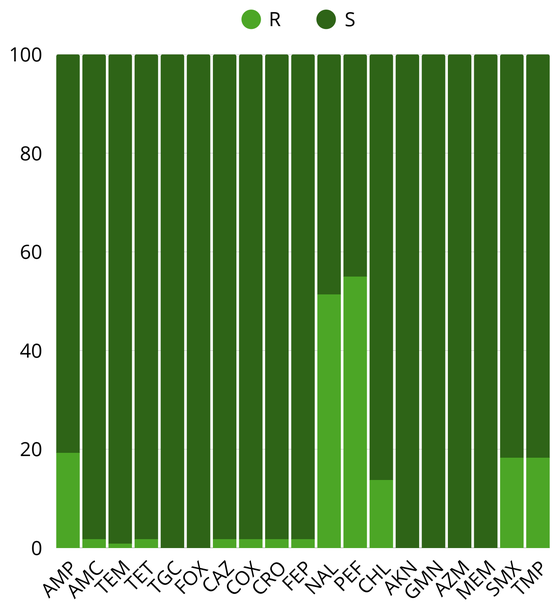
2 Methodology



3 Results

Total number of **191** isolates

- 167 Typhi
- 13 Paratyphi A
- 7 Paratyphi B
- 4 Paratyphi C

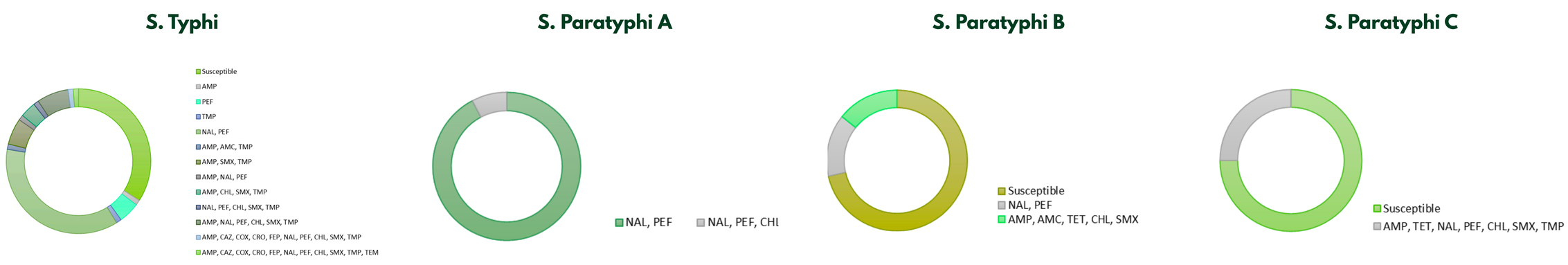


AMP: Ampicillin; AMC: Amoxicillin+Clavulanic acid; TEM: Temocillin; TET: Tetracycline; TGC: Tigecycline; FOX: Cefoxitin; CAZ: Ceftazidime; COX: Cefotaxime; CRO: Ceftriaxone; FEP: Cefepime; NAL: Nalidixic Acid; PEF: Pefloxacin; CHL: Chloramphenicol; AKN: Amikacin; GMN: Gentamicin; AZM: Azithromycin; MEM: Meropenem; SMX: Sulphametoxazole; TMP: Trimethoprim.

Table 1. Phenotypic and genotypic antimicrobial characterization of the 109 sequenced isolates.

