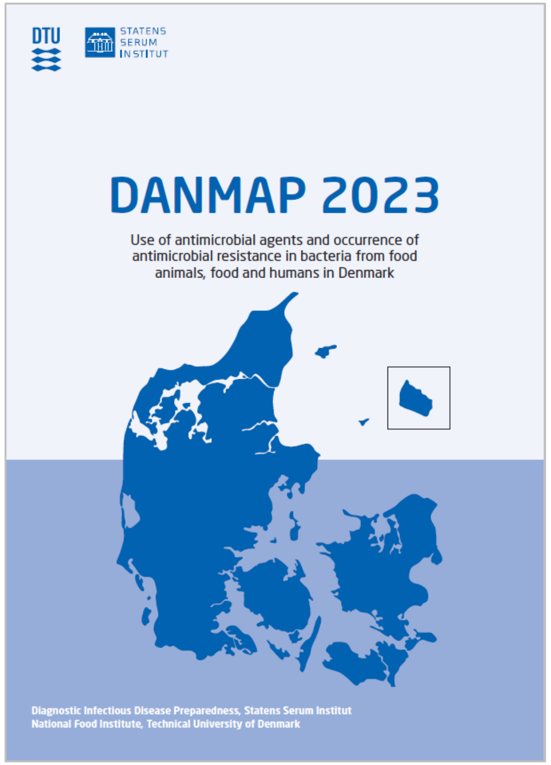
DANMAP Seminar 2024

Danish Programme for surveillance of antimicrobial consumption and resistance in bacteria from food animals, food and humans



Dagens program

10.30-10.45	Velkomst v. Henrik Ullum, Direktør v. Statens Serum Institut
10.45-12.00	DANMAP highlights v. redaktørteamet - Majda Attauabi, Statens Serum Institut - Ute Wolff Sönksen, Statens Serum Institut - Vibe D Andersen, DTU Fødevareinstituttet - Ana Sofia Ribeiro Duarte, DTU Fødevareinstituttet - Joana Pessoa, DTU Fødevareinstituttet - Jesper Larsen, Statens Serum Institut
12.00-12.30	Frokost
12.30-13.30	Nuværende udfordringer i behandling af mennesker og dyr med antibiotika - John Haugegaard, Den Danske Dyrlægeforening - Thomas Loof Hedegård & Bjarne Mikladal Christensen, Amgros
13.30-14.45	Tema: Hvordan bruges DANMAP i virkelighedens verden Poll: Evaluering af anvendeligheden af DANMAP
14.45-15.00	Afslutning og tak for i dag v. Ute Wolff Sönksen og Ana Sofia Ribeiro Duarte

Seminaret faciliteres af Ute Wolff Sönksen, Fagchef for AMR overvågningen, Statens Serum Institut

DANMAP highlights

- **Antimicrobial consumption in humans**
- **Resistance in human pathogens**
- **Antimicrobial consumption in animals**
- **Resistance in zoonotic bacteria**
- **Resistance in indicator bacteria**
- **Resistance in animal pathogens**

DANMAP Seminar 2024

Antibiotikaforbrug til mennesker

Majda Attauabi
Cand.pharm

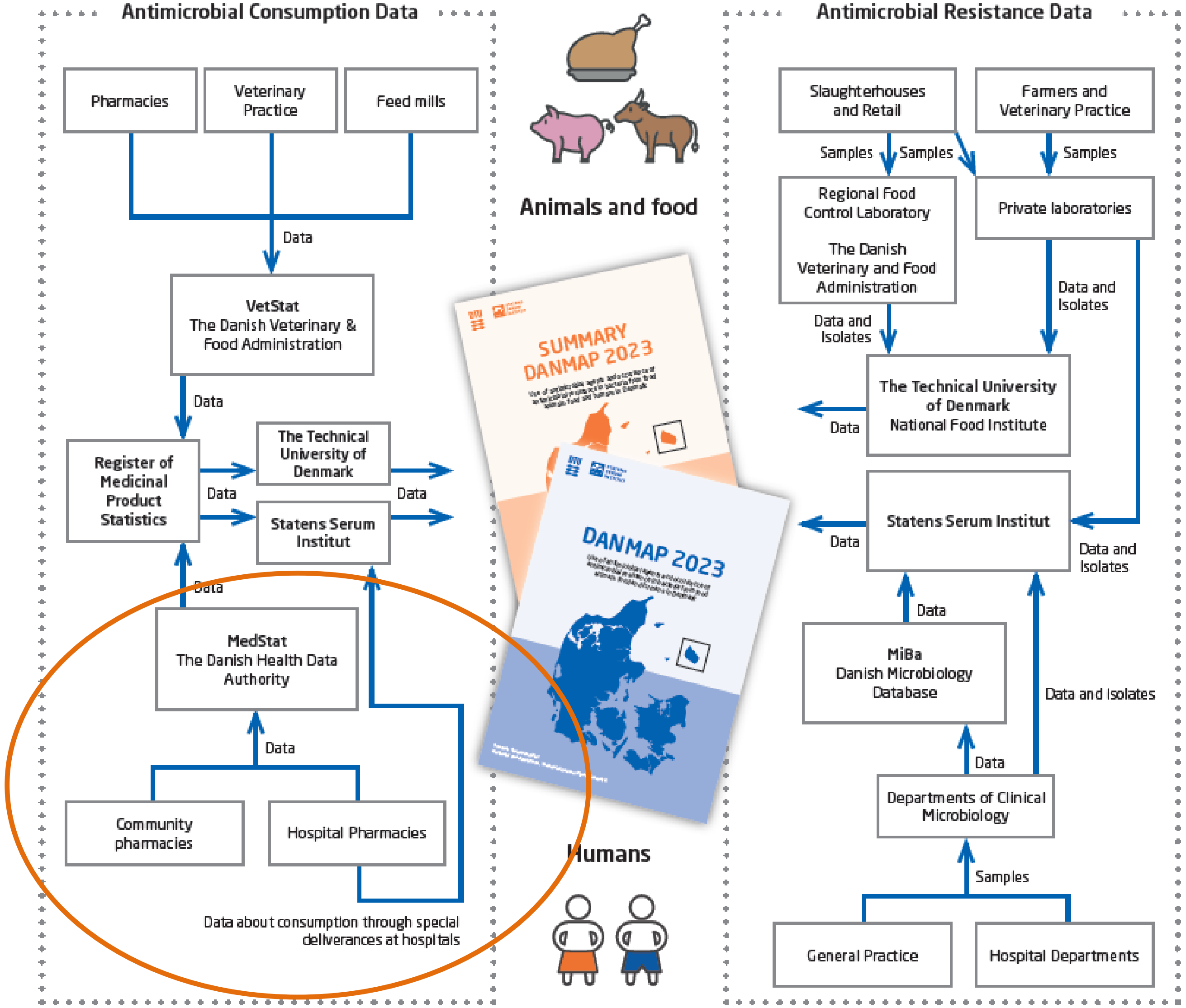
Ute Wolff Sönksen
Chief Physician

Statens Serum Institut

Agenda

- Antimicrobials in Denmark
  - Characteristics
  - AWaRe classification
  - International comparison
- Antimicrobials in primary health care
  - Age groups
  - Indications
- Antimicrobials at hospitals
  - Trends over time
  - Shortages
- Topics in focus

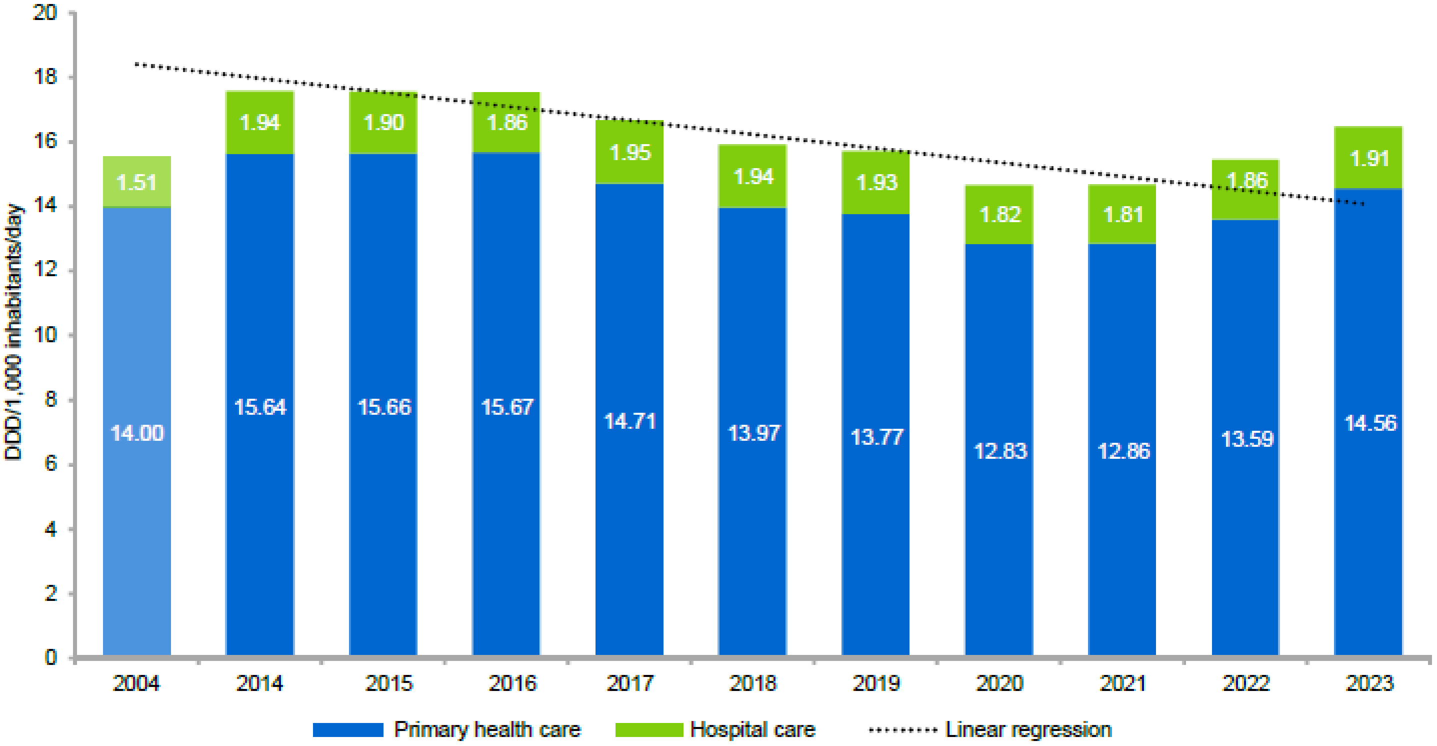
DANMAP data flow



Antibiotic consumption in Denmark

Figure 5.1 Total consumption of systemic antimicrobial agents in humans, DDD per 1,000 inhabitants per day, Denmark, 2004 and 2014-2023

DANMAP 2023

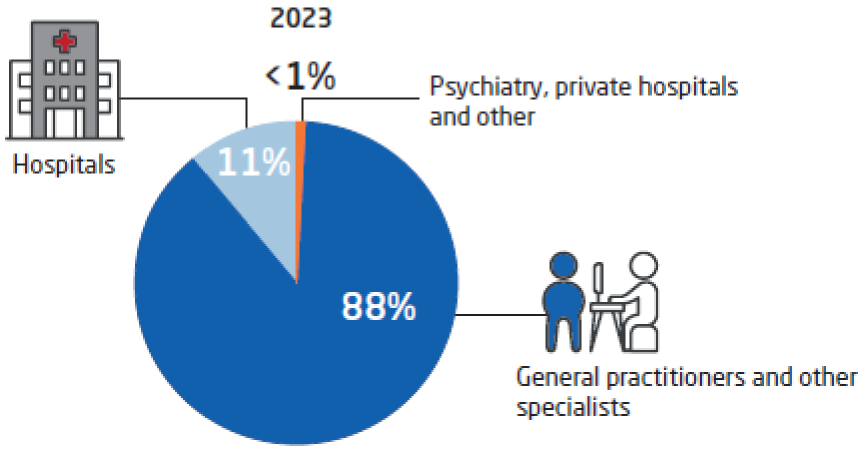


Data: Total sale of antimicrobials in Denmark

Data source: Register of Medicinal Product Statistics and 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system

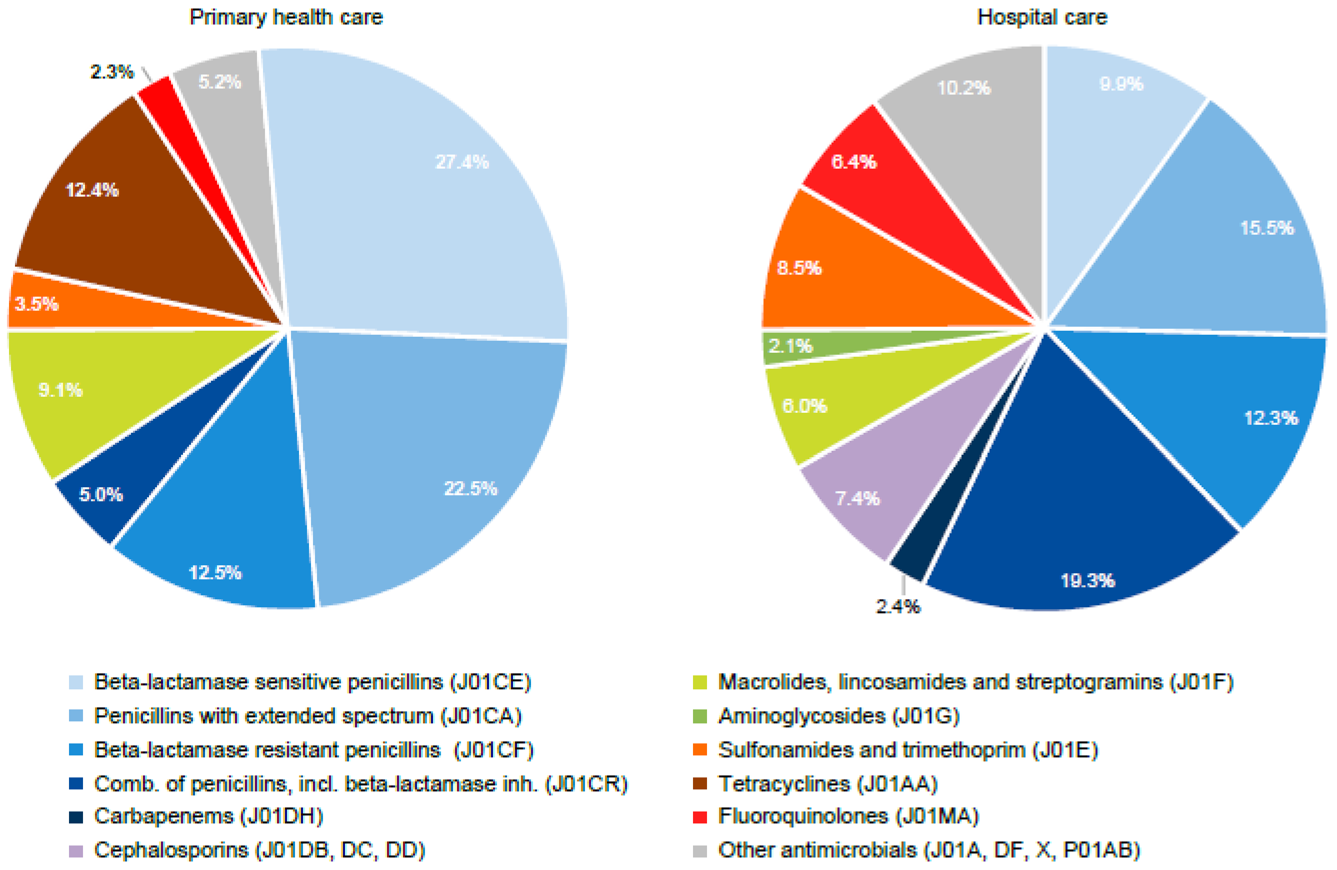
2014-2023

-6.3%



Consumption is characterised by a big share of penicillins

Figure 5.4 Percentage distribution of antimicrobial agents in primary health care and hospital care, DDD, Denmark, 2023 DANMAP 2023



Data: Registered sale of antimicrobials to individuals and antimicrobial consumption at somatic hospitals
Data source: Register of Medicinal Product Statistics and 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system

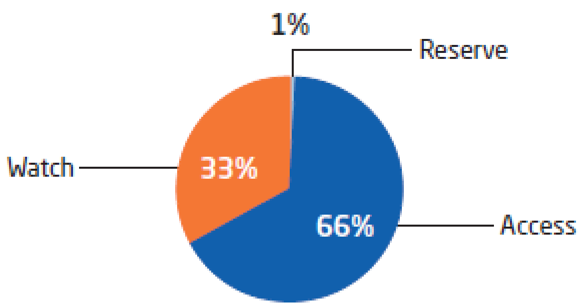
… and a big share of ”Access” antibiotics

AWaRe classification of antimicrobials in Denmark, 2023

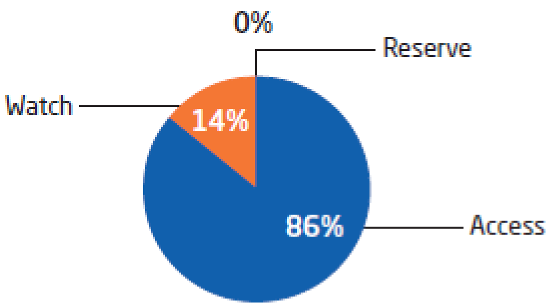
The World Health Organization (WHO) has developed the AWaRe classification system as a tool to assist antibiotic stewardship and to reduce antimicrobial resistance. Antibiotics are classified into three groups to emphasise the importance of their appropriate use:

- **Access:** Antibiotics used to treat common susceptible pathogens with lower resistance potential than antibiotics in the other groups. 60% of total antimicrobial consumption should consist of Access agents.
- **Watch:** Antibiotics that have higher resistance potential, including most of the highest priority agents. These antibiotics should be prioritised as key targets of stewardship programs and monitoring.
- **Reserve:** Antibiotics reserved for treatment of confirmed or suspected infections due to multidrug resistant organisms. These antibiotics should be considered as "last resort" options.

Hospital care

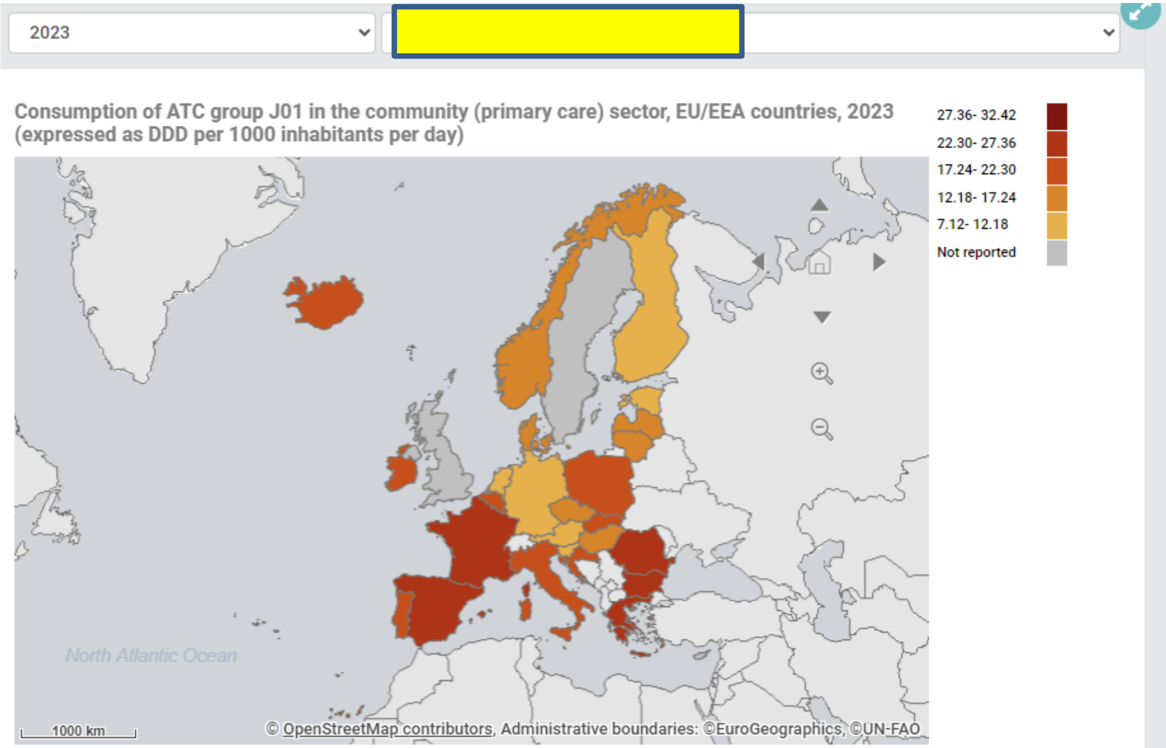


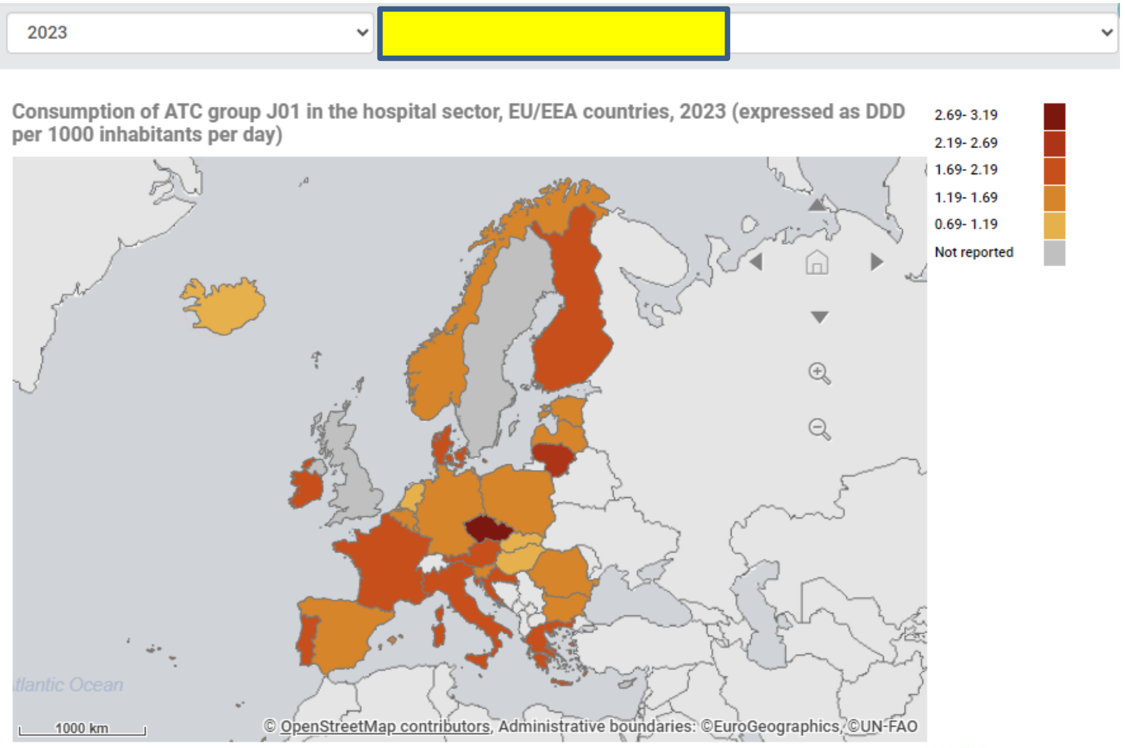
Primary health care



WHO Access, Watch, Reserve (AWaRe) classification of antibiotics for evaluation and monitoring of use, 2017. Geneva: World Health Organization; updated 2023 (WHO-MHP-HPS-EML-2023.04)

Denmark compared to EU





Source: European Centre for Disease Prevention and Control. Antimicrobial consumption in the EU/EEA (ESAC-Net) - Annual Epidemiological Report 2023. Stockholm: ECDC; 2024.

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2023

Consumption of ATC group J01 in the community (primary
(expressed as DDD per 1000 inhabitants per day)

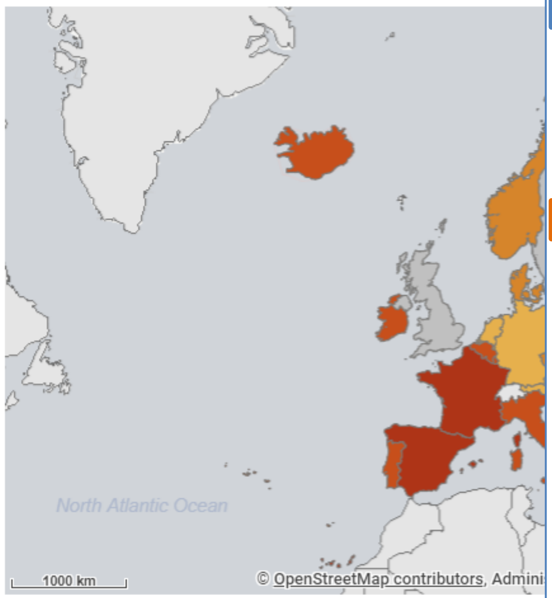


Table 2. Total consumption (community and hospital sectors combined) of antibacterials for systemic use (ATC group J01), EU/EEA countries, 2019–2023 (expressed as DDD per 1 000 inhabitants per day)

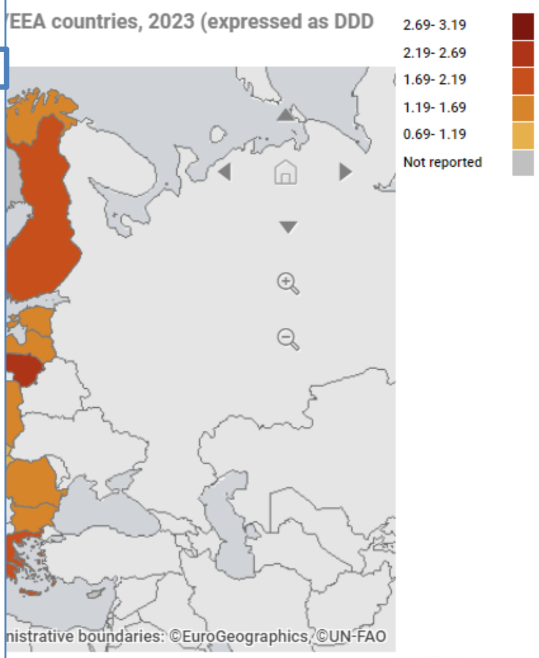
Country	2019	2020	2021	2022	2023	Trend 2019–2023	Progress towards 2030 target*: Change (%) 2019-2023	Recommended reduction (%) 2019-2030	2023	Target 2030
Austria	11.6	8.8	8.8	10.5	11.3		-3%	-3%	11.3	11.2
Belgium	21.4	16.7	17.4	20.5	20.6		-3%	-18%	20.6	17.5
Bulgaria	20.7	22.7	24.4	25.7	26.3	↑	+27%	-18%	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	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	N/A	-9%	13.3	11.5
Greece[a]	34.1	28.1	23.5	32.9	28.5	N/A	-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	N/A	-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	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:

Increase					Decrease				Target reached
≥20%	15% to <20%	10% to <15%	5% to <10%	1% to <5%	-1% to <-5%	-5% to <-10%	-10% to <-15%	-15% to <-20%	Target reached

* As per the Council Recommendation on stepping up EU actions to combat antimicrobial resistance in a One Health approach (2023/C 220/01) [8].

EEA countries, 2023 (expressed as DDD



Source: European Centre for Disease

- Annual Epidemiological Report 202

Consumption trends for antimicrobials groups

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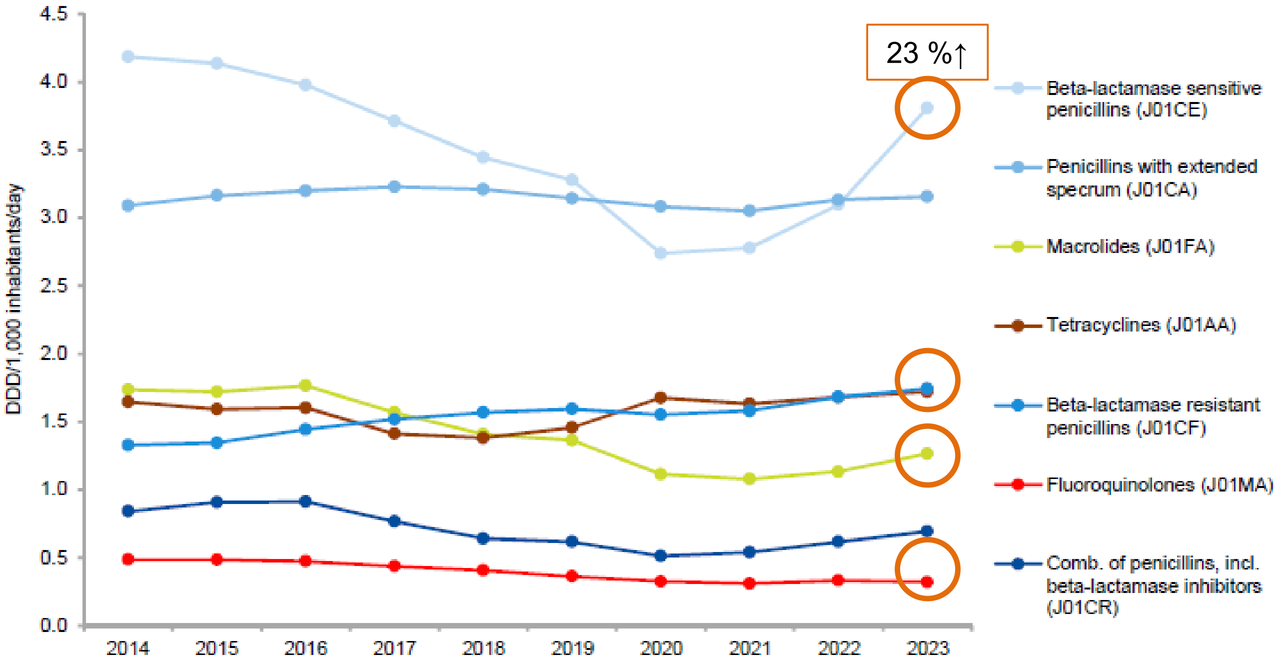
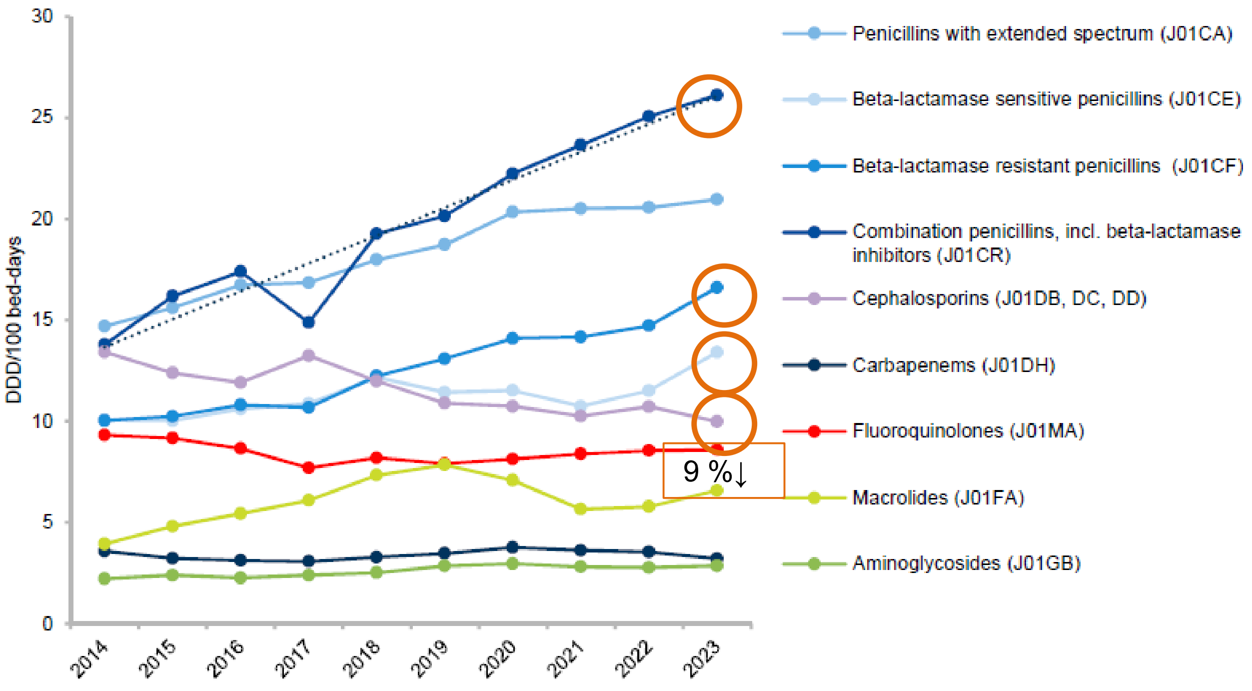
Figure 5.8 Consumption of leading antimicrobial groups for systemic use in primary health care, DDD per 1,000 inhabitants per day, Denmark, 2014-2023
DANMAP 2023



