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From ignorance to awareness: Quality of collaborative governance enhances public awareness of AMR

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A B S T R A C T

In representative democracies, the public administration plays a pivotal role in managing a myriad of public policies. While considerable knowledge exists regarding how public issue awareness influences political competition before policy enactment, its persistence in the administrative aftermath is characterized by much more uncertainty. This study addresses this puzzle within the challenging context of antimicrobial resistance (AMR) governance in Europe, posing the question: How does administrative governance shape public AMR awareness? Drawing on newly collected expert survey data from all EU member states and a recent Eurobarometer survey measuring behavioral aspects related to AMR (N = 26.502), the findings show that different aspects of administrative governance yield mixed results. Notably, there is a strong and positive relationship between the quality of collaborative governance and public awareness. These results underscore the critical role of administrative governance quality in understanding public behavior, particularly in the context of combating AMR.

1. Introduction

Administrative governance encompasses the framework and practices that govern the management, coordination, and execution of government functions and public policies. Although these responsibilities are often perceived as apolitical, focusing on values like transparency, predictability, and efficiency, it is essential to recognize that as public entities, the quality, capacity, and overall operational style of administrative governance are pivotal factors affecting democratic legitimacy (Peters, 2018).

What is less explored is the relationship between these aspects and public behavior. While we understand that the quality of administrative governance influences core societal variables like generalized trust and collective action (Martinangeli et al., 2023), the connection between administrative governance and the development and persistence of issue awareness in the public, along with its subsequent impact on behavior, remains inadequately substantiated. This study aims to bridge this gap by investigating how various facets of administrative governance affect public issue awareness within a comparative European context. Thus, acknowledging that administrative governance plays a pivotal role in shaping institutional trust and policy satisfaction, this paper explores the administration's role as an extension of the political process in shaping public opinion more broadly. The administrative aftermath in the political process is merely a new phase of the citizen-state relationship, reiterating Anthony Bertelli's (2021) claim that public administration is not merely *policy* administered, but *democracy* administered.

Particularly in instances where political issues are consensual among voters and politicians, and do not entail much disturbing expenditures for households, the routinized administrative apparatus can swiftly transition into taking charge of public governance (Carelli and Pierre, 2024). This means that the public's attention in the entire political process can be rather ephemeral and may rapidly shift to the administrative sphere where the new policy is put into action (Bertelli, 2021). Assuming that the issue is nevertheless important for voters, and still contains elements that might evolve into conflicting political features in the long-term, how does the period 'after politics' affect public issue awareness?

The exploration of public behaviors during the post-policy phase in representative democracies is not a novel endeavor. The extensive policy feedback literature elucidates how diverse channels, including social networks, personal policy preferences, and mass media, empower individuals to project their policy preferences onto the political landscape, prompting calls for renewed responsiveness (for a comprehensive overview, refer to Béland et al. (2022). However, the mechanisms through which administrative institutions specifically shape public behavior remain incompletely substantiated, especially concerning issues grappling with societal salience (Wlezien, 2005). This paper presents novel evidence that precisely addresses this knowledge gap.

Depending on the nature of an issue, the level of awareness and its persistence can have significant behavioral implications; a reasoning commonly associated with the issue of climate change (Venghaus et al., 2022). In this paper, I examine public issue awareness regarding

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antibiotics and antimicrobial resistance (AMR), a critical global public health challenge (Murray et al., 2022). AMR involves the natural development of bacterial resistance to existing antibiotics. However, the excessive use and misuse of antibiotics in healthcare and livestock production accelerate this process, rendering antibiotic treatments ineffective (Salmond and Welch, 2008).

Already today, 1.27 million people die each year as a direct consequence of this development (Murray et al., 2022)—twice as many as HIV and Malaria—and a number estimated to rise to 10 million by 2050 (O'Neill, 2014). Despite these unambiguous behavioral circumstances, the issue is predominantly studied within the natural sciences (for an overview, see Frid-Nielsen et al., 2019). In consequence, we are only beginning to understand what behavioral mechanisms that drive public expectations and the related overuse of antibiotics (cf. Davis et al., 2017), let alone what formal interventions that are appropriate to mitigate its consequences (Pierre et al., 2023).