Phenotypic profile	Genotypic profile (resistance genes, point mutations, efflux pumps)	No. of isolates
***S.* Typhi (N=85)**		
Susceptible	*aac(6')-Iaa*	28
	aac(6')-Iaa, gyrB (p.S464F)	1
AMP	*aac(6')-Iaa, bla*TEM-1B	1
PEF	*aac(6')-Iaa, gyrbB* (p.S464F)	4
TMP	*aac(6')-Iaa, dfrA7*	1
NAL, PEF	*aac(6')-Iaa, gyrA* (p.D87N)	2
	aac(6')-Iaa, gyrA (p.S83F)	22
	aac(6')-Iaa, gyrA (p.S83Y)	4
	aac(6')-Iaa, gyrA (p.S83F, p.D87N)	1
	aac(6')-Iaa, gyrA (p.S83F, p.D87N), *parC* (p.S80I)	1
	aac(6')-Iaa, qnrB19, gyrA (p.S83F)	1
AMP, AMC, TMP	*aac(6')-Iaa,bla*TEM-1B, *sul1, drfA7*	1
AMP, NAL, PEF	*aac(6')-Iaa, bla*TEM-1B, *gyrA* (p.S83F)	1
AMP, SMX, TMP	*aac(6')-Iaa, bla*TEM-1B, *sul1, dfrA7*	5
AMP, CHL, SMX, TMP	*aac(6')-Iaa, aph(6)-Id, aph(3")-Ib, bla*TEM-1B, *catA1, sul1, sul2, dfrA7*	3
NAL, PEF, CHL, SMX, TMP	*aac(6')-Iaa, gyrA* (p.S83F), *catA1, sul1, dfrA7*	1
AMP, NAL, PEF, CHL, SMX, TMP	*aac(6')-Iaa, aph(6)-Id, aph(3")-Ib, bla*TEM-1B, *gyrA* (p.S83F), *catA1, sul1, sul2, dfrA7*	5
	*aac(6')-Iaa, aph(6)-Id, aph(3")-Ib, bla*TEM-1B, *gyrA* (p.S83Y, p.D87G), *parC* (p.S80I), *catA1, sul1, sul2, dfrA7*	1
AMP, CAZ, COX, CRO, FEP, NAL, PEF, CHL, SMX, TMP, TEM	*aac(6')-Iaa, aph(6)-Id, aph(3")-Ib, bla*TEM-1B, *bla*CTX-M-15*, *catA1, qnrS1, gyrA* (p.S83F), *sul1, sul2, dfrA7,*	1
AMP, CAZ, COX, CRO, FEP, NAL, PEF, CHL, SMX, TMP	*aac(6')-Iaa, aph(6)-Id, aph(3")-Ib, bla*TEM-1B, *bla*CTX-M-15*, *catA1, qnrS1, gyrA* (p.S83F), *sul1, sul2, dfrA7*	1
***S.* Paratyphi A (N=13)**		
NAL, PEF	*aac(6')-Iaa, gyrA* (p.S83Y)	4
	aac(6')-Iaa, gyrA (p.S83F), *parC* (p.T57S)	5
	aac(6')-Iaa, gyrA (p.S83F, p.D87N), *parC* (p.T57S)	1
	aac(6')-Iaa, qnrB19, gyrA (p.S83F)	2
NAL, PEF, CHL	*aac(6')-Iaa, gyrA* (p.S83Y), *parC* (p.T57S), AcrAB–TolC	1
***S.* Paratyphi B (N=7)**		
Susceptible	*aac(6')-Iaa*	5
NAL, PEF	*aac(6')-Iaa, gyrA* (p.S83F)	1
AMP, AMC, TET, CHL, SMX	*aac(6')-Iaa, aadA2, bla*CARB-2, *tet(G), floR, sul1*	1
***S.* Paratyphi C / *S.* Choleraesuis (N=4)**		
Susceptible	*aac(6')-Iaa*	3
AMP, TET, NAL, PEF, CHL, SMX, TMP	*aac(6')-Iaa, ant(3'')-Ia, aadA1, aadA2, bla*TEM-1B, *tet(A), qnrS1, cml1, sul3, dfrA12*	1

*, Extended-spectrum beta-lactamase - ESBL; AMC, Amoxicillin-Clavulanic acid; AMP, Ampicillin; CAZ, Ceftazidime; CHL, Chloramphenicol; COX, Cefotaxime; CRO, Ceftriaxone; FEP, Cefepime; NAL, Nalidixic acid; PEF, Pefloxacine; SMX, Sulfamethoxazole; TEM, Temocillin; TET, Tetracycline; TMP, Trimethoprim.



4 Conclusion

Although typhoid and paratyphoid serotypes are rare and non-endemic in Portugal, continued laboratory surveillance is essential to monitor circulating isolates, detect emerging resistance, support control measures and enable early identification of potential outbreaks.

EFSA and ECDC (European Food Safety Authority and European Centre for Disease Prevention and Control), (2024). The European Union One Health 2023 Zoonoses report. EFSA Journal, 22(12), e9106. https://doi.org/10.2903/j.efsa.2024.9106