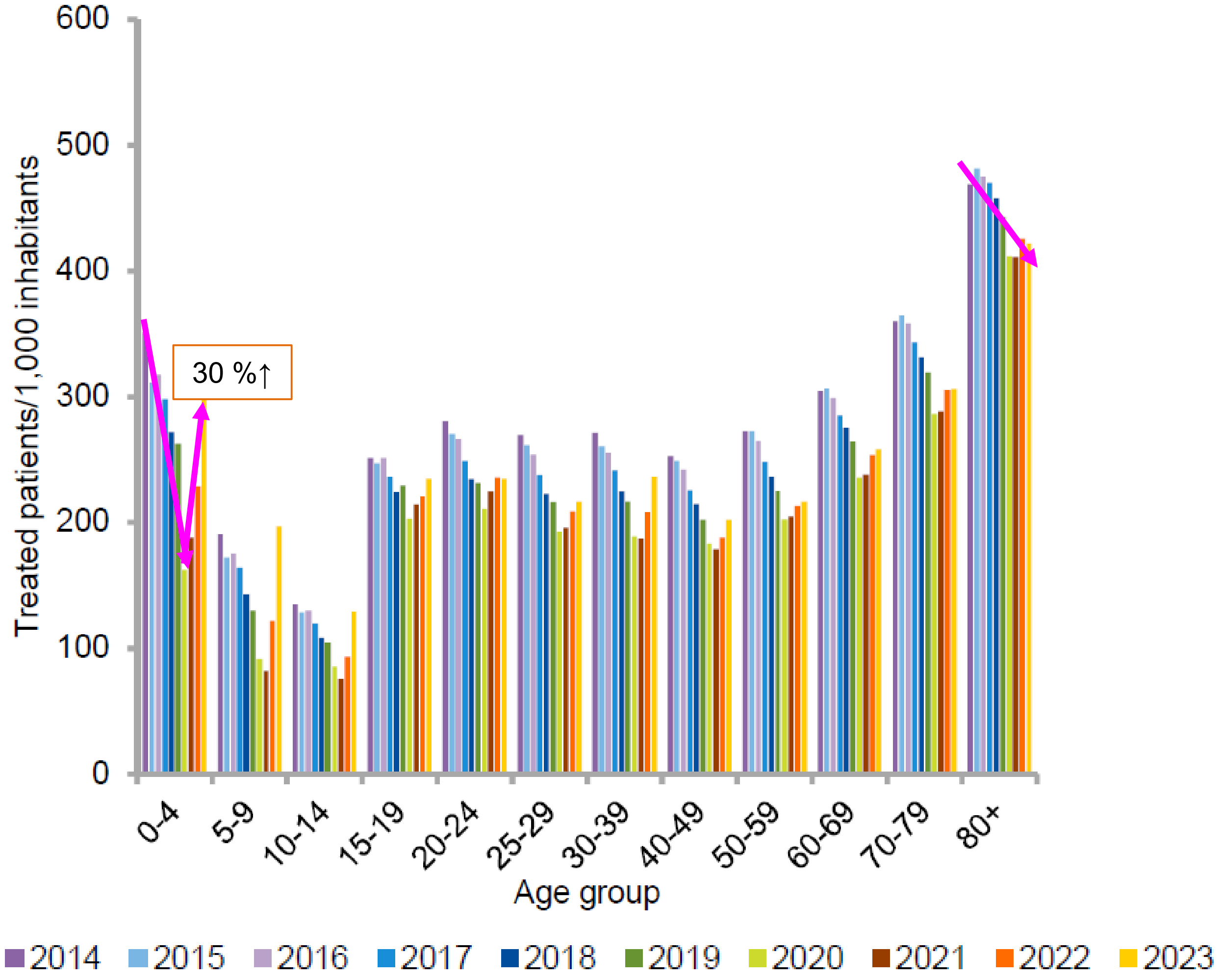
Data: Registered sale of antimicrobials to individuals
Data source: Register of Medicinal Product Statistics and 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system

Figure 5.15 Consumption of leading groups of antimicrobial agents at somatic hospitals, DDD per 100 bed-days, Denmark, 2014-2023
DANMAP 2023



Data: Antimicrobial consumption at somatic hospitals
Data source: Register of Medicinal Product Statistics, 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system and The National Patient Register

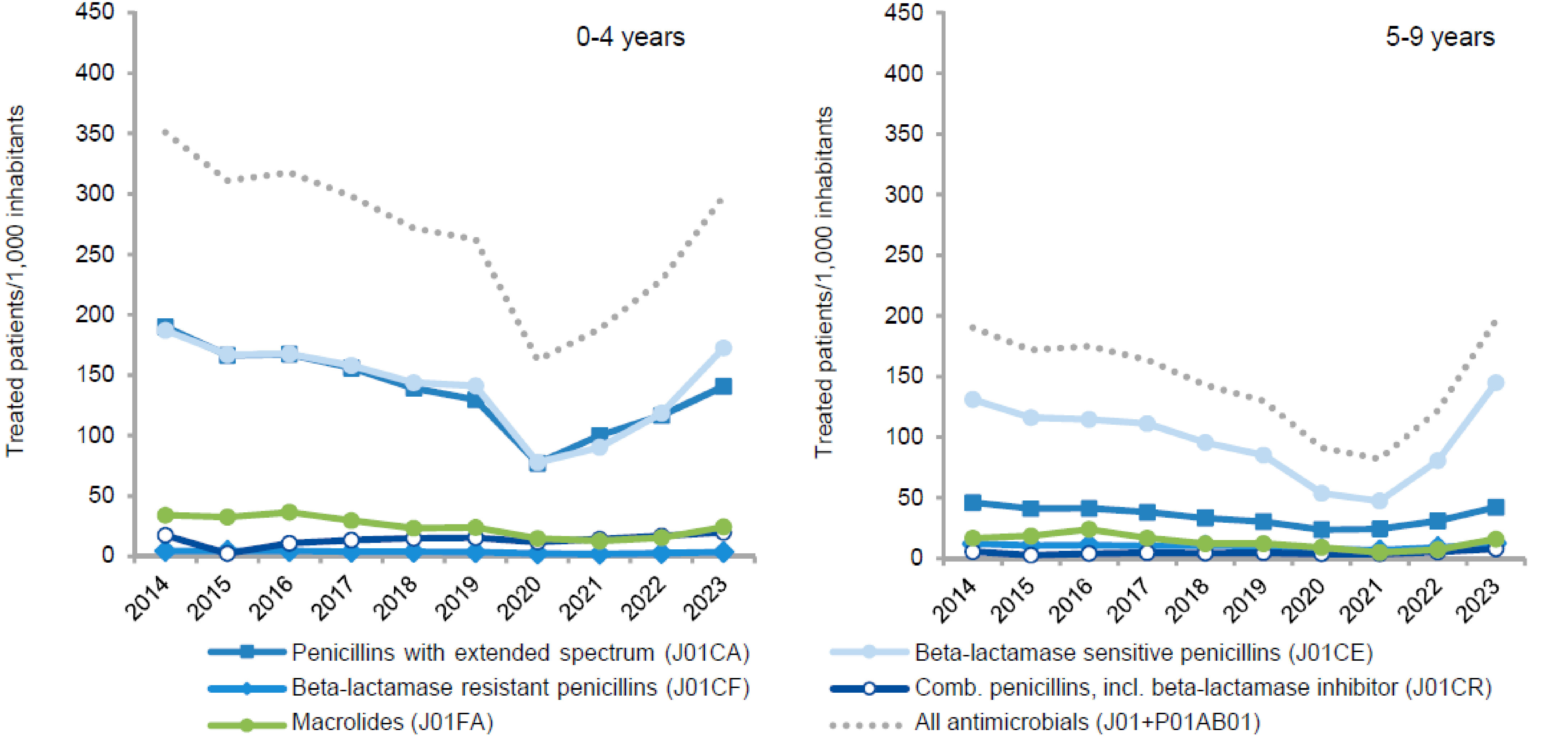
Who is treated most frequently?



Data: Registered sale of antimicrobials to individuals
Data source: Register of Medicinal Product Statistics, 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system and Statistics Denmark

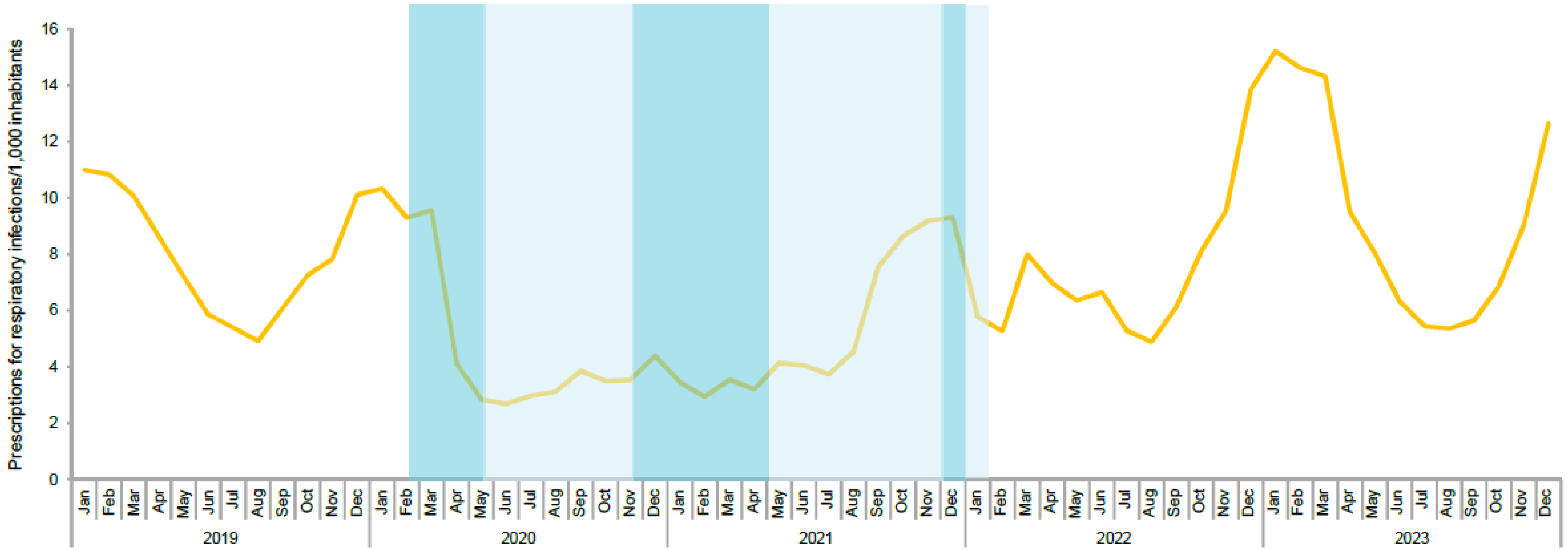
Antimicrobials for children

Figure 5.10 Consumption of main antimicrobial agents by age group, treated patients/1,000 inhabitants, Denmark, 2014-2023 DANMAP 2023



Antimicrobials for respiratory infections

Figure 5.12 Monthly antimicrobial prescriptions indicated for treatment of respiratory tract infections in primary health care, prescriptions per 1,000 inhabitants, Denmark, 2019-2023 DANMAP 2023



COVID-19 restrictions in place

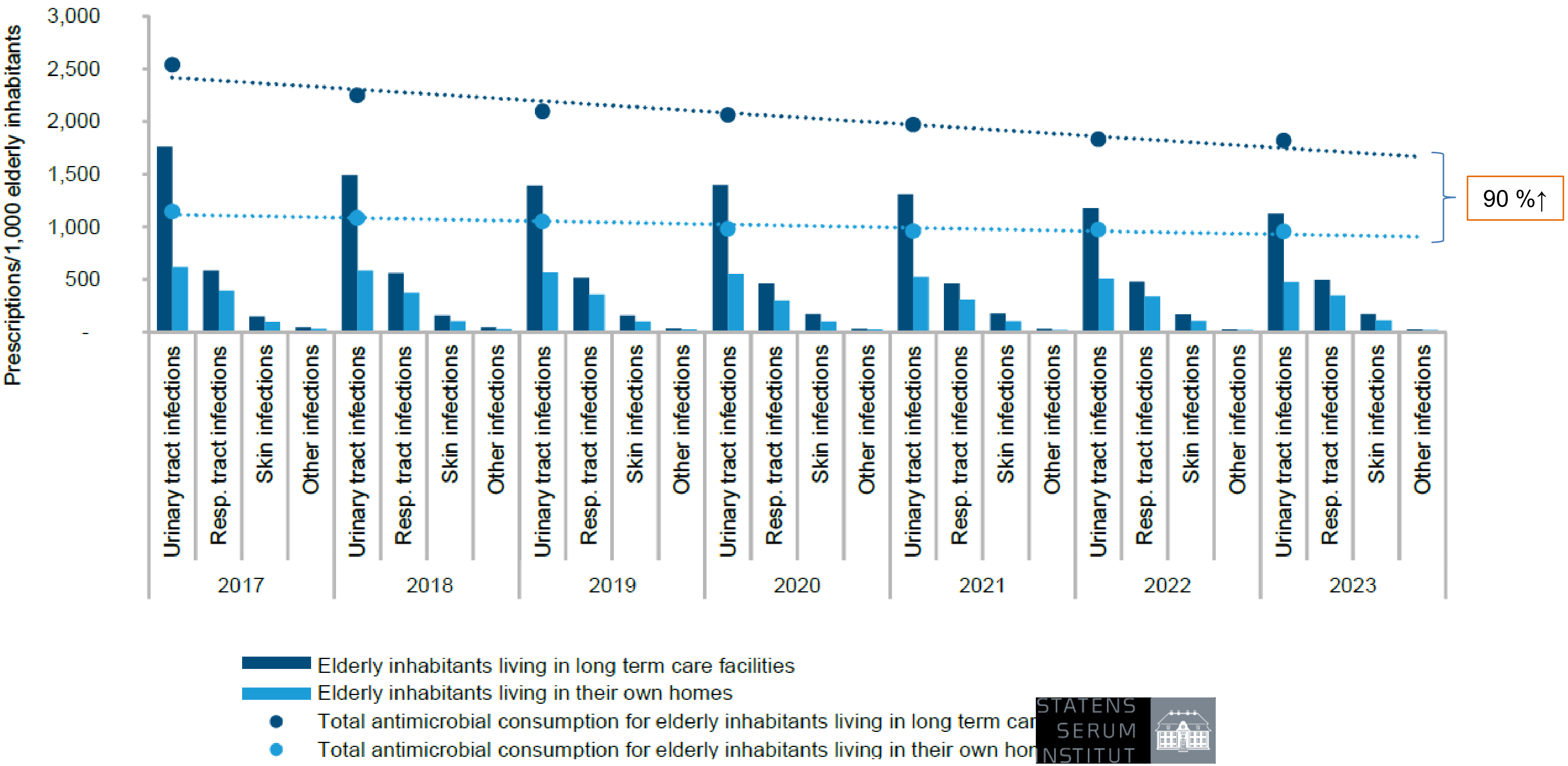
Fewer restrictions in place

Data: Registered sale of antimicrobials to individuals

Data source: Register of Medicinal Product Statistics and 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system

Antimicrobials for elderly inhabitants

Figure 5.13 Consumption of antimicrobials (J01 and P01AB01) in primary health care for elderly inhabitants living in long term care facilities and for elderly inhabitants living in their own homes, Denmark, 2017-2023 DANMAP 2023



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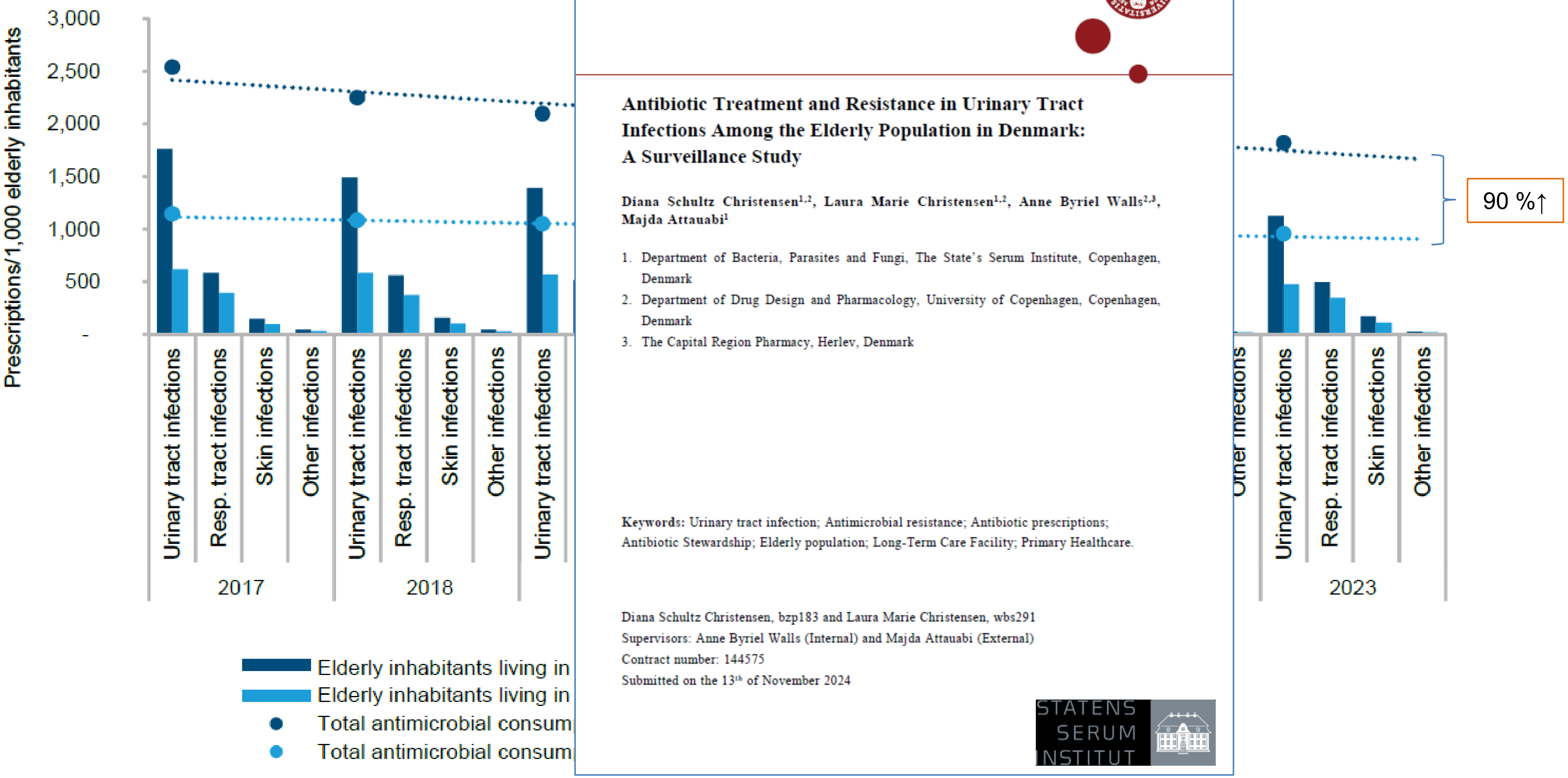
Antimicrobials for elderly inhabitants

Figure 5.13 Consumption of antimicrobials (J01 and F ... in long term care facilities and for elderly inhabitants living in their ow... DANMAP 2023



UNIVERSITY OF COPENHAGEN
FACULTY OF HEALTH AND MEDICAL SCIENCES

Antibiotic Treatment and Resistance in Urinary Tract Infections Among the Elderly Population in Denmark: A Surveillance Study

Diana Schultz Christensen[1,2], Laura Marie Christensen[1,2], Anne Byriel Walls[2,3], Majda Attauabi[1]

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2. Department of Drug Design and Pharmacology, University of Copenhagen, Copenhagen, Denmark
3. The Capital Region Pharmacy, Herlev, Denmark

Keywords: Urinary tract infection; Antimicrobial resistance; Antibiotic prescriptions; Antibiotic Stewardship; Elderly population; Long-Term Care Facility; Primary Healthcare.

Diana Schultz Christensen, bzp183 and Laura Marie Christensen, wbs291
Supervisors: Anne Byriel Walls (Internal) and Majda Attauabi (External)
Contract number: 144575
Submitted on the 13th of November 2024

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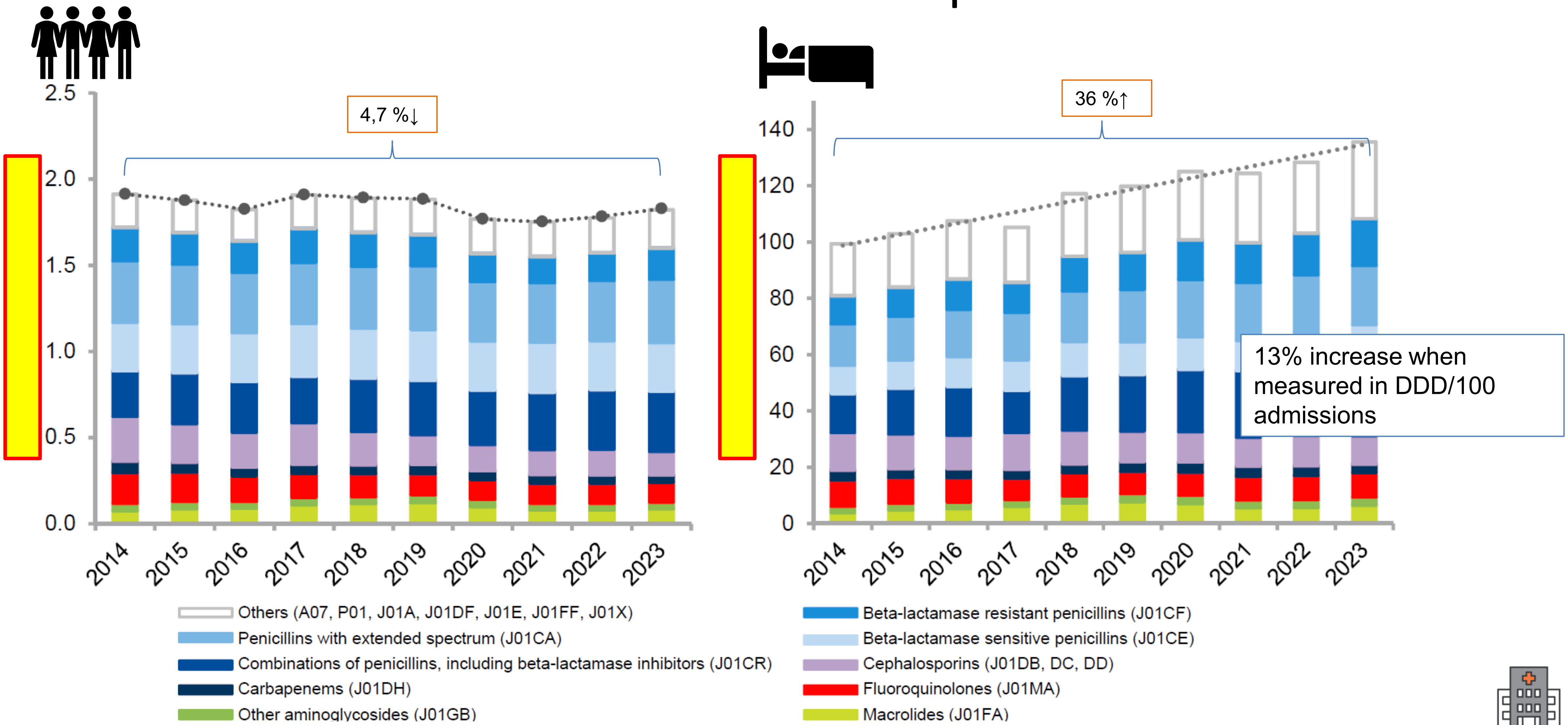
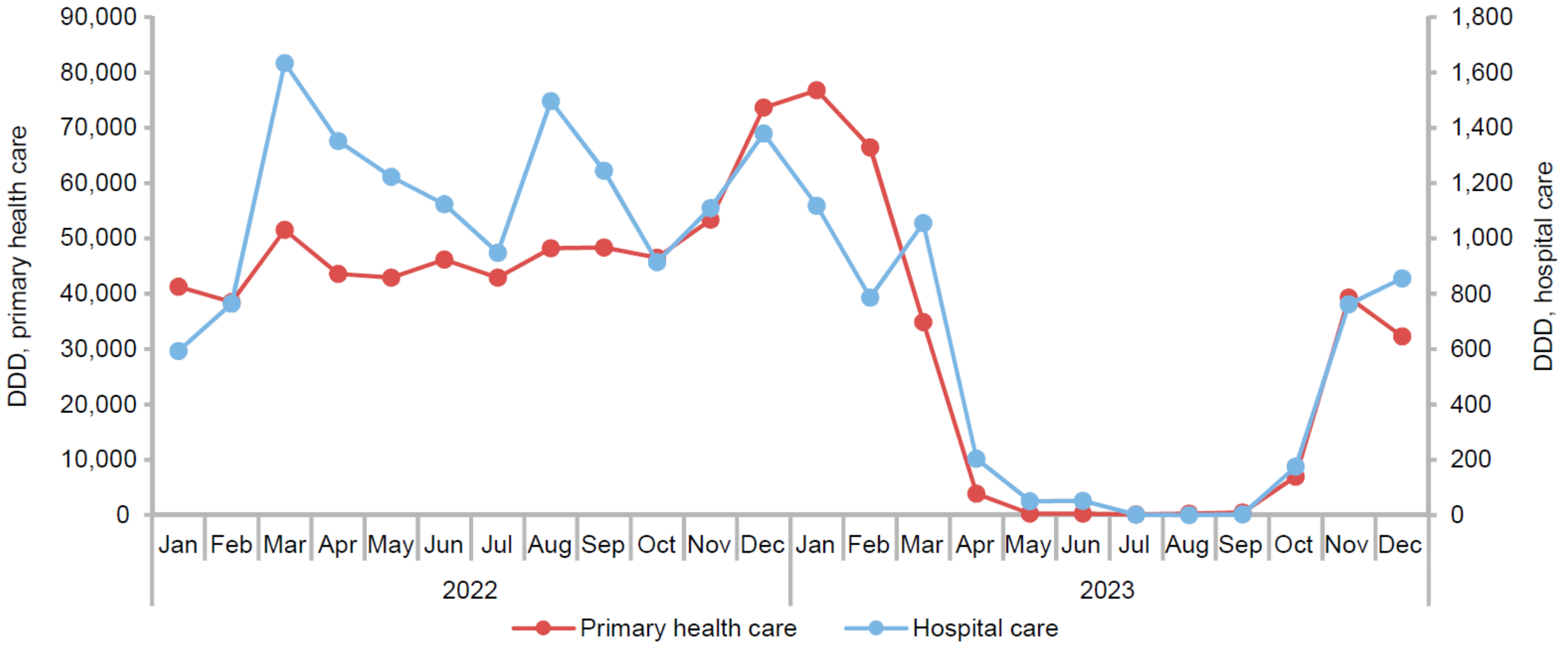
Antimicrobials at hospitals



Data: Antimicrobial consumption at somatic hospitals
Data source: Register of Medicinal Product Statistics, 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system and The National Patient Register

Shortages challenge supply of antimicrobials

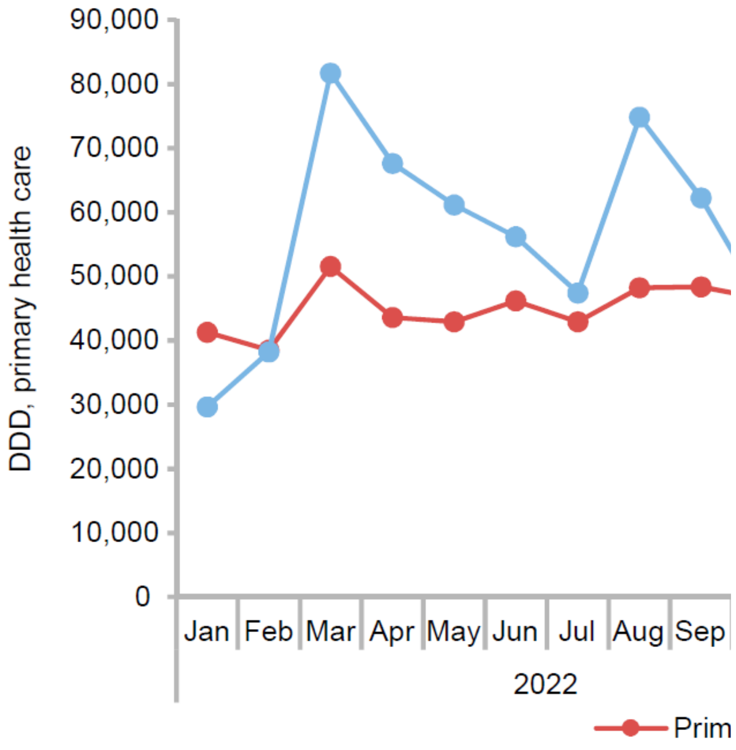
Figure 5.21 Monthly consumption of nitrofurantoin by health care sector, DDD, Denmark, 2022-2023 DANMAP 2023



Data: Antimicrobial consumption in Denmark
Data source: Register of Medicinal Product Statistics, 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system

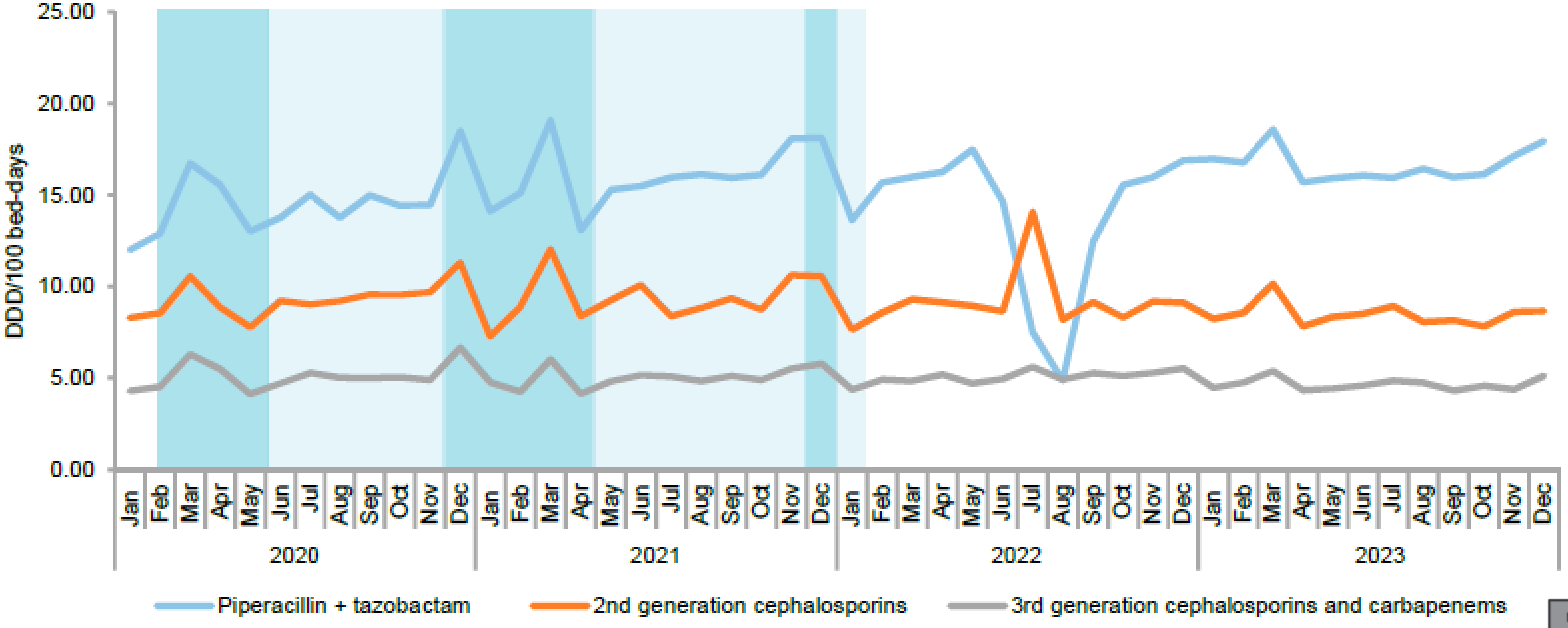
Shortages challenge supply of antimicrobials

Figure 5.21 Monthly consumption of nitrofurantoin by health care sector, DDD, Denmark, 2022-2023 DANMAP 2023



Data: Antimicrobial consumption in Denmark
Data source: Register of Medicinal Product Statistics, 202

Figure 5.19 Consumption of key antimicrobials used for treatment of seriously ill patients in hospital, DDD per 100 bed-days, Denmark, 2020-2023 DANMAP 2023



Data: Antimicrobial consumption at somatic hospitals
Data source: Register of Medicinal Product Statistics, 2024 edition of the Anatomical Therapeutic Chemical (ATC) classification system and The National Patient Register

Shortages challenge supply of antimicrobials

Table 5.8 Consumption of selected antimicrobials on special delivery to hospitals, DDD, 2014-2023 DANMAP 2023

Antimicrobial	Year									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
J01MA12 Levofloxacin	4,470	7,240	8,080	8,180	6,710	7,360	20,370	44,200	41,530	45,360
J01XE01 Nitrofurantoin										7,950
J01EE01 Sulfamethoxazol and trimethoprim	6,820	6,590	6,704	8,188	7,596	7,136	3,094	8,585	2,610	3,760
J01CE02 Phenoxymethylpenicillin				5,085	417			5,183		2,792
J01GB01 Tobramycin						6,895	6,840	4,790	3,850	2,620
J01CF05 Flucloxacillin	2,690	2,313	2,275	2,200	1,783	1,790	1,665	1,873	2,540	2,233
J01CR02 Amoxicillin and beta-lactamase inhibitor	721	10,743	3,276	2,579	3,882	4,348	4,277	3,934	4,177	1,726
J01MA02 Ciprofloxacin	710	1,155	1,195	690	766	726	1,028	908	935	890
J01CR05 Piperacillin og beta-lactamaseinhibitor				16,465	4,457				63,808	
J01CE08 Benzathine benzylpenicillin	316	562	372	1,514	618	538	748	544	524	652

Data: Consumption of antimicrobials on special delivery
Data source: Danish Hospital Pharmacies

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Topics in focus

Textbox 5.1

International approach to im

What makes a market vulnerable? Which factors need
repeated shortages and length of shortages are not n
elevated risk of withdrawal[1]. The deregistration proble
will be mentioned here, but it's a multifactual problem

Textbox 5.3

Infection Prevention and Control and prevention of Antimicrobial Resistance goes hand in hand

In Denmark there are numerous activities concerning infection prevention and control (IPC) and antimicrobial resistance (AMR) - both on the national and on the international level.