Furthermore, AMR is typically described as a highly technical and non-salient political issue. The technicality refers both to complexity in the very phenomenology of micro-bacterial development and its entailed transnational proliferation, and to the challenge of creating and sustaining polycentric governance to effectively and concertedly managing the issue on a global scale (Carelli and Pierre, 2024; Harring and Krockow, 2021). In turn, the European AMR governance is to a great extent initiated and led by the administrative level of government. As recently argued, the issue exhibits intriguing patterns of complex problem-solving among professional senior civil servants in Europe who enjoy unusually high degrees of latitude for action to manage the issue. Hence, we can observe the administrative 'task' of AMR to be substantial in the EU (Carelli and Pierre, 2024; Carelli, 2024).

This paper offers a unique opportunity to investigate the association between various dimensions of administrative quality with issue awareness. Drawing on original expert survey data involving experts and senior civil servants working in the field of AMR policy in Europe, as well as a recent Eurobarometer survey encompassing 26.502 individuals, the findings reveal an intriguing trend. Traditional administrative activities such as monitoring bacterial developments and tracking antibiotic consumption have either a negative or no discernible association with public issue awareness. However, when administrations effectively establish collaborative governance by involving multiple actors and organizations within the governance framework, a strong and positive relationship with issue awareness emerges.

While the analytical concept of 'collaborative governance' is not particularly stringent *per se*—and may vary across different issues (Ansell and Gash 2008)—this paper leverages original expert survey data to gauge perceptions of collaborative governance implementation in the AMR field. Departing from Ansell and Gash's (2008) broad view of collaborative governance, which highlights the involvement of non-stake stakeholders, I define it more narrowly as "the process of public policy decision-making that involves the collective and cooperative engagement of multiple stakeholders." In this context, stakeholders can include private entities, public agencies, NGOs, and community groups. The central features of this distinctive form of governance typically involve the inclusion of all relevant stakeholders affected by the issue, information sharing among these stakeholders, and a shared decision-making function.

In the specific issue of AMR governance, the quality of collaborative governance refers to the extent to which relevant stakeholders are integrated into the national action against AMR and the degree to which these actors are coordinated. This matter is measured based on expert perceptions. It is important to note that the effectiveness of collaborative governance is contingent upon contextual factors unique to each state. For instance, in regions with extensive use of antibiotics in the livestock production, effective governance may necessitate broad involvement from that sector's stakeholders. A high score on this dimension indicates that when states empower multiple government levels, sectors, and non-state organizations to collaboratively own and address the AMR challenge, it becomes deeply integrated into societal structures. This approach creates new communication channels, thereby enhancing issue visibility for citizens. By fostering widespread stakeholder engagement and ensuring robust coordination, collaborative governance can effectively address complex issues like AMR.

These findings will, naturally, be further discussed throughout the text. The article is structured as follows. I begin by discussing the relevant literature, followed by a theoretical framework that outlines my expectations. Thereafter, I discuss aspects related to methodology and data, before presenting the results. Lastly, I discuss the results' wider implications and conclude with suggestions for future research.

2. The issue of issue awareness

The concept of public issue awareness lacks a universally stipulated definition. In the context of this paper, I define it as the depth of knowledge and consciousness among citizens concerning specific societal concerns or challenges. It encapsulates individuals' capacity to recognize and comprehend diverse issues affecting the public sphere, thereby reflecting a collective awareness within the community. Notably, in political science, the more commonly employed term is 'political knowledge,' which proves pivotal as a predictor for various outcomes, including vote choice, voter turnout, and policy expectations (Barabas et al., 2014; Kraft, 2024). Establishing a precise measure of political knowledge is, however, difficult given its construction of two highly contested concepts; 'the political' and 'knowledge'. Regardless, Delli Carpini et al. (1996, p. 19) proposes a definition of political knowledge as "the range of factual information about politics that is stored in the long-term memory."

One problem that can arise when adhering to such a definition of political knowledge is that some issues may possess all properties of a full-fledged political issue but remain absent in the analysis. A telling example is the volume *The Un-Politics of Air Pollution* in which Crenson (1971) demonstrates how an issue with major ramifications for virtually all citizens can escape scrutiny, political action and ideological formation and thus remain a mere 'fact' but not a political issue. Such scenario is reminiscent in crisis management and climate change studies, where scholars often emphasize the 'wicked' nature of the issues, implying an absence of sufficient government intervention, popular attention, and media coverage despite being estimated to carry widespread consequences for societies and are characterized by temporal deadlines (cf. Levin et al., 2012). Thus, somewhat paradoxically, political issues are not always deemed political issues. AMR concords well with this description, implying that it is a political issue but given only very limited political attention and ideological conflict it remains mainly a mere factual issue (Carelli and Pierre, 2024).

