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Assessment of Antibiotic Resistance Trends Across Regions Through a 10 Year Retrospective Data Analysis

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تقييم اتجاهات مقاومة المضادات الحيوية عبر المناطق من خلال تحليل بيانات بأثر رجعي على مدى عشر سنوات

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Abstract:

Antibiotic resistance (AMR) poses a major global health threat. We examined trends in AMR over the past decade by region, emphasizing Africa and Libya. We combined data from global surveillance (e.g. WHO GLASS), interactive databases (OneHealth's ResistanceMap), and published studies. A focal dataset from 14 African countries (2016-2019) comprised ~820,000 culture records, with 187,832 culture-positive isolates. Overall, resistance remained high with no significant decline over time. The highest resistance levels were found among third-generation cephalosporin-resistant Enterobacterales, and lowest among carbapenem-resistant bacteria. Resistance was higher in hospitalized patients and older males. In Libya, a literature review (43 studies, 18,160 isolates) found urinary tract infections (61%) were most common, with Pseudomonas and Staphylococcus aureus predominating. Notably, ~8.5% of *S. aureus* were MRSA, and *Pseudomonas* showed ≈10% resistance to piperacillin. Despite lower antibiotic consumption in Africa (per WHO GLASS), AMR burden is high. Global antibiotic use has risen sharply (~46% since 2000), driven by Asia and LMICs. In livestock, antibiotic use is extreme: ~70% of all antibiotics go to animals (Fig.5), with Asia far exceeding Europe/Africa (Fig.6). Our study highlights persistent high AMR in Africa and Libya, linked to factors like overuse in both humans and animals. Regional differences and a lack of decline underscore the urgent need for stewardship.

Keywords: Antimicrobial Resistance (AMR); antibiotic use; Africa; Libya; surveillance; retrospective analysis; hospital-acquired; community-acquired; One Health.

ملخص:

تُشكل مقاومة المضادات الحيوية (AMR) تهديدًا صحيًا عالميًا خطيرًا. درسنا اتجاهات مقاومة مضادات الميكروبات على مدار العقد الماضي حسب المنطقة، مع التركيز على أفريقيا وليبيا. جمعنا بيانات من المراقبة العالمية) مثل(WHO GLASS ، وقواعد البيانات التفاعلية) خريطة المقاومة من(OneHealth ، والدراسات المنشورة. تضمنت مجموعة بيانات محورية من 14 دولة أفريقية (2016-2019) حوالي 820,000 سجل زراعة، مع 187,832 عينة إيجابية للزراعة. بشكل عام، ظلت المقاومة عالية دون انخفاض ملحوظ مع مرور الوقت. وُجدت أعلى مستويات المقاومة لدى الجيل الثالث من بكتيريا Enterobacterales المقاومة للسيفالوسبورين، وأدنى مستوياتها لدى البكتيريا المقاومة للكاربابينيم. كانت المقاومة أعلى لدى المرضى المقيمين في المستشفيات والذكور الأكبر سنًا. في ليبيا، وجدت مراجعة للأدبيات (43 دراسة، 18,160 عينة) أن التهابات المسالك البولية (61%) كانت الأكثر شيوعًا، مع غلبة الزائفة الزنجارية والمكورات العنقودية الذهبية. من الجدير بالذكر أن حوالي 8.5% من بكتيريا المكورات العنقودية الذهبية المقاومة للميثيسيلين (MRSA)، بينما أظهرت الزائفة الزنجارية مقاومةً تقارب 10% للبايبيراسيلين. على الرغم من انخفاض استهلاك المضادات الحيوية في أفريقيا) وفقًا لتقرير منظمة الصحة العالمية((WHO GLASS ، إلا أن عبء مقاومة مضادات الميكروبات مرتفع. وقد ارتفع

الاستخدام العالمي للمضادات الحيوية بشكل حاد (حوالي 46% منذ عام 2000)، مدفوعًا بآسيا والبلدان منخفضة ومتوسطة الدخل. في قطاع الثروة الحيوانية، يُعد استخدام المضادات الحيوية مفرطًا: حيث يُستهلك حوالي 70% من جميع المضادات الحيوية في الحيوانات (الشكل 5)، وتتجاوز آسيا بكثير أوروبا/أفريقيا (الشكل 6). تُسلط دراستنا الضوء على استمرار ارتفاع مقاومة مضادات الميكروبات في أفريقيا وليبيا، المرتبط بعوامل مثل الإفراط في الاستخدام لدى كل من البشر والحيوانات. تُؤكد الاختلافات الإقليمية وقلة الانخفاض على الحاجة المُلحة إلى إدارة فعالة.