Across Europe as well as globally it is increasingly stressed that controlling AMR in human health must be based on aligning ef-

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si.dk

Textbox 5.2

HALT 4 - An audit on i among residents in Da

HALT 4 (https://hygiejne.ssi.dk/overvaagr
Facilities 4) is a European project manage

In 2023, the National Center for Infection

Textbox 5.4

Consumption of antimicrobials in the Faroe Islands

Background
The Faroe Islands (FI) consist of 18 islands inhabited by approximately 54,000 inhabitants, approximately 22,000 of whom live in the capital Tórshavn. Sjúkrahúsverkid consists of the main hospital (Landssjúkrahúsid, LS, with 130 beds), located in Tórshavn, and two smaller hospitals in K

Elsebeth Tvenstrup Jensen, Ann Winther Jensen, Anne Kjerulf, Lena Lambaa, and Marianna Konoy
For further information: Elsebeth Tvenstrup Jensen, etj@ssi.dk and Anne Kjerulf, alf@ssi.dk

In conclusion…

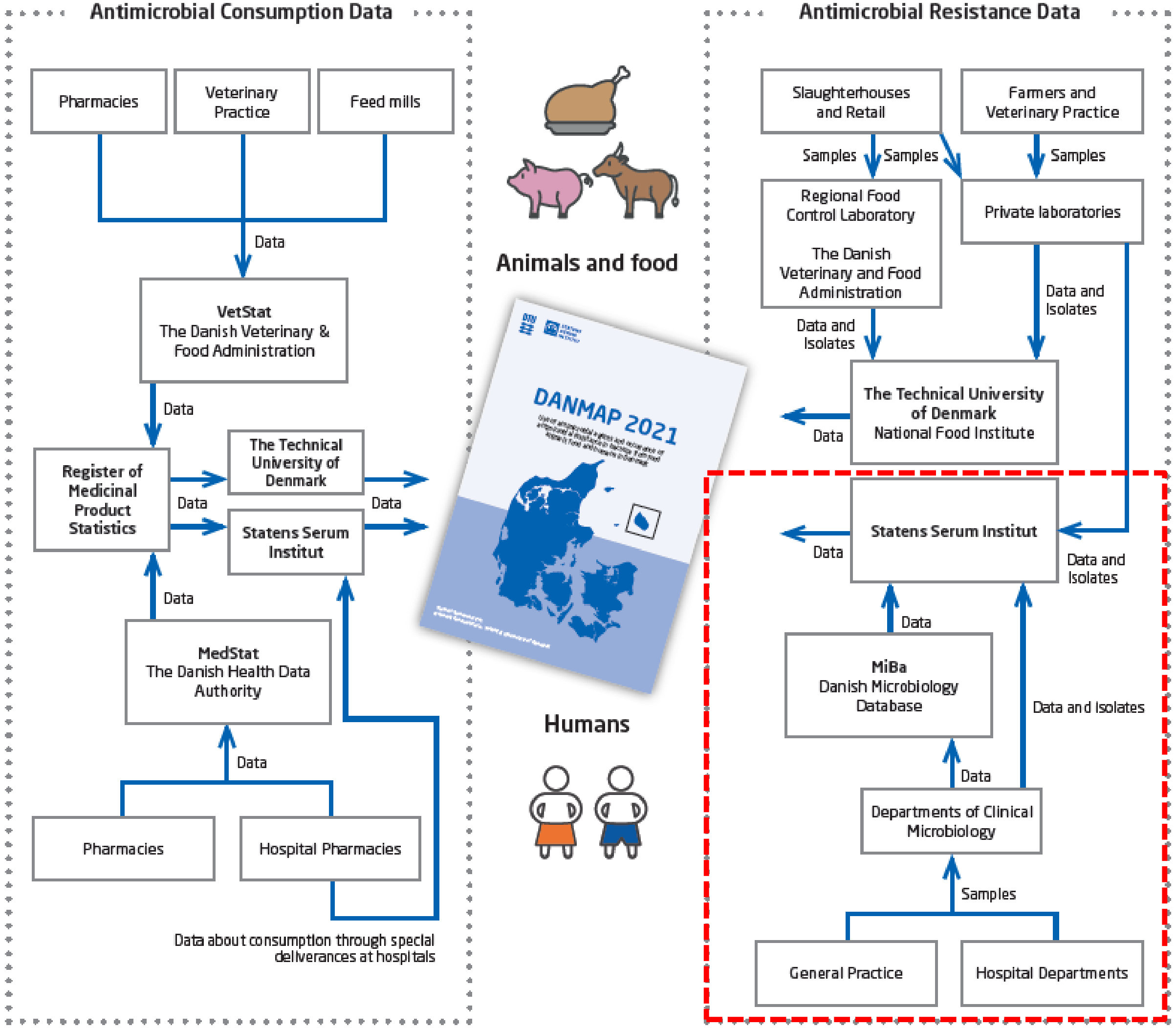
- Total antimicrobial consumption in 2023 has increased since the decreases in 2020-2021
- ”Access antibiotics”/penicillins are used to a large extent in Denmark in both sectors
- Elderly and children have the highest treatment frequency
- Treatment of urinary tract infections is decreasing, but still with considerable difference between elderly in their own homes and elderly at care homes
- Consumption at hospitals is increasing when measured by bed-days or admissions
- Product shortages still challenge supply of antibiotics, but action is taken on national and international level

DANMAP Seminar 2024

Antibiotic resistance in human clinical isolates

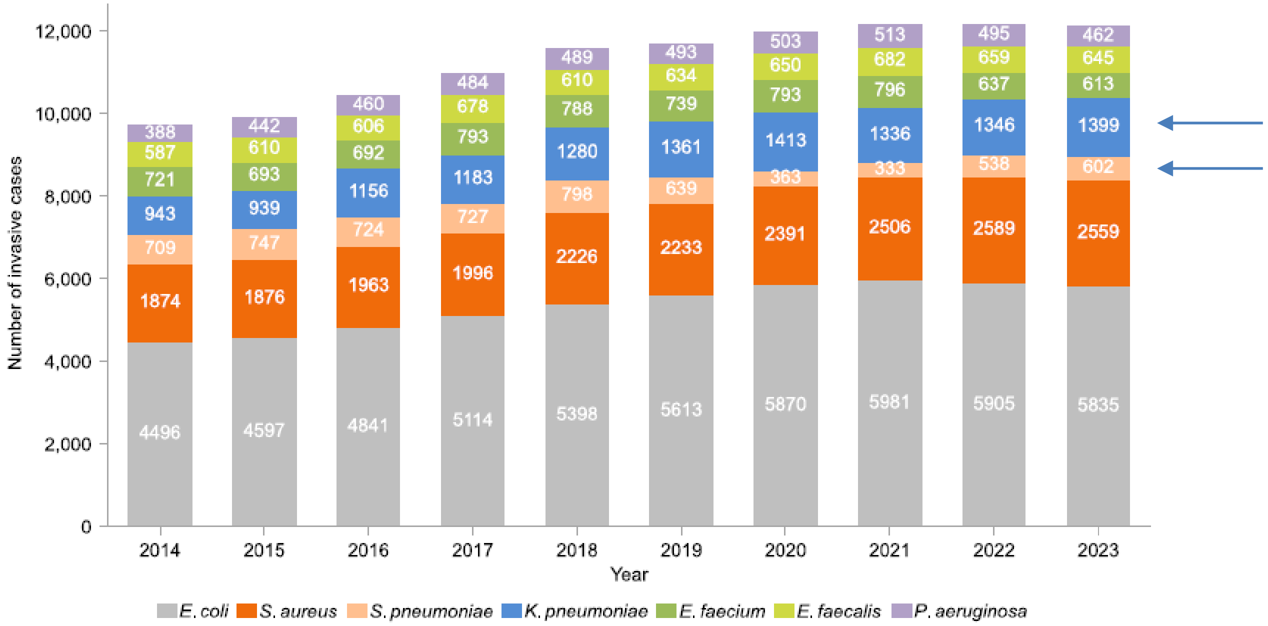
Mikkel Lindegaard & Ute Wolff Sönksen
Referencelaboratoriet for antibiotikaresistens
Statens Serum Institut

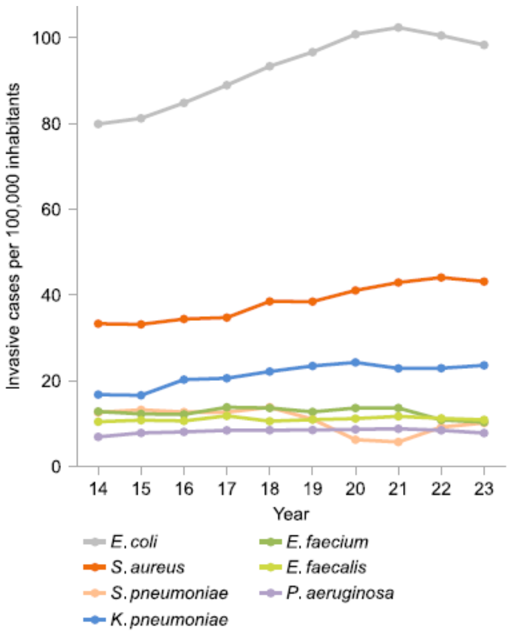
Resistance in human pathogens



Monitored invasive infections

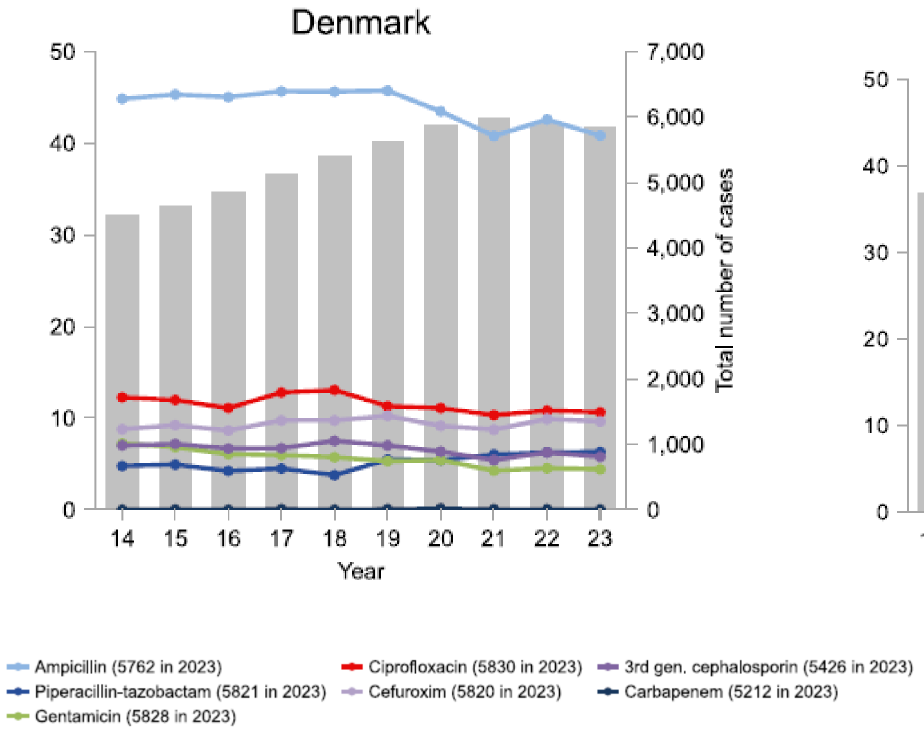
Figure 8.1 Number of invasive cases for bacterial species under surveillance, Denmark, 2014-2023 DANMAP 2023





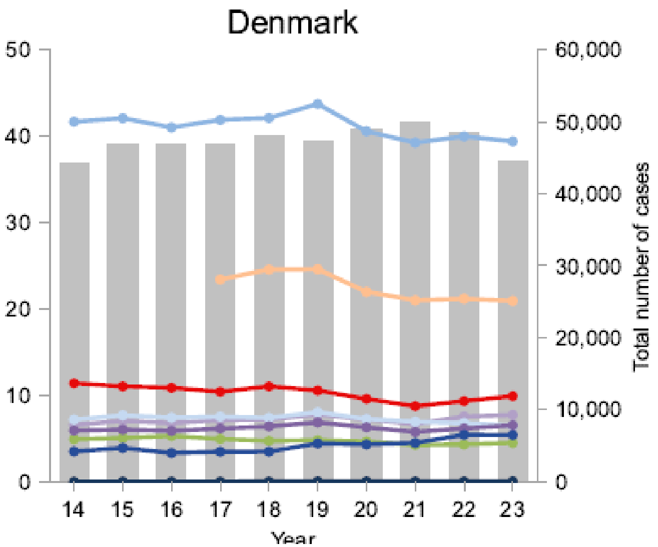
E. coli - invasive infections and urine

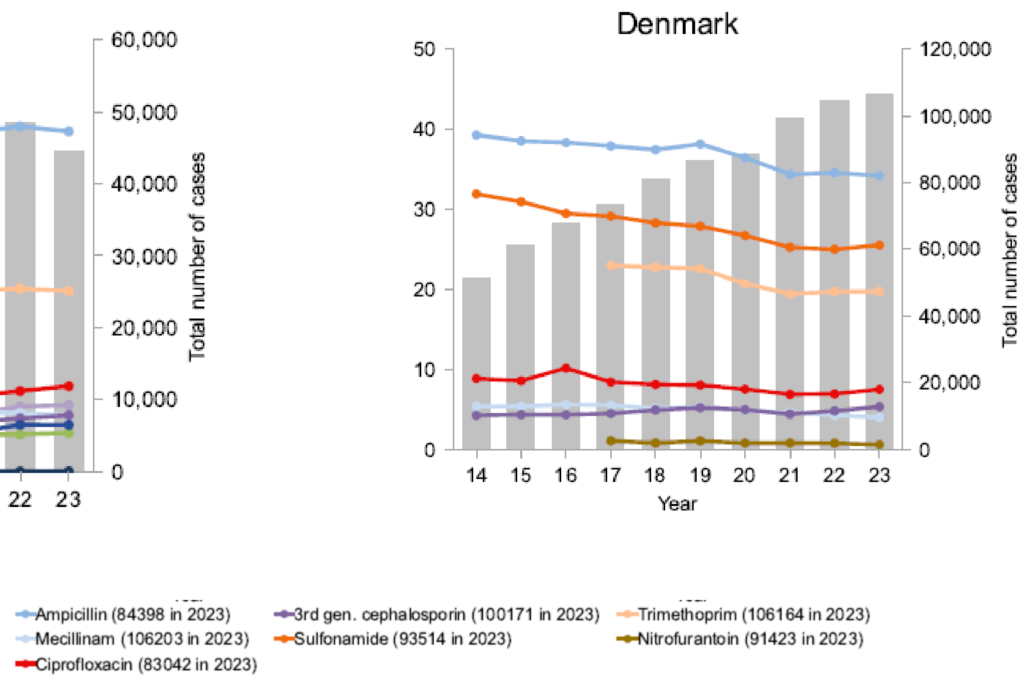
Invasive infections



Hospital urines

Primary healthcare urines





E. coli - invasive infections and urine

Invasive infections

Hospital urines

Primary healthcare urines

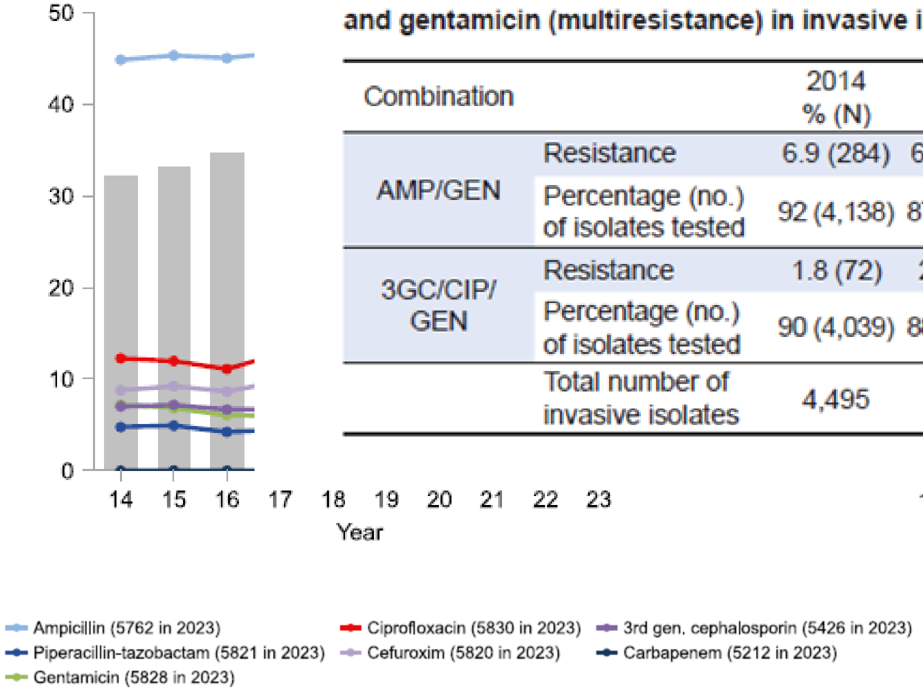
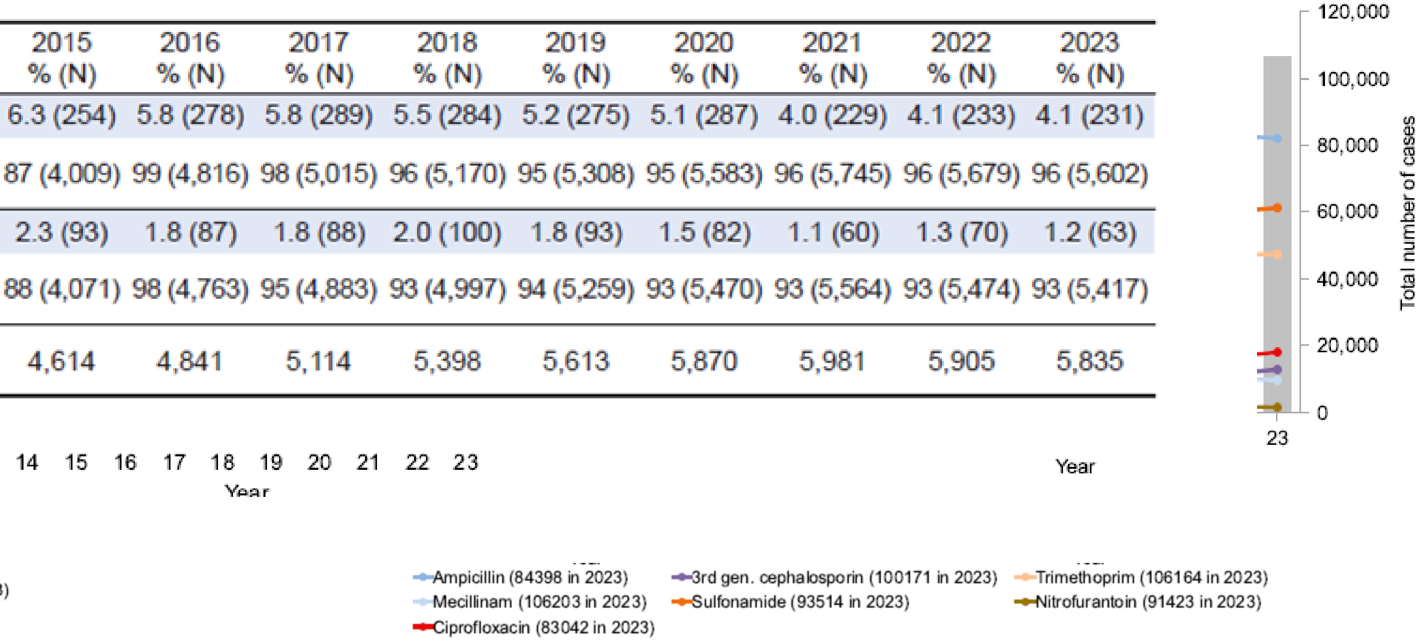
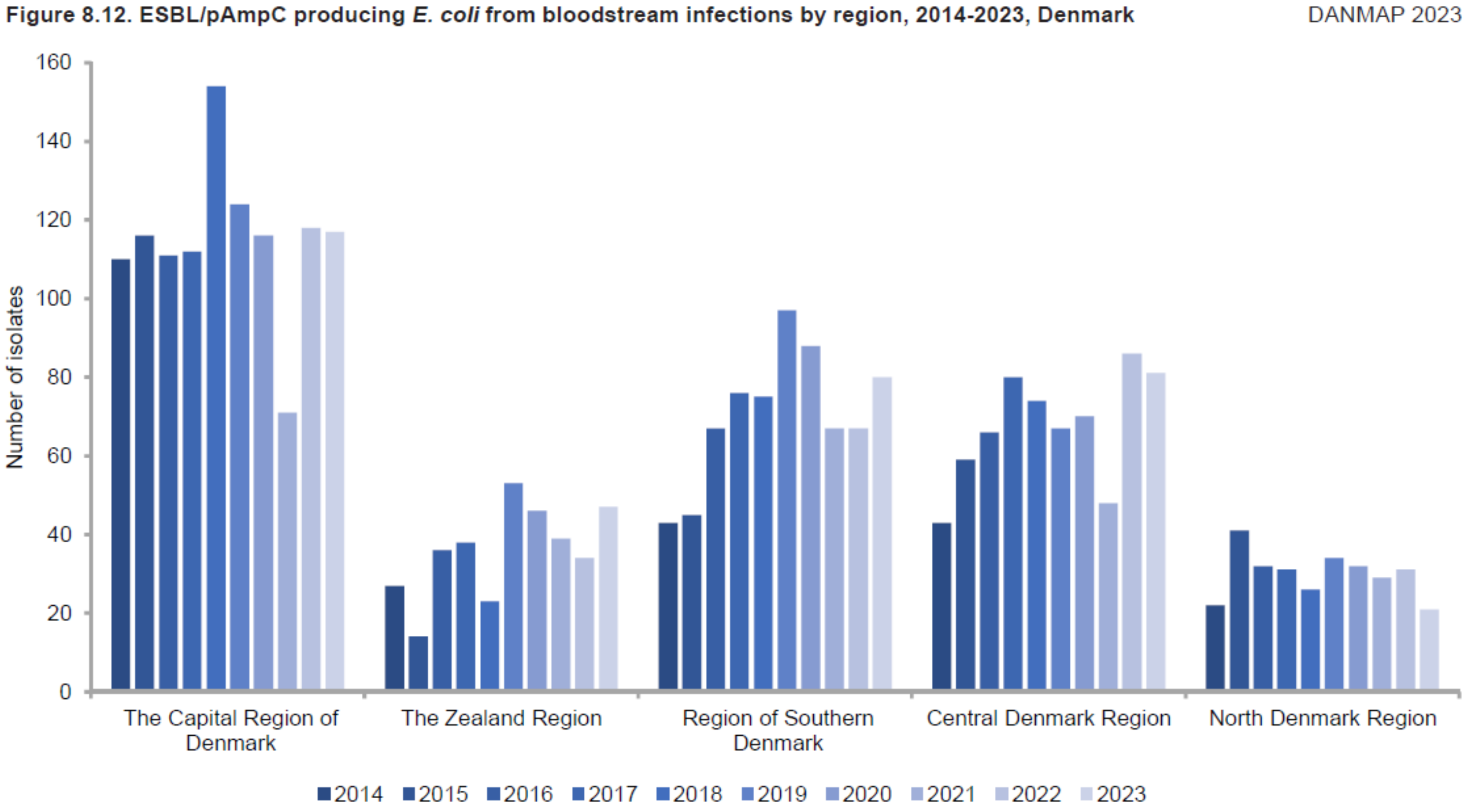


Table 8.4 *Escherichia coli*. Combined resistance to 1) ampicillin and gentamicin and 2) 3rd generation cephalosporins, ciprofloxacin, and gentamicin (multiresistance) in invasive isolates from humans, Denmark, 2014-2023 DANMAP 2023

Combination		2014 % (N)	2015 % (N)	2016 % (N)	2017 % (N)	2018 % (N)	2019 % (N)	2020 % (N)	2021 % (N)	2022 % (N)	2023 % (N)
AMP/GEN	Resistance	6.9 (284)	6.3 (254)	5.8 (278)	5.8 (289)	5.5 (284)	5.2 (275)	5.1 (287)	4.0 (229)	4.1 (233)	4.1 (231)
	Percentage (no.) of isolates tested	92 (4,138)	87 (4,009)	99 (4,816)	98 (5,015)	96 (5,170)	95 (5,308)	95 (5,583)	96 (5,745)	96 (5,679)	96 (5,602)
3GC/CIP/ GEN	Resistance	1.8 (72)	2.3 (93)	1.8 (87)	1.8 (88)	2.0 (100)	1.8 (93)	1.5 (82)	1.1 (60)	1.3 (70)	1.2 (63)
	Percentage (no.) of isolates tested	90 (4,039)	88 (4,071)	98 (4,763)	95 (4,883)	93 (4,997)	94 (5,259)	93 (5,470)	93 (5,564)	93 (5,474)	93 (5,417)
	Total number of invasive isolates	4,495	4,614	4,841	5,114	5,398	5,613	5,870	5,981	5,905	5,835

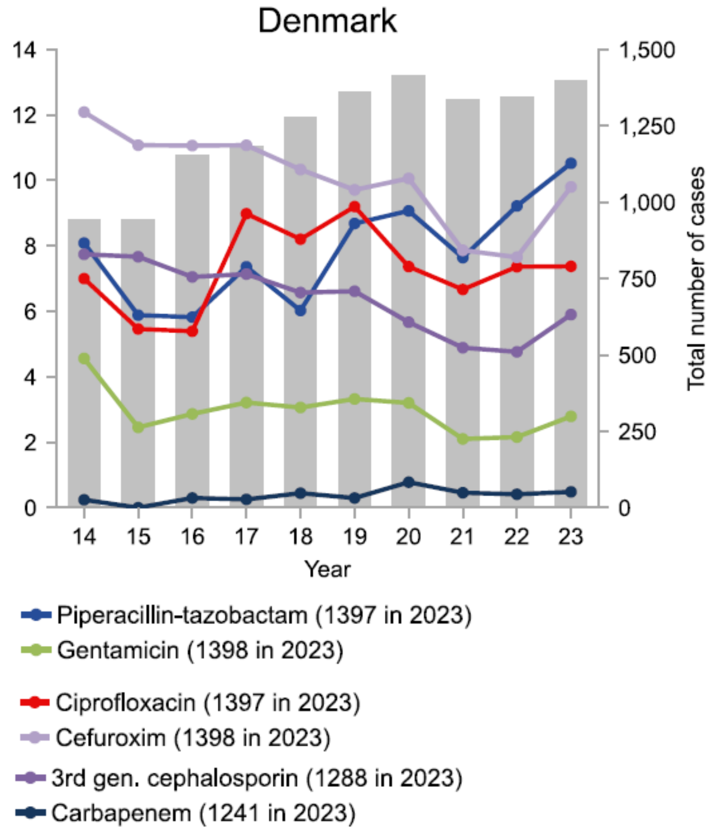


ESBL *E. coli* from invasive infections

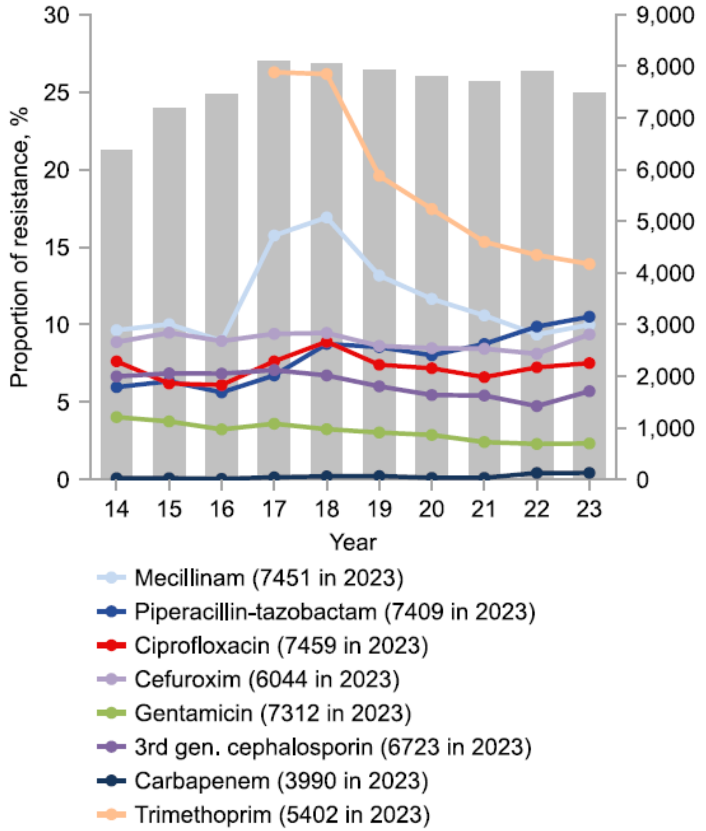


K. pneumoniae – invasive infections and urine

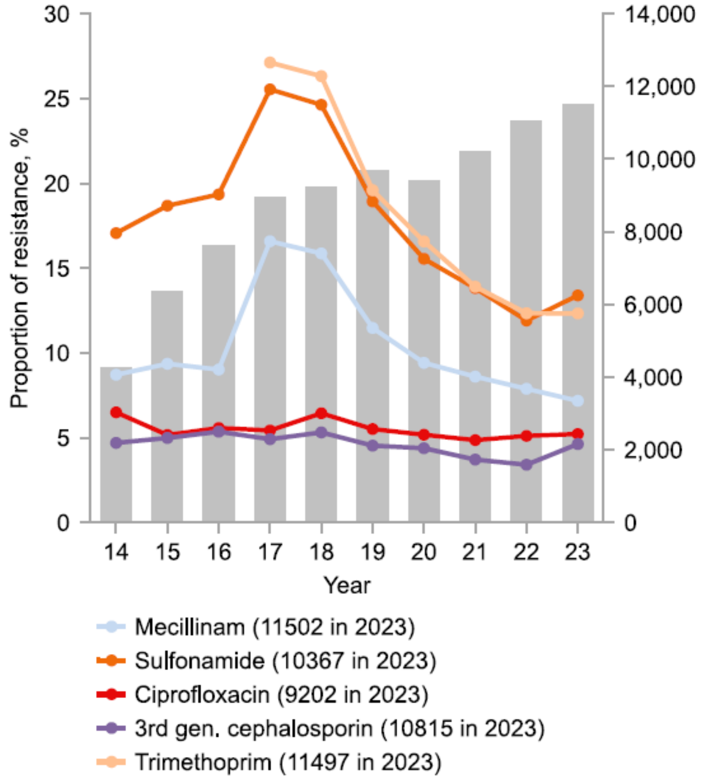
Invasive infections



Hospital urines



Primary healthcare urines



K. pneumoniae – invasive infections

Table 8.8 Invasive *Klebsiella pneumoniae*. Table of resistance percentages, 2014-2023 DANMAP 2023

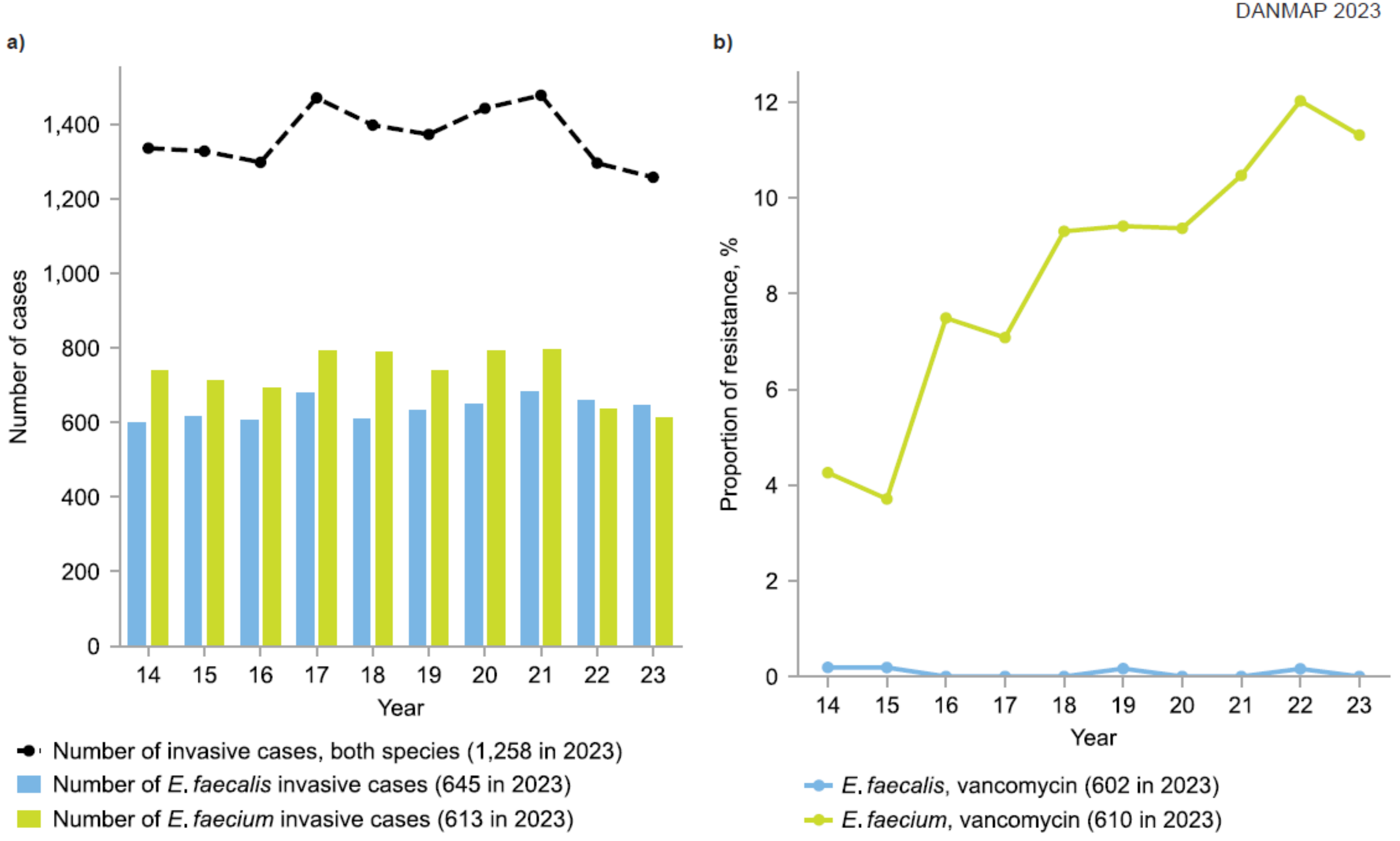
Substance	Percent resistant invasive *K. pneumoniae* isolates									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Piperacillin/tazobactam	8.1	5.9	5.8	7.4	6.1	8.7	9.1	7.5	9.2	10.5
Gentamicin	4.6	2.5	2.9	3.2	3.1	3.3	3.2	2.1	2.2	2.8
Ciprofloxacin	7.0	5.5	5.4	9.0	8.1	9.2	7.4	6.7	7.4	7.4
Cefuroxime	12.1	11.1	11.1	11.1	10.3	9.7	10.1	7.9	7.7	9.8
3rd gen. cephalosporins	7.7	7.7	7.3	7.1	6.1	6.6	5.3	4.9	4.8	5.9
Carbapenem	0.2	0.0	0.3	0.3	0.5	0.3	0.8	0.5	0.4	0.5
Total number of isolates	943	939	1,156	1,183	1,280	1,361	1,413	1,336	1,346	1,399