Meanwhile (Gilens, 2001), demonstrates how the lack of issue-specific knowledge is inherently different from political knowledge, and, drawing on classic democratic theory, that factual knowledge is indeed an essential explanatory variable for the formation of public opinion more broadly (see e.g. Berelson, 1952). Citing Kuklinski et al. (1998) he shows that only 28% among the most politically knowledgeable Americans knew that crime-rates were diminishing at the time. In consequence, the analysis suggests that the possession of issue-specific knowledge is more decisive for political preference formation than general political knowledge, allowing for the conclusion: "the influence of raw facts can be substantial" (Gilens, 2001, p. 392). Similarly, Oscarsson (2007) exploits data from six general elections inSweden and demonstrates that factual knowledge outweighs cognitive heuristics in vote choice, thus lending support for an identical conclusion. Or, as recently postulated: "peoples' policy preferences change when they are provided with factual information" (Bendz and Oskarson, 2022, p. 629).

2.1. AMR awareness

In this paper, I shall consider factual knowledge of antibiotics and its consumption as a proxy for AMR awareness. Similar to the issue of climate change, the factual knowledge of AMR can certainly be divided into several categories, as Nisbet and Myers (2007) considers the awareness, knowledge, and belief of the reality of global warming. AMR awareness is both concerned with the basic facts of what antibiotics are, and that its overconsumption drives bacterial resistance towards the current supply of antibiotics that proliferate within and across societies. Naturally, AMR knowledge is also a matter of degree; understanding all its elements is unexpected for most citizens, but the knowledge of the basic features of antibiotics and the existence of AMR will be used in the evaluation of AMR awareness. The operationalization is further discussed in the Methods section.

AMR awareness across Europe is moderate, according to recurrent Eurobarometer surveys (2009, 2013, 2016, 2018, 2022; see Fig. 1 below) and various case studies (Mazinska et al., 2017; Andre et al., 2010; Napolitano et al., 2013). However, awareness is characterized by significant heterogeneity across nations (Grigoryan et al., 2007), sub-national regions (Rönnerstrand and Lapuente, 2017), and social groups (Price et al., 2018, p. 1476). In addition, low awareness is manifested in several ways, with typical examples such as the basic misunderstandings of whether antibiotics kill viruses, viral infections, and/or infectious diseases; whether AMR concerns microbial spread and/or immunity; and a belief that the issue is caused by 'others', broadly defined (McCullough et al., 2016). In consequence, widespread lack of knowledge may jeopardize public health as it shapes "inaccurate expectations for antibiotic prescription" (Mazinska et al., 2017, p. 13) (see Fig. 2).

Thus, we can observe fascinating European variation in antibiotic consumption and the prevalence of AMR (Collignon et al., 2018; Pierre et al., 2023), but also of general knowledge relating to AMR. The latest Eurobarometer survey shows, for instance, that 77% of the Swedish population knows that antibiotics do not kill viruses, compared to Cyprus' corresponding 34%. Awareness is also heavily influenced by the individual's age, level of education, and gender (cf. Mazinska et al., 2017). Regarding perceptions of the creeping crisis of AMR, current evidence suggests that citizens' concern is only moderate. The association is also rather enigmatic, since higher confidence in public health institutions is associated with less worry, although one could expect the relationship to thrive in the exact opposite direction (Rönnerstrand et al., 2016).

2.2. What factors create and sustain AMR awareness?

Investigating what factors that best can explain varying levels of AMR awareness is a daunting task given the substantial size of the literature on issue awareness, and the relatively small (but growing) literature seeking to link political and behavioral variables with AMR