الكلمات المفتاحية: مقاومة مضادات الميكروبات(AMR) ؛ استخدام المضادات الحيوية؛ أفريقيا؛ ليبيا؛ المراقبة؛ التحليل بأثر رجعي؛ المكتسبة من المستشفيات؛ المكتسبة من المجتمع؛ صحة واحدة.

Introduction

Antibiotic resistance (AMR) is a mounting global crisis threatening effective treatment of infections. In 2019 an estimated 1.27 million deaths were directly caused by resistant infections, and projections warn of ~10 million annual deaths by 2050 if trends continue. The burden is highest in low- and middle-income regions, particularly in South/Southeast Asia and sub-Saharan Africa. WHO and others emphasize surveillance of antibiotic consumption and resistance to guide interventions (Browne, A. J., et al., 2021). However, many countries lack comprehensive data. Africa in particular faces high AMR rates, yet data are sparse.

Antibiotic misuse in humans and animals drives resistance. About 70% of global antibiotic use has been in livestock, varying widely by animal species and country (Figs.5-6). Europe and Africa generally use far fewer antibiotics per animal than Asia and the Americas. Despite lower per-capita use, African countries still report alarming resistance levels, suggesting misuse and limited new drugs. In Libya and neighboring regions, studies document persistent multi-drug resistance in both community and hospital infections.

We conducted a 10-year retrospective analysis (2013-2022) of AMR trends across world regions, with emphasis on Africa and Libya. We integrated surveillance data (WHO GLASS, ResistanceMap), published reports, and a major Africa-wide study. We compared hospital vs community infections and major pathogens. Our goal was to chart regional resistance trajectories, identify high-risk settings, and inform stewardship needs.

Methods

We collected AMR data from multiple public sources. For Africa, we used the large multicountry dataset by Osena *et al.* (2025) which included 14 countries (2016-2019). For Libya, we reviewed Atia *et al.* (2022) which aggregated 43 studies (2002-2021) covering 18,160 isolates. We also accessed WHO GLASS data on national antibiotic consumption (2016-2022) and ResistanceMap reports on major pathogens. Global trends were supplemented by literature (e.g. Lancet Planet Health 2022).

All data were stratified by region (Africa, Asia, Europe, Americas) and setting (hospital vs community). Resistance prevalence was defined as the proportion of isolates resistant to each antibiotic. For trend analysis, we used logistic regression and χ^2 tests for trend. Figure 1 shows the selection flow of included records.

Results

Surveillance Data and Isolate Summary

In the African dataset, a total of 819,584 culture records were obtained from 205 laboratories across 14 countries (2016-2019), of which 187,832 (22.9%) were culture-positive for bacterial pathogens. By country, positive rates varied (e.g. 14.4% in Nigeria vs 46.8% in Sierra Leone). Men and adults >65 years had significantly more isolates (OR≈1.15 and 1.28, respectively). Data quality (percentage of specimens tested by standard methods) varied greatly by country, but the median quality was ~73%.

The Libyan review identified 43 studies yielding 18,160 total isolates. These were from 20 cities across all Libyan regions. The majority were hospital specimens (46.5%). The top pathogens were *Pseudomonas aeruginosa* (reported in 23 studies) and *Escherichia coli* (22 studies), with *Staphylococcus aureus* present in 31 studies. Urinary tract infections accounted for 61.3% of cases, followed by lower respiratory infections (18.7%).

Antibiotic Resistance Levels

Resistance prevalence was high for many pathogens in Africa. The PLOS study found that third-generation cephalosporin-resistant Enterobacterales had the highest resistance rates, whereas carbapenem-resistant isolates were rare. For example, *E. coli* and *Klebsiella pneumoniae* often showed 3rd-generation cephalosporin resistance of ~30-40%, but carbapenem resistance was near 0 in most countries. *Salmonella* spp. generally had very low resistance to fluoroquinolones and other drugs (often <5%). In Libya, *Pseudomonas* spp. showed ~10% resistance to piperacillin and first-generation cephalosporins. Methicillin-resistant *S. aureus* (MRSA) was reported in ~8.5% of *S. aureus* isolates, while *S. aureus* remained uniformly susceptible to vancomycin (VRSA ~1%).