Table 8.9 Invasive *Klebsiella pneumoniae*. Combined resistance to 3rd generation cephalosporins, ciprofloxacin, and gentamicin (multidrug-resistance) in invasive isolates from humans, Denmark, 2015-2023 DANMAP 2023

	2015 % (N)	2016 % (N)	2017 % (N)	2018 % (N)	2019 % (N)	2020 % (N)	2021 % (N)	2022 % (N)	2023 % (N)
Resistance	1.1 (9)	1.6 (18)	2.4 (27)	1.7 (20)	2.4 (30)	1.5 (19)	1.0 (13)	1.0 (13)	1.9 (24)
Percentage (no.) of isolates tested for combined resistance (multiresistance)	89 (840)	98 (1,131)	95 (1,122)	93 (1,188)	94 (1,275)	93 (1,308)	93 (1,248)	94 (1,259)	92 (1,287)
Total number of invasive isolates	943	1,156	1,183	1,280	1,361	1,413	1,336	1,346	1,399

Enterococci and vancomycin resistant enterocci

Figure 8.11 Invasive Enterococci faecalis/faecium isolates from humans:
a) annual number of isolates from unique cases and b) proportion of vancomycin resistant isolates, Denmark, 2014-2023

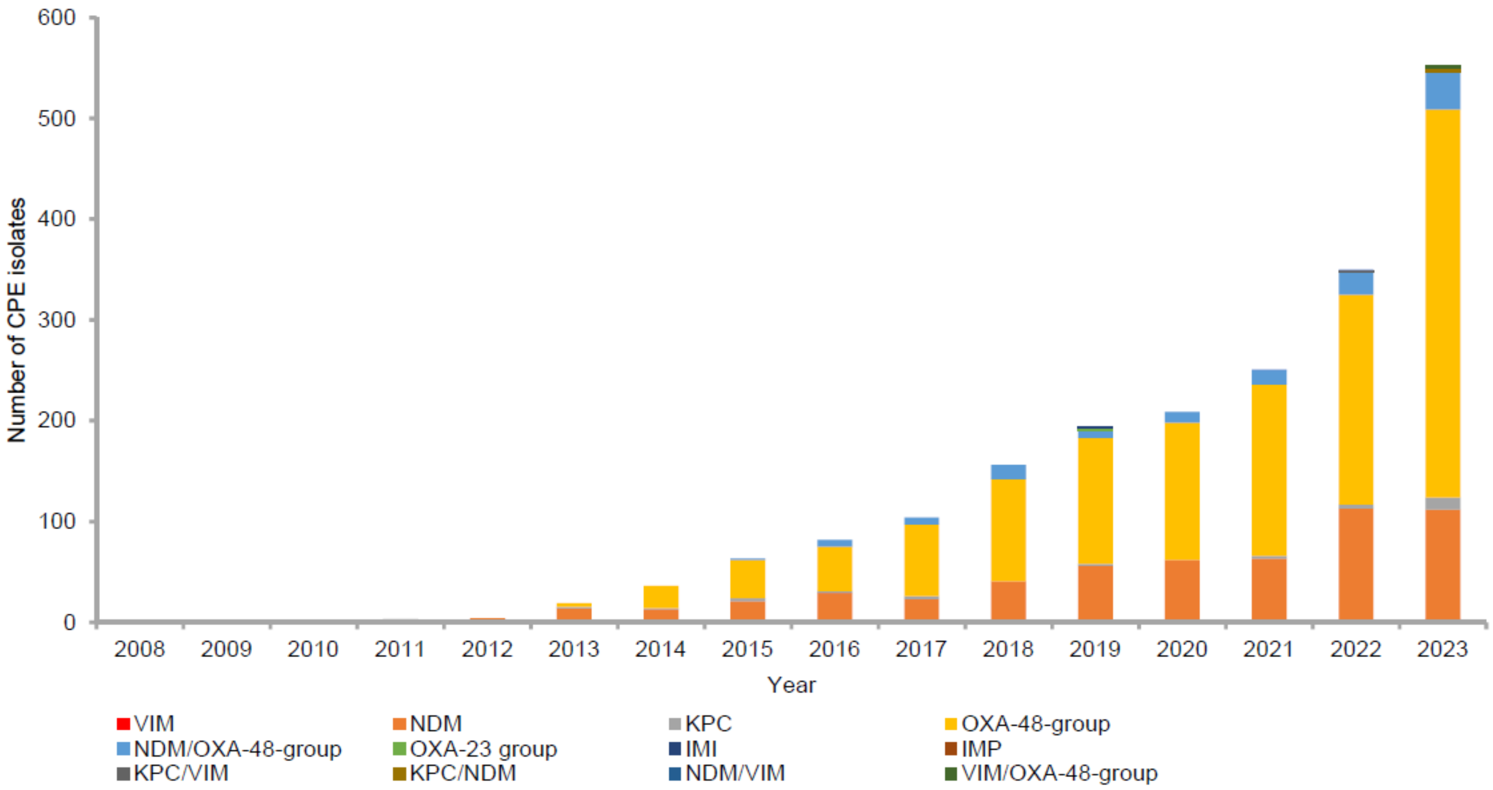


The ref lab received altogether:

494 isolates in 2023 (compared to 662 in 2022), the majority (94%) being VanB.
The dominating cone since 2021 is *E.faecium* of the type ST80-CT2406.

CPE

Figure 8.13 Numbers of carbapenemase-producing Enterobacterales (CPE), Denmark, 2008-2023 DANMAP 2023



2023: 552 CPE (from 436 patients)

385 isolates with OXA-48
109 isolates with NDM
37 isolates with both OXA-48 and NDM

CPE/CPO

Figure 8.14 Number of clinical and screening CPE isolates per region, Denmark, 2018-2023 DANMAP 2023

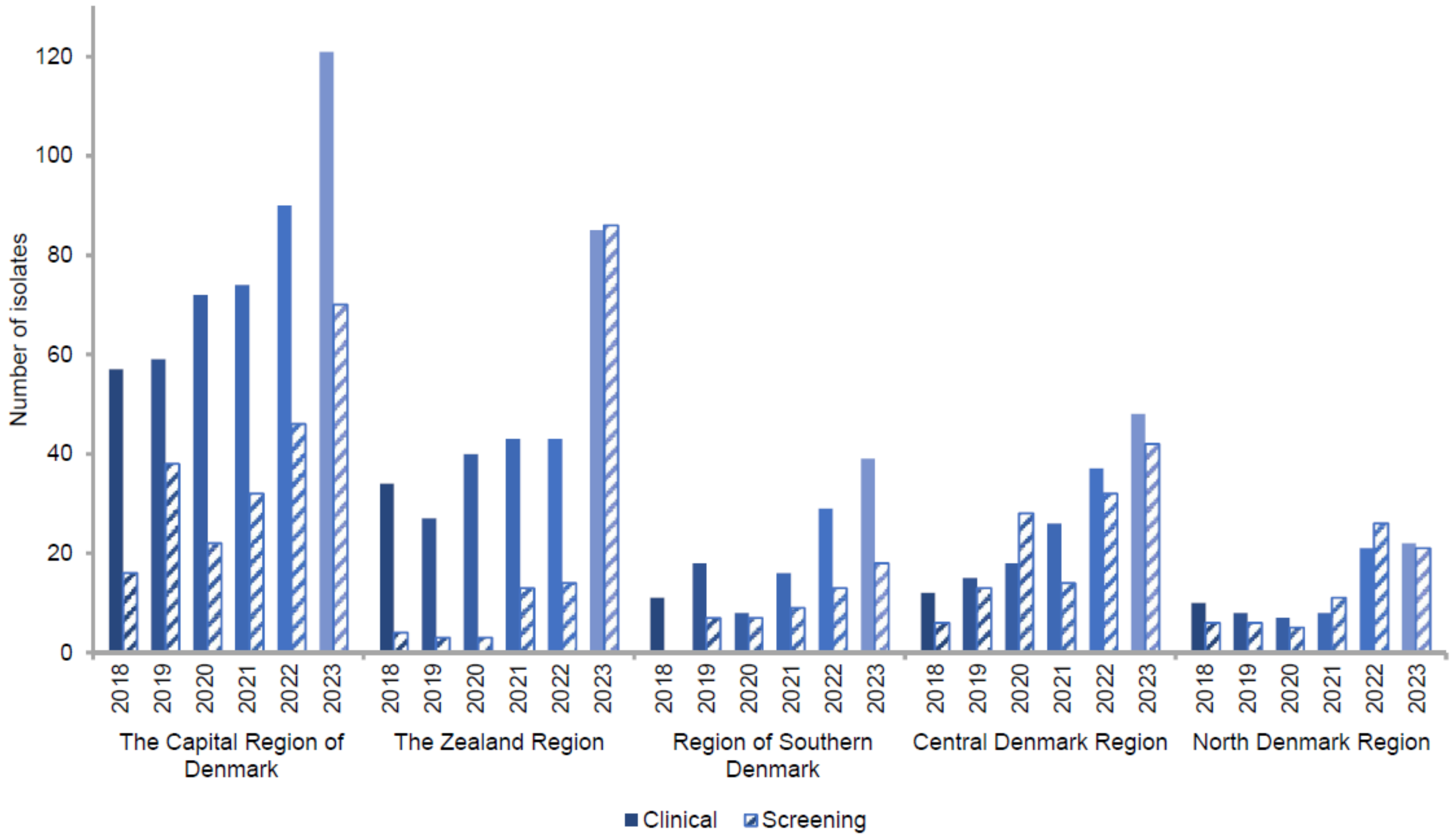
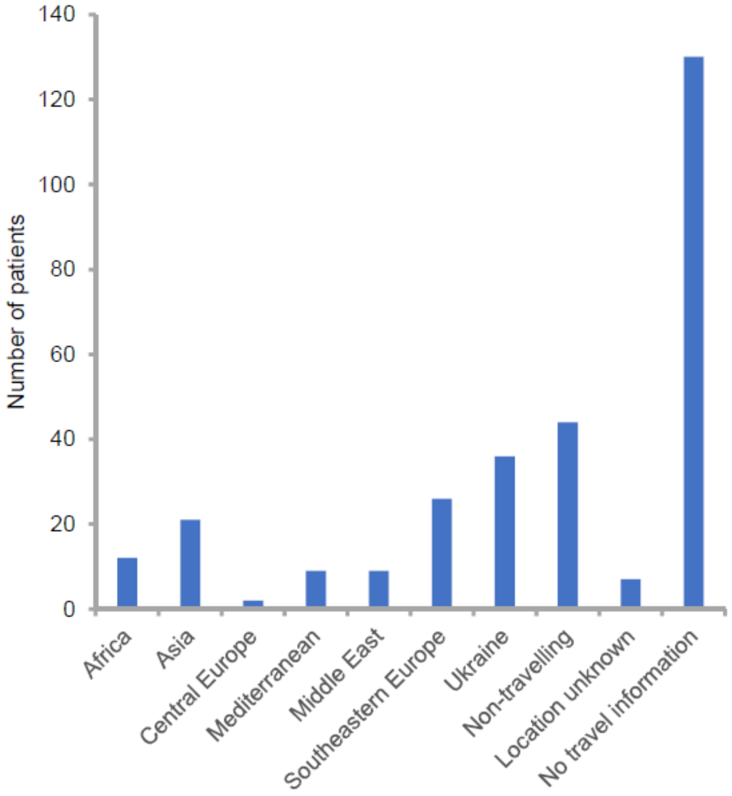


Figure 8.17 Place of origin of CPO, 2019-2023 DANMAP 2023



26 outbreaks in 2023, (24 CPE, 2 CPO): the majoriy domestic outbreaks, eight new, 18 ”old” (known from previous years).

MRSA

Figure 8.20b Number of new MRSA cases 2014-2023, Denmark, divided in infection and screening samples

DANMAP 2023

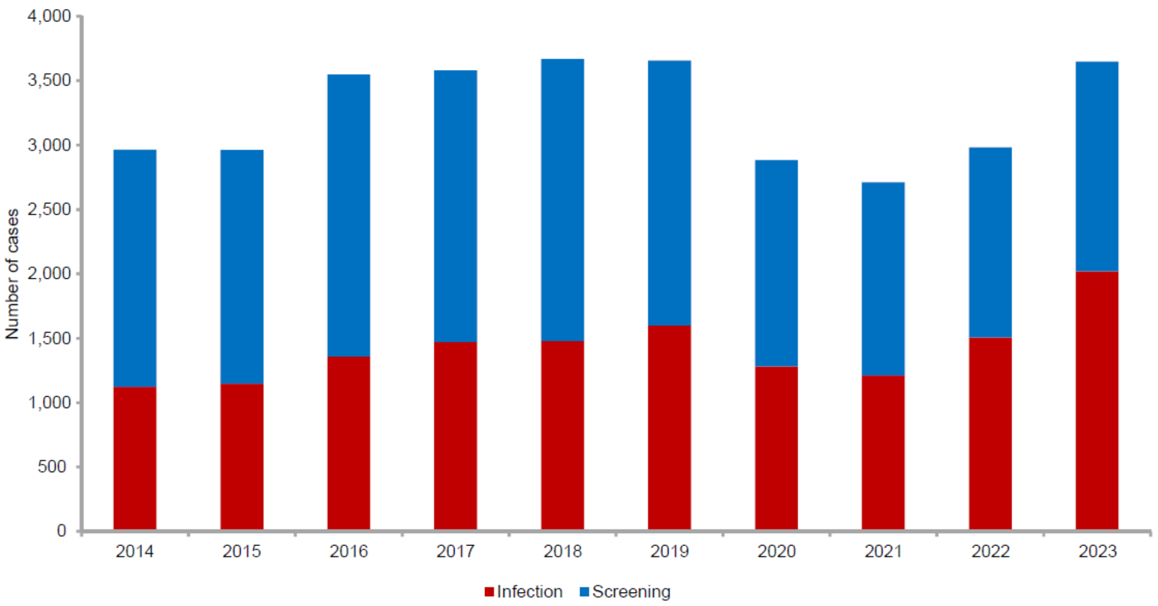
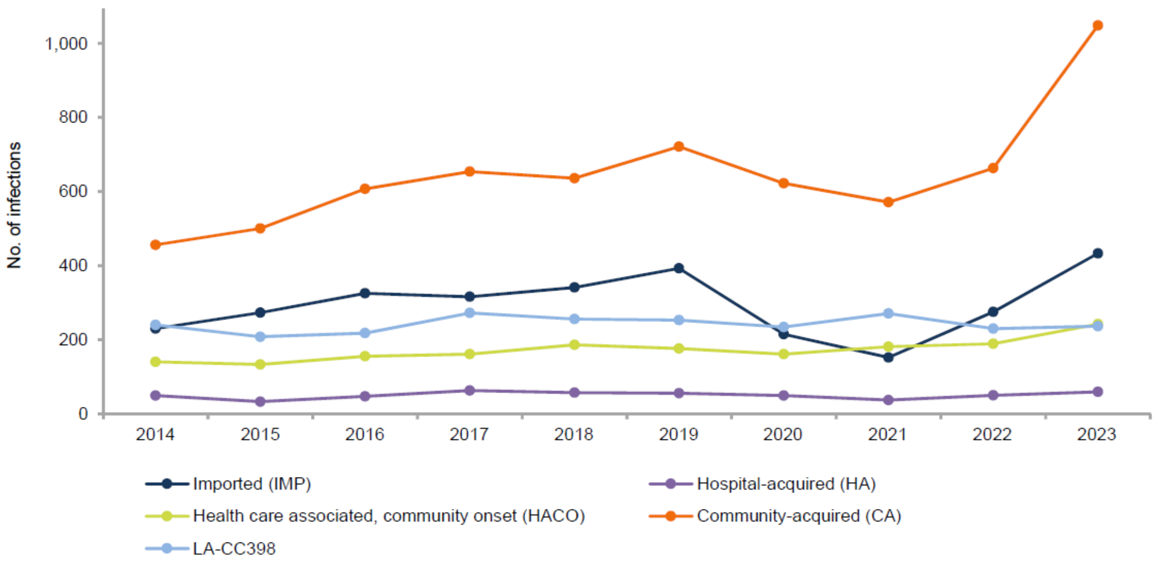


Figure 8.21 Number of MRSA infections according to epidemiological classification, 2014-2023, Denmark

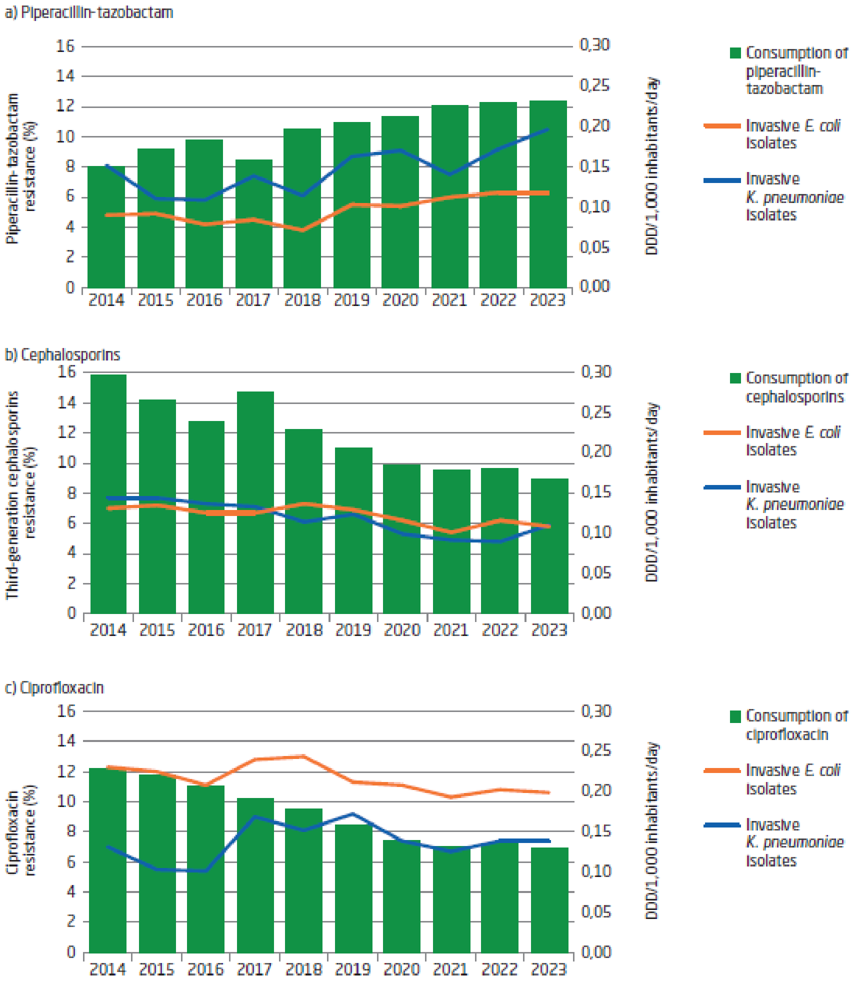
DANMAP 2023



In 2023:
3,649 cases (20% increase) of MRSA compared to 2022 – primarily community-acquired or travel-related. LA-MRSA relatively stable, accounting for 23% of all MRSA infections.
41 MRSA outbreaks (hospitals and nursing homes)
1.5% of bloodstream infections with *S.aureus* were caused by MRSA (39/2,571 cases)

New in Summary
– comparisson of AMC and AMR for certain antibiotics

Figure 6.6 Resistance (%) in invasive *Escherichia coli* and *Klebsiella pneumoniae* combined with antimicrobial consumption (DID), Denmark, 2014-2023



Main messages

- The incidence of invasive infections appears to have reached a plateau
- After years of decreasing resistance rates, they have now either stabilised or are increasing
  - *K. pneumoniae* resistance towards piperacillin-tazobactam is now at 10.5 %!
- Decreasing numbers of invasive enterococcal infections but also in VRE – a ”real change” or less testing?
- Continued increase in outbreaks of CPO – many with unknown epidemiology
- After a decrease in the number of MRSA during the pandemic, numbers are increasing again

This year’s textboxes

Textbox 8.1

Danish surveillance of azole resistant *Aspergillus fumigatus* from clinical samples - a 4-year update

Karen Marie Thyssen Astvad, Rasmus Krøger Hare, Karin Meinike Jørgensen, Nissrine Abou-Chakra, Jan Berg Gertsen, Lise Kristensen, Flemming Schønning Rosenvinge, Lisbeth Lützen, Ea Sofie Marmolin, Bent Løwe Røder, Sofia Sulim, Michael Pedersen, Jette Bangsborg, Raluca Datcu, Turid Snekloth Søndergaard and Maiken Cavling Arendrup
For further information: Karen Astvad, kaas@ssi.dk

Table 1 Yearly number of isolates and patients

	Qua									
	1 Q4 2018-Q3 2019		2 Q4 2019-Q3 2020							
	*N**	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Patients	675		562		688		618		2,543	
Isolates	978		843		883		751		3,455	
Susceptible	922	94.3%	782	92.8%	832	94.2%	718	95.6%	3,254	94.2%
Resistant	56	5.7%	61	7.2%	51	5.8%	33	4.4%	201	5.8%
R env.	35	3.6%								
R other Cyp51A	14	1.4%								
R non-Cyp51A**	7	0.7%								

R env.: Resistance due to alterations of
but were phenotypically similar to same-
resistant isolate had an N248K mutation

Textbox 8.2

Increasing rates of drug resistance in *Mycobacterium tuberculosis* isolates in Denmark

Dorte Bek Folkvardsen and Erik Svensson, International Reference Laboratory of Mycobacteriology, SSI
For further information: Dorte Bek Folkvardsen dbe@ssi.dk

Textbox 8.3

First results from antimicrobial resistance monitoring in *Shigella* spp. in Denmark

Jeppe Boel
For further information: Jeppe Boel, jebl@ssi.dk

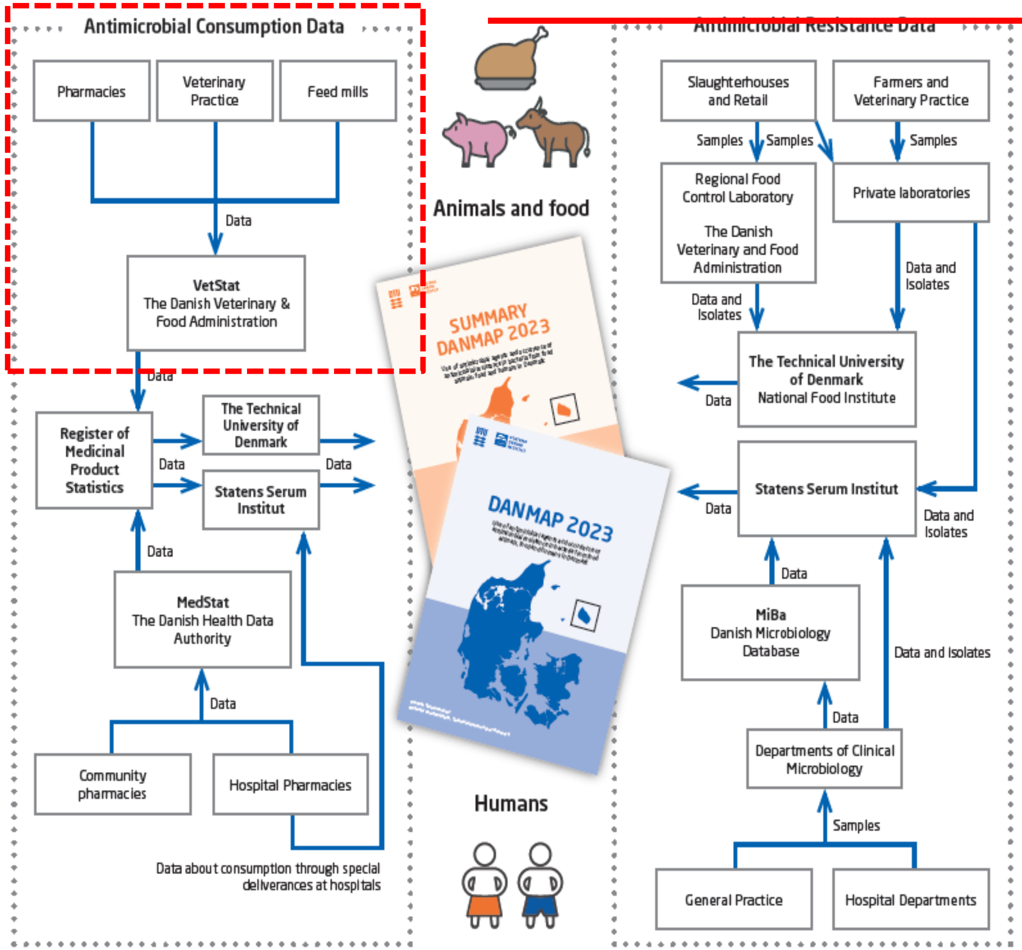
DANMAP Seminar 2024

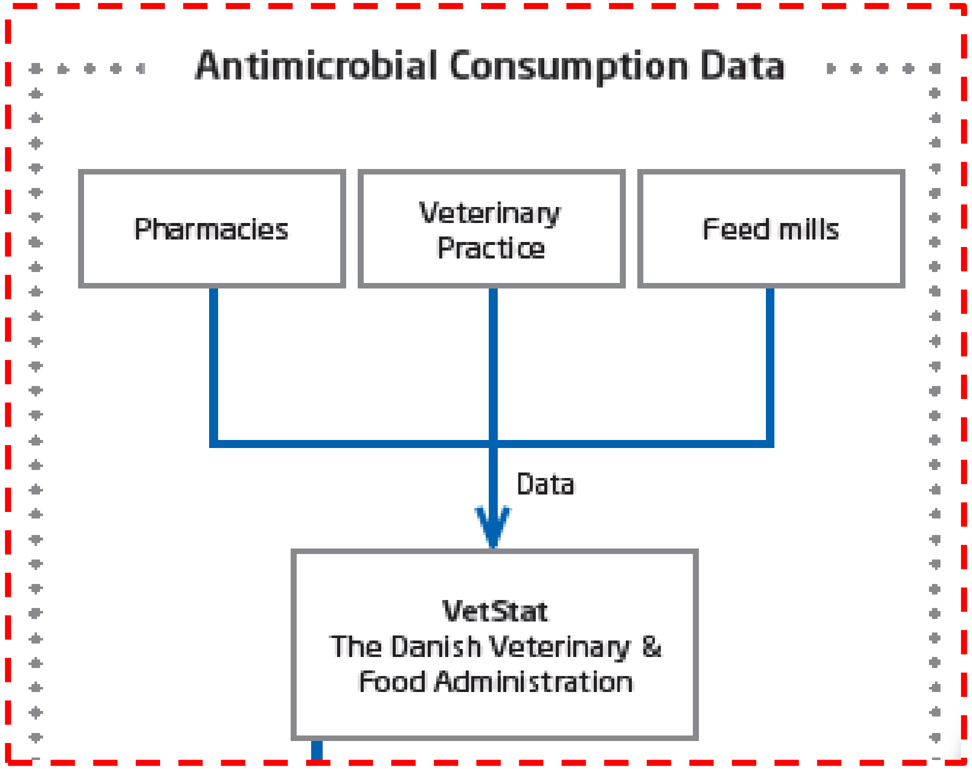
Antimicrobial consumption in animals

Marianne Sandberg
Veterinarian, Senior researcher
DTU, Food

Vibe Dalhoff Andersen
Veterinarian, Senior researcher
DTU, Food

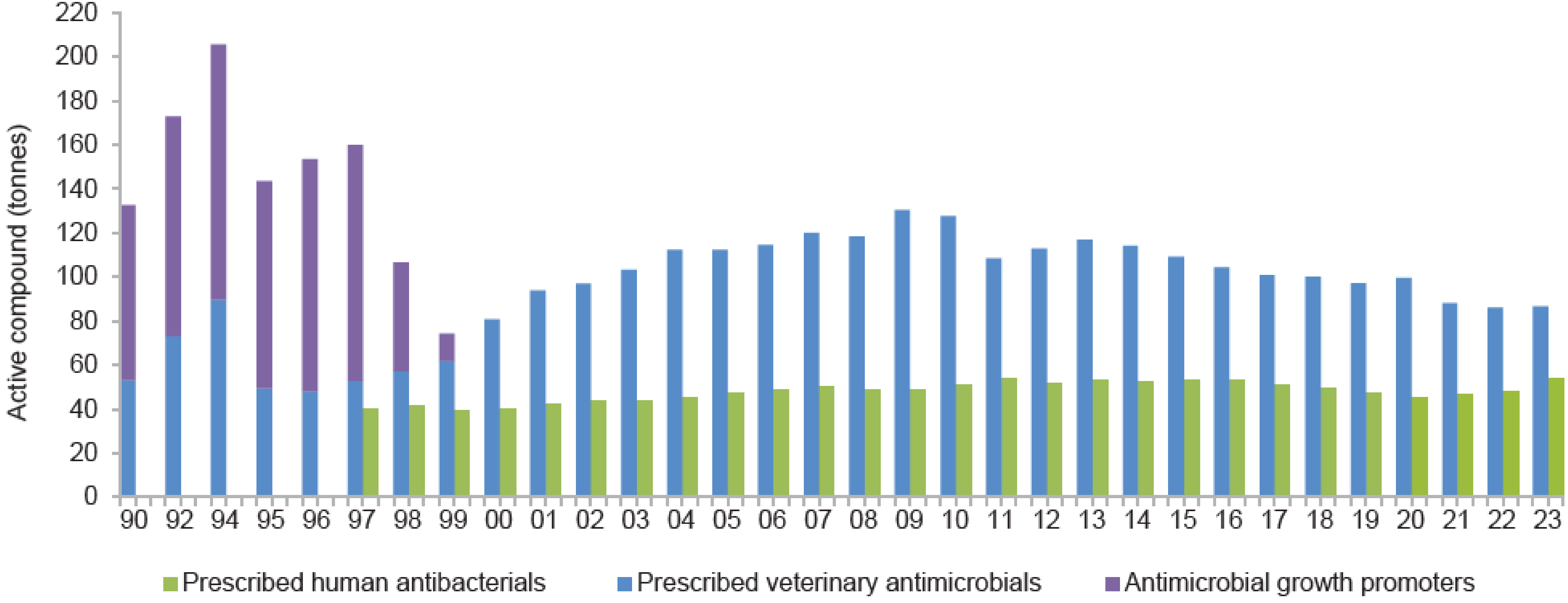
Data flow - VetStat



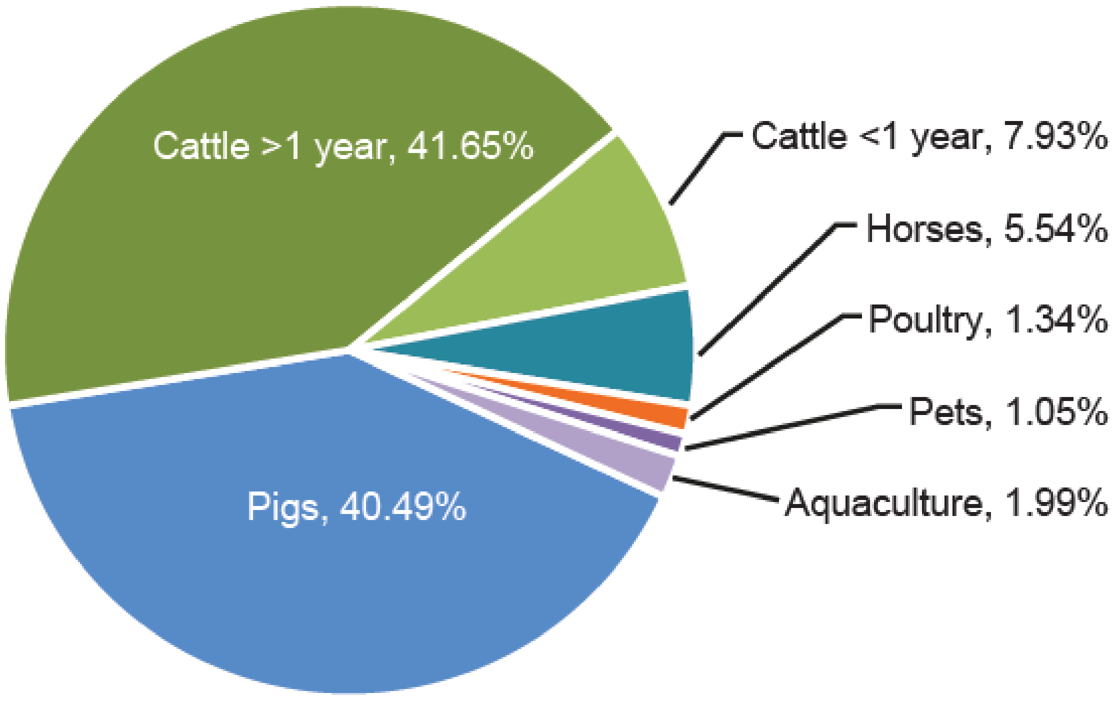


DANMAP

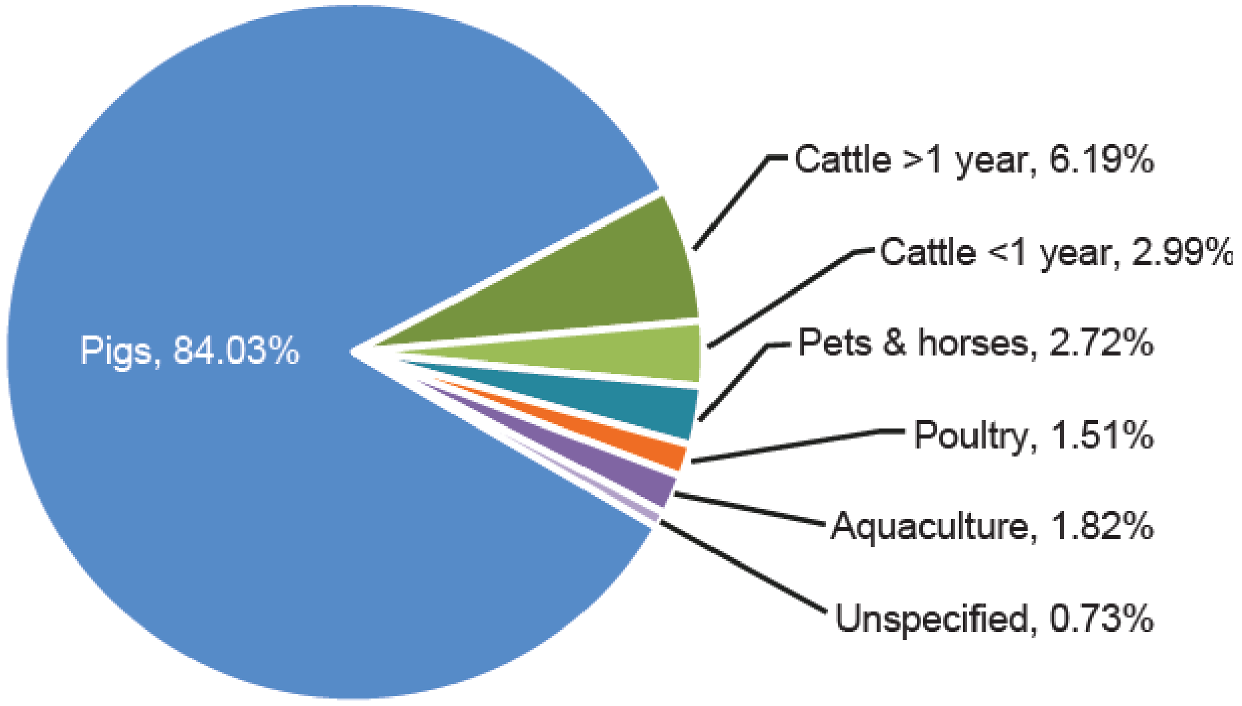
Antimicrobial consumption in animals and humans – a historical overview



