

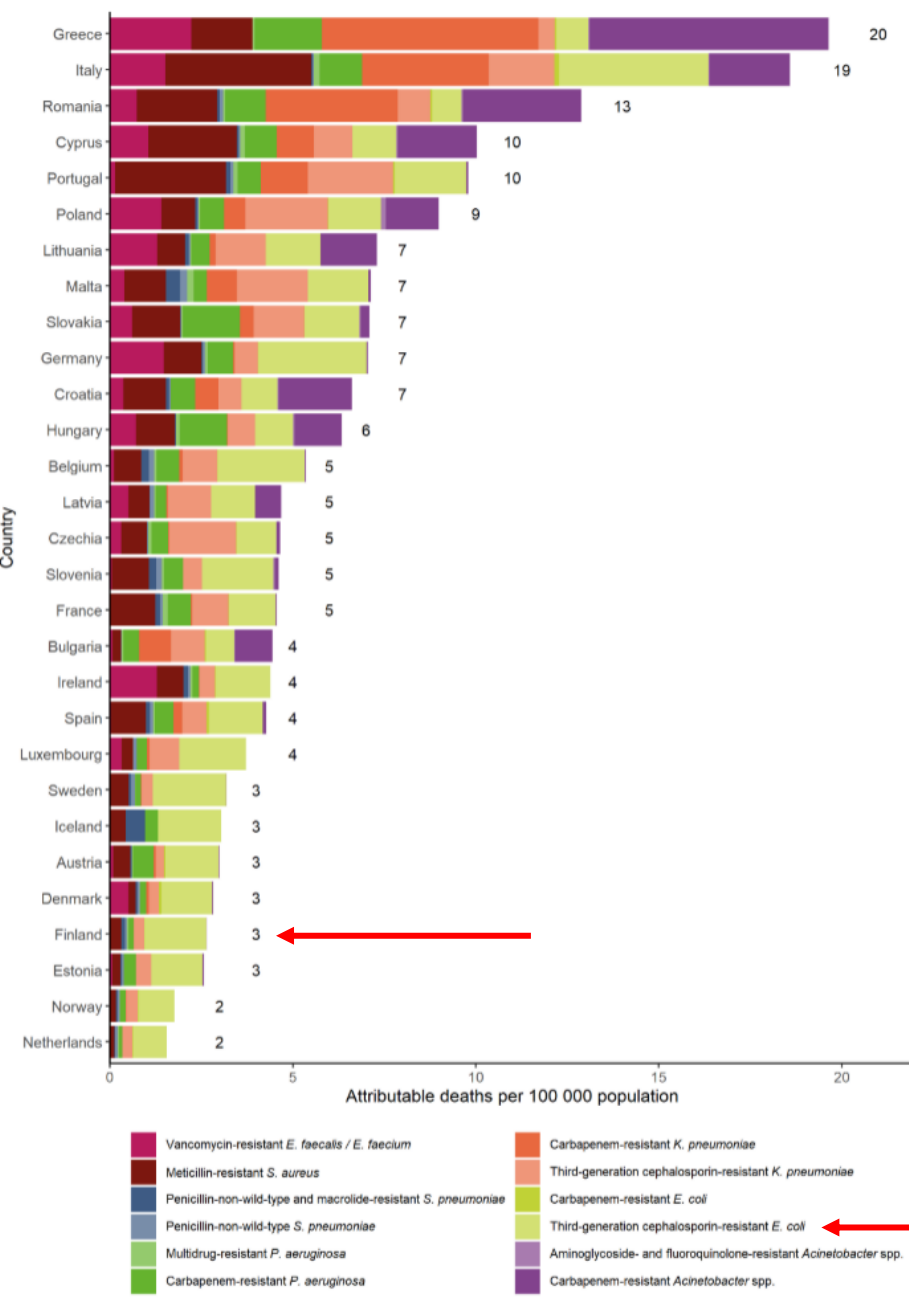


ESBL-*E.coli* in Finland: What can we learn from the Finnish surveillance data

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Figure 5. Estimations of the burden of infections with antibiotic-resistant bacteria presented as attributable deaths per 100 000 population by country*, EU/EEA, 2020



Attributable deaths due to antimicrobial resistant bacteria

FINLAND

1. 3GC-resistant *E. coli*
 - In Finland, the most important antimicrobial resistant bacterium, causing largest AMR-attributable death burden
2. 3GC-resistant *K. pneumoniae*
3. MRSA

Source:
 European Centre for Disease Prevention and Control. Assessing the health burden of infections with antibiotic-resistant bacteria in the EU/EEA, 2016-2020. Stockholm: ECDC; 2022.



*For Sweden, data reported to EARS-Net for 2016-2020 could not be checked for possible duplicate cases reported from the same patient.

WHO: Bacterial Priority Pathogens List

- “Bacterial pathogens of public health importance to guide research, development and strategies to prevent and control AMR”

Source:

WHO Bacterial Priority Pathogens List, 2024: bacterial pathogens of public health importance to guide research, development and strategies to prevent and control antimicrobial resistance.

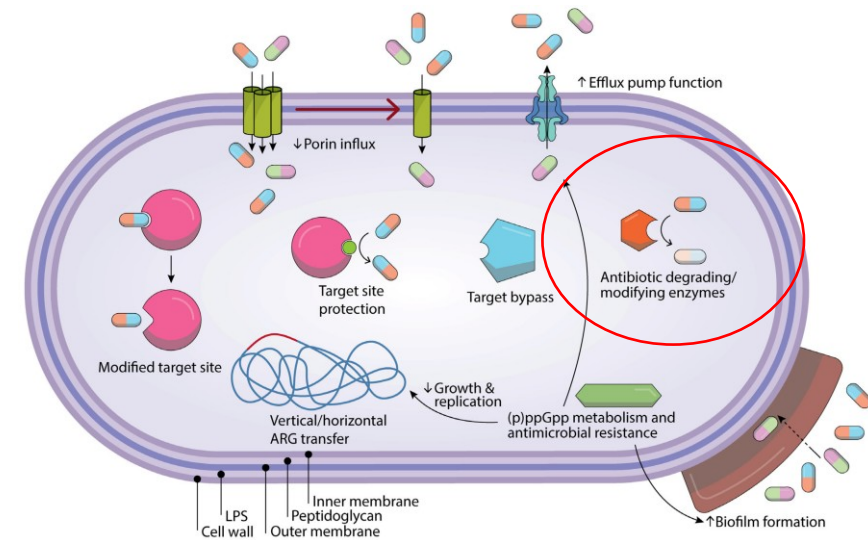
Geneva: World Health Organization; 2024. Licence: CC BY-NC-SA 3.0 IGO

Fig. 1. WHO Bacterial Priority Pathogens List, 2024 update



ESBL = Extended-Spectrum Beta-Lactamase

- **Most frequent cause of 3GC resistance (>90%) among *E. coli* in Finland**
- Enzymes hydrolysing 1st - 3rd-generation cephalosporins (1-3GC), penicillins, and aztreonam
- CTX-M worldwide the most frequent ESBL
 - Also others such as TEM and SHV
- Frequently plasmid-mediated genes
 - Can be transferred to other bacteria



Source:

Tahmasebi H, Arjmand N, Monemi M, et al.