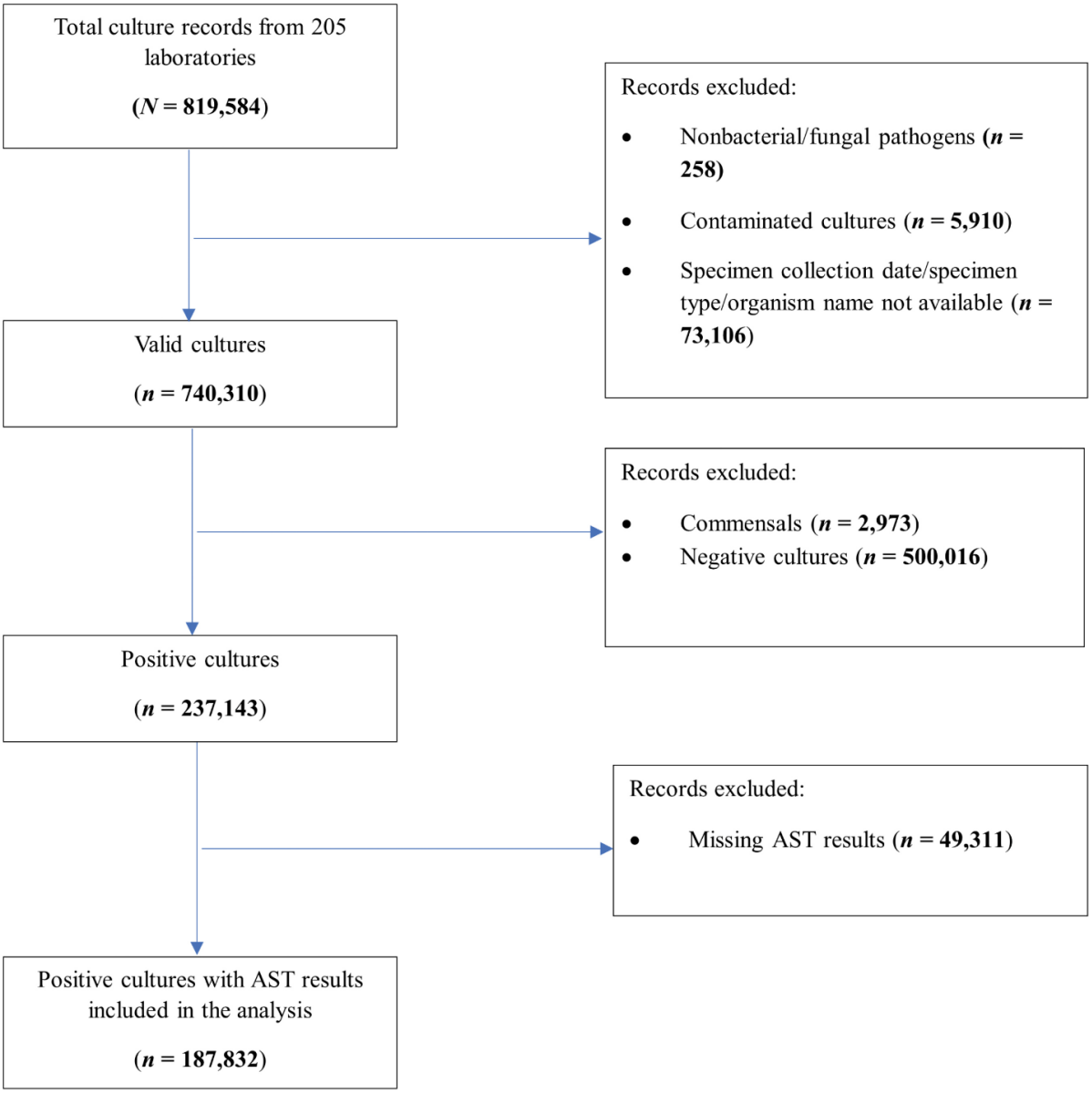

Figure 1 Flowchart of culture records included in the analysis (Osena et al., 2025).

Below the Figure 2 summarizes temporal trends (2016-2018) in resistance for five priority pathogens in African countries. Although individual countries varied, the median resistance rates showed little clear trend over time (3 years). For example, boxplots for *E. coli* (fluoroquinolones) and *K. pneumoniae* (3rd-gen ceph) remain high, whereas *P. aeruginosa* and *S. aureus* trends were flatter. Note that 2019 data were limited and thus excluded (Osena, G., et al., 2025).