Relative distribution of biomass and antimicrobial consumption, animals, 2023

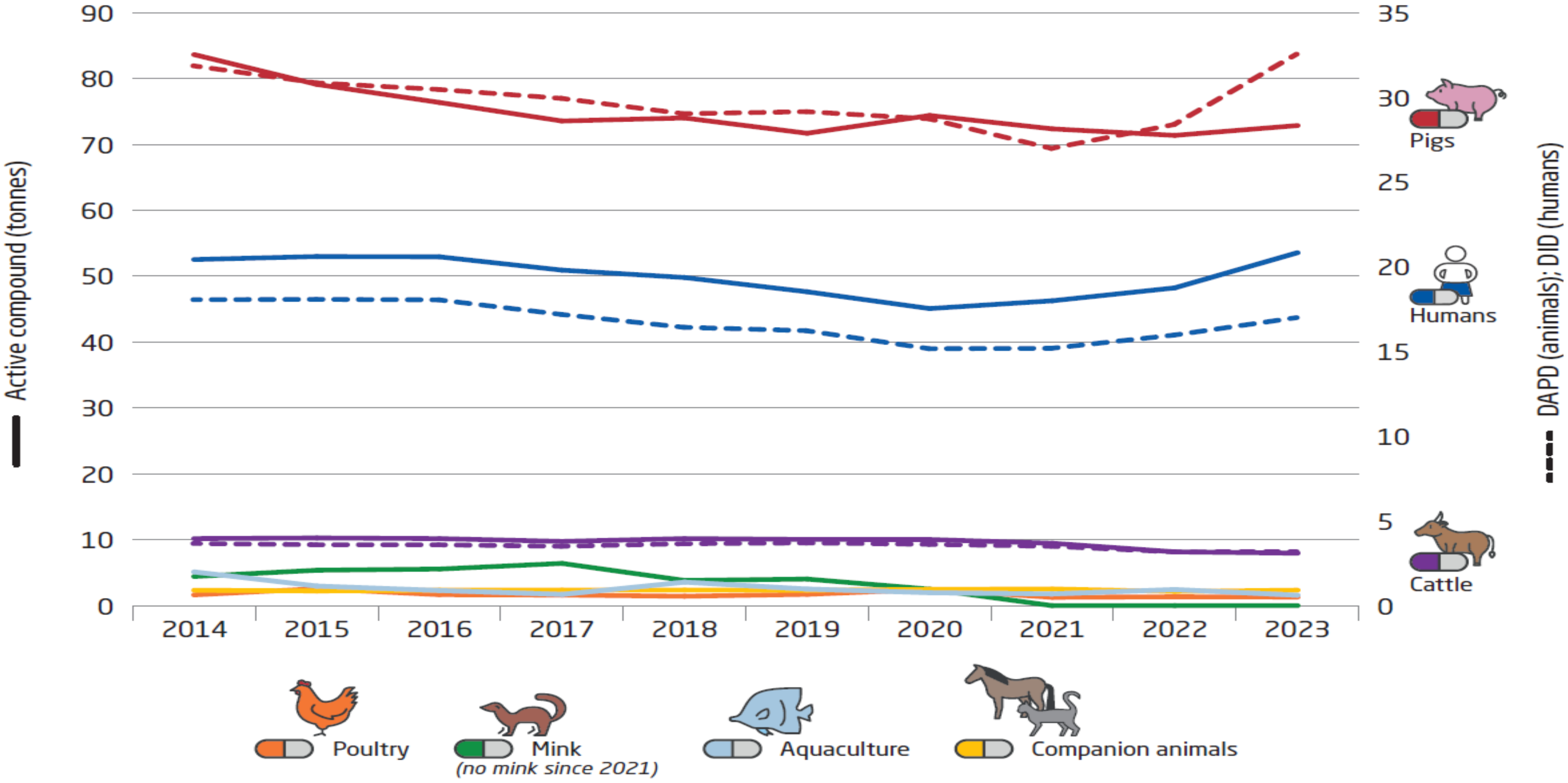


Live biomass



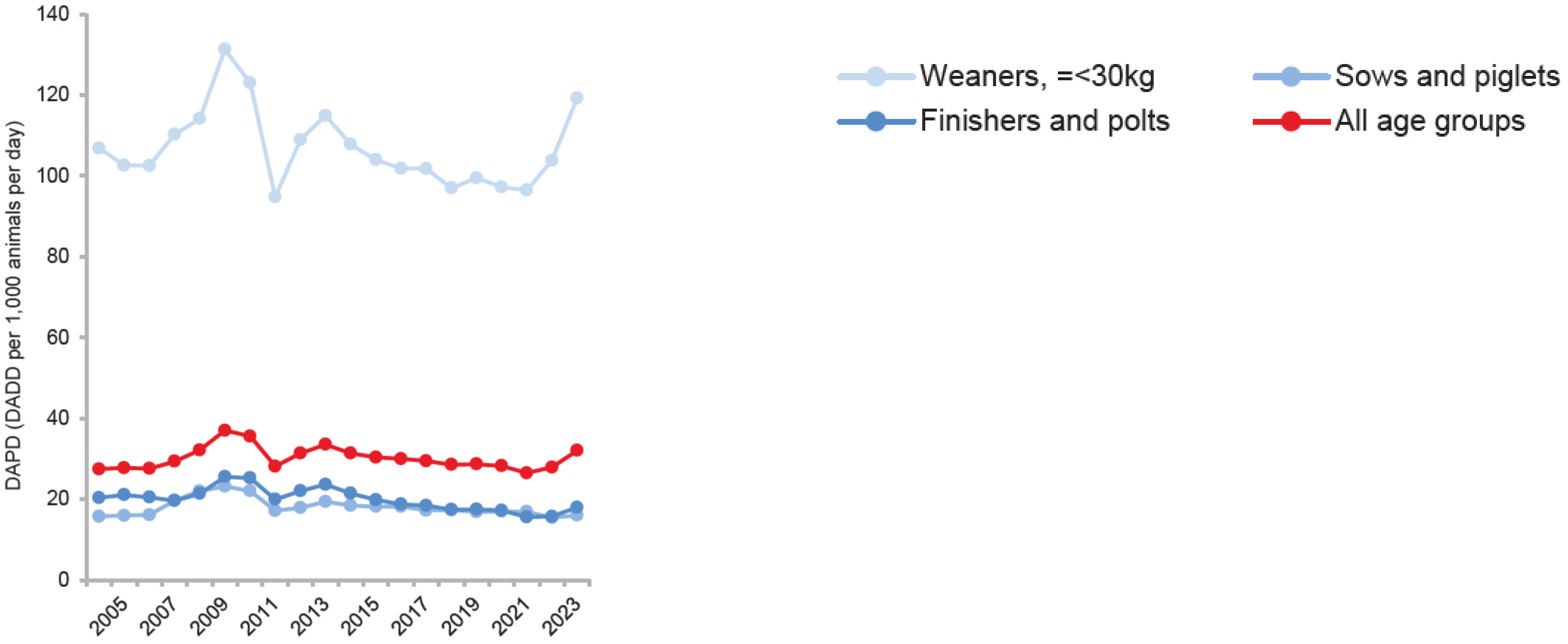
Active compound

Antimicrobial consumption in animals and humans, 2014-2023

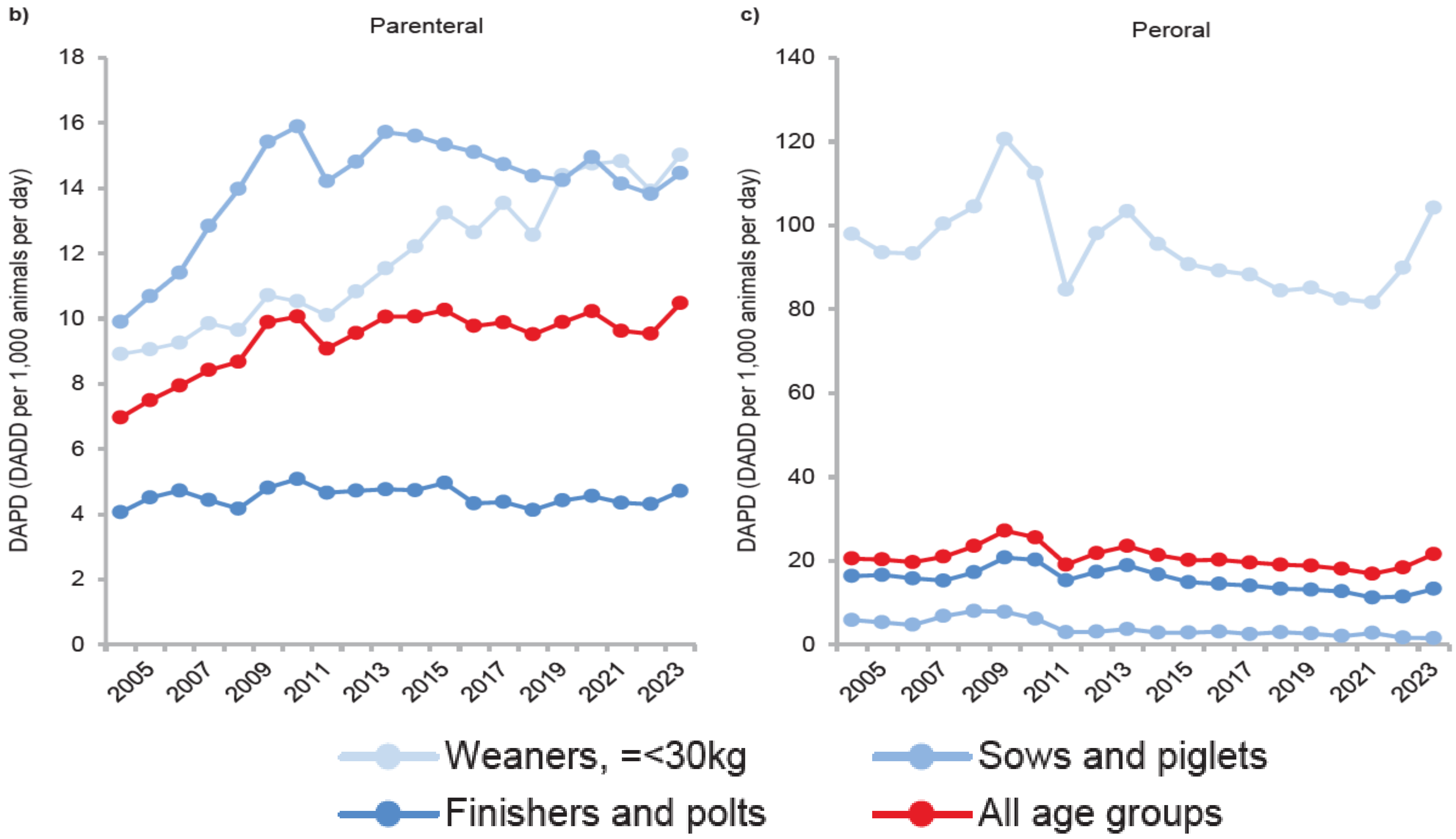


Small amounts of kg active compound were used by unspecified animal species in 2023

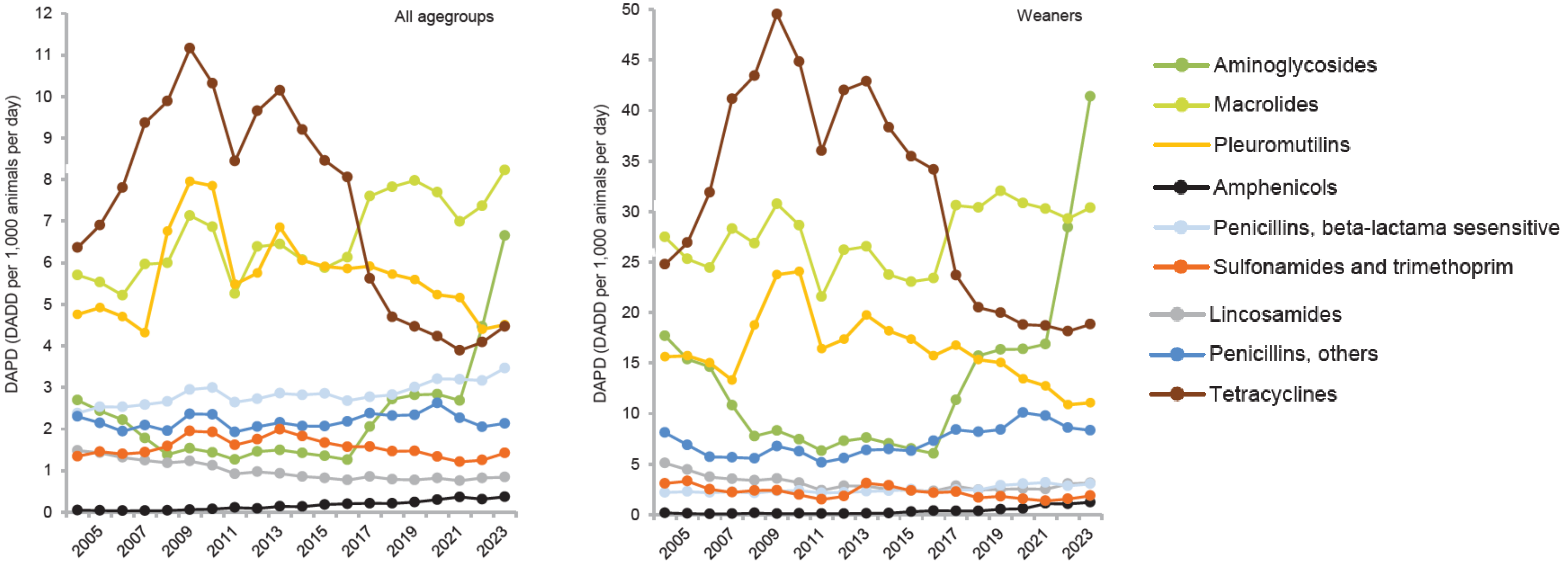
Consumption of antimicrobials in pigs



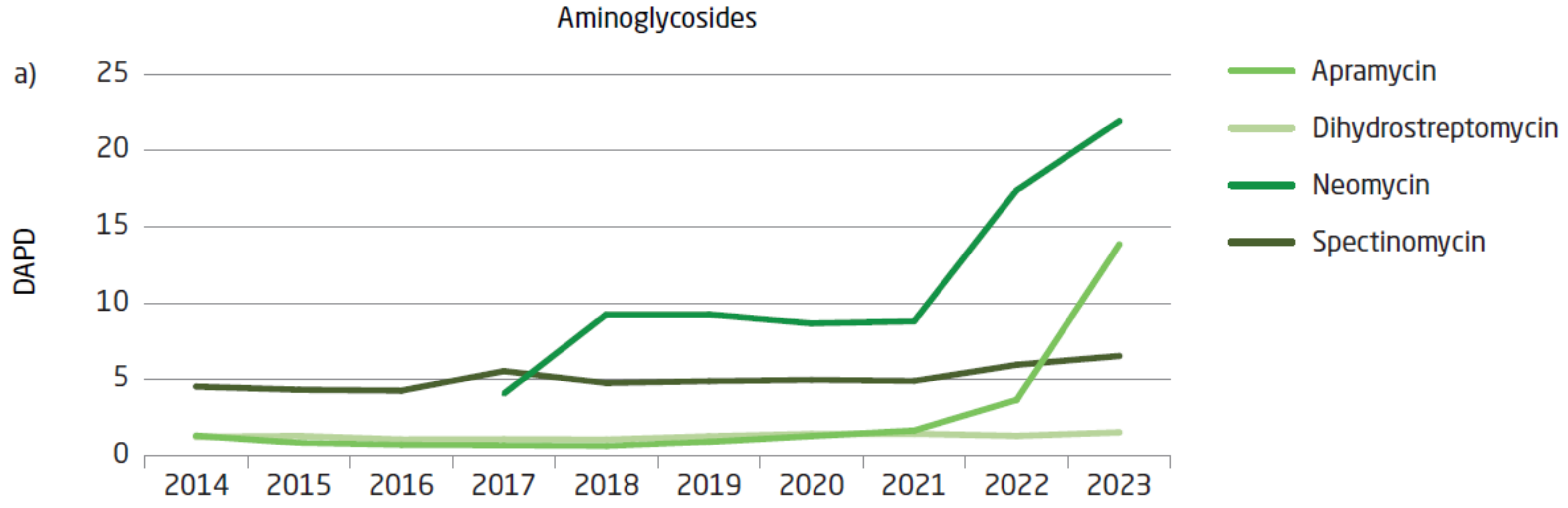
Consumption of antimicrobials in pigs

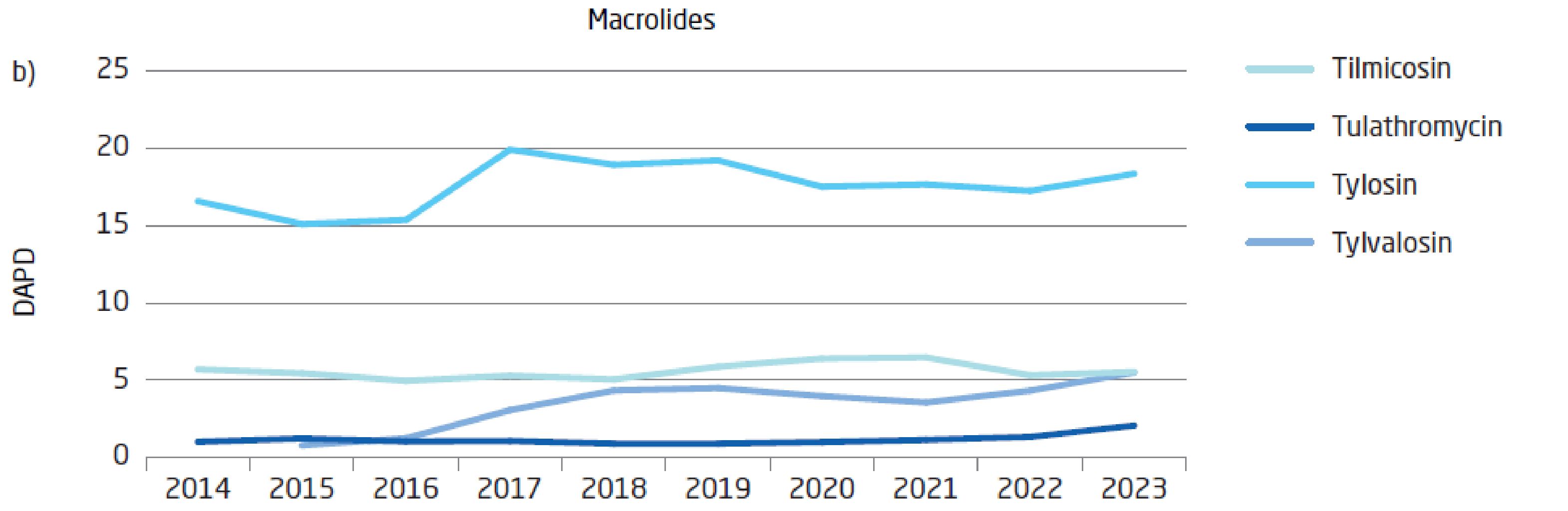


Consumption of antimicrobials in pigs

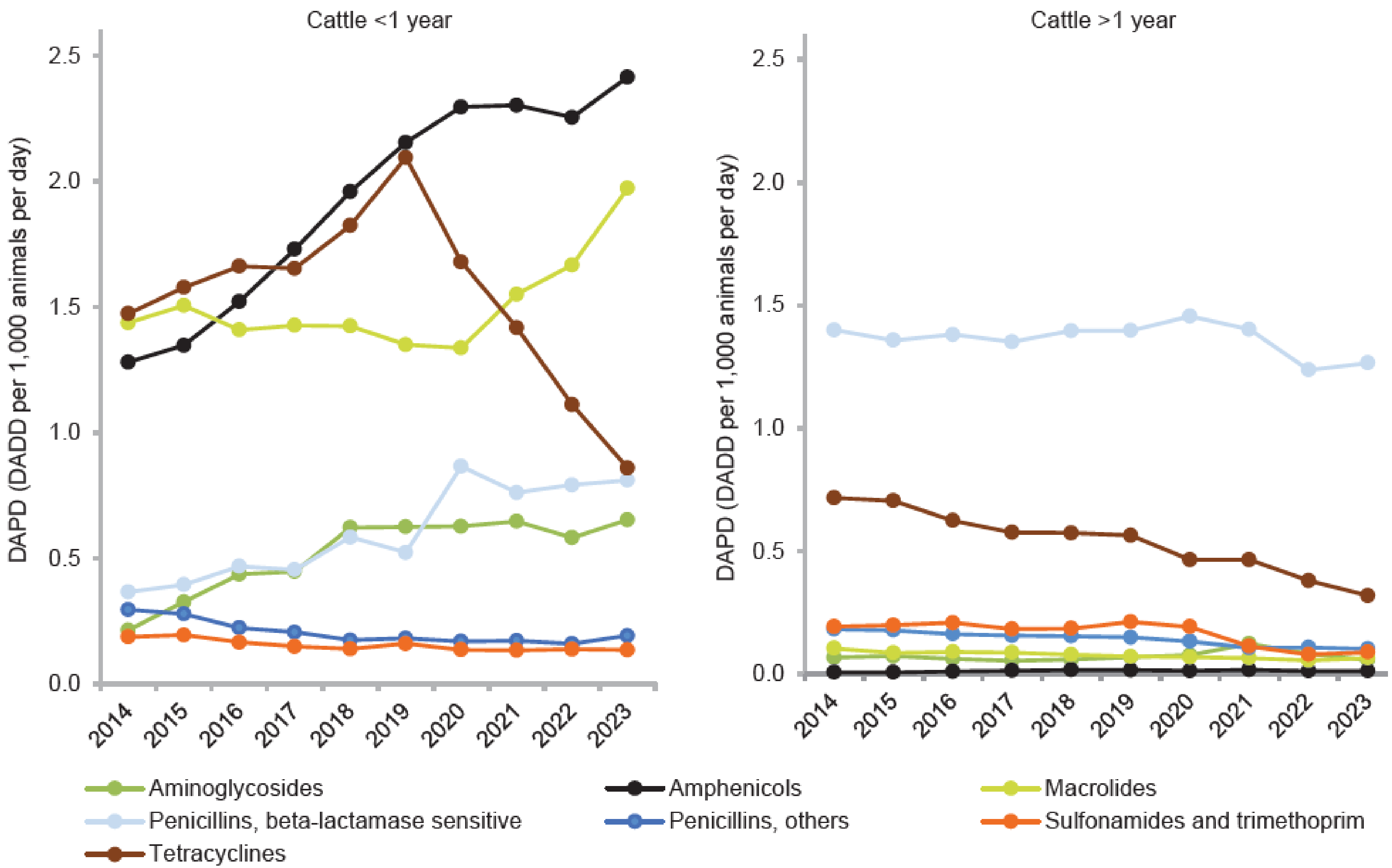


Consumption of antimicrobials in weaners

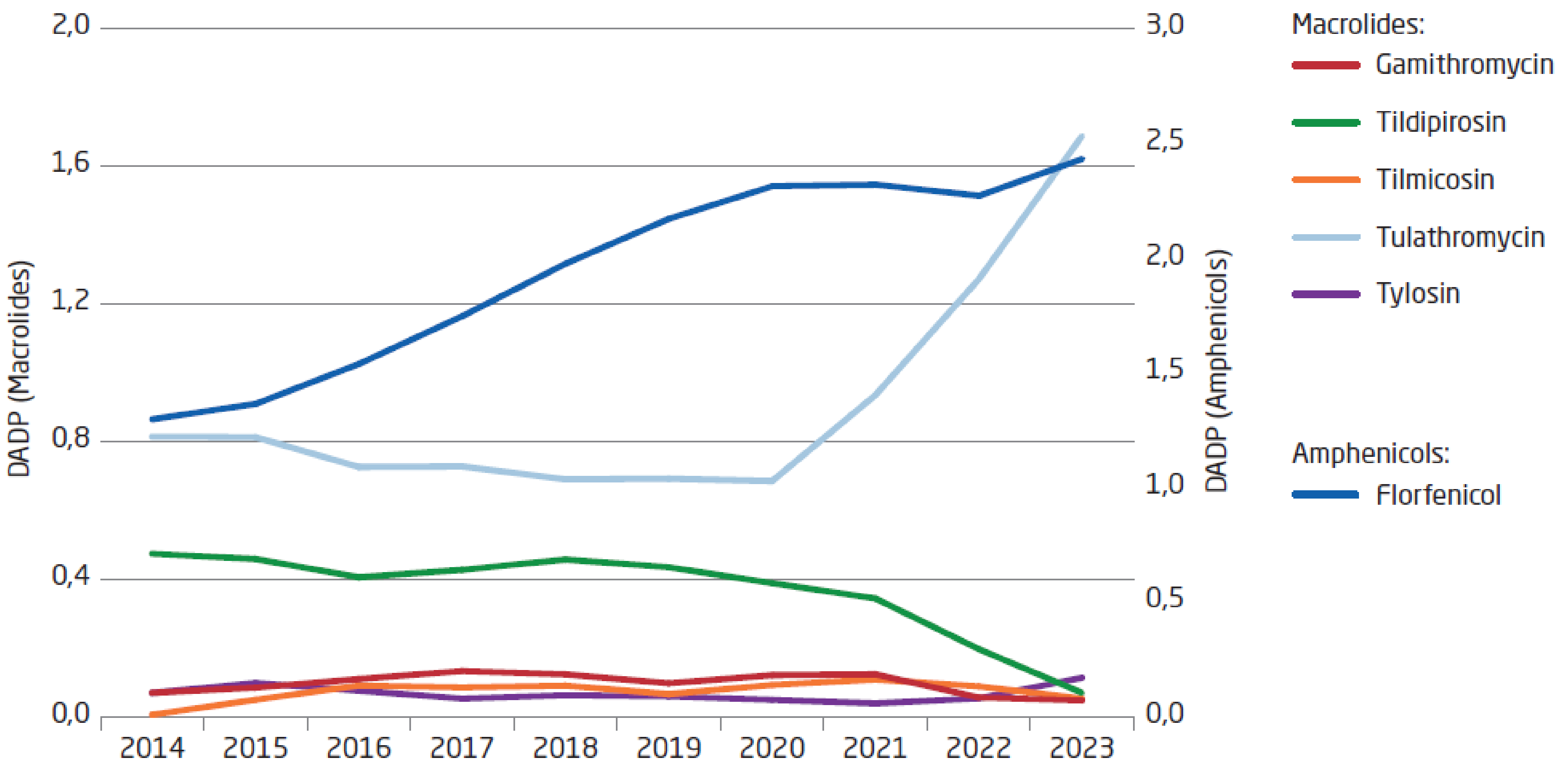




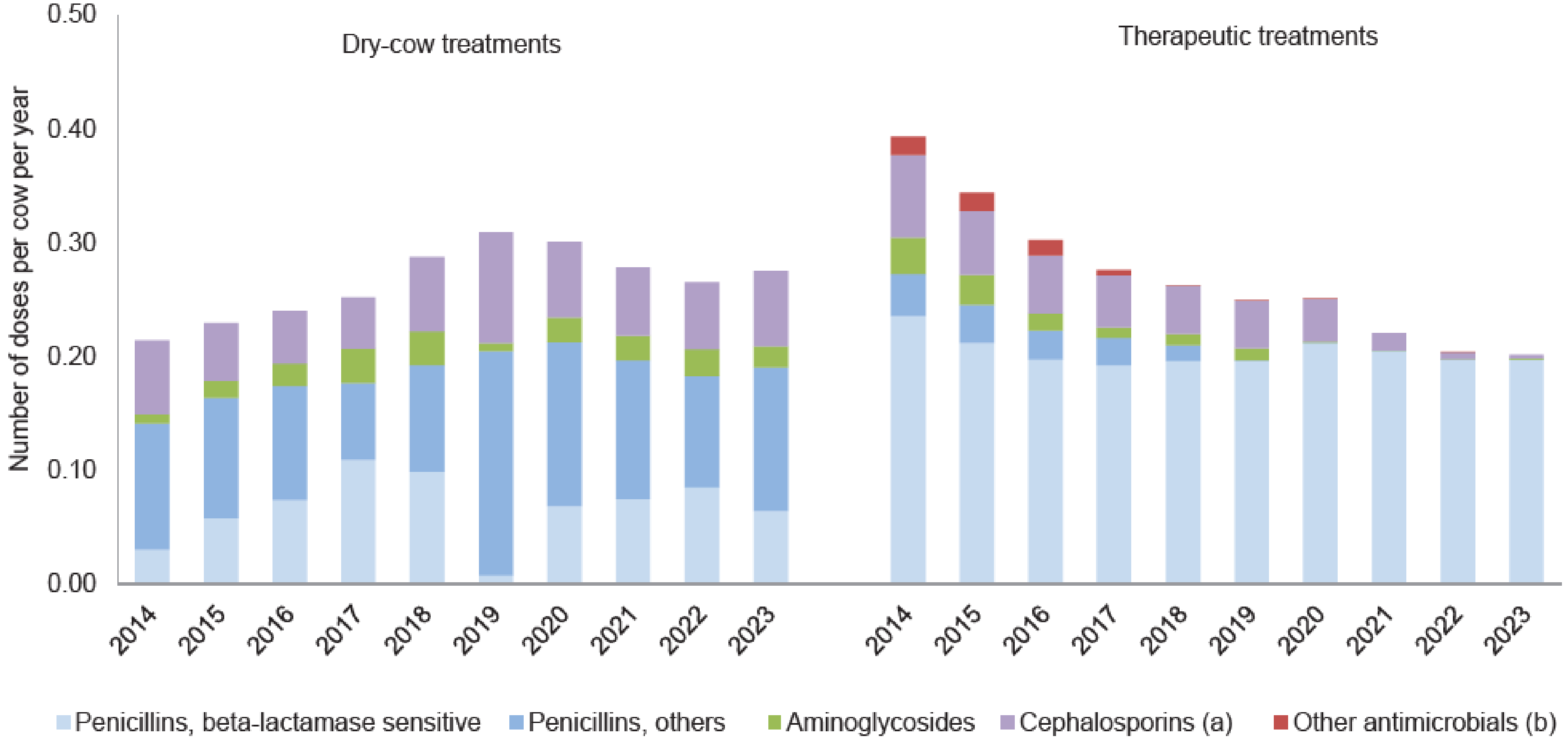
Consumption of antimicrobials in cattle



Consumption of antimicrobials in cattle < 1 year



Antimicrobial consumption in cattle, intramammaries



Text boxes

Textbox 4.1

A shift in the use of aminoglycosides following the ceased use of zinc oxide

The use of zinc oxide in Veterinary Medicinal Products (
sideration of the risks for the environment. Prior to this,
post-weaning diarrhea in piglets. The political ambition
increase in antimicrobial use. While the Danish pig indus
post-weaning diarrhea in the years leading up to the ba
the use of neomycin in 2022; as described in the DANM

Textbox 4.2

Veterinary medicines and antibiotic resistance

In recent decades, veterinary medicine has focused on a One Health approach that integrates considerations regarding the health of both animals and humans. This has led to new guidelines for the responsible use of antibiotics in animals, aiming to reduce the development of resistance. As part of these efforts, the EU's Veterinary Medicines Regulation (2019/6) was implemented in 2022 with the goal of harmonizing the use of veterinary medicines, including reserving critical drugs for humans and generally ensuring responsible use. Veterinarians support these initiatives, but unfortunately, certain provisions in the regulation, especially Article 106, cause significant challenges for many veterinarians, which may impact a responsible use in a negative way. Veterinarians are required to prescribe medications strictly according to the Summary of Product Characteristics (SPC) which, depending on the available drugs, limits their ability to tailor treatments to individual animals or herds.