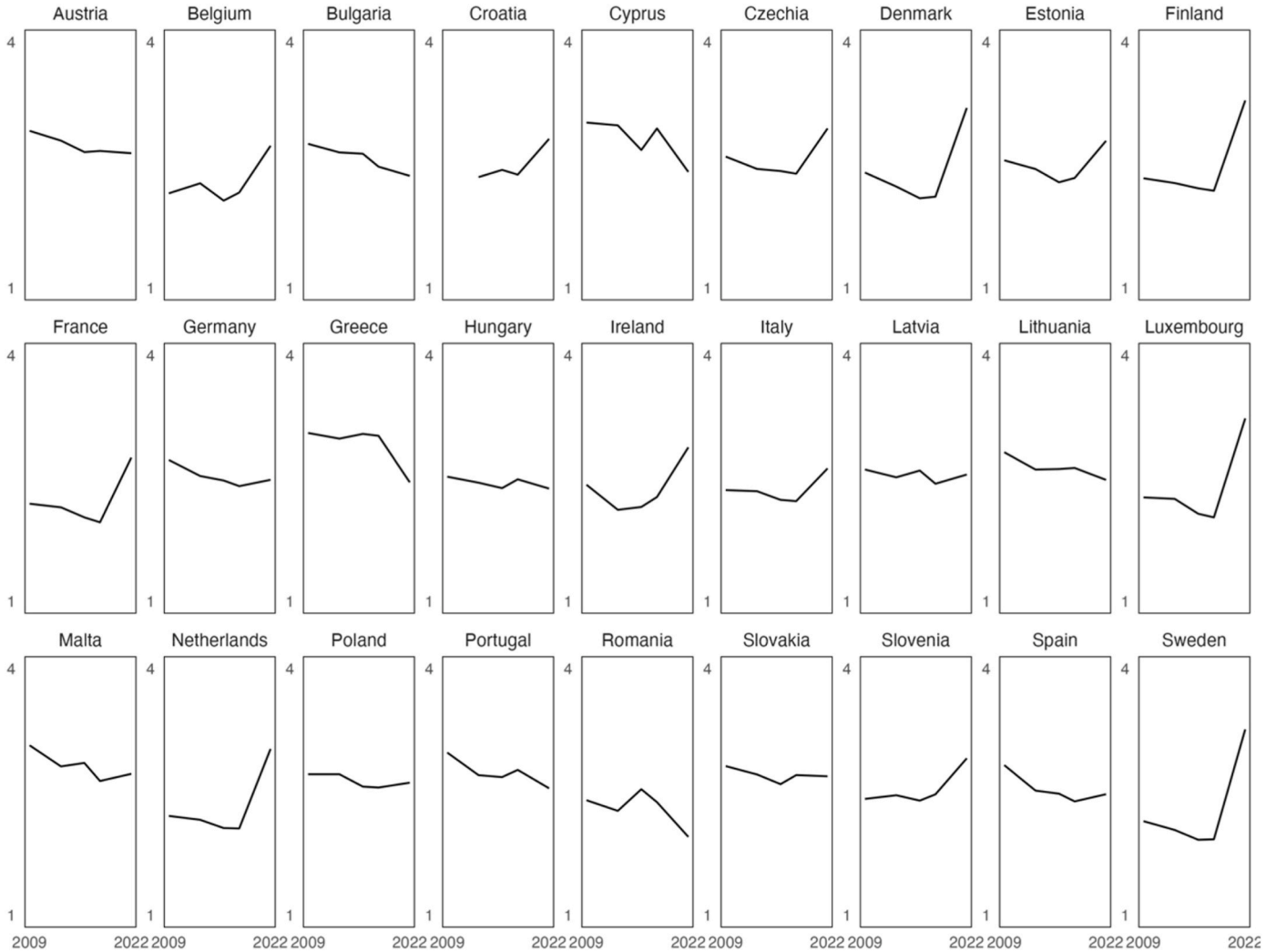

Fig. 1. Recent trends of AMR awareness, by country, 2009–2022.