From Cure to Crisis: Understanding the Evolution of Antibiotic

Resistant Bacteria in Human Microbiota. *Biomolecules*. 2021

15(1):93. <https://doi.org/10.3390/biom15010093>

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Finnish problem with ESBLs

- **Treatment of severe infections (Bloodstream infections (BSI), pyelonephritis)**
 - **Empiric drug of choice: Cefuroxime (2GC)**
 - Delay in initiation of effective antimicrobial therapy
 - **Likely to increase the duration of infection and length of hospital stay**
 - Increased healthcare costs
 - May increase the risk for adverse health effects or death
 - **Increased usage of even broader-spectrum antibiotics, i.e. carbapenems**
- **Simultaneous resistance (Finres 2024)**
 - **ESBL-*E. coli***
 - **Blood: Fluoroquinolones approx. 70 %, aminoglycosides approx. 30 %**
 - **Urine: Fluoroquinolones approx. 60 %, trimethoprim approx. 60%**

Increased 3GC resistance

Blood isolates

- **3GCR-*E. coli***

- **World** (WHO/GLASS 2023): **44,8 %** (highest in Africa 70,7 %)
- **Europe** (ECDC/EARS-Net 2024): **16,0 %** (6.8–38.7 %)
- **Finland** (Finres 2024): **6,1 %** (ESBL)

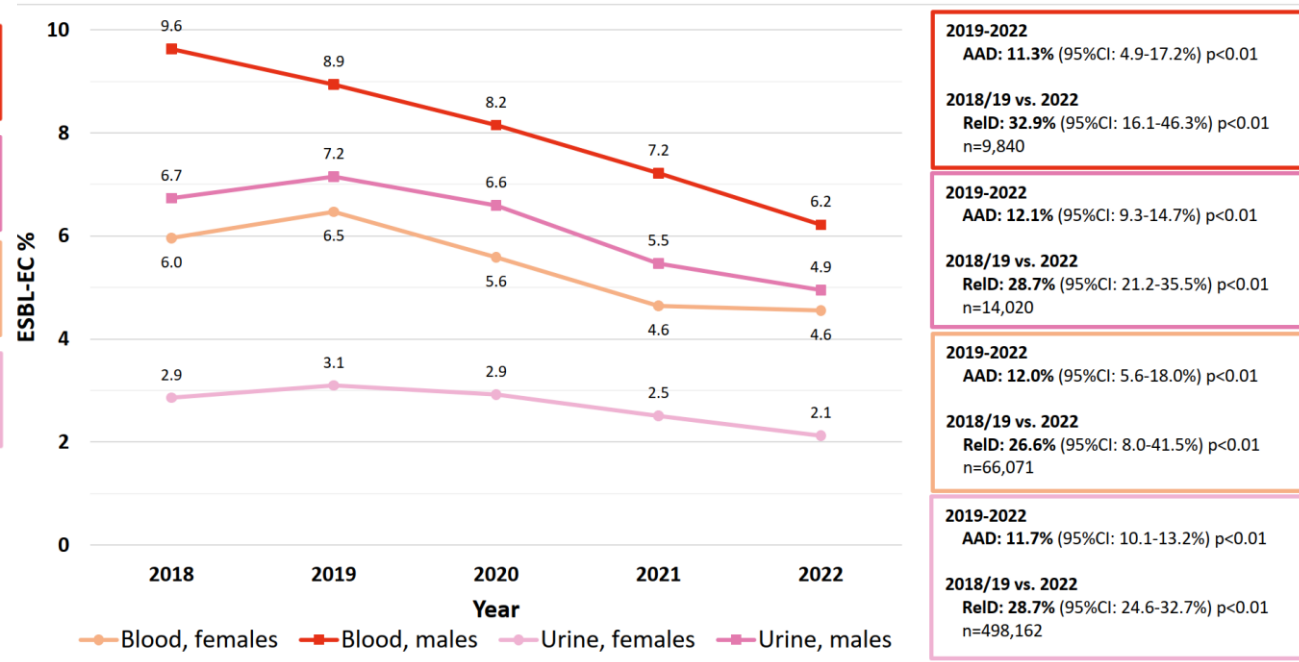
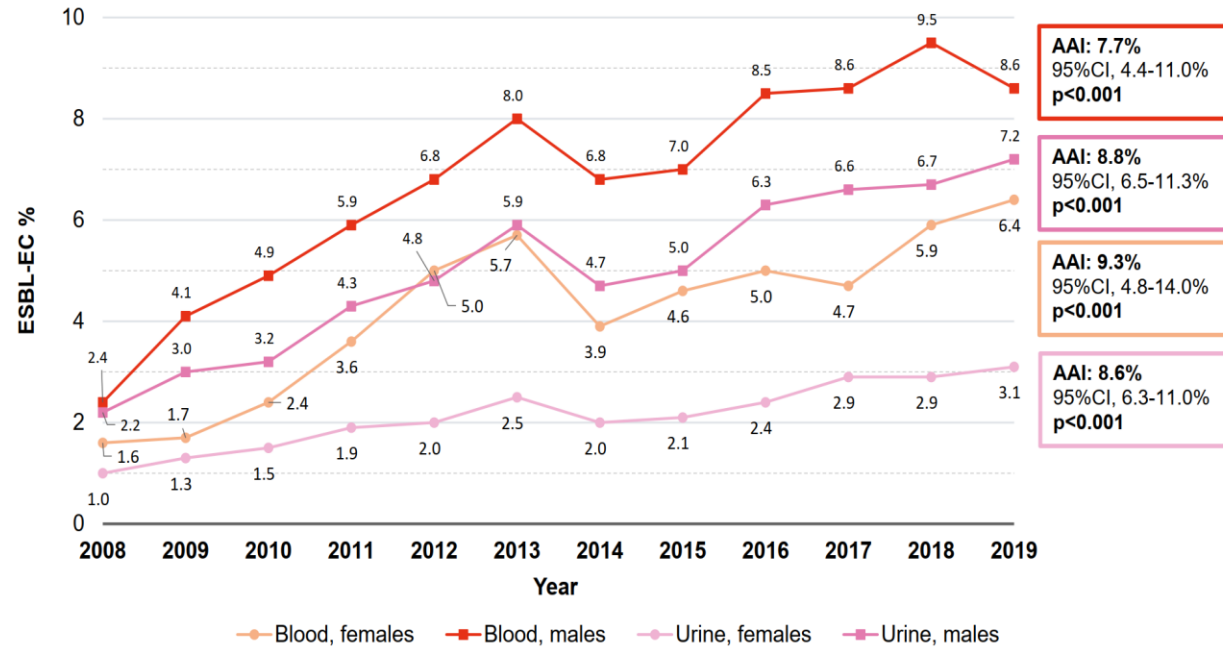
Classical epidemiologic features