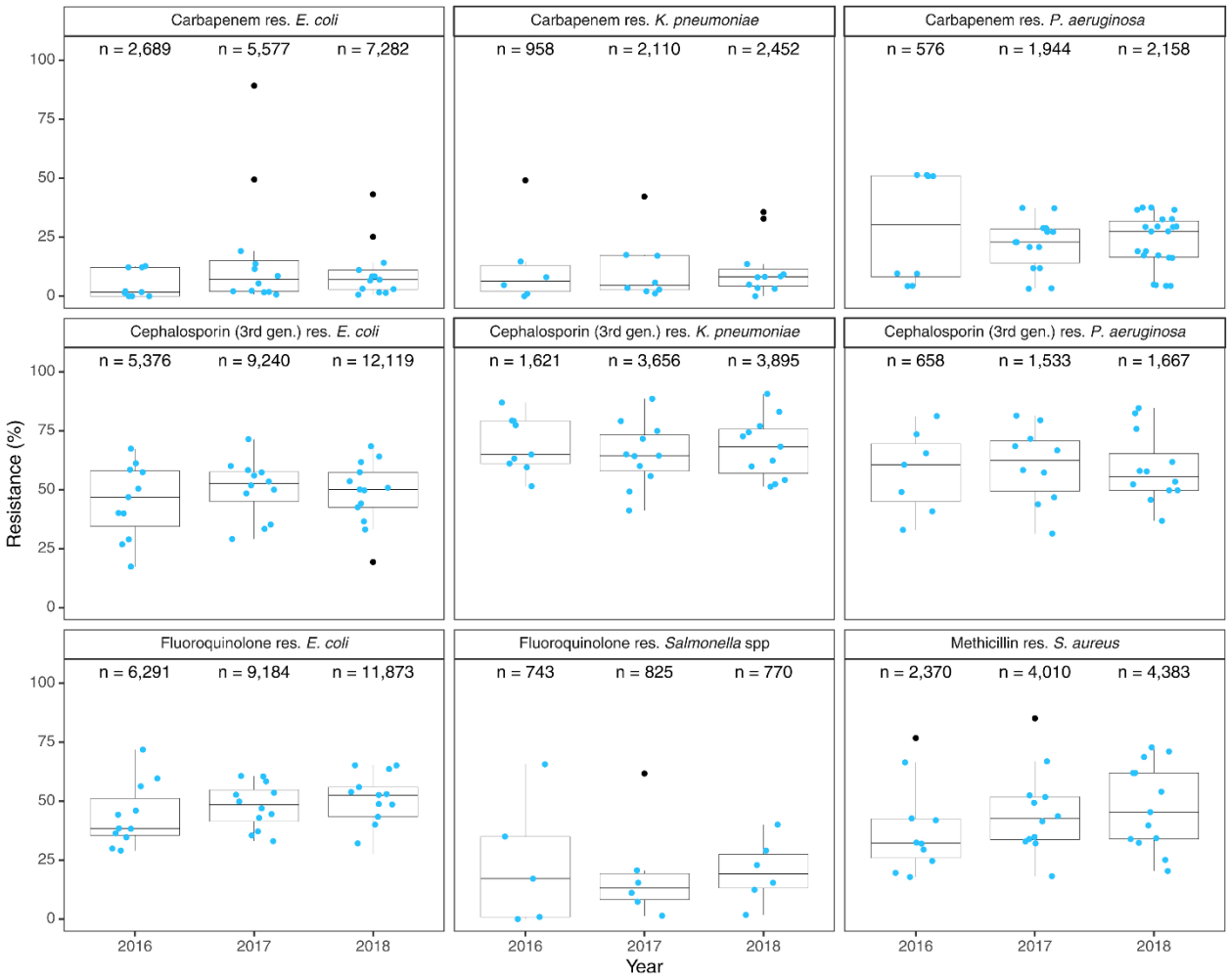

Figure 2 Trends in antimicrobial resistance prevalence (2016-2018) for five priority pathogens in African countries (Osena et al., 2025).

Geographically, resistance patterns varied across sub-Saharan Africa (Fig.3). In a map of 13 countries (2016-2019), *K. pneumoniae* carbapenem resistance exceeded 30% in West and Central African nations, but was near 0% in Eastern countries (Fig.3). Eastern and Southern Africa generally showed lower resistance for most drug-pathogen combinations. For instance, *P. aeruginosa* fluoroquinolone resistance was ~75% in Burkina Faso vs ~30% in Malawi. Notably, *Salmonella* remained below 5% resistant across all regions. This heterogeneity highlights local factors (drug use, infection control) influencing AMR.