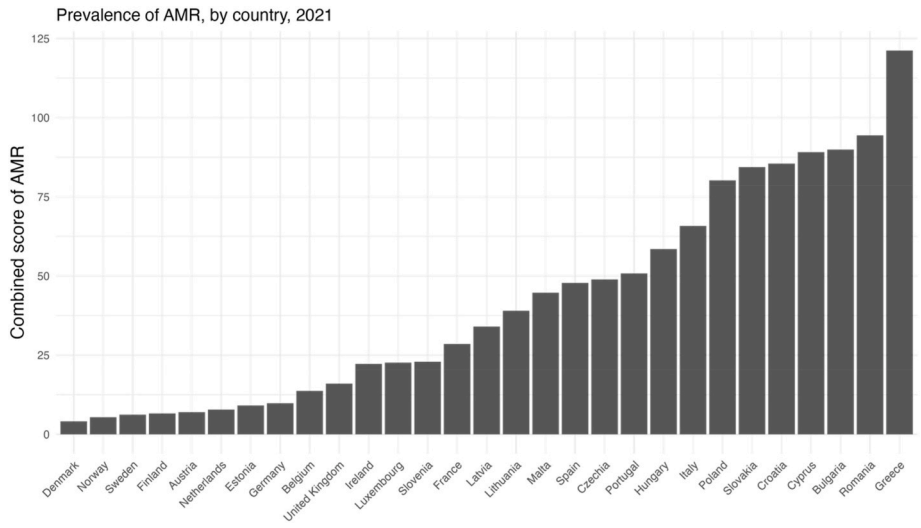

Fig. 2. AMR prevalence in the EU27. The scale depicts the aggregated resistance to diverse antibiotics from isolates, presented as a percentage within the range of 0–300. Further details are available in the Appendix.

can only provide with preliminary hypotheses of the causal relationships. Therefore, the present analysis has both exploratory and theory-developing intentions. Beginning at the most elementary level, AMR awareness is hypothesized to be positively associated with awareness campaigns (Alejandro et al., 2023), as more exposure of the issue should augment its relative size in the targeted agent's cognitive space. However, little evidence confirms this relationship. On the contrary, campaigns aimed to raise AMR awareness have so far proved relatively dysfunctional in various contexts (Huttner et al., 2019). Through the same causal mechanism, the personal consumption of antibiotics is expected to be directly associated to AMR awareness, an association that has, however, not yet been sufficiently substantiated in the literature (Pearson and Chandler, 2019; Vallin et al., 2016).

Other individual-level factors that are assumed to be associated with antibiotic consumption, and therefore presumably also AMR awareness, are level of education, age, political interest (Gianino et al., 2018; McNulty et al., 2007) and gender (Schröder et al., 2016). Finally, drawing on ample evidence from collective action research, the individual's institutional and interpersonal trust has proved positively associated with low usage of antibiotics, and is expected to hold the same association with AMR awareness (Robertson et al., 2018).

AMR awareness can also be closely associated with institutions, such as the arrangement and quality of the healthcare system (Cars et al., 2001), the capacities to surveilling and monitoring antibiotic-resistant developments and antibiotic consumption, and the recommendations and guidelines outlined in the NAP against AMR (Carelli et al., 2023; Patel et al., 2023) and, naturally, how well that is implemented. On a more general level, socio-economic and cultural variables such as income levels and levels of corruption (Rönnerstrand and Lapuente, 2017) are expected to be associated with AMR knowledge.

This suggests that government efforts to educate citizens—whether through campaigns, through guidelines and regulations, through effective transparency and communication, data-sharing, and non-state stakeholder involvement—may significantly impact individuals' awareness levels. The literature on climate change, another 'wicked' policy issue, provides some evidence of this scenario (Kollmuss and Agyeman, 2002). However, it remains uncertain to what extent such insights can be applied into the AMR field. The specific agencies involved, their respective roles, and their collaborative outcomes differ considerably from those in other cases, making direct comparisons potentially misleading. Nonetheless, the underlying principle remains the same: government actions and the manner in which they are executed likely influence the public's knowledge and awareness of an issue at hand.

In summary, despite being a crucial variable for mitigating AMR and thereby reducing the risk of significant consequences for large-scale mortality, the politico-administrative factors contributing to AMR awareness has received fairly little attention in the literature. The current literature recommends assessing the impact of several individual-level variables such as age and education, but also the quality of the institutional framework that works directly and indirectly with administering the issue, i.e., AMR-related variables such as accurate national prescribing guidelines, surveillance and monitoring systems, and factors such as the general economy and corruption. I now turn to presenting a theoretical framework that elaborates on these proposed relationships.

3. Theoretical framework

3.1. Collaborative governance

Sustaining public issue awareness is expected to be associated with the issue's prolonged and widespread visibility in society. The rationale is that wider issue ownership and channels for communication in society increases the chances for citizen exposure of information related to AMR. This idea is well-developed in European AMR governance, although to varying extents across states (Carelli et al., 2023), where the so-called One Health approach is often adopted to create holistic governance (Robinson et al., 2016). In addition, the literature on participatory governance (Dryzek, 2000), collaborative governance (Ansell and Gash, 2008) and co-production (Ostrom, 1996) have offered ample evidence concerning positive side-effects for issue awareness after citizen involvement in the phases of policy implementation.