DANMAP

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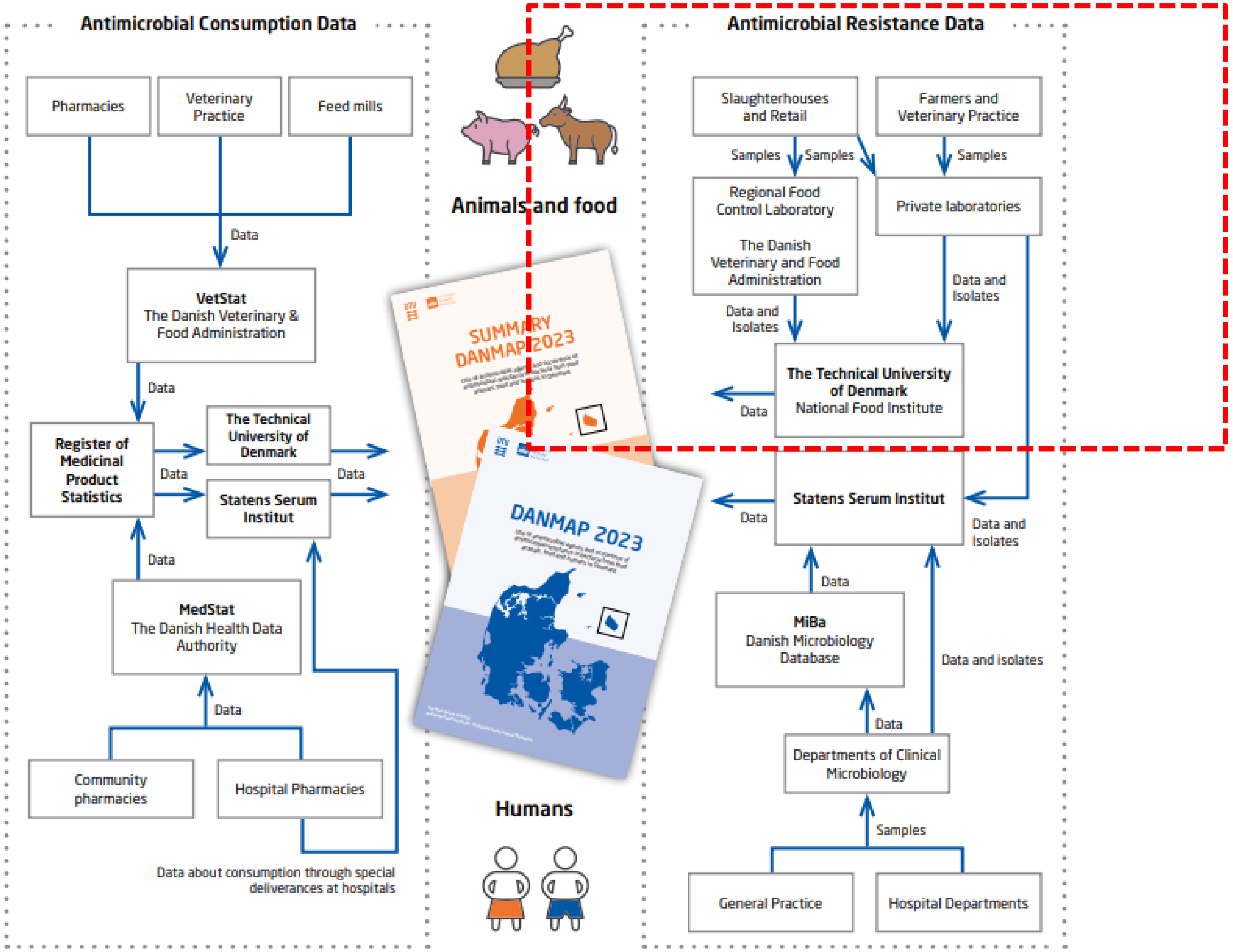
DANMAP Seminar 2024

Antimicrobial resistance in indicator bacteria from food animals and food

Ana Sofia Ribeiro Duarte
Senior Researcher, DVM, PhD

DTU National Food Institute


Antimicrobial Consumption Data
Pharmacies
Veterinary Practice
Feed mills
Data
VetStat
The Danish Veterinary & Food Administration
Data
Register of Medicinal Product Statistics
The Technical University of Denmark
Statens Serum Institut
Data
Data
Data
MedStat
The Danish Health Data Authority
Data
Community pharmacies
Hospital Pharmacies
Data about consumption through special deliverances at hospitals
Animals and food
Humans
SUMMARY DANMAP 2023
DANMAP 2023
Antimicrobial Resistance Data
Slaughterhouses and Retail
Farmers and Veterinary Practice
Samples
Samples
Samples
Regional Food Control Laboratory
The Danish Veterinary and Food Administration
Private laboratories
Data and Isolates
Data and Isolates
The Technical University of Denmark
National Food Institute
Data
Statens Serum Institut
Data
Data and Isolates
Data
MiBa
Danish Microbiology Database
Data and isolates
Data
Departments of Clinical Microbiology
Samples
General Practice
Hospital Departments

Overview of animal isolates reported in DANMAP 2023

Caecal samples:

- All samples: indicator *E. coli*
- Broilers and cattle: *Campylobacter jejuni*
- Pigs: *Campylobacter coli, Salmonella* spp. (*S. Typhimurium, S. monophasic Typhimurium, S. Derby*), *Enterococcus faecalis*
- Cattle and pigs: ESBL/AmpC/CP-producing *E. coli*

Meat samples collected at retail:

- Pork and beef meat: ESBL/AmpC/carbapenemase-producing *E. coli*

EC Decision 2020/1729/EU

Carcass swabs at the slaughterhouse:

- Pig carcasses: *Salmonella* spp. (*S.* Typhimurium, *S.* monophasic Typhimurium, *S.* Derby)

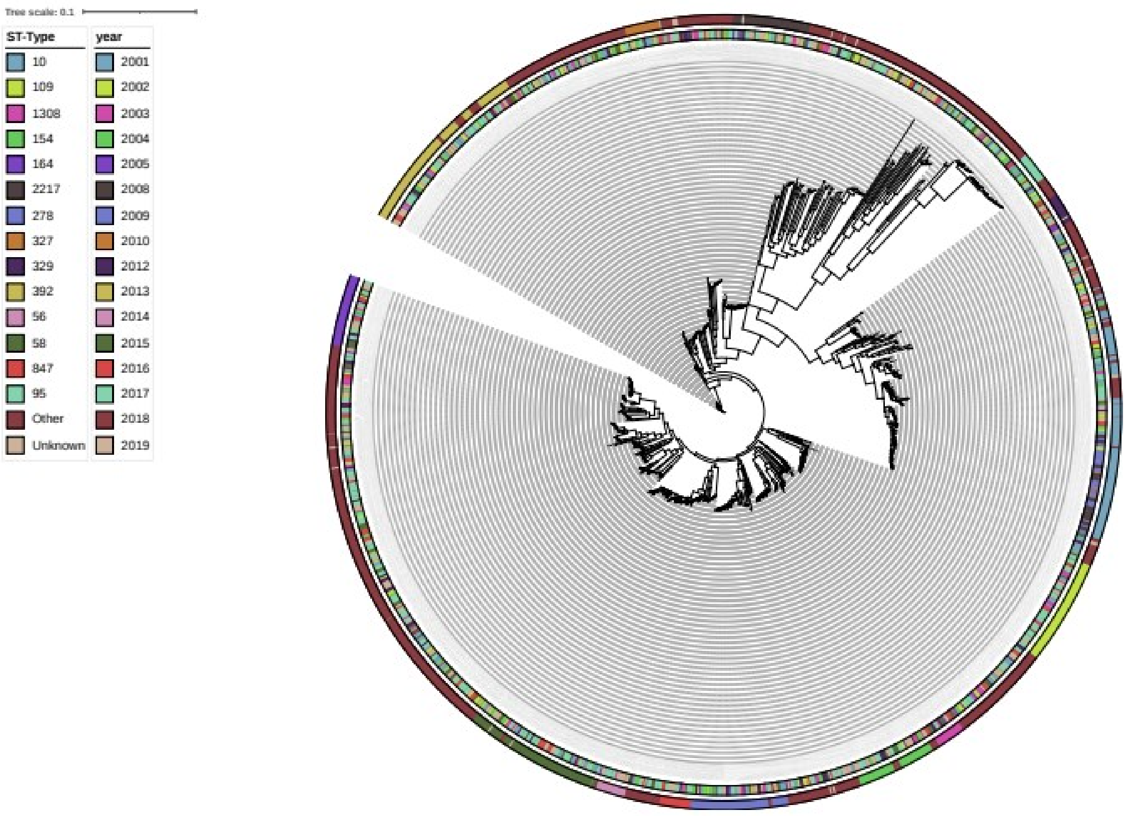
National Salmonella control program

Resistance in indicator bacteria - Textboxes

Textbox 7.1 – Ecogenomics of Danish cattle *E. coli* between 2001 and 2019

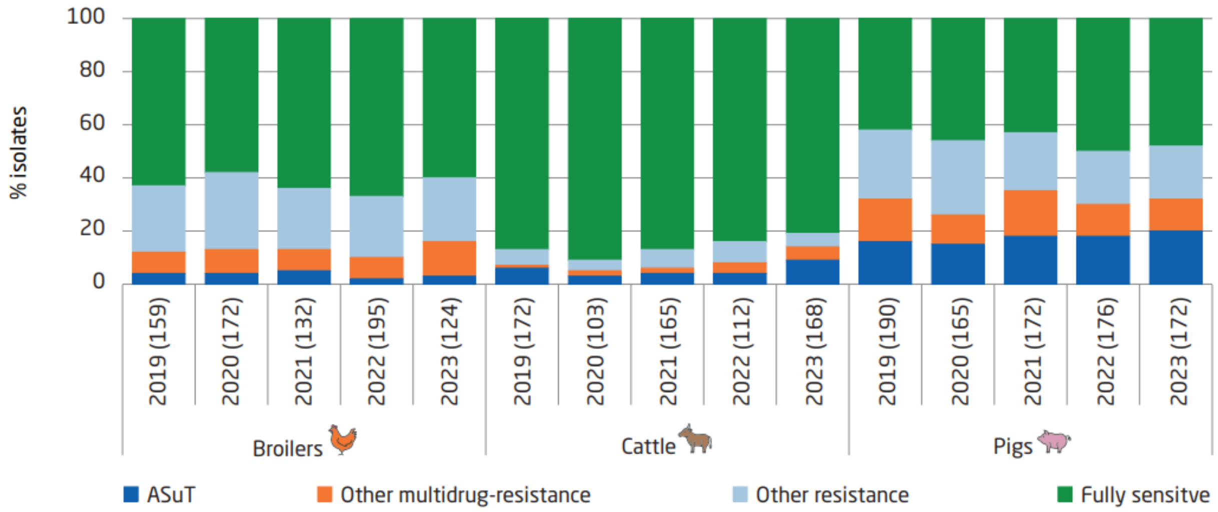
Saria Otani, Panos Sapountzi (DTU Food)

Figure 1 Overview of phylogenetic relationships between isolates, serotype and collection year (color-coded) DANMAP 2023

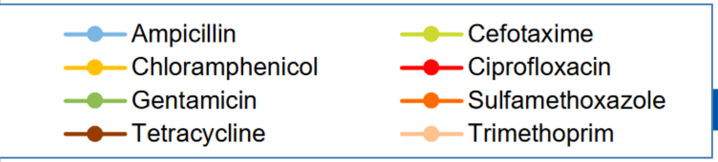


DANMAP 2023 - Indicator *E. coli*

Figure 5.1 Distribution (%) of fully sensitive, resistant and multidrug-resistant *Escherichia coli* isolates from broilers, cattle and pigs, Denmark, 2019-2023



- In the last 5 monitoring years:
  - No significant trend in **%FS** in broilers and pigs
  - Significant decrease in **%FS** in cattle
  - Significant increase in **%MDR** in cattle
- Ampicillin, Sulfamethoxazole and Tetracycline (**ASuT**) resistance still the most common MDR profile in cattle and pigs
- **%ASuT** increased in cattle
- **Other AMR** patterns dominate in broilers

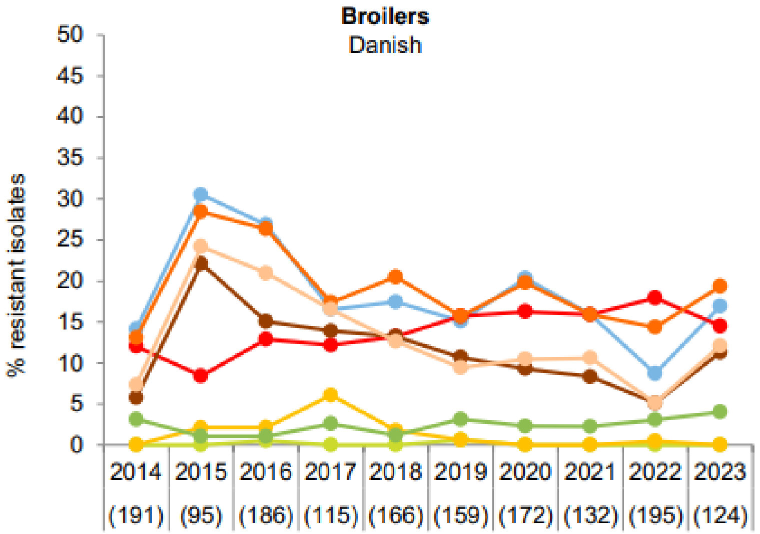


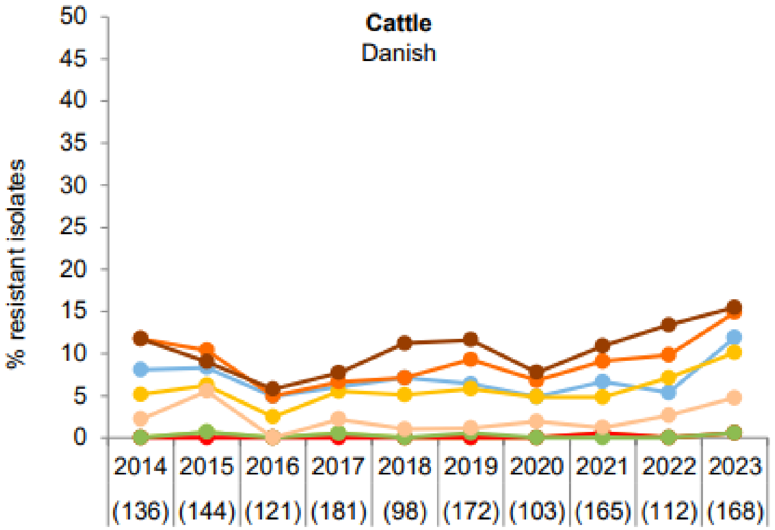
DANMAP 2023 - Indicator *E. coli*

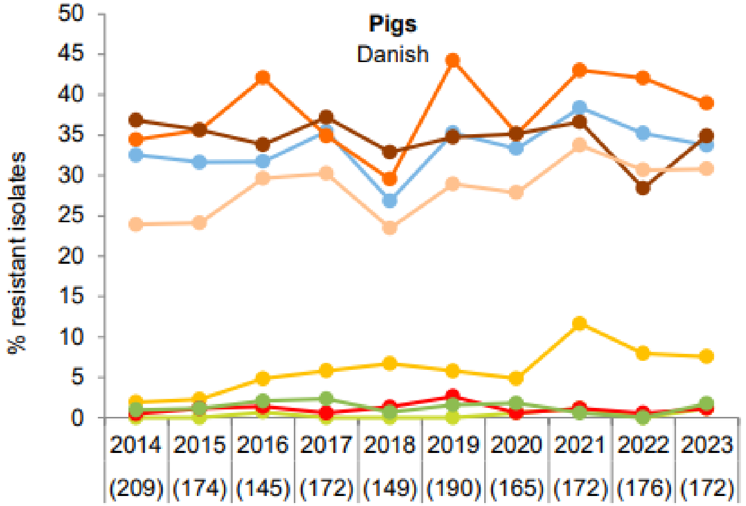
Broilers

Cattle

Pigs







- Increase in % resistance to several substances in **broilers** and continued increase in **cattle**
- Increase in % resistance to tetracycline in **pigs**

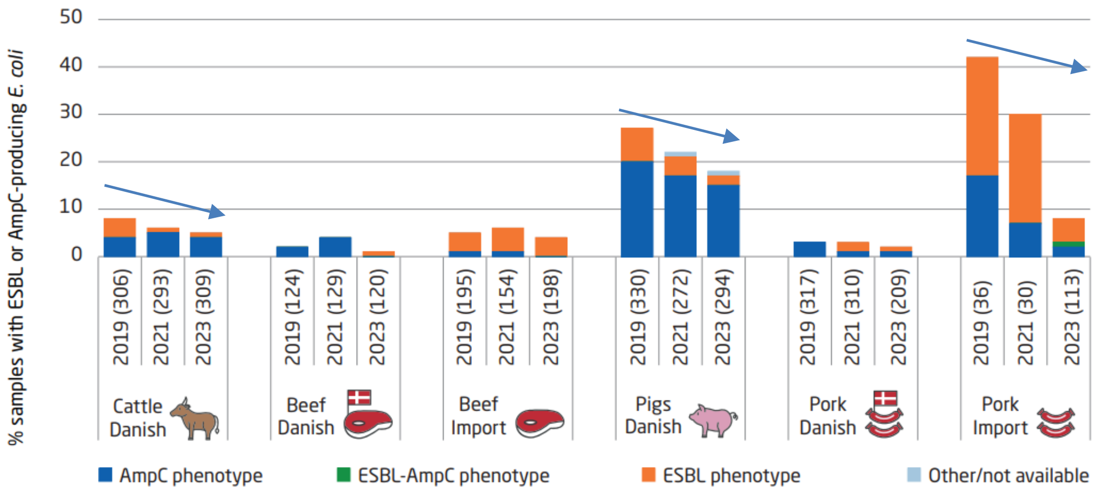
- Decrease in % resistance to ciprofloxacin in **broilers**
- Decrease in % resistance to ampicillin and sulfamethoxazole in **pigs**

DANMAP 2023 - ESBL-, AmpC-, CP-producing *E. coli*

- No detection of **CP-producing *E. coli***
- **%ESBL/AmpC-producing *E. coli*:**

- overall decreased in 2023
- 5-year significant decrease in **cattle, pigs** and **imported pork**
- higher in **pigs** than in cattle
- higher in **imported meat**

Figure 5.2 Occurrence (%) of samples with phenotypic ESBL- or AmpC-producing *E. coli* from animals and meat recovered by selective enrichment, Denmark, 2019-2023



DANMAP 2023 - ESBL-, AmpC- producing *E. coli*

Table 7.3 Number of ESBL and AmpC enzymes detected in beta-lactamase-producing *E. coli* isolates from animals and meat recovered by selective enrichment, Denmark, 2023

DANMAP 2023

	Cattle	Beef		Pigs	Pork	
Enzymes	Danish	Danish	Import	Danish	Danish	Import
blaCTX-M-1		1	1	5	3	2
blaCTX-M-15	1		3			1
blaCTX-M-27						1
blaCTX-M-32			2			
blaCTX-M-55				2		3
blaDHA-1	1			2		
blaOXA-1			1	1		
blaOXA-10	1					
blaSHV-12			1			
blaTEM-15	1					
blaTEM-52B	1					
Chromossomal AmpC (T-32A)				1		
Chromossomal AmpC (C-42T)	10		1	44	2	2
Number of AmpC genotypes	9	0	1	44	2	2
Number of ESBL genotypes	3	1	7	9	3	7
Number of AmpC+ESBL genotypes	1	0	0	1	0	0
Number (%) positive samples	13 (4%)	1 (1%)	8 (4%)	54 (18%)	5 (2%)	9 (8%)
Number of tested samples	309	120	198	294	209	113

Number of AmpC phenotypes	11	0	45	2	2
Number of ESBL phenotypes	2	8	5	3	6
Number of ESBL+AmpC phenotypes	0	0	1	0	1
Other phenotypes	0	0	3	0	0
Number of isolates (%)	13 (4%)	8 (4%)	54(18%)	5 (2%)	9 (8%)
Number of samples	309	198	294	209	113

- Phenotypic and genotypic profiles mostly in concordance
- 11 different **ESBL genes** detected
- Genes **CTX-M-1** and **CTX-M-15** most common among ESBL-producing isolates
- **CTX-M-15** most frequent in isolates from **imported beef**
- Upregulated AmpC promotor **C-42T** mutations most common among AmpC-producing isolates, except for one T-32A mutation
- Two ESBL- and AmpC-producing isolates with C-42T mutation, together with blaOXA-1 (in pig) and blaOXA-10 (in cattle)

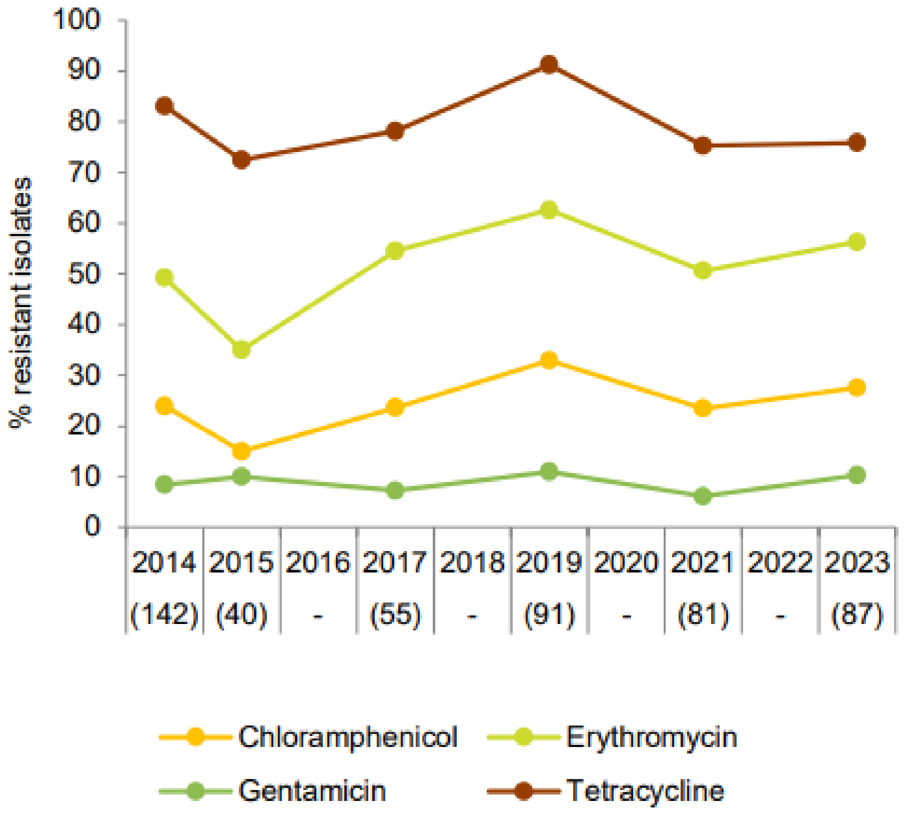
DANMAP 2023 - Indicator *Enterococcus faecalis* from pigs

- **No resistance** to ampicillin, ciprofloxacin, linezolid, teicoplanin, tigecycline and vancomycin

- **Overall increase** in resistance compared to 2021:
  - 1% - tetracycline
  - 4% - gentamicin
  - 5% - chloramphenicol and erythromycin

- **33% MDR**, most common profile **TET-ERY-CHL**

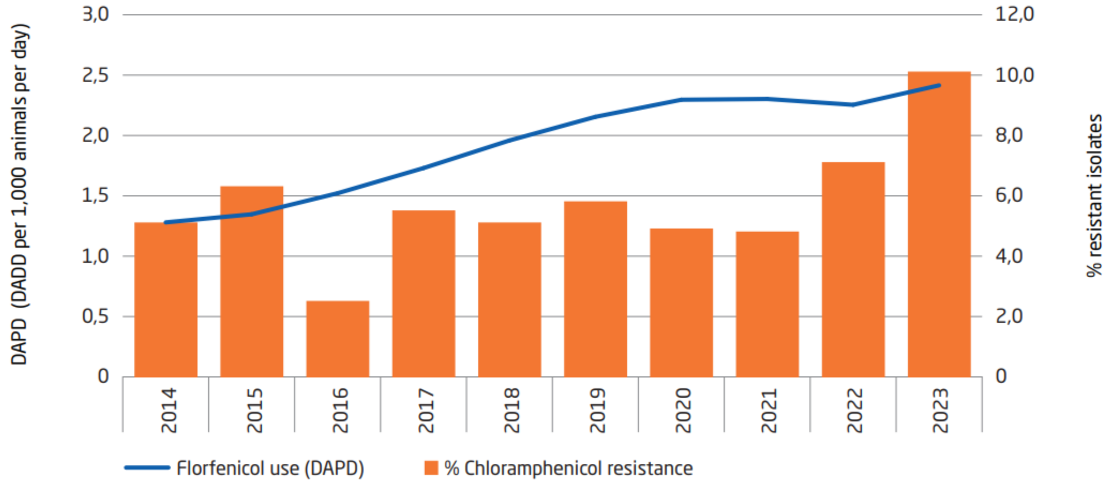
Figure 7.4 Resistance (%) among *Enterococcus faecalis* isolates from pigs, Denmark, 2023 DANMAP 2023



Trends of antimicrobial consumption and resistance in indicator *E. coli* from calves

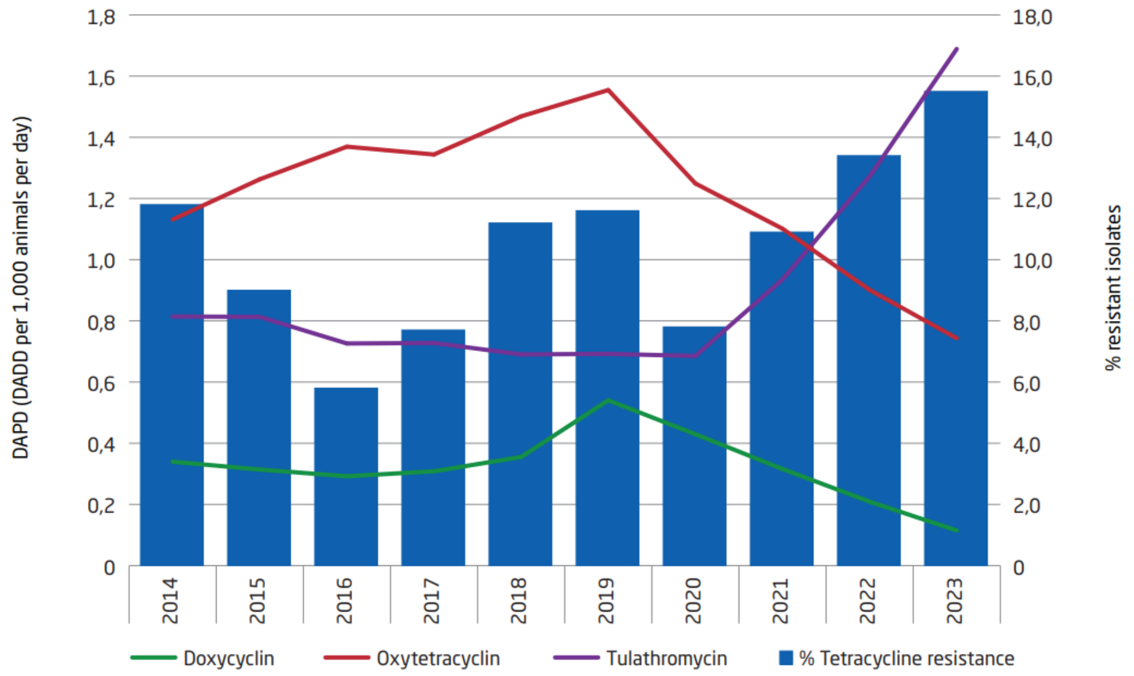
- **10-year increase in the consumption of macrolides and amphenicols in calves**

Figure 5.4 Amphenicol resistance (%) in indicator *E. coli* and florfenicol consumption (DAPD) in calves, Denmark, 2014-2023



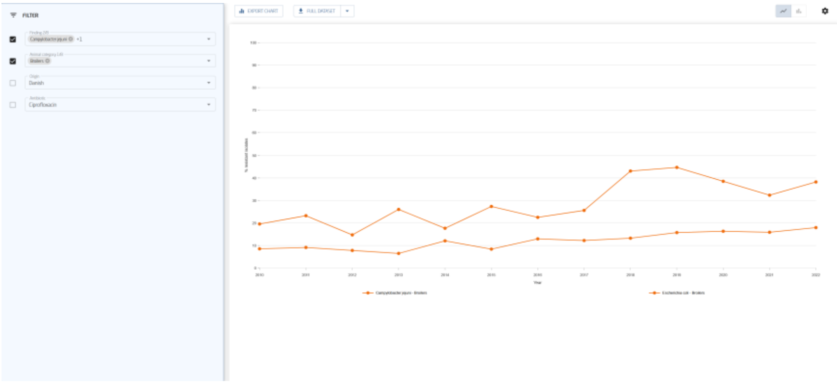
- increased use of **florfenicol** -> increase in **chloramphenicol** resistance

Figure 5.5 Tetracycline resistance (%) in indicator *E. coli* and antimicrobial consumption (DAPD) in calves, Denmark, 2014-2023



- increased use of **tetracycline** (until 2019) + increased use of **tulathromycin** (after 2019) -> increase in **tetracycline** resistance

DANMAP Explorer - interactive AMR data visualisation



DANMAP Explorer 1

Explore data on resistance in indicator and zoonotic bacteria

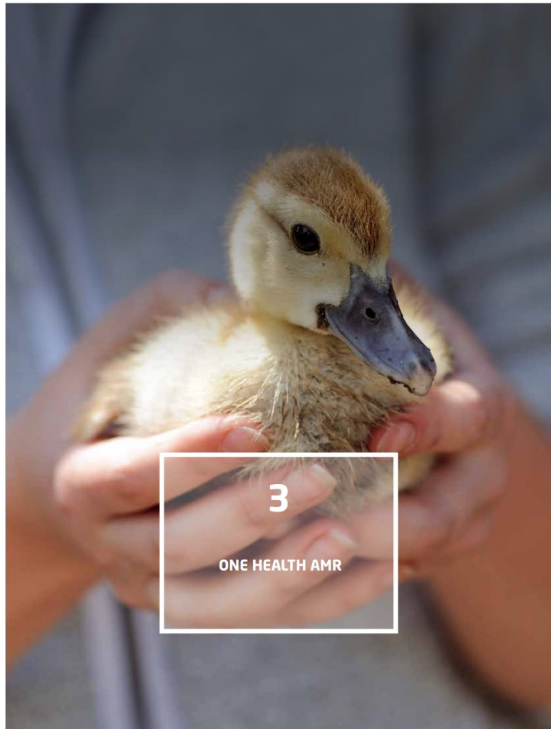
DANMAP Explorer 2

Explore data on ESBL/AmpC-producing *E. coli*

Available at : www.danmap.org

DANMAP Seminar 2024

One Health antimicrobial resistance



Ana Sofia R. Duarte, Patrick Munk
DTU National Food Institute

Mikkel Lindegaard, Ute Wolff Sönksen
Statens Serum Institut

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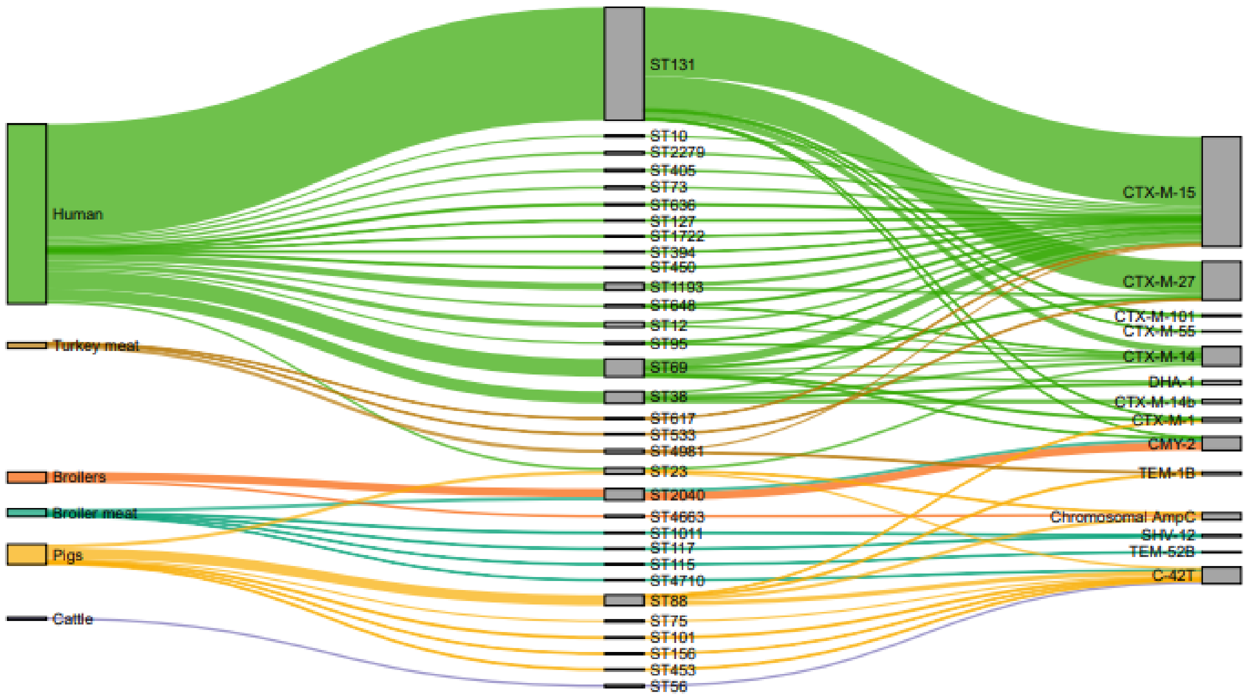
DANMAP 2023 - ESBL-, AmpC- producing *E. coli*