ESBL-*E. coli*

- COMMUNITY SPREAD
- Community-acquired infections
 - Also, healthcare-associated infections
- Typical patients:
 - Elderly
 - Recurrent urinary tract infections (UTIs)
 - Long-term care patients
 - Travellers
- ***E. coli* is the most common cause of**
 - UTIs
 - BSIs (>50% urosepsis)

Proportion of ESBL-*E. coli*

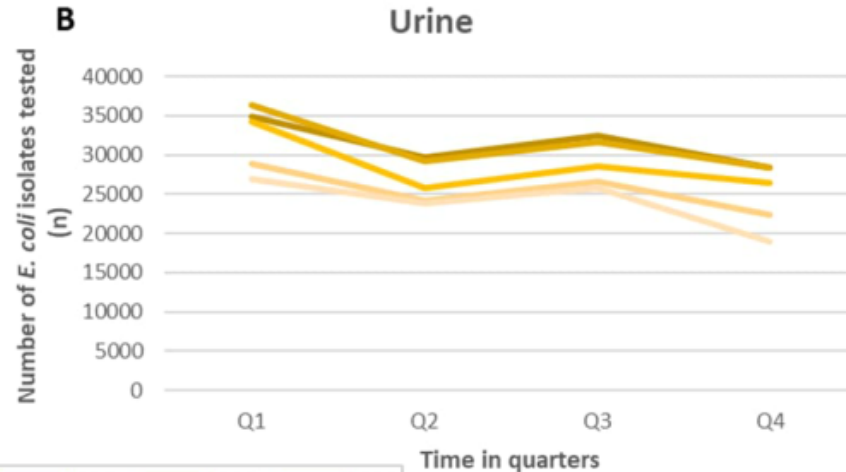
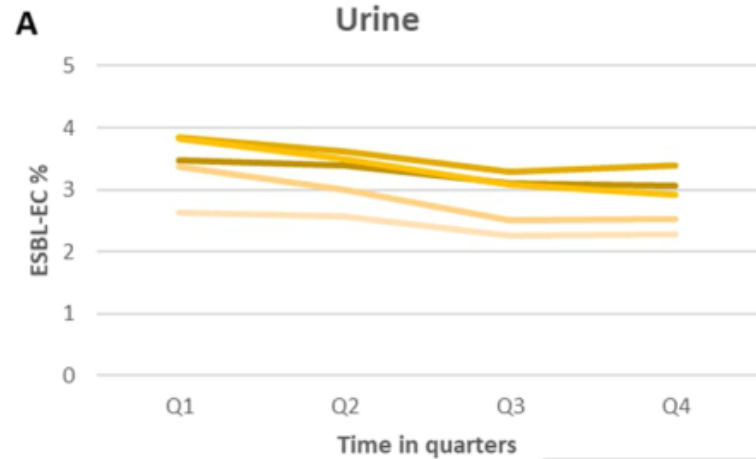
- Larger ESBL proportion among
 - BSIs vs. UTIs
 - Males vs. females
- Rapid decrease after the pandemic onset



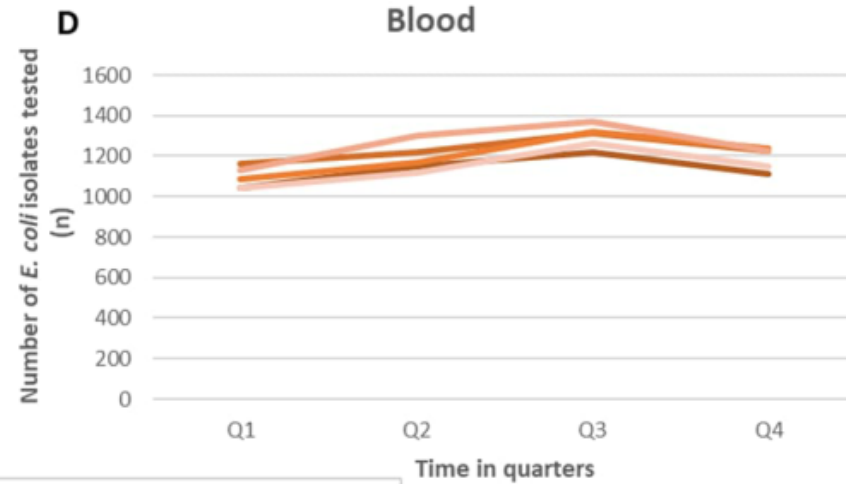
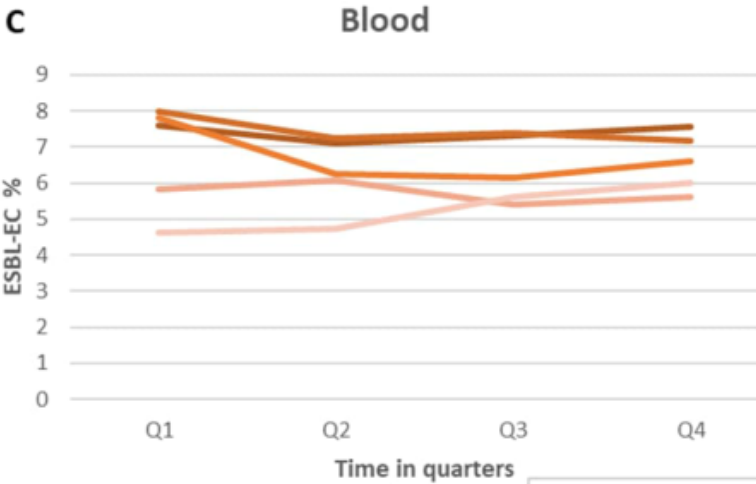
Reference:

Ilmavirta, H., Ollgren, J., Räisänen, K. et al. Impact of the COVID-19 pandemic on extended-spectrum β -lactamase producing *Escherichia coli* in urinary tract and blood stream infections: results from a nationwide surveillance network, Finland, 2018 to 2022. *Antimicrob Resist Infect Control* 13, 72 (2024). <https://doi.org/10.1186/s13756-024-01427-z>