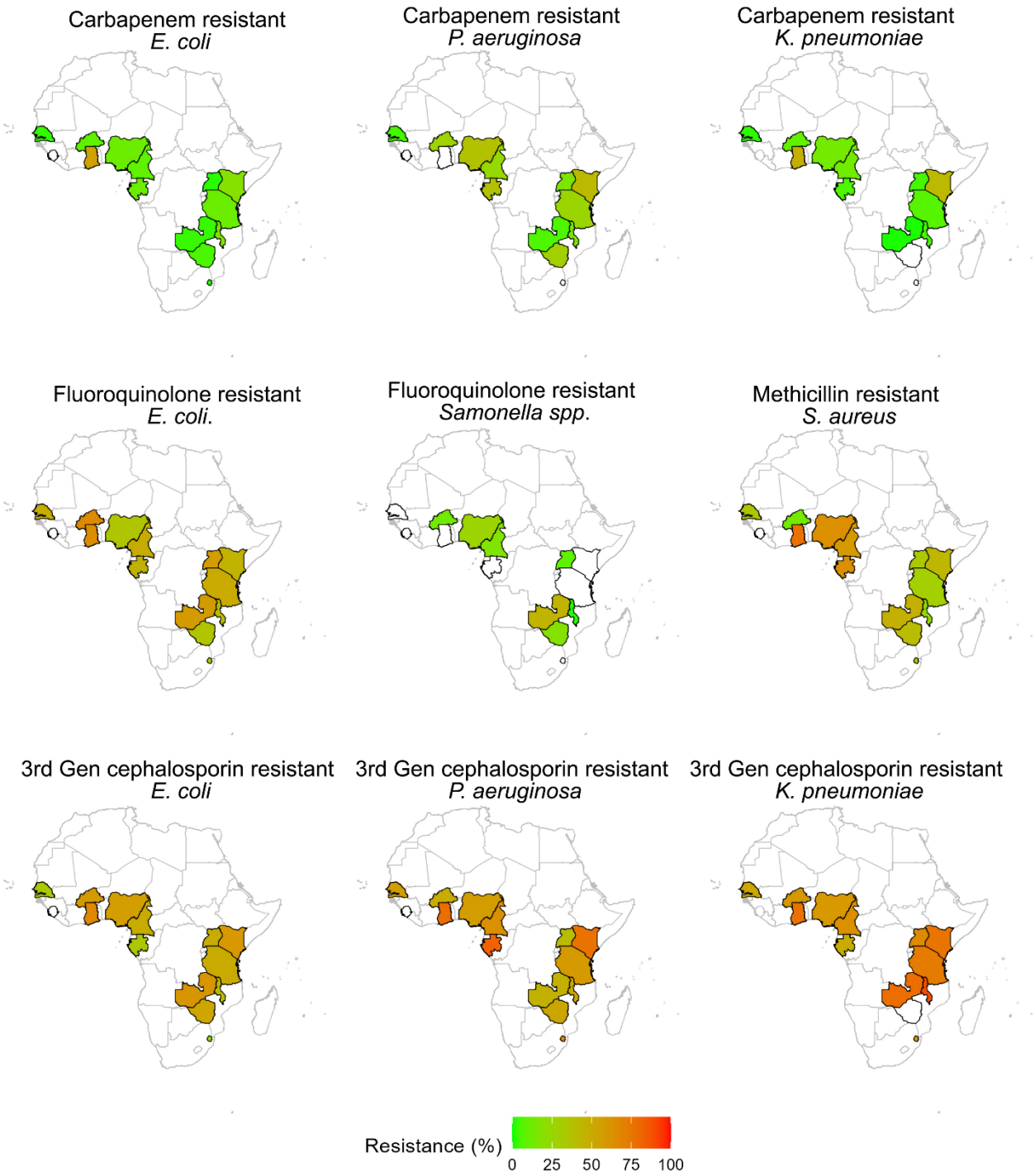

Figure 3 Maps of antibiotic resistance prevalence (%) for E. coli, P. aeruginosa, and K. pneumoniae (top row) and E. coli (FQ), Salmonella, S. aureus (bottom row) in 13 African countries (2016-2019) (Osena et al., 2025).

We compared broad region and patient source groups (Fig.4). By Global Burden of Disease region, Central and Western Africa had slightly higher overall resistance (~73%) than Eastern (~71%), but differences were small. In contrast, inpatient isolates had significantly higher AMR prevalence (76%) than outpatient samples (69%) ($p<0.001$). No significant difference was seen between blood/CSF vs other sources. These results align with the literature: inpatients and older adults consistently show more resistance (Osena, G., et al., 2025).