In practice, this means to create a joint space for governance in which a significant range of stakeholders are asked to participate. Creating, to not say sustaining collaborative and horizontal governance is all but simple (Peters, 2015, p. 26), but a merit is its activation and prevalence in various societal domains. For example, allowing different political levels, various public authorities from different policy sectors, private companies, and non-governmental organizations to partially 'own' the issue will make it active and clearly visible for the citizenry. In effect, there is reason to believe larger visibility in society is associated with more public deliberation and prevailing levels of issue knowledge.

Therefore, the adoption of collaborative governance strategies to combat AMR is presumed to have a positive impact on public awareness of AMR, which prompts a first hypothesis.

H1. The quality of collaborative governance is positively associated

with public AMR awareness.

This assumption is grounded in five key factors that underpin this association. Firstly, by involving stakeholders from diverse sectors, collaborative governance incorporates a spectrum of perspectives and expertise. Secondly, it establishes communication channels that effectively disseminate information about AMR to a broader population. Thirdly, the engagement of multiple stakeholders promotes active citizen participation, fostering a sense of involvement with the issue. Fourthly, assembling various stakeholders in a holistic governance approach contributes to framing AMR as a prioritized policy issue. Lastly, collaboration facilitates the diffusion of norms and shared values, potentially influencing public perceptions and raising awareness of the issue.

3.2. The shadow of corruption on administrative governance

Collaborative arrangements, often existing informally and horizontally, are inherently vulnerable, susceptible to misuse, high costs, and a deviation from their intended ideals. A pivotal factor impeding the envisioned positive relationship between collaborative governance and AMR awareness is corruption. Corruption introduces the risk of incomplete or inaccurate information reaching the public, thereby eroding the transparency essential for cultivating awareness. Moreover, it fosters selective communication and favoritism in disseminating information, resulting in certain groups or sectors being better informed than others, thereby distorting the overall public perception.

Drawing on well-settled perspectives that recognize corruption as a hindrance to AMR governance (Collignon et al., 2018; Rönnerstrand and Lapuente, 2017) and governance more broadly (Patterson, 2024; Rothstein, 2011; Holmberg and Rothstein, 2011), a central factor to acknowledge in evaluating the impact of administrative governance on public AMR awareness is corruption. Indeed, corruption exhibits a close association with antibiotic consumption, evident at the regional level in Europe, where regions marked by high corruption levels also tend to be significant consumers of antibiotics. These findings reveal intriguing intra-national variations, such as the consumption patterns in Italy's northern and southern regions aligning with those in Sweden and Romania, respectively (Rönnerstrand and Lapuente, 2017). However, the literature has yet to sufficiently theorize and assess the channels through which corruption influences AMR.

The quality of the regulatory framework is argued to influence the applicability of operations undertaken to minimize antibiotic consumption and to maintaining good infection control in hospitals and similar facilities (Mueller and Östergren, 2016). In high-corruption settings, it is postulated that hierarchical supervision of actions and enforcements of laws and regulations are dysfunctional, thus enabling—or *nurturing*—dysfunctional incentive structures among prescribers and users of antibiotics.

On the citizen level in such circumstances, masses of individuals embrace limited levels of trust towards the state and among its fellow citizens, which make them more inclined to distrust official recommendations and deflect from societal collective action. In addition, the livestock industry is a significant economic activity where antibiotics can be used for animal growth-promotion and to prevent large-scale animal infections, linking its consumption directly to substantial financial gains and losses (Landers et al., 2012). Such excessive usage is banned throughout Europe (Schmerold et al., 2023) but given the nonexistence of regulatory capacities required to monitoring and ensuring public compliance to these regulations, incentives structures are instead expected to foster excessive antibiotic consumption among individuals and industries.

In turn, institutional arrangements outlined in the legal framework thus loses its relevance if the informal and corrupt exchanges predominate in the public sector. As such, bad administrative governance and the related obstructed public service delivery is assumed to negatively influence AMR awareness, prompting the hypothesis.

H2. Public sector corruption is negatively associated with public AMR awareness.

4. Data and method

This section describes the research design employed to analyze the data. It is supported by additional information in the Appendix regarding summary statistics, robustness controls and various regression diagnostics.

4.1. Dependent variable

The data employed for testing the theoretical expectations are gathered from multiple sources. For the dependent variable and the various individual-level factors, data are used from a recent Eurobarometer survey (Eurobarometer 522). Specifically, this survey reports data regarding knowledge, attitudes, and behavior with reference to antibiotic resistance from 26.502 individuals in all EU member states. It was conducted by face-to-face interviews between 21 February and 21 March in 2022 on behalf of the European Commission. Due to the Covid-19 pandemic, total or partial online interviews were implemented in some member states (for more details, see EU Commission, 2022).