Timing of the decrease in ESBL proportion



— 2018 — 2019 — 2020 — 2021 — 2022



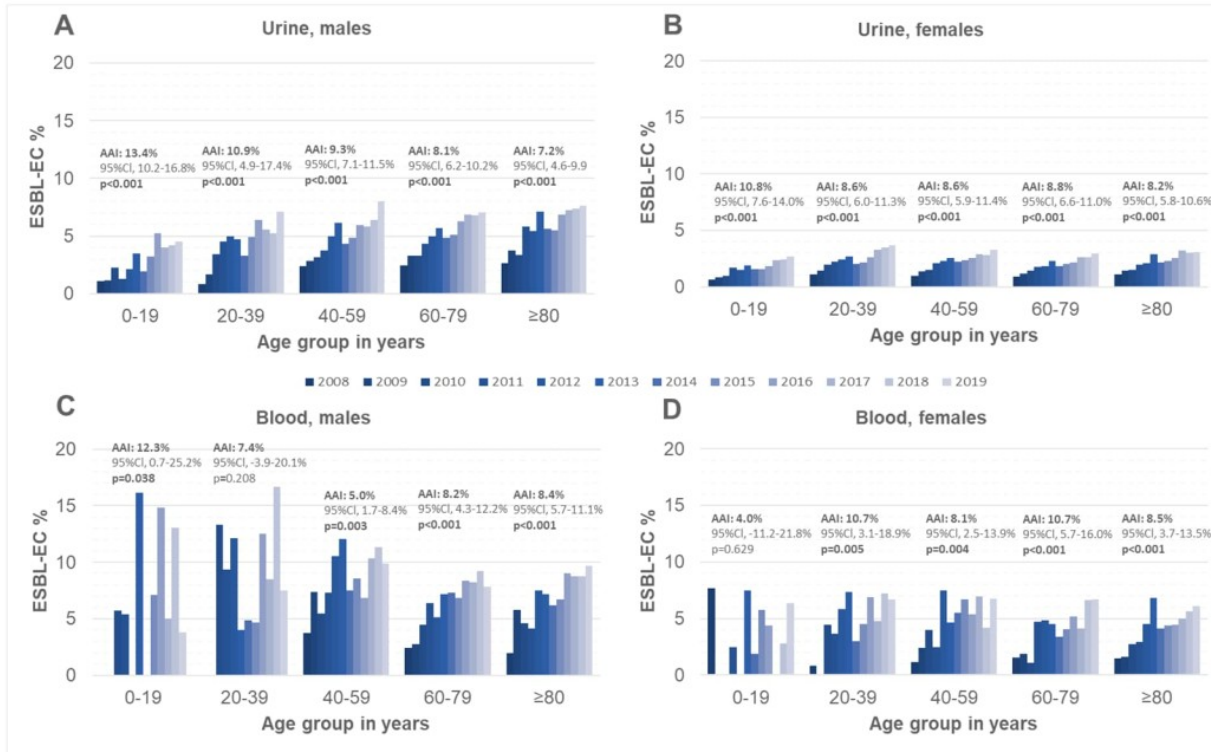
— 2018 — 2019 — 2020 — 2021 — 2022

Decrease started in Q2-3 of 2020

Reference:
Ilmavirta, H., Ollgren, J., Räisänen, K. et al. Impact of the COVID-19 pandemic on extended-spectrum β -lactamase producing *Escherichia coli* in urinary tract and blood stream infections: results from a nationwide surveillance network, Finland, 2018 to 2022. *Antimicrob Resist Infect Control* 13, 72 (2024). <https://doi.org/10.1186/s13756-024-01427-z>

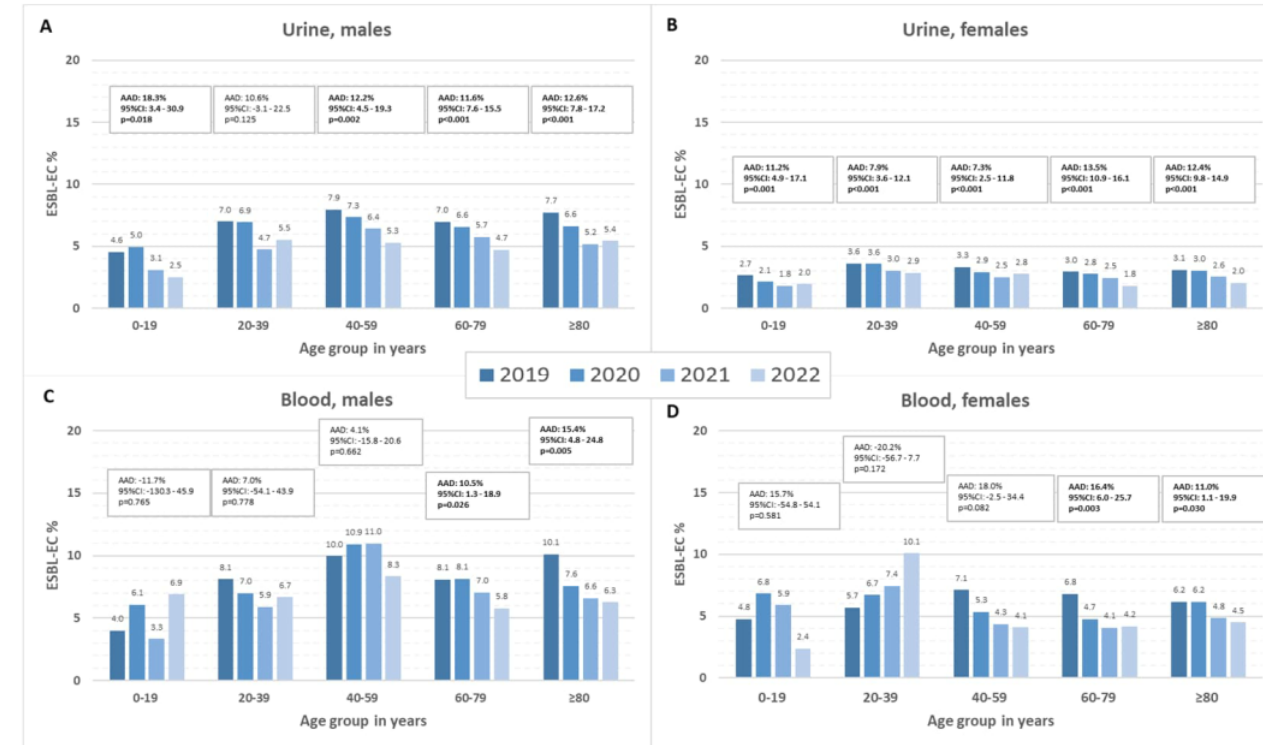
ESBL proportions by age groups

Highly similar changes in most age groups!