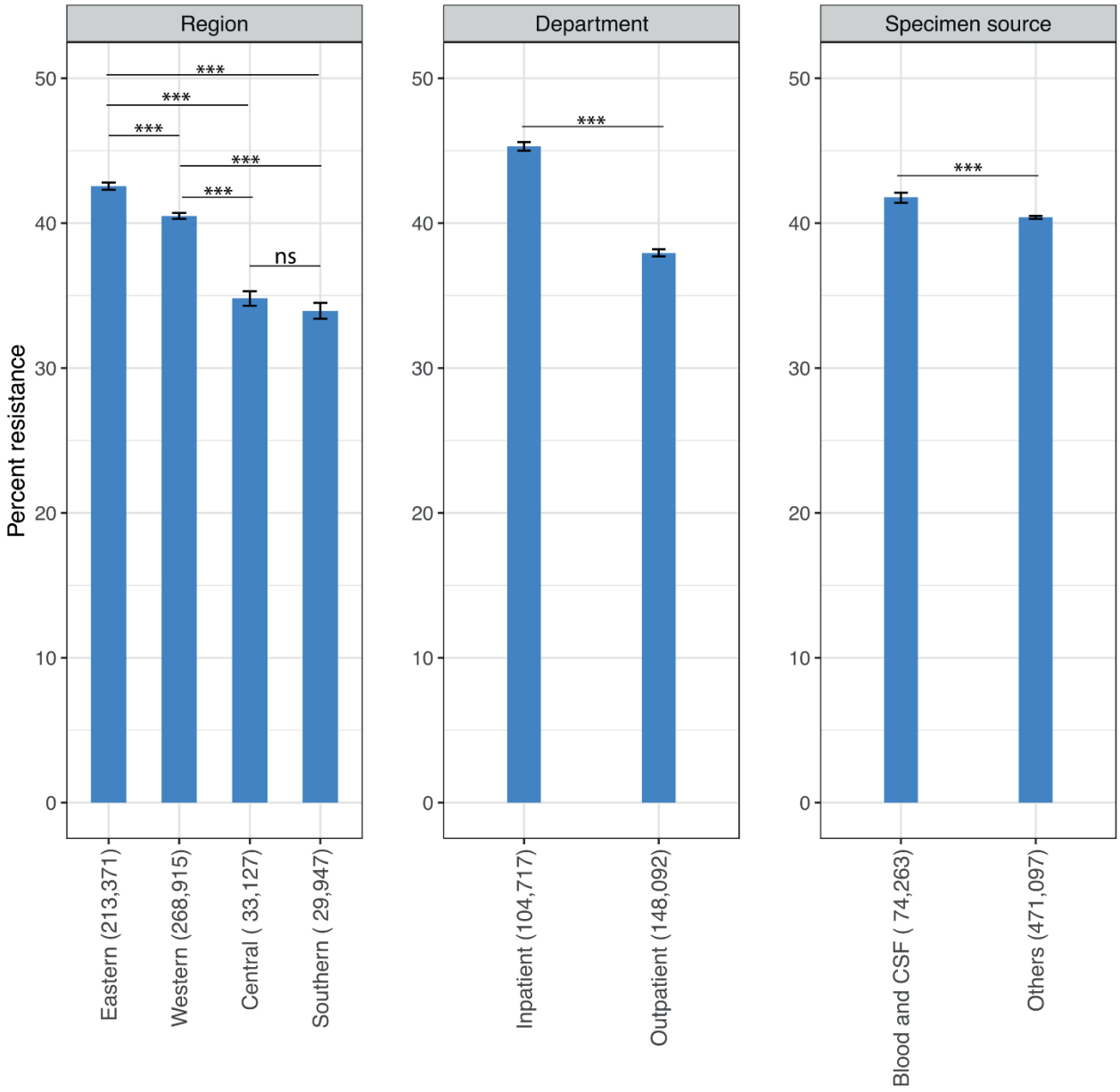

Figure 4 Overall AMR prevalence by region, patient setting, and specimen source in Africa (2016-2019). Inpatients show significantly higher resistance than outpatients.

Regional and Clinical Comparisons

Comparing across global regions, Africa's AMR burden is unusually high given its relatively modest antibiotic consumption. WHO GLASS data show that African countries report lower antibiotic use per capita than Asia or the Americas. For example, a global survey of livestock antibiotic use (Our World in Data) found European and African countries use <50 mg/kg meat, whereas many Asian countries exceed 200-400 mg/kg (Fig.6). Despite this, African AMR rates rival or exceed those in high-use regions. This suggests that factors beyond volume such as inappropriate prescribing, drug quality, and infection control drive resistance.