Figure 3.1 A Sankey diagram comprised of 1202 ESBL Ec isolates from humans, animals and food showing the relationship between the isolates' source, sequence type and ESBL/AmpC gene or mutation DANMAP 2023



The flows between nodes are coded according to source. Only flows of five or more isolates are shown

- Sequence types strongly associate with species:
- ST131 humans
- ST2040 broilers/broiler meat
- ST4981 turkey meat
- ST88 pigs
- ST56 for cattle

- Resistance determinants found in humans and animals/meat:
- AmpC plasmid-mediated gene CMY-2
- ESBL genes CTX-M-1, CTX-M-15 and CTX-M-27

- CTX-M-15 and CTX-M-27 - turkey meat
- CMY-2 – broilers and broiler meat
- CTX-M-1 - pigs

DANMAP 2023 - ESBL-, AmpC- producing *E. coli*

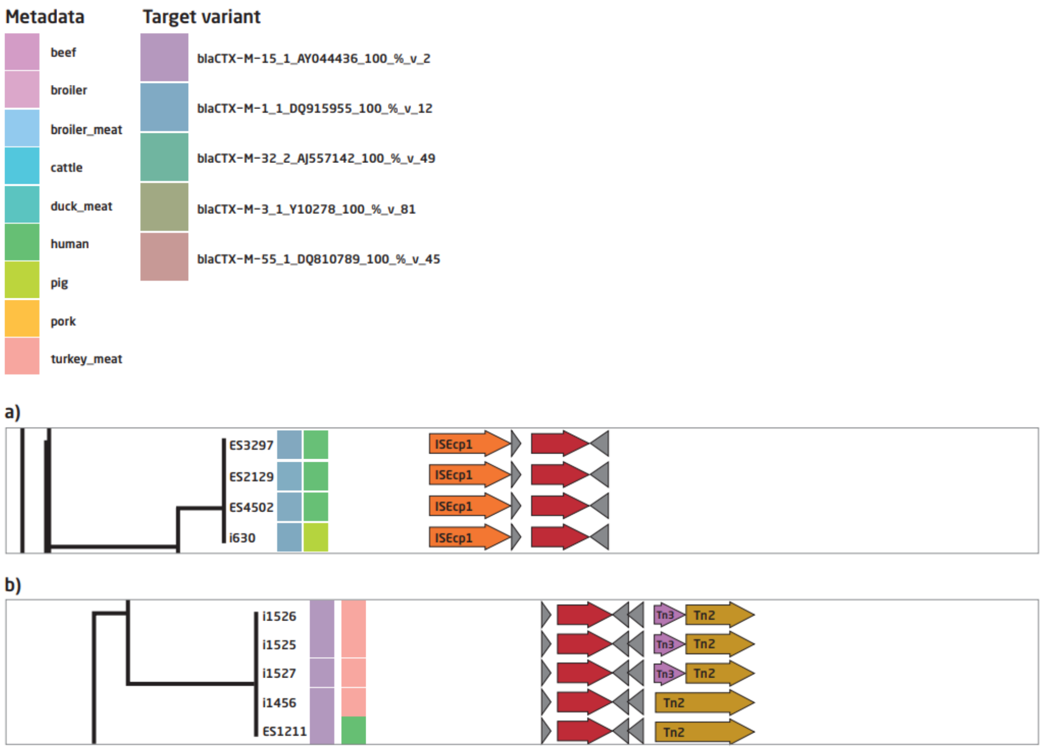
- Flankophile - analysis of the DNA sequence of the gene's flanking region (*i.e.* the genetic code that comes before and after a gene)

- determination of a probable common source -> possibility of horizontal gene transfer

- Focus on ESBL genes CTX-M-1, CTX-M-14, CTXM-15, CTX-M-27, CTX-M-55, TEM-52B, and AmpC genes DHA-1, CMY-2

- **CTX-M-1** could be shared by **pigs** and **humans** (a)
- **CTX-M-15** could be shared by **humans** and **turkey meat** (b)

Figure 8.2 ESBL genes CTX-M-1 (a) and CTX-M-15 (b) identical in both gene and flanking region sequences between *E. coli* isolates of animal origin and human origin



Details from Flankophile plots, showing a – clustering of CTX-M-1 genes of human- and pig origin; b - clustering of CTX-M-15 genes of human- and turkey meat origin. From left to right: distance tree of the gene's flanking regions (straight vertical lines indicate that the flanking regions are 95% identical); color annotation columns representing the target variant (left) and the host (right); arrows depicting the gene synteny, with the target sequence in red

Flankophile is available at: Center for Genomic Epidemiology

DANMAP Seminar 2024

Resistance in Zoonotic Bacteria

Joana Pessoa
Postdoc, DVM, PhD

Foodborne Pathogens and Epidemiology
DTU National Food Institute

Ana Sofia R. Duarte (DTU Food)
Jeppe Boel (SSI)

Resistance in zoonotic bacteria - Textboxes

Textbox 6.1 – Trends in phenotypic- and genotypic fluoroquinolone resistance in *Campylobacter jejuni* from broilers and broiler meat in Denmark

Ana Sofia Ribeiro Duarte (DTU)

Figure 2 Distribution of clonal complexes (CCs) among resistant-predicted *C. jejuni* isolates of Danish- and EU origin DANMAP 2023

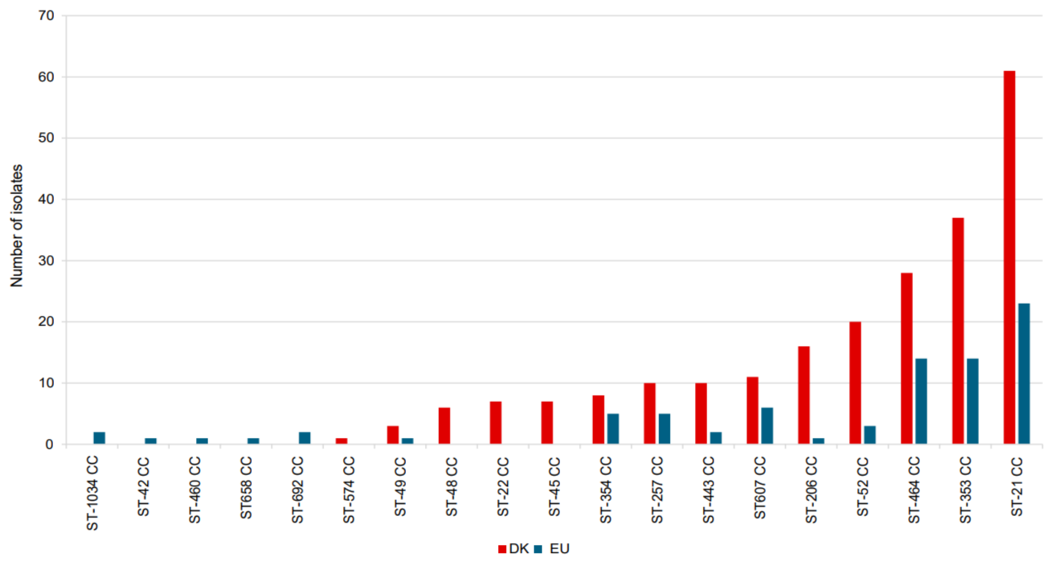
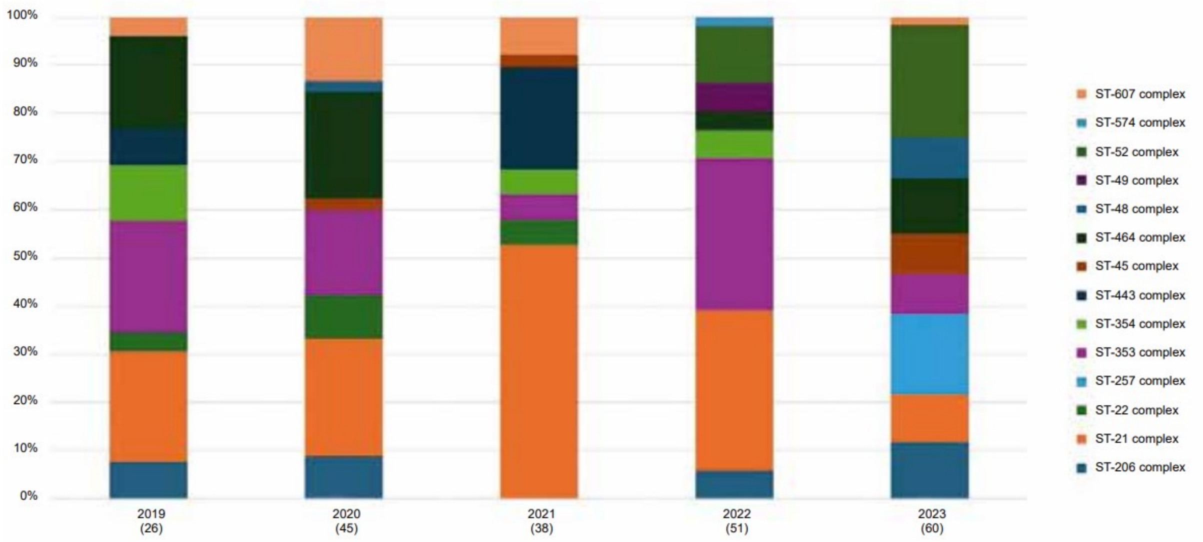
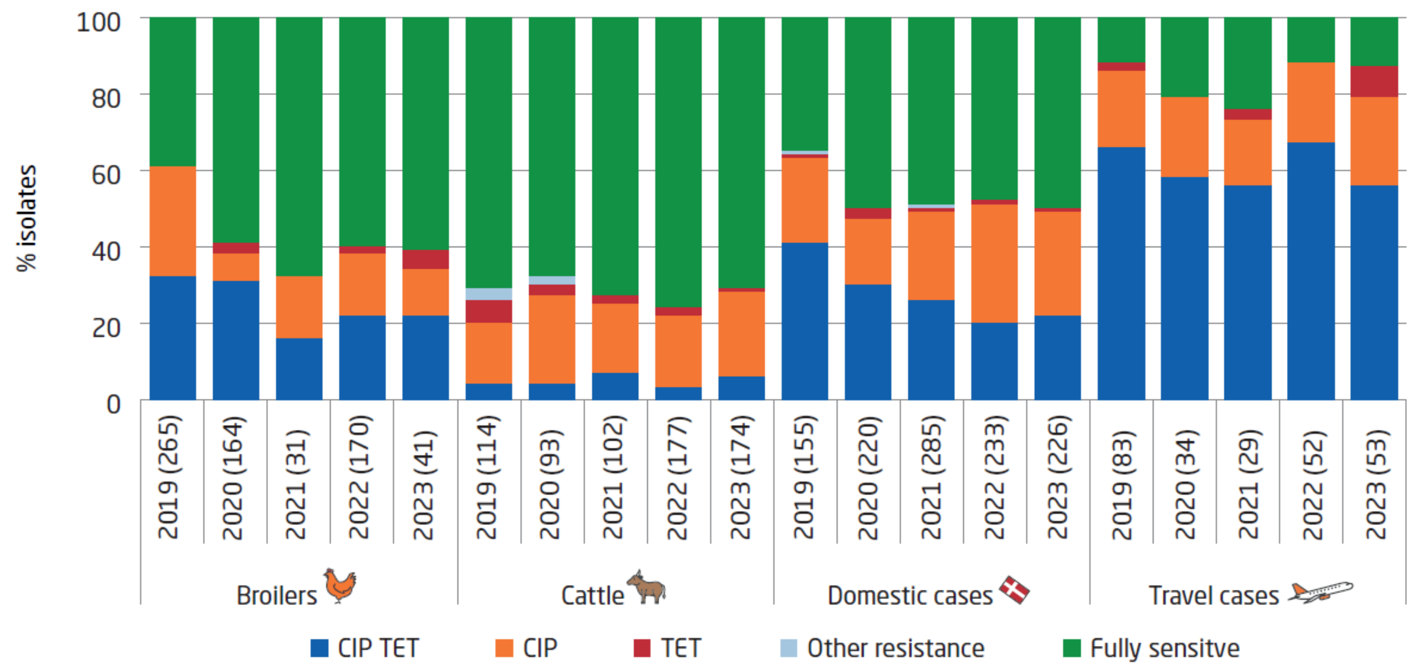


Figure 3 Percentage of clonal complex abundance among *C. jejuni* resistant mutants of Danish origin, 2019-2023 DANMAP 2023



DANMAP 2023 – *Campylobacter jejuni*

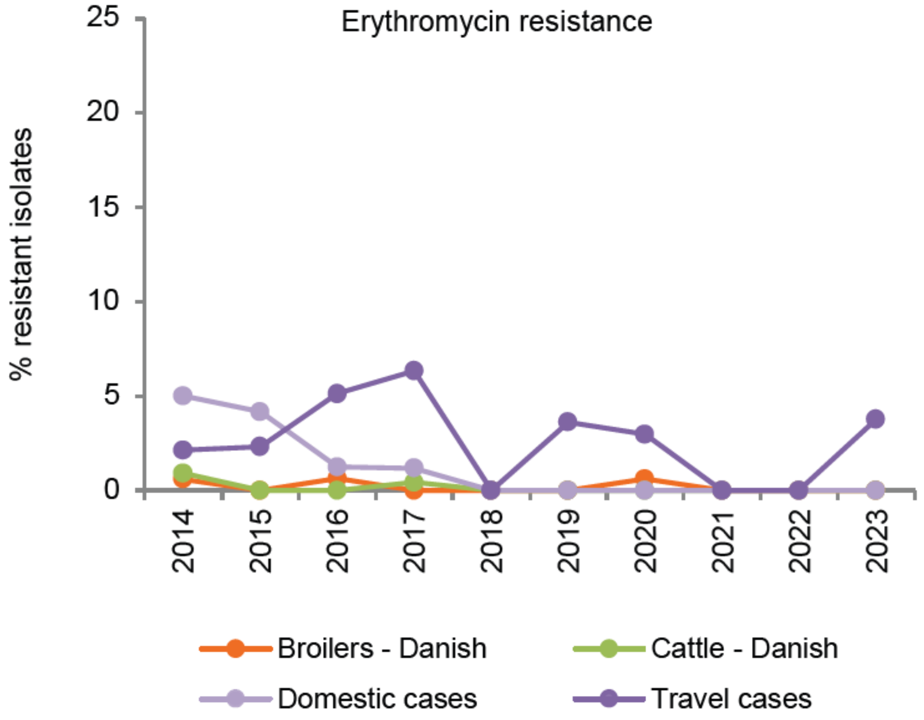
AMR profiles among *C. jejuni*



- Small increase in **% FS** in **broilers**
- Decrease in **%FS** in **cattle**
- Resistance levels among **domestic cases** comparable with 2022
- Overall highest resistance: **travel cases**
- **CIP & TET** resistance remains common in humans & animals

DANMAP 2023 – *C. jejuni* & *C. coli*

Resistance to macrolides & carbapenems remained low

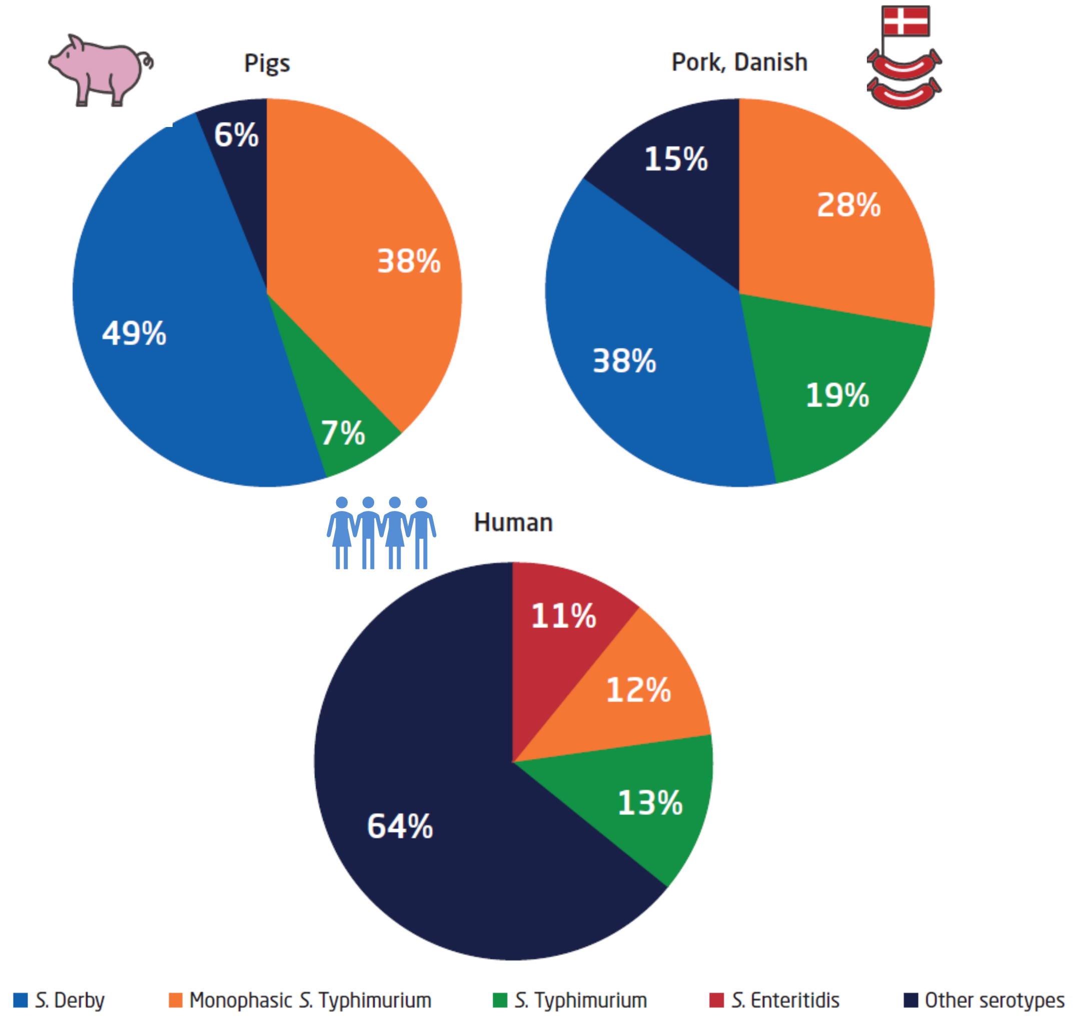


Campylobacter coli

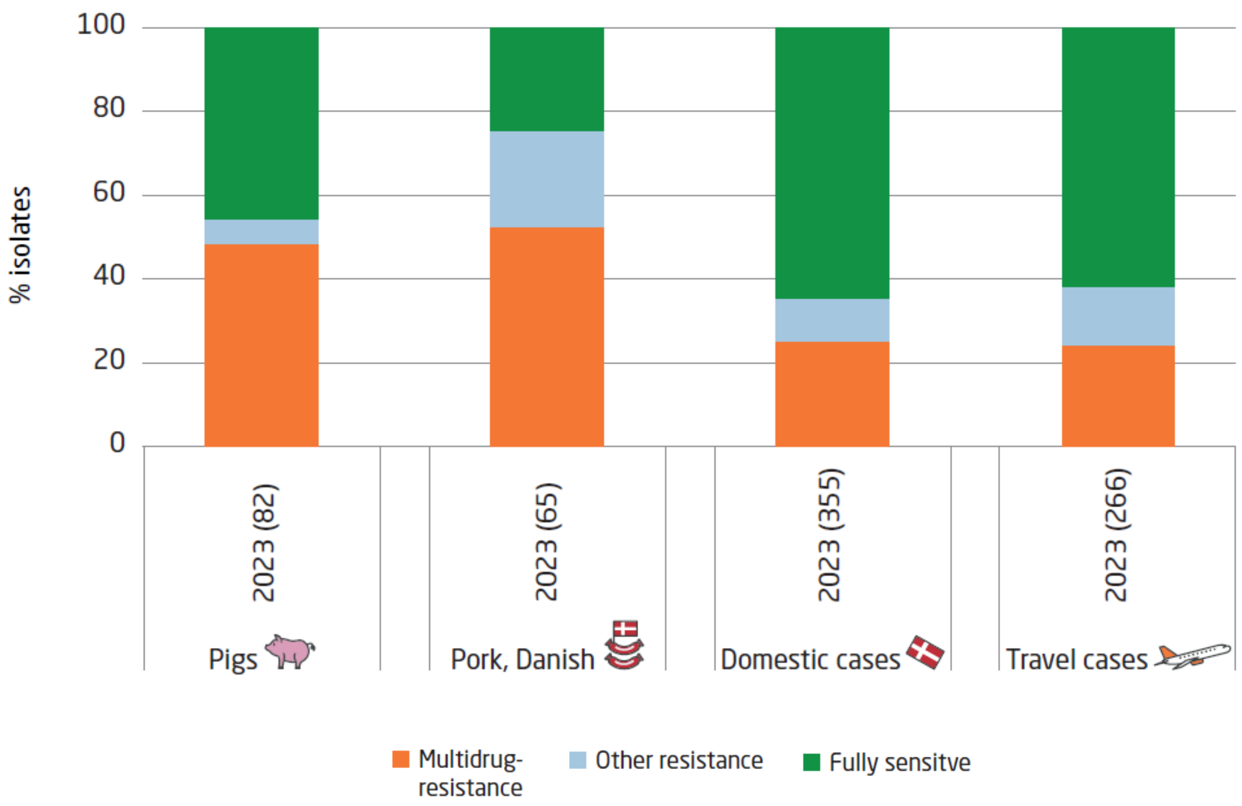
- Reported for the **1st time** for clinical **human** isolates
- Overall **higher** resistance levels in **human** isolates
- **Erythromycin** resistance at 6% & 11% in pigs & humans
- **CIP** & **TET** resistance increased in pigs
- No **ertapenem** resistance in pigs

DANMAP 2023 – *Salmonella* spp.

Serotype distribution

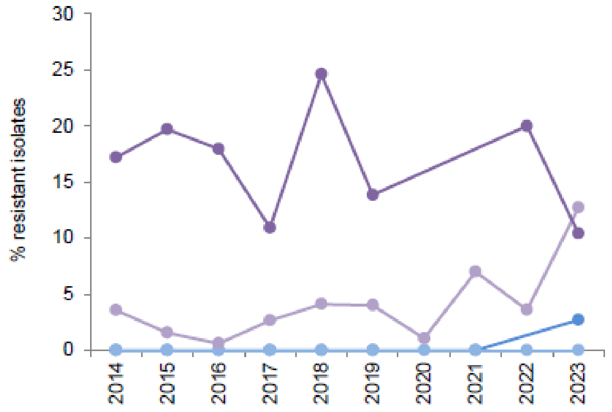


AMR profiles

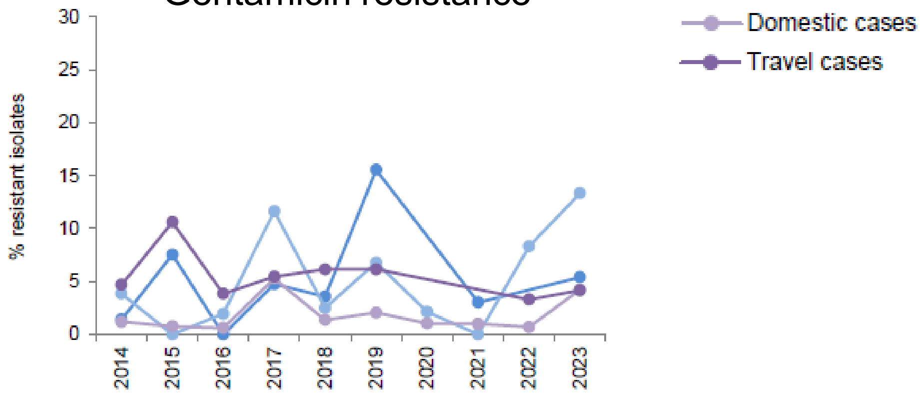


DANMAP 2023 – *S.* Typhimurium

Ciprofloxacin resistance

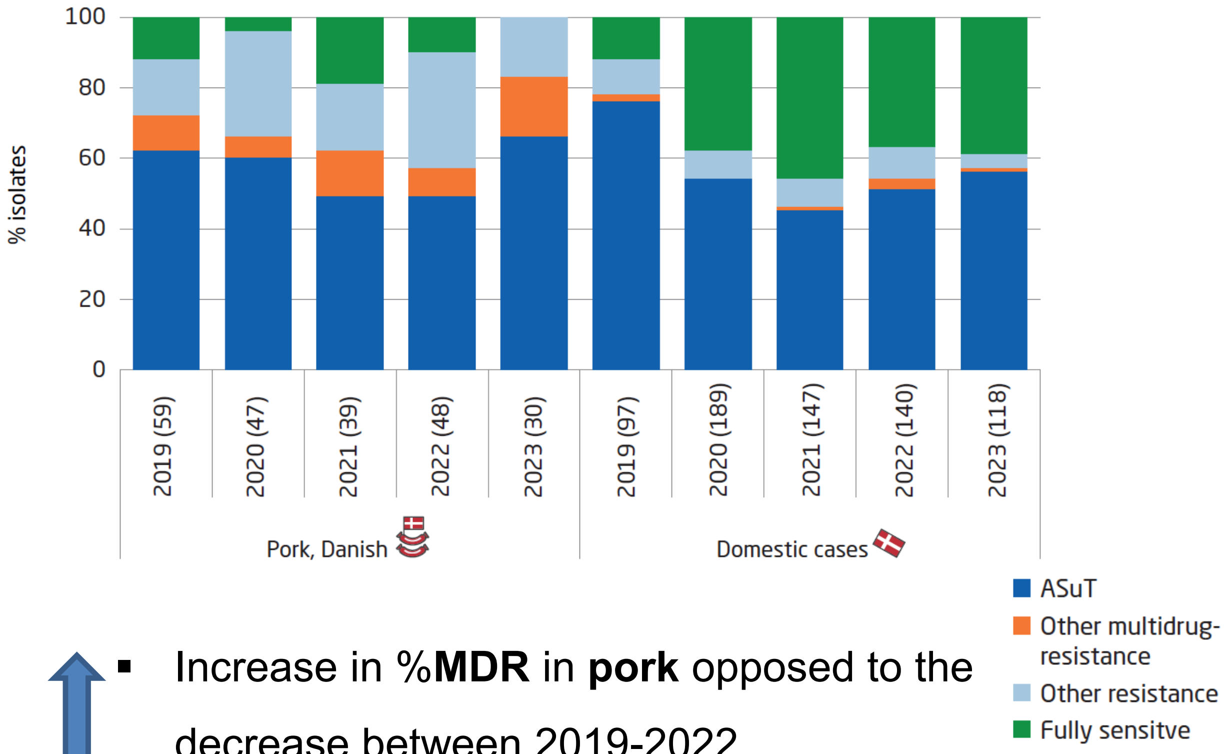


Gentamicin resistance



- Increase in %**CIP** resistance in **domestic cases**
- Overall Increase in %**gentamicin** resistance

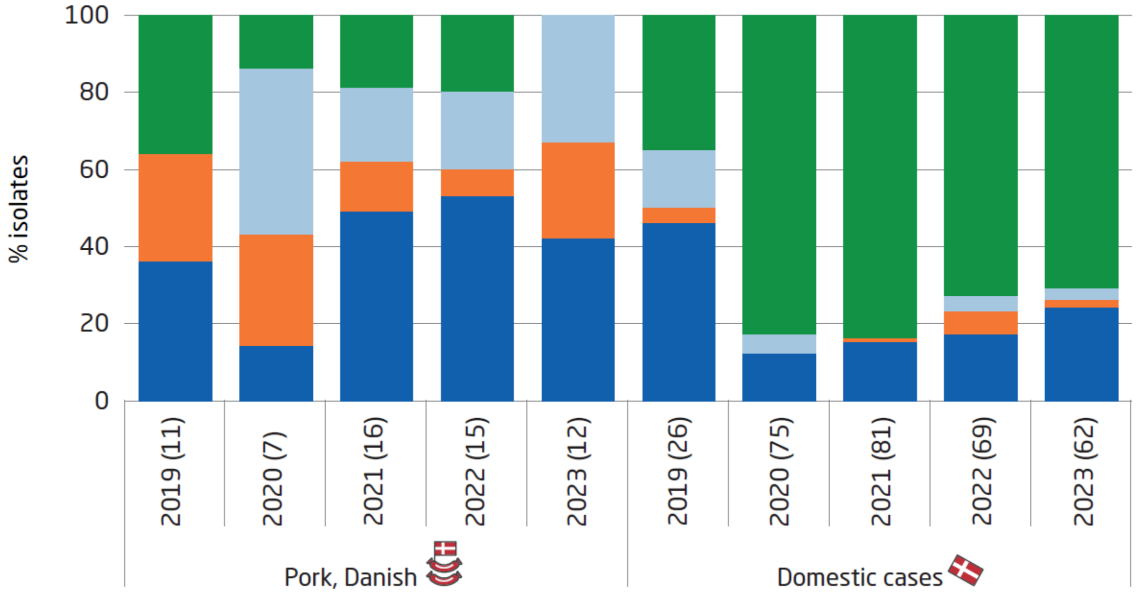
AMR profiles



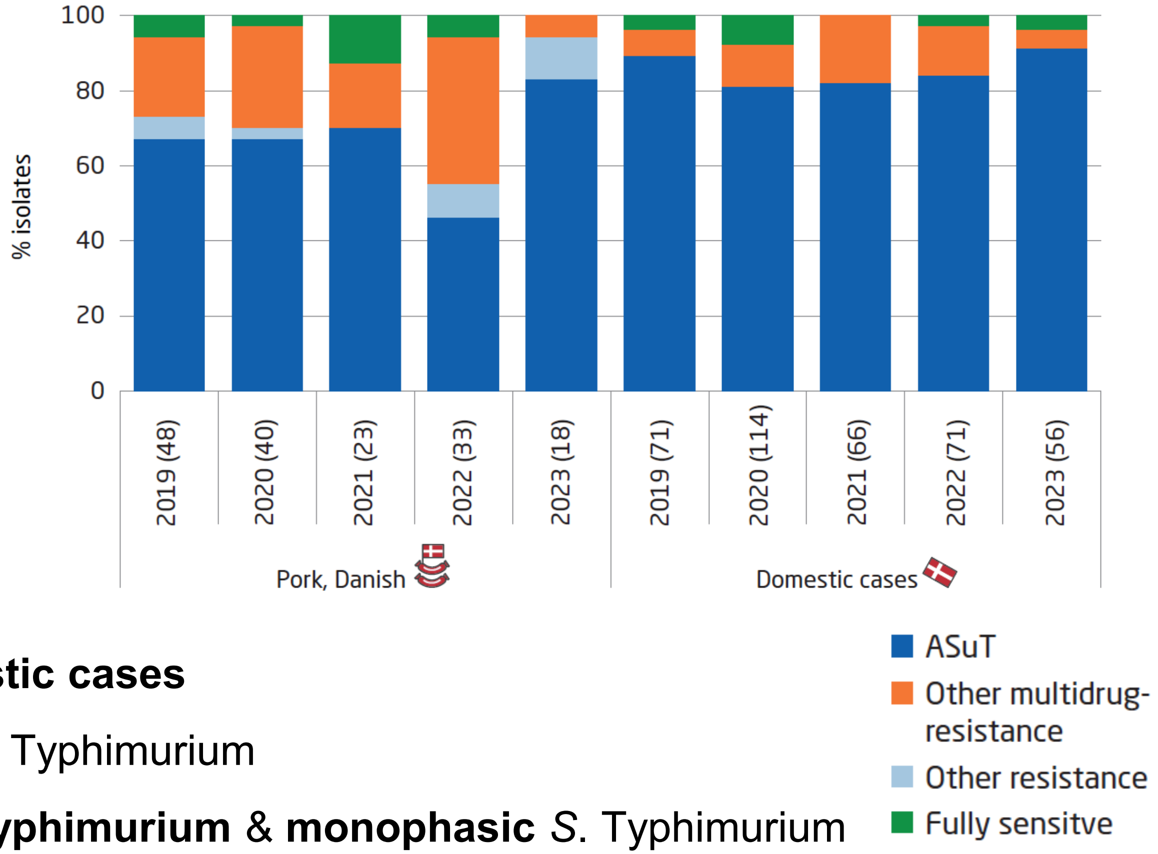
- Increase in %**MDR** in **pork** opposed to the decrease between 2019-2022
- Increase in the ratio between **other MDR** & **ASuT**