Reference:

Ilmavirta Heikki, Ollgren Jukka, Räisänen Kati, Kinnunen Tuure, Hakanen Antti J, Jalava Jari, Lyytikäinen Outi. Increasing proportions of extended-spectrum β -lactamase-producing isolates among *Escherichia coli* from urine and bloodstream infections: results from a nationwide surveillance network, Finland, 2008 to 2019. *Euro Surveill.* 2023;28(43):pii=2200934. <https://doi.org/10.2807/1560-7917.ES.2023.28.43.2200934>



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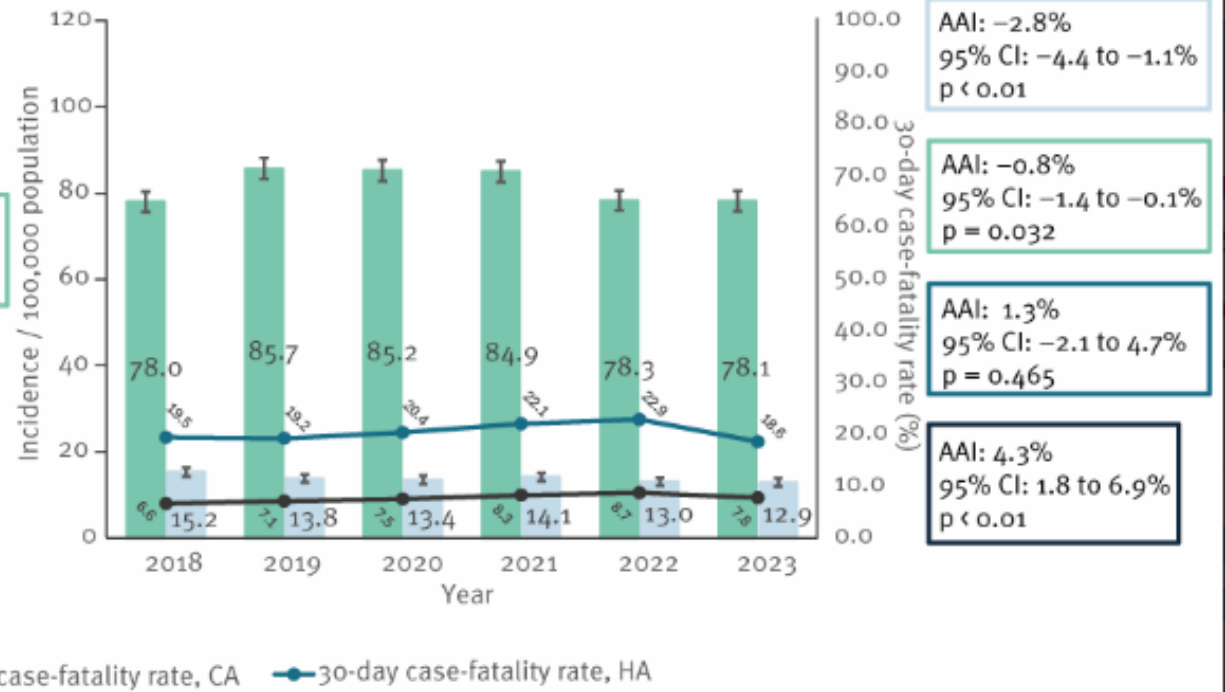
Ilmavirta, H., Ollgren, J., Räisänen, K. et al. Impact of the COVID-19 pandemic on extended-spectrum β -lactamase producing *Escherichia coli* in urinary tract and blood stream infections: results from a nationwide surveillance network, Finland, 2018 to 2022. *Antimicrob Resist Infect Control* 13, 72 (2024). <https://doi.org/10.1186/s13756-024-01427-z>

ESBL-*E. coli* vs. ei-ESBL-*E. coli*

C. Healthcare-associated and community-acquired ESBL (n = 1,916)



D. Healthcare-associated and community-acquired non-ESBL (n = 31,670)



1) 3-fold decrease in healthcare-associated BSIs vs. community-acquired BSIs

2) Significantly higher decrease among ESBL-*E. coli* BSIs than non-ESBL-*E. coli* BSIs

3) 30-day case-fatality seemed to peak in 2021-2022 in healthcare-associated ESBL-*E. coli* BSIs

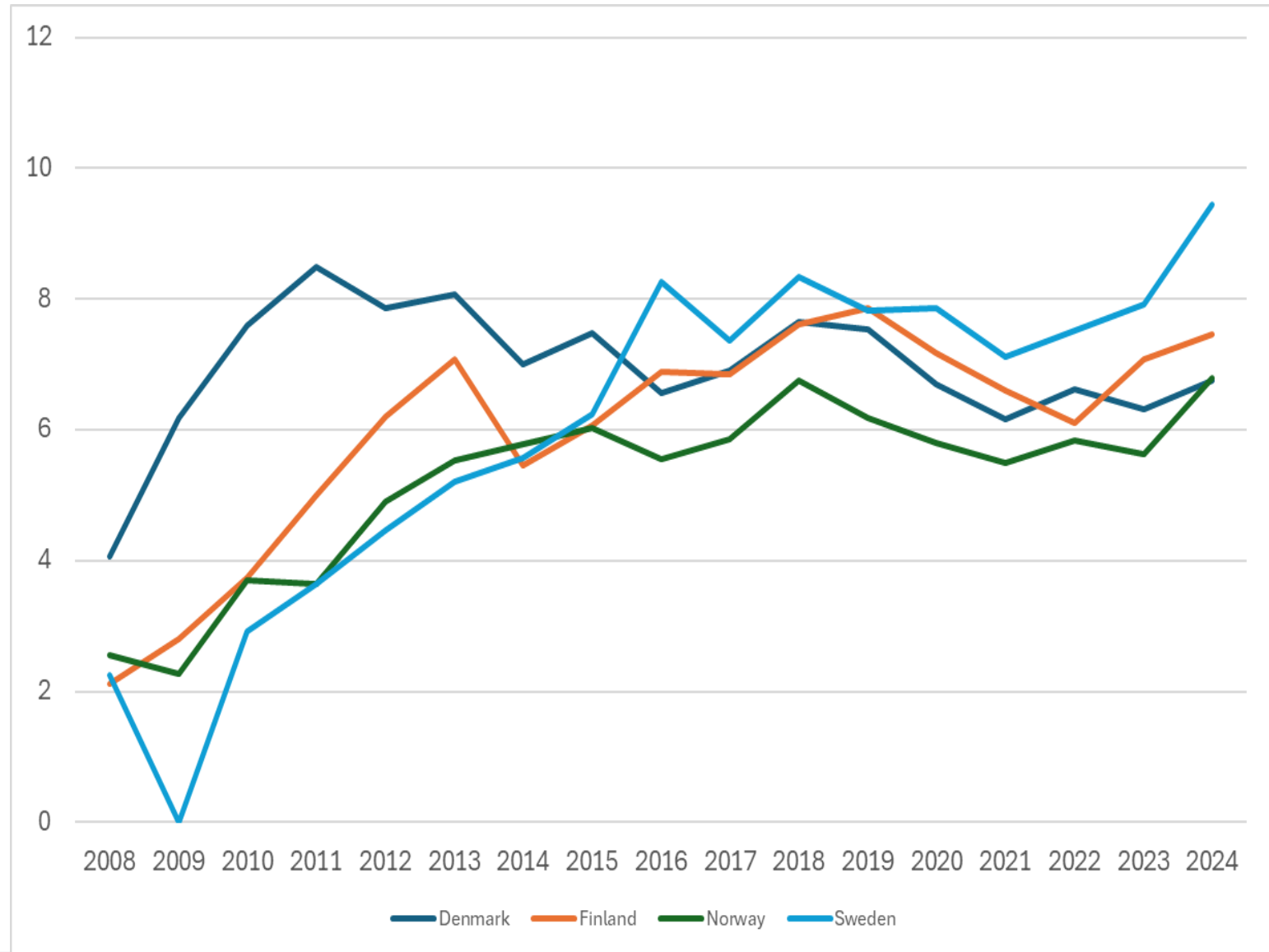
Reference:

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Finland vs. other Nordic countries

BSIs

3GCR-*E. coli* %



Why did it increase and then decrease?

THE INCREASE

- Food & animal sources?
 - No clear evidence between severe ESBL-*E. coli* infections and food (Kurittu P et al, Front Mikrob 2022)
 - Some evidence in Europe between human infections and food & animal sources
 - Person-to-person transmission considered most important
- Foreign travel / cross-border import?
 - App. 20% of Finnish travellers got ESBL-*E. coli* colonisation during travel outside of the Nordics (Kantele A. et al, Clinical Infectious Diseases 2015)
 - Traveller's diarrhoea (TD) and antibiotic treatment for TD independent risk factors
 - Further transmission probability at home app. 12% (Arcilla MS, Lancet Inf Dise 2017)
- How is it transmitted in health-care settings, especially long-term care facilities?
- Antimicrobial consumption
 - In Finland, lower than European mean, decreasing overall trend
 - Cephalosporins commonly used in Finland

Why did it increase and t

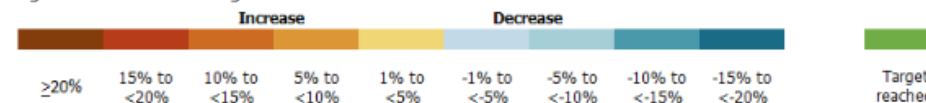
THE DECREASE

1. Heavily decreased foreign travel
 - Travellers at airports 1 % 4/2020
2. Enhanced COVID-related IPC measures in healthcare settings
 - Decrease in healthcare-associated infections
3. Social restriction, possibly improved hand hygiene
4. Decrease in antibiotic consumption
 - 2019-2023 ab consumption decreased 12,9% in Finland (ECDC, ESAC-Net)
 - COVID-19 related IPC measures -> less respiratory bacterial pathogens -> less antibiotics for respiratory tract infections -> decreased antibiotic pressure
 - Less prescriptions: amoxicillin, doxycycline, and atzithromycin in Finland, but no change in UTI antimicrobial prescriptions (Kari H, PLoS One 2023)

Table 2. Total consumption (community and hospital sectors combined) of antibacterials for systemic use (ATC group J01), EU/EEA countries, 2019–2023 (expressed as DDD per 1 000 inhabitants per day)

Country	2019	2020	2021	2022	2023	Trend 2019–2023	Progress towards 2030 target*			
							Change (%) 2019–2023	Recommended reduction (%) 2019-2030	2023	Target 2030
Austria	11.6	8.8	8.8	10.5	11.3		-3%	-3%	11.3	11.2
Belgium	21.4	16.7	17.4	20.5	20.6		-3%	-18%	20.6	17.5
Bulgaria	20.7	22.7	24.4	25.7	26.3		+27%	-18%	26.3	17.0
Croatia	18.8	15.7	18.2	20.2	21.2		+13%	-9%	21.2	17.1
Cyprus	30.1	28.9	25.0	33.5			N/A	-27%	N/A	22.0
Czechia	16.9	13.4	13.7	17.1	18.1		+7%	-9%	18.1	15.4
Denmark	15.3	14.3	14.4	15.2	16.2		+6%	-9%	16.2	13.9
Estonia	11.8	10.5	10.1	12.4	12.7		+8%	-3%	12.7	11.4
Finland	14.7	11.9	11.3	12.5	12.9		-12%	-9%	12.9	13.3
France	25.1	20.3	21.5	24.3	24.1		-4%	-27%	24.1	18.3
Germany					13.3		N/A	-9%	13.3	11.5
Greece ^a	34.1	28.1	23.5	32.9	28.5		-16%	-27%	28.5	24.9
Hungary	14.4	11.2	11.9	14.4	14.2		-2%	-9%	14.2	13.1
Iceland	19.3	16.5	16.8	18.6	18.5		-4%	N/A	18.5	N/A
Ireland	22.8	18.6	17.8	23.1	22.4		-2%	-27%	22.4	16.6
Italy	21.7	18.4	17.5	21.9	23.1		+6%	-18%	23.1	17.8
Latvia	13.9	11.9	11.6	14.9	14.9		+7%	-9%	14.9	12.6
Lithuania	16.3	14.2	14.1	18.5	18.7		+15%	-9%	18.7	14.6
Luxembourg ^a	21.1	16.1	15.9	19.1	20.2		-4%	-18%	20.2	17.3
Malta	20.7	16.6	15.8	24.0	22.9		+11%	-18%	22.9	17.0
Netherlands	9.5	8.5	8.3	9.1	9.6		+1%	-3%	9.6	9.2
Norway	14.9	13.9	14.0	15.3	15.5		+4%	N/A	15.5	N/A
Poland	23.6	18.5	20.2	23.6	23.2		-2%	-27%	23.2	17.3
Portugal	19.3	15.2	15.3	18.8	19.7		+2%	-9%	19.7	17.6
Romania	25.8	25.2	25.7	27.6	27.4		+6%	-27%	27.4	18.8
Slovakia	19.3	14.4	16.0	20.8	20.1		+4%	-9%	20.1	17.6
Slovenia	13.0	10.2	10.2	12.4	13.4		+3%	-9%	13.4	11.8
Spain	24.9	19.7	20.0	23.2	24.1		-3%	-27%	24.1	18.2
Sweden	11.8	10.3	10.1	11.2			N/A	-3%	N/A	11.4
EU/EEA**	19.8	16.4	16.4	19.3	19.9		+1%	N/A	19.9	N/A
EU***	19.9	16.4	16.4	19.4	20.0		+1%	-20%	20.0	15.9

Progress towards EU target:



ESBL vs. non-ESBL BSI

Patients with ESBL-*E. coli* BSI

- 1) Case-fatality rate 1,3-1,4-fold
- 2) More frequently
 - a) aged 20-69 years
 - b) males
 - c) with healthcare-associated infections
- 3) Increased number/severity of comorbidities

TABLE 1

Univariate analysis of characteristics of patients with bloodstream infections of extended-spectrum beta-lactamase (ESBL)-producing and non-ESBL-producing *Escherichia coli*, Finland, 2018–2023 (n = 33,586)

Characteristics	<i>E. coli</i> , total (n = 33,586)		ESBL-EC (n = 1,916)		non-ESBL-EC (n = 31,670)		p value	p value, adjusted residual
	n	% ^a	n	% ^a	n	% ^a		
Age (years)								
<1	214	0.6	6	0.3	208	0.7	<0.01	0.033
1–19	275	0.8	11	0.6	264	0.8		0.110
20–69	10,624	31.6	661	34.5	9,963	31.5		<0.01
≥70	22,473	66.9	1,238	64.6	21,235	67.1		0.014
Median	76		76		76		0.030	
Range	0–103		0–102		0–103			
Sex								
Male	13,955	41.6	975	50.9	12,980	41.0	<0.01	
Female	19,631	58.4	941	49.1	18,690	59.0		
Comorbidity (CCI score)								
With a score	30,789	91.7	1,795	93.7	28,994	91.6	Not applicable	
0	16,558	53.8	775	43.2	15,783	54.4	<0.01	<0.01
1–2	11,301	36.7	775	43.2	10,526	36.3		<0.01
>2	2,930	9.5	245	13.6	2,685	9.3		<0.01
Not available	2,797	8.3	121	6.3	2,676	8.4	Not applicable	
Median	0		1		0		<0.01	
Range	0–15		0–9		0–15			
Infection origin								
Healthcare-associated	4,971	14.8	417	21.8	4,554	14.4	<0.01	
Community-acquired	28,615	85.2	1,499	78.2	27,116	85.6		
Case-fatality rate								
2-day	982	2.9	73	3.8	909	2.9	0.018	
7-day	1,709	5.1	129	6.7	1,580	5.0	<0.01	
30-day	3,256	9.7	246	12.8	3,010	9.5	<0.01	

CCI: Charlson comorbidity index; ESBL-EC: extended-spectrum beta-lactamase-producing *Escherichia coli*.

^a Percentages refer to the total number of known cases in each column.

Reference:

Ilmavirta Heikki, Ollgren Jukka, Räisänen Kati, Kinnunen Tuure, Jalava Jari, Lyytikäinen Outi. Epidemiology and risk factors of *Escherichia coli* bloodstream infections associated with extended-spectrum beta-lactamase production: a national surveillance and data linkage study, Finland, 2018 to 2023. *Euro Surveill.* 2025;30(40):pii=2500196. <https://doi.org/10.2807/1560-7917.ES.2025.30.40.2500196>

30-day case-fatality

Factors associated with increased risk of 30-day case-fatality

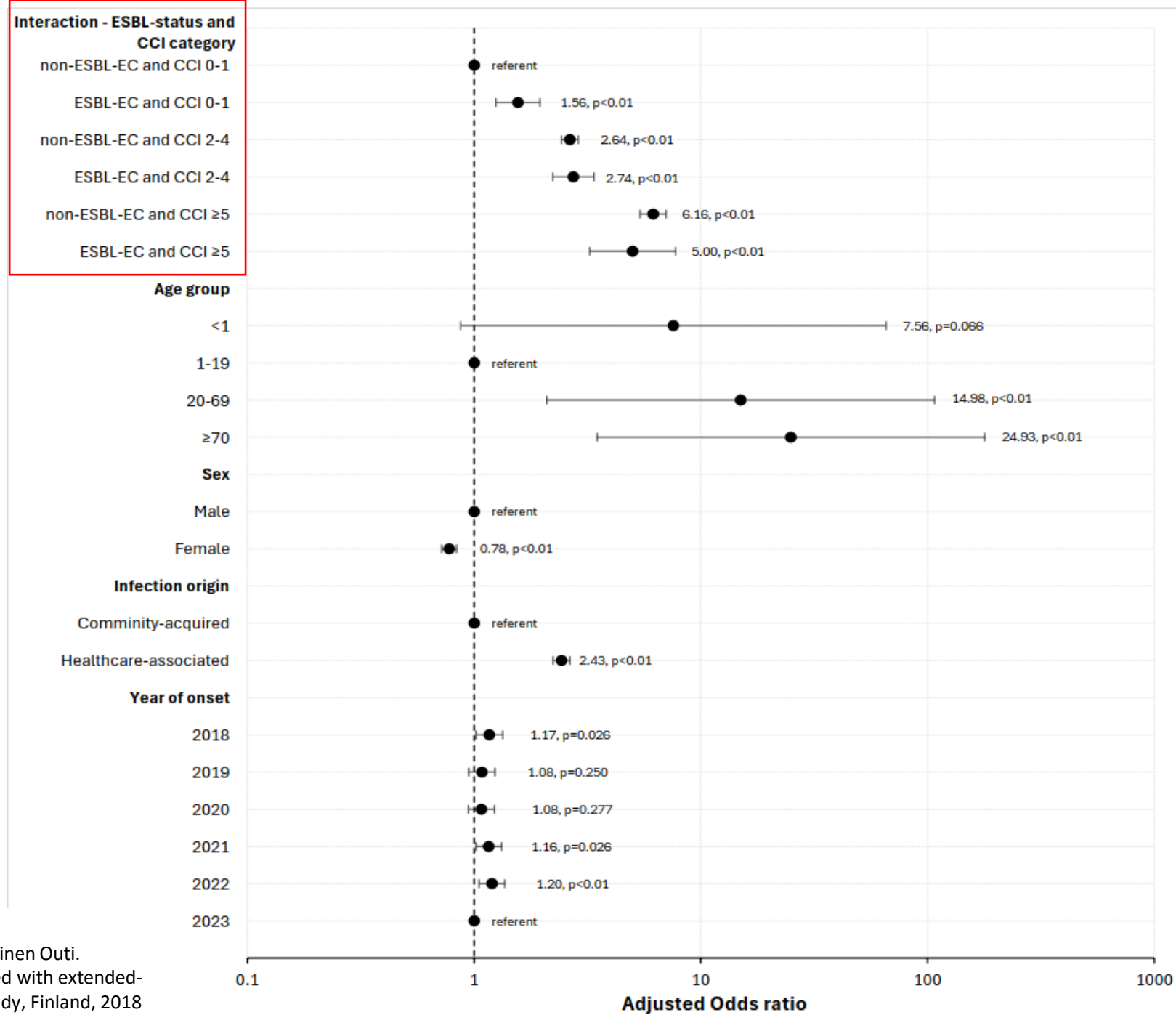
- Age
- Comorbidity
- Healthcare-associated infection
- Male sex

ESBL-production was not associated with increased risk of 30-day case-fatality in patients with increased comorbidity

- ESBL-*E. coli* is efficiently treated/diagnosed using current guidelines?
- High-risk patients die due to their comorbidities?