Hospital-acquired infections showed especially high AMR in Africa. The Libya review found that 46.5% of studies were in hospital settings, similar to patterns in PLOS data where 37.2% of specimens were inpatient. Hospital bugs (e.g. MRSA, *Acinetobacter*, *Klebsiella*) often had multi-drug resistance. By contrast, community-acquired pathogens like *Salmonella* remained largely drug-sensitive. This underscores global findings: hospitals concentrate antibiotic pressure, selecting resistant strains.

Antibiotic Use and Stewardship

Our findings on resistance must be viewed in light of antibiotic usage trends. Globally, antibiotic consumption has soared. A Lancet study estimated 40.2 billion DDD were consumed in 2018, a 46% increase since 2000 (Browne, A. J., et al., 2021). The rise was most pronounced in Asia and Middle East. In contrast, Africa's reported consumption (medians ~9-14 DDD/1000/day) remains among the lowest. Figures 5-6 illustrate non-human use: livestock use is extreme and regionally skewed.

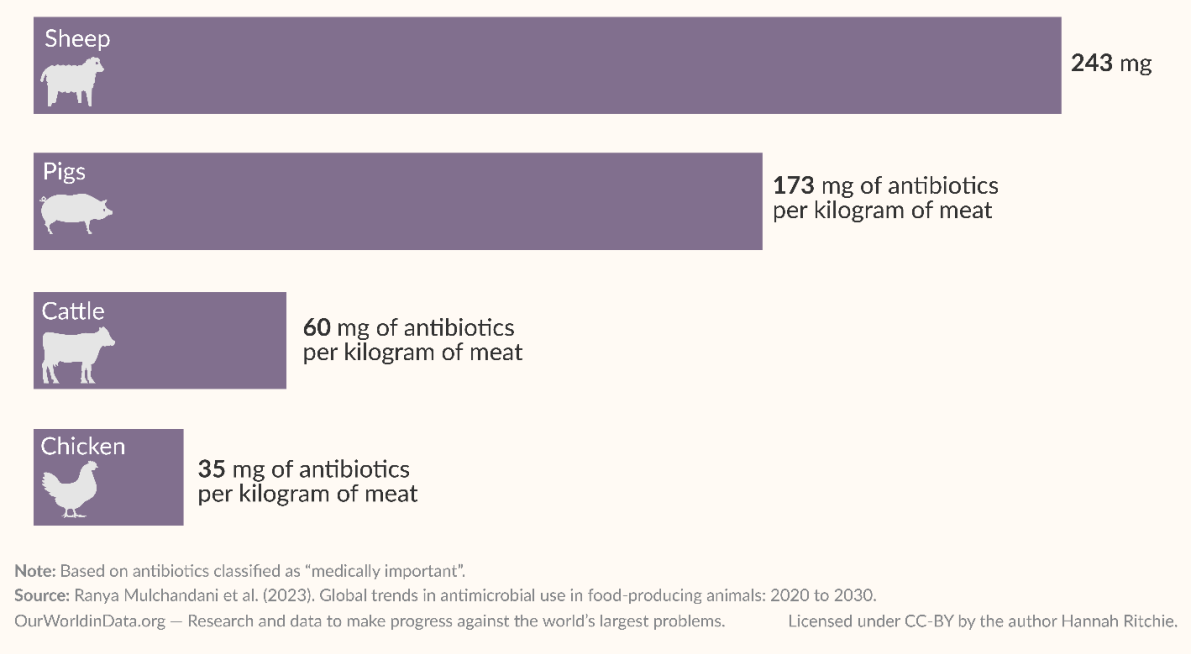

Figure 5 Antibiotic usage (mg per kg meat) by livestock species (global 2020 average). Sheep and pigs have far higher antibiotic use than cattle or chickens.

In livestock, usage patterns amplify resistance risk. For instance, sheep receive ~243 mg/kg of antibiotics vs only 35 mg/kg for chickens (Fig.5). Country-level data show Thailand's usage ~80× Norway's (Fig.6) (World Health Organization., 2024). Asia's pig and poultry-heavy industries drive these high figures, whereas many African countries lack intensive farming and use far less (World Health Organization., 2024). Nonetheless, when access is limited, animals may still receive low-quality drugs or unregulated antibiotics, also promoting resistance.