DANMAP 2023 – *S*. Typhimurium

S. Typhimurium



Monophasic *S.* Typhimurium



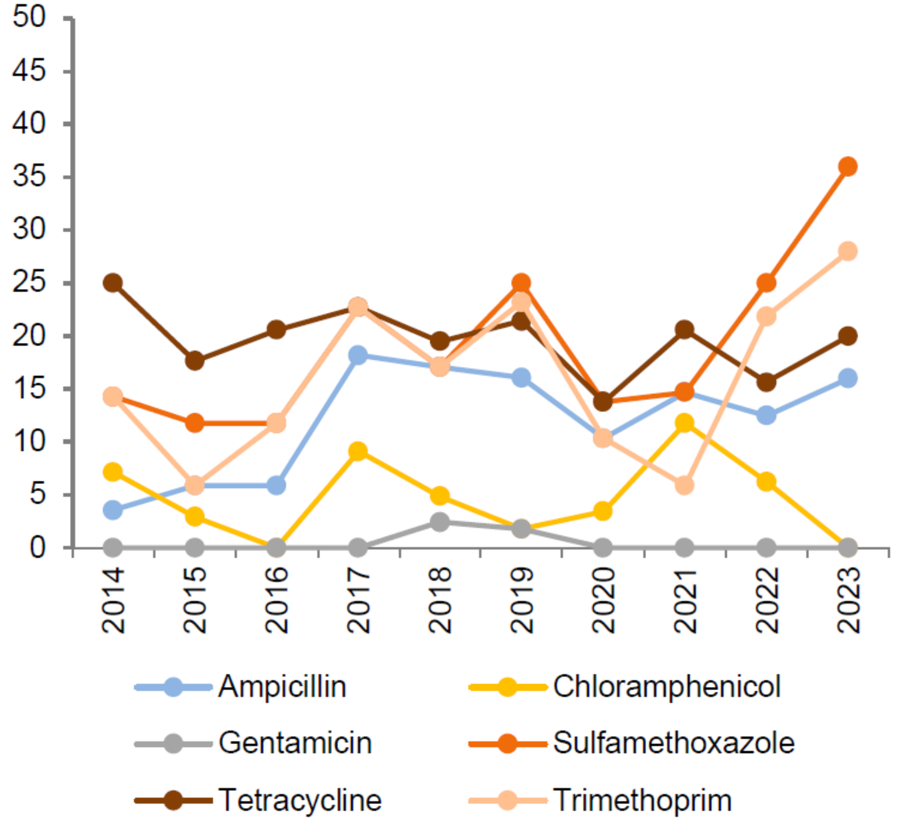
- High **%FS** in ***S.* Typhimurium** from **domestic cases**
- Markedly higher **%MDR** in **monophasic** *S*. Typhimurium
- Evident differences in **%ASuT** among ***S.* Typhimurium** & **monophasic** *S*. Typhimurium

DANMAP 2023 – *S.* Enteritidis & *S.* Derby

S. Enteritidis

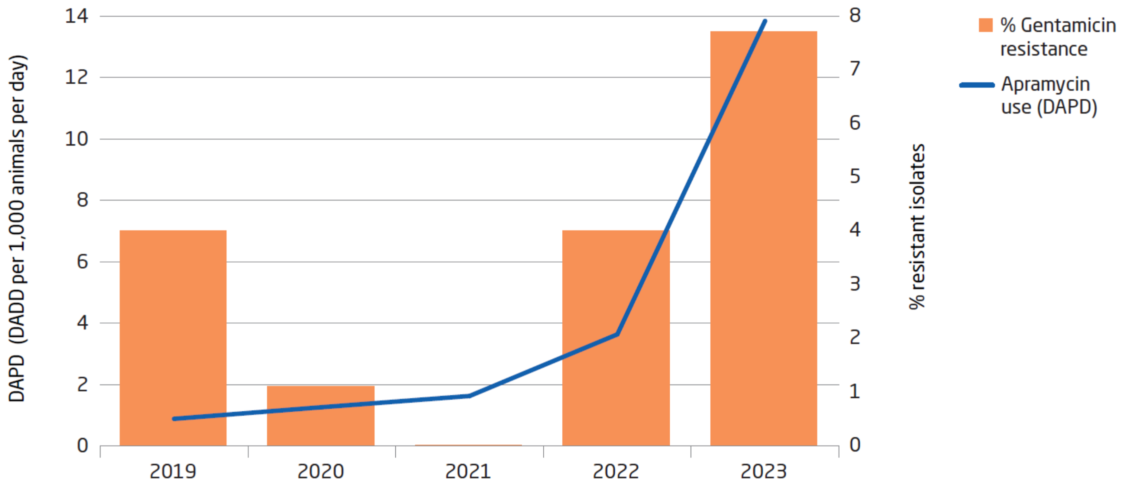
Antimicrobial agent	Human: Domestically acquired %	Human: Travel abroad reported %	Human: Total %
Amikacin	0	0	0
Ampicillin	8	11	9
Azithromycin	0	0	0
Cefotaxime	0	0	0
Ceftazidime	0	0	0
Chloramphenicol	0	0	0
Ciprofloxacin	47	32	39
Colistin	42	32	37
Gentamicin	0	0	0
Meropenem	0	0	0
Nalidixic acid	47	32	39
Sulfonamide	5	0	3
Tetracycline	3	5	4
Tigecycline	5	3	4
Trimethoprim	0	0	0
Fully sensitive (%)	39	49	45
Number of isolates	38	37	76

S. Derby

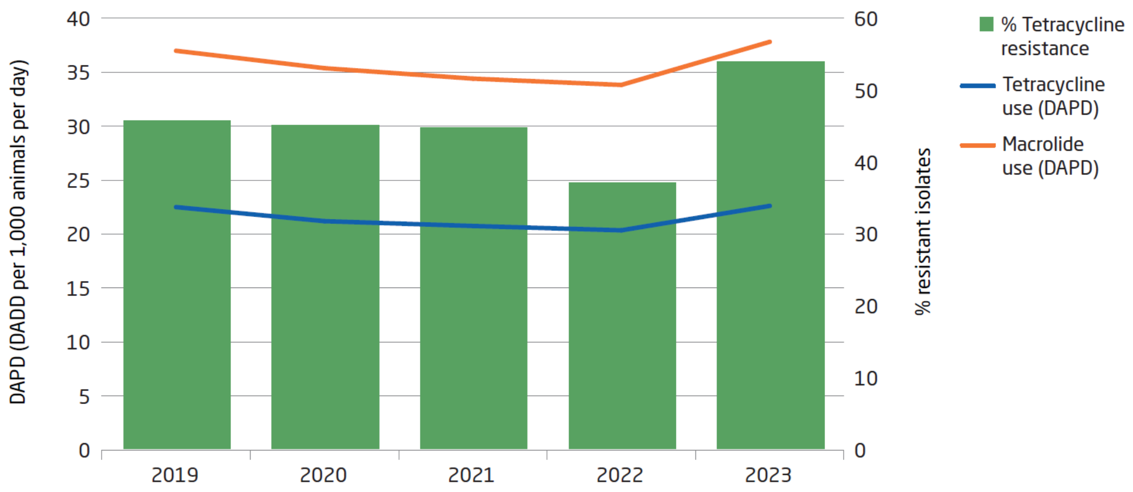


Antimicrobial consumption trends & resistance in *Salmonella* spp. from Danish pork

Gentamicin resistance & apramycin consumption (DAPD) in weaners



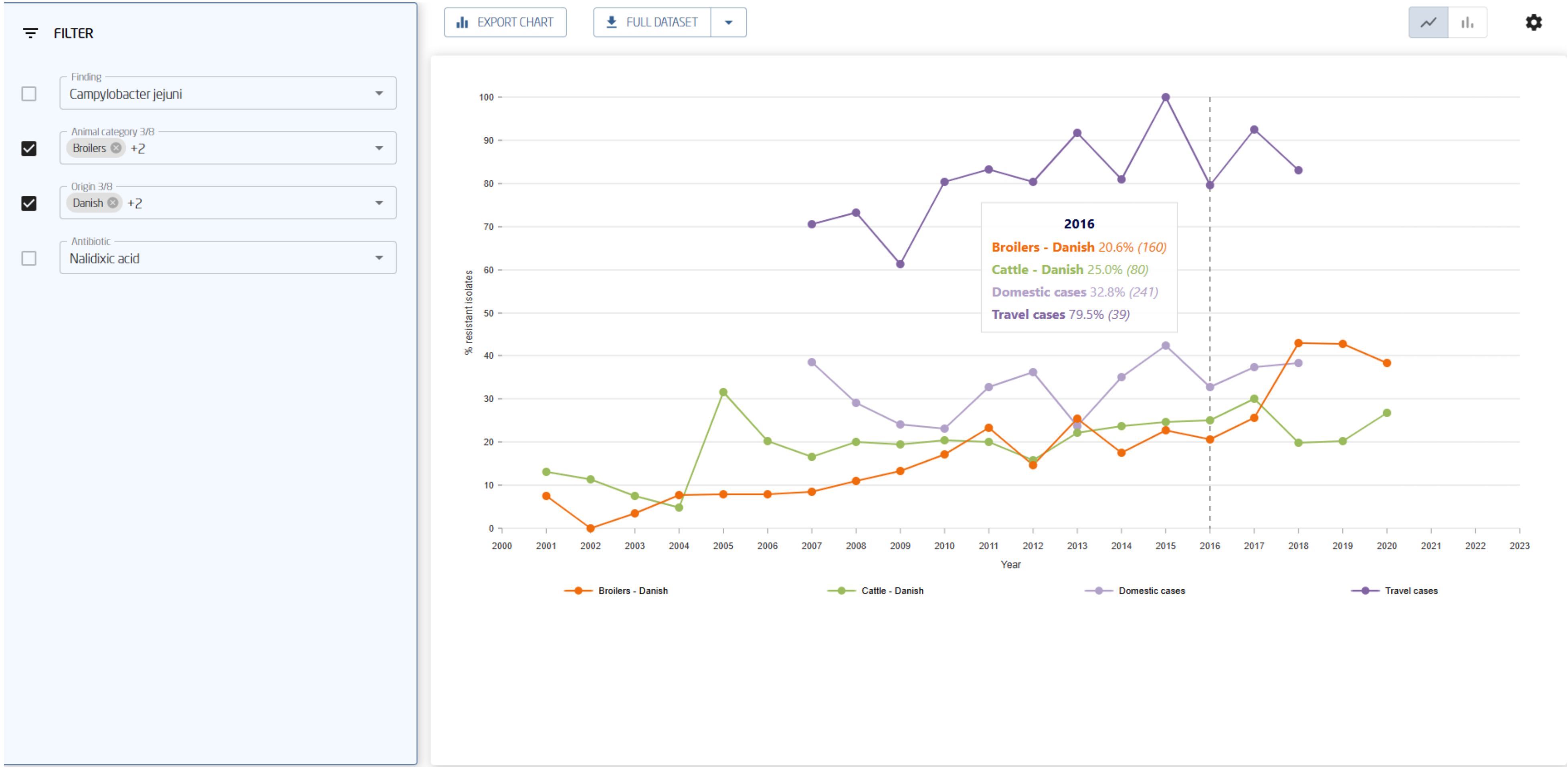
Tetracycline resistance & macrolide & tetracycline consumption (DAPD) in weaners & finishers



- Increase in the use of **apramycin**
- Increase in %**gentamicin** resistance

- Increase in the use of **tetracyclines** & **macrolides**
- Increase in %**tetracycline** resistance

DANMAP Explorer - interactive AMR data visualisation



Available at: www.danmap.org

Resistance in pathogenic bacteria from pigs

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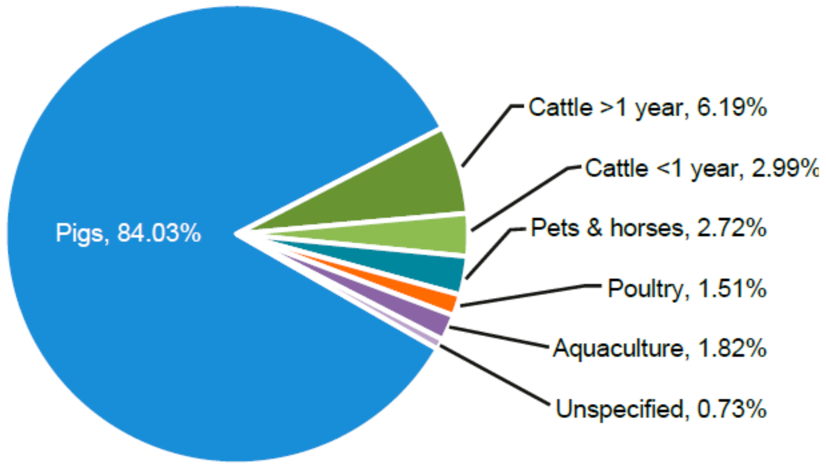
Peter Damborg
Department of Veterinary and Animal Sciences
University of Copenhagen

Svend Haugegaard & Charlotte M. Salomonsen
Veterinary Laboratory
The Danish Agriculture and Food Council

Background

- **Veterinary Laboratory, The Danish Agriculture and Food Council**
  – Receives clinical samples from pigs
  – Performs bacterial culturing, species identification and antimicrobial susceptibility testing (AST)
  – Published in **DANMAP** since 2015
    - *Actinobacillus pleuropneumoniae*
      – Lung infections
    - Haemolytic *Escherichia coli*
      – Primarily diarrhoea in weaners
    - *Streptococcus suis*
      – Septicaemia, meningitis, arthritis, endocarditis and other organs



Active compound

DANMAP

Background

- **Danish Veterinary Consortium**
  - Whole-genome sequencing (WGS)
    - Illumina platforms
  - Identification of resistance genes/mutations
    - ResFinder and PointFinder
  - Comparison of AST and WGS results
    - 1st choice: ECOFFs (EUCAST)
    - 2nd choice: Tentative ECOFFs (EUCAST)
    - 3rd choice: Animal-specific clinical breakpoints (CLSI)
    - 4th choice: Human clinical breakpoints (CLSI)

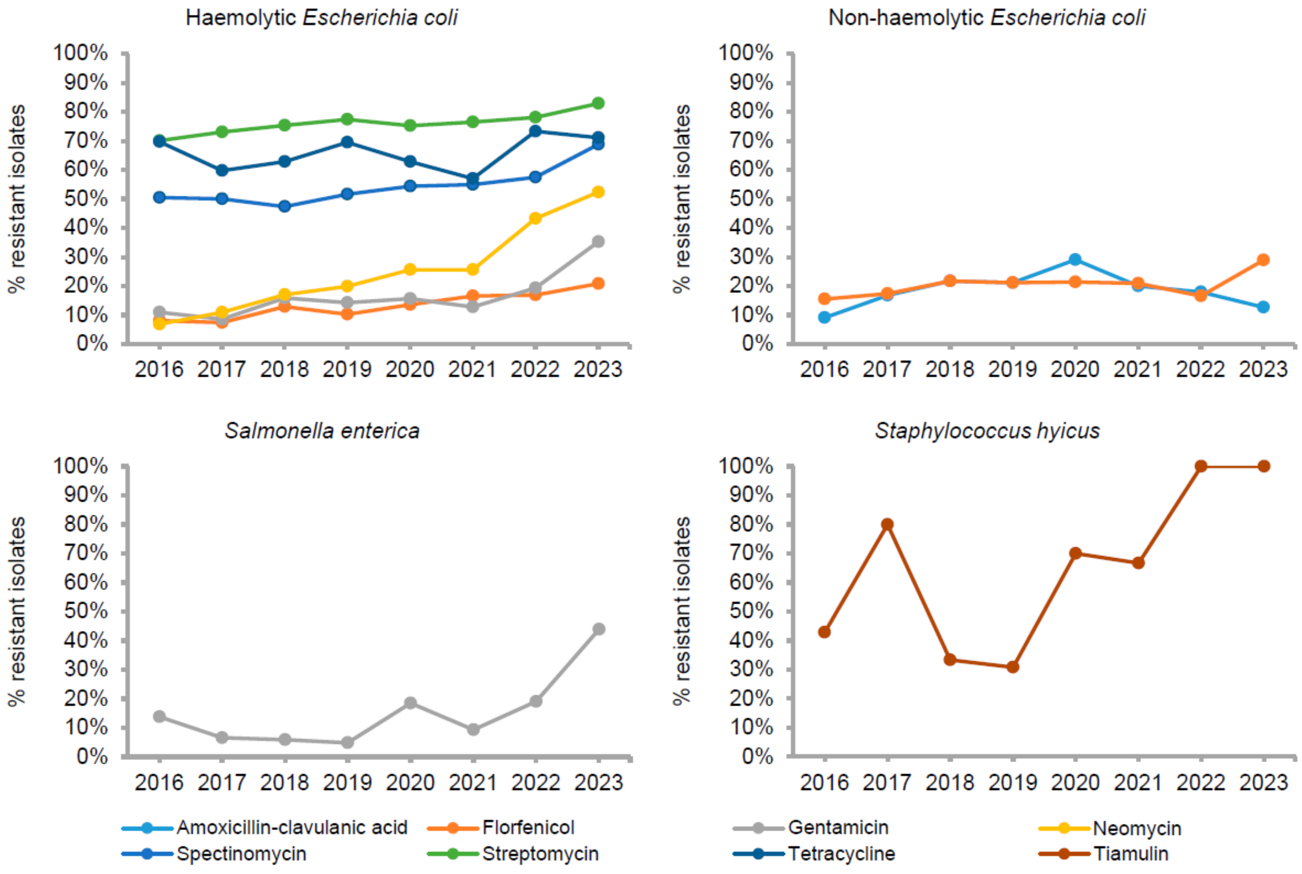
List of pathogenic bacteria

- *A. pleuropneumoniae* (AST and WGS)
- *Bordetella bronchiseptica* (AST and WGS)
- *Clostridium perfringens* (WGS)
- *Erysipelothrix rhusiopathiae* (WGS)
- Haemolytic and non-haemolytic *E. coli* (AST and WGS)
- *Glaesserella parasuis* (WGS)
- *Klebsiella pneumoniae* (AST and WGS)
- *Salmonella enterica* (AST and WGS)
- *Staphylococcus hyicus* (AST and WGS)
- *S. suis* (AST and WGS)

AST (phenotypic resistance)

Figure 9.1 Statistically significant temporal changes in antimicrobial resistance phenotypes among pathogenic bacteria from pigs, Denmark, 2023 vs. 2022 and 2023 vs. 2018

DANMAP 2023



↑ (n=9)

↓ (n=1)

WGS (resistance mechanisms)

Table 9.3 Statistically significant temporal changes in resistance mechanisms identified through whole genome sequencing of pathogenic bacteria from pigs, Denmark, 2023 vs. 2022 and 2023 vs. 2021 DANMAP 2023

Pathogen	Resistance gene/mutation	Class	Phenotype	2021 Presence (%)	2022 Presence (%)	2023 Presence (%)	2023 vs. 2022 P value	2023 vs. 2021 P value
Cp	*ant(6)-Ib*	Aminoglycoside	Streptomycin	73.8%	85.7%	87.8%	0.80	0.03
	tet(44)	Tetracycline	Doxycycline, Tetracycline, Minocycline	73.8%	85.7%	87.8%	0.7989	0.0298
H-Ec	*aac(3)-IV*	Aminoglycoside	Apramycin, Gentamicin, Tobramycin	9.6%	21.8%	25.8%	0.5081	0.0037
	aph(3')-Ia	Aminoglycoside	Neomycin, Kanamycin, Lividomycin, Paromomycin, Ribostamycin	30.8%	34.5%	62.9%	0.0001	0.0000
	tet(B)	Tetracycline	Doxycycline, Tetracycline, Minocycline	21.2%	35.5%	38.2%	0.7677	0.0110
	aph(4)-Ia	Aminoglycoside	Hygromycin	9.6%	20.0%	21.3%	0.8611	0.0269
	$bla_{\text{TEM-127}}$	Beta-lactam	Amoxicillin, Ampicillin, Cephalothin, Piperacillin, Ticarcillin	0.0%	0.9%	4.5%	0.1749	0.0436
	cmlA1	Amphenicol	Chloramphenicol	14.4%	7.3%	18.0%	0.0279	0.5580
	mef(C)	Macrolide	Erythromycin	0.0%	0.0%	4.5%	0.0385	0.0436
	mph(G)	Macrolide	Erythromycin	0.0%	0.0%	4.5%	0.0385	0.0436
	tet(B)	Tetracycline	Doxycycline, Tetracycline, Minocycline	21.2%	35.5%	38.2%	0.7677	0.0110
NH-Ec	*floR*	Amphenicol	Chloramphenicol, Florfenicol	22.8%	11.5%	28.6%	0.0264	0.4669
	lnu(F)	Lincosamide	Lincomycin	5.4%	0.0%	8.6%	0.0375	0.5334
	mef(C)	Macrolide	Erythromycin	3.3%	1.9%	12.9%	0.0426	0.0315
	mph(B)	Macrolide	Erythromycin, Spiramycin, Telithromycin	8.7%	7.7%	0.0%	0.0308	0.0104
	mph(G)	Macrolide	Erythromycin	3.3%	1.9%	12.9%	0.0426	0.0315
Kp	*aph(3'')-Ib*	Aminoglycoside	Streptomycin	8.3%	37.5%	54.2%	0.3487	0.0111
	aph(6)-Id	Aminoglycoside	Streptomycin	8.3%	37.5%	54.2%	0.3487	0.0111
Se	*aac(3)-IV*	Aminoglycoside	Apramycin, Gentamicin, Tobramycin	0.0%	7.7%	25.8%	0.0509	0.0177
	aph(4)-Ia	Aminoglycoside	Hygromycin	0.0%	7.7%	25.8%	0.0509	0.0177
	$bla_{\text{TEM-1B}}$	Beta-lactam	Amoxicillin, Ampicillin, Cephalothin, Piperacillin, Ticarcillin	63.2%	59.0%	87.1%	0.0155	0.0776
	sul1	Folate pathway antagonist	Sulfamethoxazole	31.6%	20.5%	51.6%	0.0107	0.2420
	tet(B)	Tetracycline	Doxycycline, Tetracycline, Minocycline	47.4%	59.0%	77.4%	0.1285	0.0371
Ss	*erm*(B)	Macrolide, Lincosamide, Streptogramin B	Erythromycin, Lincomycin, Clindamycin, Quinupristin, Pristinamycin IA, Virginiamycin S	58.3%	64.8%	74.3%	0.1272	0.0201

Abbreviations: Cp, *Clostridium perfringens*; H-Ec, haemolytic *Escherichia coli*; NH-Ec, non-haemolytic *Escherichia coli*; Kp, *Klebsiella pneumoniae*; Se, *Salmonella enterica*; Ss, *Streptococcus suis*

↑ (n=22)

↓ (n=1)

Neomycin resistance in haemolytic *E. coli*

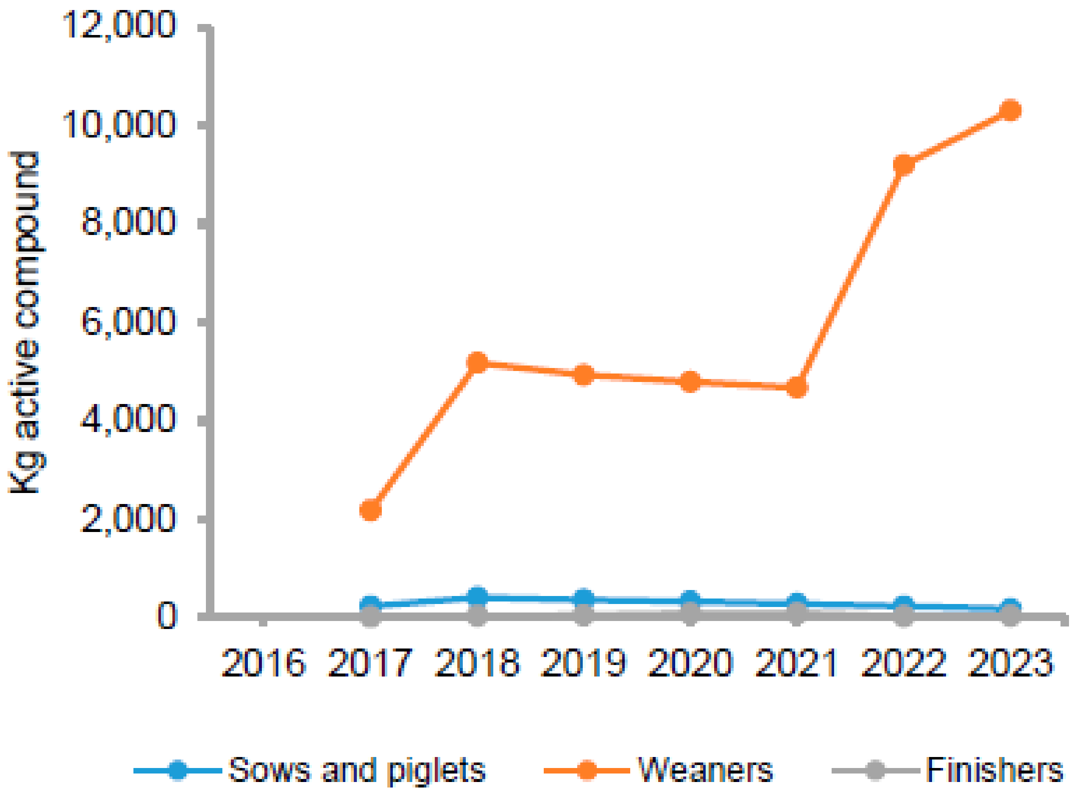
Neomycin resistance in haemolytic *E. coli* increased from 6.9% in 2016 to 52.3% in 2023

Problematic because neomycin is one of only a few drugs recommended in Denmark as first choice for treating *E. coli*-associated post-weaning diarrhoea

Neomycin resistance in haemolytic *E. coli*

- ***aph(3´)-Ia*** was present in 62.9% of sequenced haemolytic *E. coli* isolates
  - Also found in non-haemolytic *E. coli* (14.3%), *K. pneumoniae* (8.3%) and *S. enterica* (38.7%)
- Haemolytic *E. coli* also displayed medium to high frequencies of resistance to the other first-choice drugs
  - Amoxicillin/clavulanic acid (14.1%)
  - Spectinomycin (68.8%)
  - Trimethoprim/sulfamethoxazol (58.4%)
  - Streptomycin (82.9%)

Figure 9.2 Neomycin use in pigs by age group, Denmark, 2016-2023 DANMAP 2023



Gentamicin resistance in haemolytic *E. coli*

Gentamicin resistance in haemolytic *E. coli* increased from 10.9% in 2016 to 35.2% in 2023

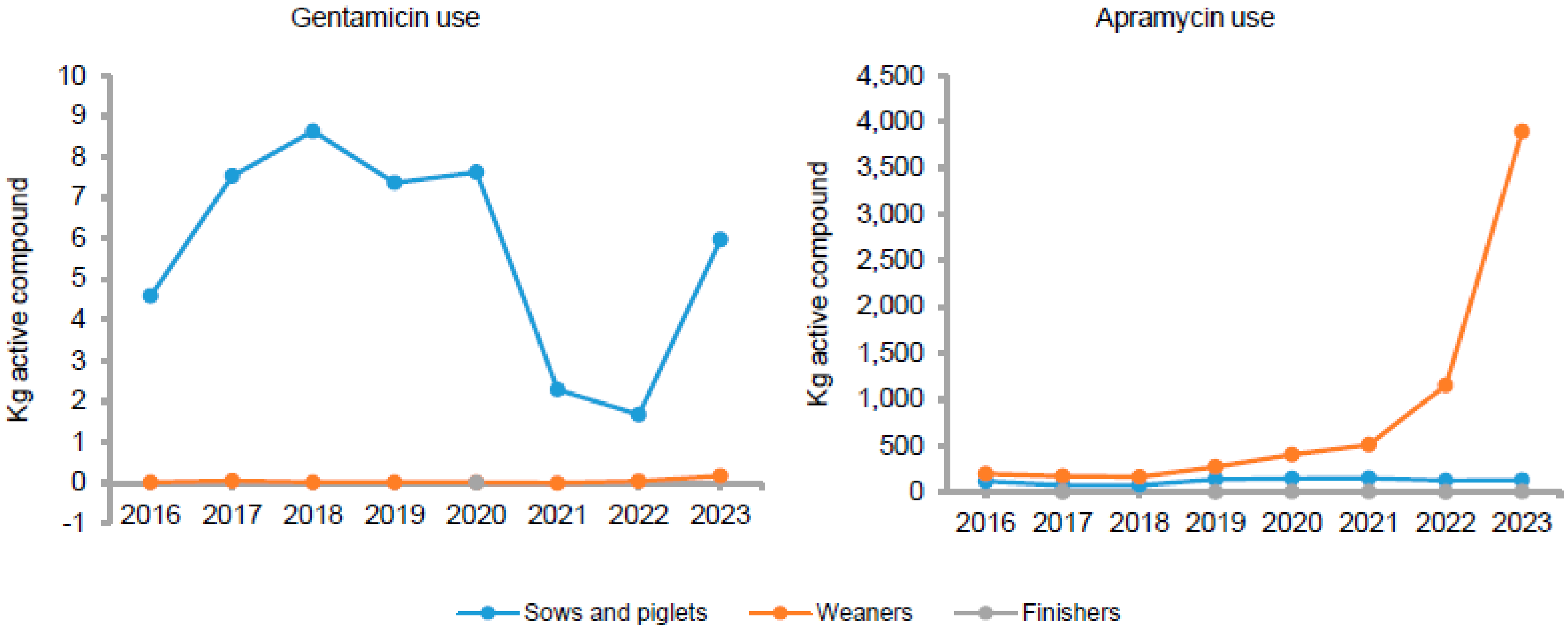
Concerning because gentamicin is considered critically important for human medicine WHO

Gentamicin resistance in haemolytic *E. coli*

- ***aac(3)-IV*** was present in 25.8% of sequenced haemolytic *E. coli* isolates
  - Also found in non-haemolytic *E. coli* (7.1%), *K. pneumoniae* (12.5%) and *S. enterica* (25.8%)
- ***aac(3)-IId, aac(3)-IVa*** *and* ***ant(2´´)-Ia*** were present in 6.7%, 1.1% and 2.2% of sequenced haemolytic *E. coli* isolates
- ***aac(3)-IV***, ***aac(3)-IId*** and ***aac(3)-IVa*** confer resistance both to gentamicin and apramycin (but not to neomycin)

Gentamicin resistance in haemolytic *E. coli*

Figure 9.3 Gentamicin and apramycin use in pigs by age group, Denmark, 2016-2023 DANMAP 2023



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Gentamicin resistance in haemolytic *E. coli*

Gentamicin resistance in haemolytic *E. coli* increased from 10.9% in 2016 to 35.2% in 2023

Concerning because gentamicin is considered critically important for human medicine by WHO

… and because apramycin is recommended in Denmark as an alternative drug for treating *E. coli*-associated post-weaning diarrhoea

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Other findings

- Resistance towards carbapenems, 3rd, 4th and 5th generation cephalosporins, oxazolidinones and polymyxins remained at a low level

- The observed concordance between AST results and WGS-based detection of resistance mechanisms was
  - 99.6% for *A. pleuropneumoniae*
  - 79.6% for *B. bronchiseptica*
  - 94.2% for haemolytic *E. coli*
  - 94.3% for non-haemolytic *E. coli*
  - 76.0% for *K. pneumoniae*
  - 97.3% for *S. enterica*
  - 91.5% for *S. hyicus*
  - 94.5% for *S. suis*

DANMAP 2024

- Pathogenic bacteria from pigs
  - AST but not WGS
- Bacteria causing acute mastitis in cows
  - Diagnostics at SSI
  - AST of selected pathogenic bacteria

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Thank you for your attention!

Questions and comments

Thanks to….

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- All data providers for textboxes and textbox authors
- Data Integration and Analysis Secretariat at SSI
- Infectious Disease Epidemiology & Prevention Unit at SSI
- National Food Institute, DTU
- Statistics Denmark
- The Danish Agriculture and Food Council
- The Danish Aquaculture Producer Organisation
- The Danish Health Data Authority and the Register of Medicinal Products Statistics
- The Danish Veterinary and Food Administration's Animal Medicine and Veterinary Trade Division
- The Danish Veterinary and Food Administration's Food and Feed Safety Division
- The Departments of Clinical Microbiology and the DANRES group - Danish Study Group for Antimicrobial Resistance Surveillance
- The meat inspection staff and company personnel at the participating slaughterhouses
- Unit of Mycology at SSI
- Local Veterinary and Food inspections units
- Antimicrobial Resistance Reference Laboratory and Surveillance Unit
- The Danish Veterinary and Food Administration's Laboratory, Ringsted
- Foodborne Pathogens Unit at SSI
- Neisseria and Streptococcus Typing Unit at SSI
- Staphylococcus Laboratory at SSI

EAAD – European Antibiotic Awareness Day

EUROPEAN ANTIBIOTIC AWARENESS DAY – A EUROPEAN HEALTH INITIATIVE

Antimicrobial resistance targets[i] -2024 update[ii]-
(2023 data)

ecdc

European Union

Target achieved | Progress | Regress

Reduce by 20% the total consumption of antibiotics in humans Defined daily doses (DDDs) per 1 000 inhabitants per day	2019 baseline	19.9	-
	2023	20.0	+0.6%
	2030 TARGET	15.9	-20%
At least 65% of the total consumption of antibiotics in humans belongs to the 'Access' group of antibiotics As defined in the AWaRe classification of the WHO *Percentage point difference from 2019.	2019 baseline	61.1%	-
	2023	61.5%	+0.4% *
	2030 TARGET	65%	+3.9% *
Reduce by 15% the total incidence of bloodstream infections with meticillin-resistant *Staphylococcus aureus* (MRSA)* Number per 100 000 population *Excluding France	2019 baseline	5.6	-
	2023	4.6	-17.6%
	2030 TARGET	4.8	-15%
Reduce by 10% the total incidence of bloodstream infections with third-generation cephalosporin-resistant *Escherichia coli** Number per 100 000 population *Excluding France	2019 baseline	10.7	-
	2023	10.4	-3.6%
	2030 TARGET	9.7	-10%
Reduce by 5% the total incidence of bloodstream infections with carbapenem-resistant *Klebsiella pneumoniae** Number per 100 000 population *Excluding France	2019 baseline	2.5	-
	2023	4.0	+57.5%
	2030 TARGET	2.4	-5%

i- Council Recommendation targets on stepping up EU actions to combat antimicrobial resistance in a One Health approach (2023/C 220/01)
ii- Full data available in ECDC Annual Epidemiological Reports on antimicrobial resistance and antimicrobial consumption

DANMAP

Read more at:

DANMAP
The Danish Integrated Antimicrobial Resistance Monitoring and Research Programme

About Press releases Reports Seminars Contact

DANMAP

DANMAP is the Danish Programme for surveillance of antimicrobial consumption and resistance in bacteria from food animals, food and humans.

REPORT 2023 LATEST PRESS RELEASE

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