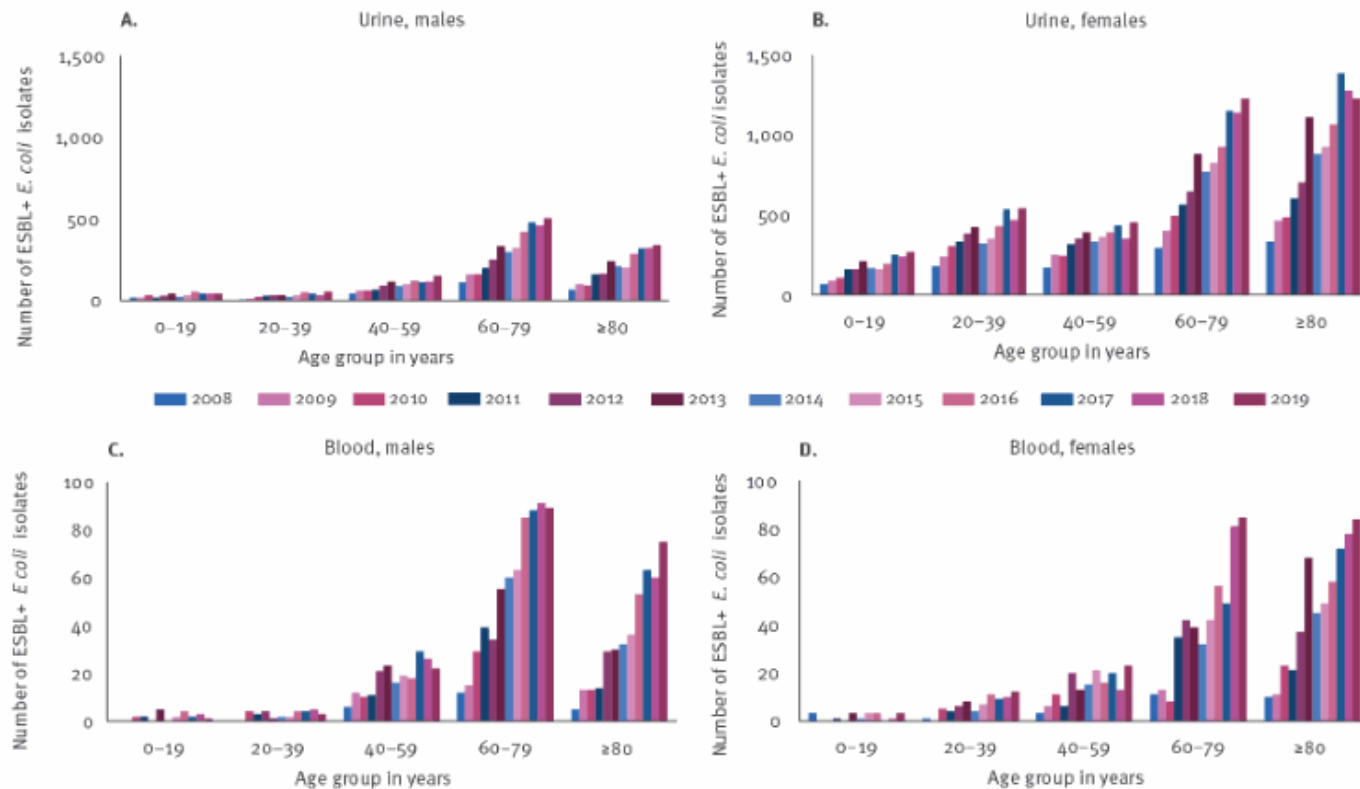
Source:

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Number of ESBL-*E.coli* UTIs and BSIs (Morbidity)

Figure 3. The annual number of extended-spectrum β -lactamase-producing *Escherichia coli* isolates within urine cultures among (A) males and (B) females and within blood cultures among (C) males and (D) females stratified by age group, Finland, 2008–2019



[Click to view](#)

- Greatest morbidity in patients aged > 60 years
- Likely to increase due to aging Finnish population

Source:

Ilmavirta Heikki, Ollgren Jukka, Räisänen Kati, Kinnunen Tuure, Hakanen Antti J, Jalava Jari, Lyytikäinen Outi. Increasing proportions of extended-spectrum β -lactamase-producing isolates among *Escherichia coli* from urine and bloodstream infections: results from a nationwide surveillance network, Finland, 2008 to 2019. *Euro Surveill.* 2023;28(43):pii=2200934. <https://doi.org/10.2807/1560-7917.ES.2023.28.43.2200934>

ESBL+ : isolate positive for extended-spectrum β -lactamase-producing *Escherichia coli*.

Conclusions

1. The proportion and incidence of ESBL-*E. coli* has increased very widespread in Finnish population
 - Morbidity likely increases in aging Finnish population
2. Age and sex should be considered in AMR surveillance as well as in treatment and prevention guidelines of *E. coli* UTIs and BSIs
3. Informing foreign travellers on MDR-bacteria, appropriate usage of antimicrobials, and proper personal- and hand-hygiene is crucial
4. Evaluation of the compliance of IPC measures in healthcare settings may be beneficial, especially in long-term care facilities
5. National Finnish AST reporting could be enhanced to create better environment for AMR study and surveillance purposes -> ongoing!

Related publications

- I. Ilmavirta H, Ollgren J, Räisänen K, Kinnunen T, Hakanen AJ, Jalava J and Lyytikäinen O.
Increasing proportions of extended-spectrum β -lactamase-producing isolates among *Escherichia coli* from urine and bloodstream infections: results from a nationwide surveillance network, Finland, 2008 to 2019.
Eurosurveillance. 2023;28(43):pii=2200934.
- II. Ilmavirta H, Ollgren J, Räisänen K, Kinnunen T, Hakanen AJ, Rantakokko-Jalava K, Jalava J and Lyytikäinen O.
Impact of the COVID-19 pandemic on extended-spectrum β -lactamase producing *Escherichia coli* in urinary tract and blood stream infections: results from a nationwide surveillance network, Finland, 2018 to 2022.
Antimicrobial Resistance & Infection Control. 2024 Jul 6;13(1):72.
- III. Ilmavirta H, Ollgren J, Räisänen K, Kinnunen T, Jalava J and Lyytikäinen O.
Epidemiology and risk factors of *Escherichia coli* bloodstream infections associated with extended-spectrum beta-lactamase production: a national surveillance and data linkage study, Finland, 2018 to 2023.
Eurosurveillance. 2025;30(40):pii=2500196.

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