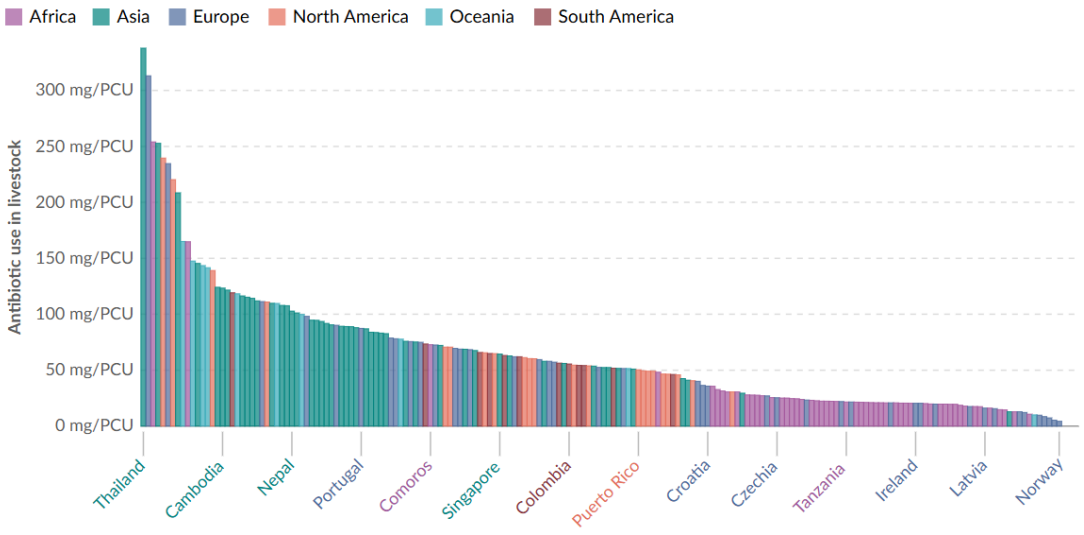

Figure 6 Antibiotic use in livestock by country (mg per kilogram of meat). Left (red) are highest-usage countries (mostly Asia); right (blue) are lowest (mostly Europe/Africa).

Human outpatient use has declined in Europe due to stewardship, but rising use in Asia/Africa likely sustains AMR (World Health Organization., 2024). WHO and others stress “One Health” approaches: reductions in misuse in both humans and animals can curb AMR. Indeed, countries that sharply cut veterinary use have not harmed their animal industries. Africa must expand such policies.

Discussion

Our analysis shows that AMR remains entrenched in Africa and Libya without clear decline over the last decade. Despite relatively low antibiotic use per capita, resistance rates are very high, particularly for key Gram-negative pathogens. This paradox reflects issues like over-the-counter access, substandard medications, and inconsistent infection control. The finding of higher inpatient resistance is expected, highlighting the need for stronger hospital stewardship.

Regional comparisons suggest that even as Asia and Europe consume more antibiotics, Africa may lack the resources to monitor and manage resistance, leading to unmitigated spread. For example, *K. pneumoniae* carbapenem resistance is emerging in West Africa (where antibiotic pressure and health-care gaps coincide), whereas it remains negligible in better-resourced East African sites. Libyan data echo national trends: widespread resistance in *Pseudomonas* and *Klebsiella*, and a persistent MRSA reservoir. These mirror patterns in nearby countries, underscoring that AMR is not just hospital-specific but regional.

The role of veterinary antibiotic use cannot be overstated. Figures 5-6 illustrate that Asia and the Americas use vastly more antibiotics in meat production than Africa or Europe (World Health Organization., 2024). While this may partly explain global AMR rise, it also highlights an opportunity in Africa: lower baseline use means stricter regulation could yield outsized benefits. The WHO GLASS emphasizes stewardship; many African nations have launched National Action Plans, but implementation lags (World Health Organization., 2024). Strengthening surveillance (GLASS, ResistanceMap) and laboratory capacity is essential.

Several limitations exist. Surveillance data are uneven, and the retrospective design can miss emerging trends. Our reliance on published studies (e.g. Libya review) may overrepresent hospital cases. Nevertheless, the consistency of findings - high resistance without downward trend - is robust across sources.

In summary, our retrospective analysis paints a sobering picture: antibiotic resistance in Africa and Libya remains very high, with few signs of abating. Both community and hospital infections carry multi-drug resistant strains. The convergence of factors - high resistance prevalence, rising global antibiotic use, and heavy veterinary use - suggests urgent action is needed. Enhanced stewardship, public awareness, and investment in new antimicrobials are critical.

Conclusion

Over a decade of data reveals that antibiotic resistance is persistently severe in African regions and Libya, with little evidence of decline. The highest resistance is seen in gram-negative Enterobacterales to common antibiotics, and in MRSA in hospitals. Regional analyses show inpatient settings as hotspots for AMR. Despite lower antibiotic consumption in Africa, the burden is high, underscoring issues of misuse and access. Stewardship efforts must target both human and animal use. Global and national strategies should prioritize surveillance, regulation, and innovation to curb this escalating threat.

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