The dependent variable employed—AMR awareness—is constructed as an ordinal variable ranging from 0 to 4. It consists of four survey items that seek to measure knowledge about antibiotics. The specific statements of which respondents were asked to agree or disagree with are: (i) "antibiotics kill viruses"; (ii) "antibiotics are effective against colds"; (iii) unnecessary use of antibiotics makes them become ineffective"; and (iv) "taking antibiotics often has side-effects such as diarrhea". I describe the statistical distributions in each of these variables in the Appendix. Merging these items into a composite measure yields a proxy of how knowledgeable the respondent is, where 0 simply means having zero accurate answers and 4 exhibiting impeccable responses. Descriptive statistics of this composite variable are displayed in Table 1.

An advantage with this measure is its standardization in the recurrent Eurobarometer surveys. For descriptive purposes, I therefore provide a graphical demonstration of the temporal development of AMR awareness in Europe from 2009 until 2022. Fig. 1 shows relatively stable patterns with values around 2.5–3.0 across most member states, but that several countries have experienced recent growth since the last measurement in 2018.

However, while the variable encompasses several dimensions of AMR knowledge, it is certainly not capturing the full range of issues centered around the AMR problem. As such, it focuses primarily on what antibiotics are and its capacity to treat diseases, and less on AMR as a distinct issue. Thus, the composite indicator is, to my knowledge, the most elaborate attempt to measure individuals' AMR awareness across the European states, but this potential limitation of measurement validity is acknowledged. Nevertheless, the Eurobarometer survey highlights a key issue concerning AMR: the misunderstanding among individuals about which diseases antibiotics can effectively treat, and the critical consequences if misuse and overconsumption persists.

Table 1
Summary of responses.

	Frequency	Percentage	Cumulative percentage
Zero accurate answers	1300	4.91	4.91
One accurate answer	2528	9.54	14.44
Two accurate answers	7214	27.22	41.66
Three accurate answers	7213	27.22	68.88
Four accurate answers	8247	31.12	100.00

Note: While not structured as an additive index, the Cronbach's Alpha for this assessment yields .27, reinforcing the validity of the current approach. The four items in question serve to gauge distinct aspects of AMR awareness, as opposed to measuring dimensions of the same aspect.

4.2. Independent variable

Each EU member state has some degree of administrative governance against AMR. What factors that create quality of administrative governance is debatable (cf. Patel et al., 2023), but previous research has pinpointed several core features that at least define the overall arrangements of institutions aimed to manage AMR (Pierre et al., 2023). Still, the hitherto most elaborate attempt to measure AMR governance cross-nationally has a significant limitation as it is constructed on outlined activities in a respective national action plan (Patel et al., 2023). The style and substance of these plans vary immensely across Europe, which mirrors different administrative traditions rather than governance quality. In turn, some countries do not even fit the analytical framework of the NAP (such as Bulgaria, Estonia, and Romania), but even more importantly, the outlined activities tell us little about how AMR governance work in practice. It is one thing to plan for action, and another one to act.

A slightly better, though still inadequate, measure of the quality of AMR governance is centered upon its outcomes, i.e., the prevalence of resistant bacteria. Phrased differently, countries with high levels of AMR are expected to have ill-quipped systems for managing the issue, such as lacking or malfunctioning surveillance systems, coordination mechanisms, persistent funding, and prescription guidelines. Therefore, we can observe an indirect manifestation of AMR governance by combining prevalence scores of three of the most aggravating resistant bacteria – *Klebsiella pneumoniae* (K pneu), *Escherichia coli* (E coli), and Methicillin-Resistant *Staphylococcus Aereus* (MRSA) in 2021. These bacteria account for around three quarters of all AMR-related deaths in the OECD countries (OECD, 2023). I describe them in greater detail in Appendix Fig. 2 illustrates the distribution among the EU27.

Meanwhile, the 'objective' scores of AMR prevalence cannot be broken down into specific components of governance quality, making it misleading to directly link these outcome to governance practices. Thus, to withstand the issue of the incomplete representations of AMR governance by, on the one hand, recognizing merely the outlined governance activities in national action plans, and on the other hand, the aggregate and latent outcome of governance, I employ a unique survey with experts and civil servants in Europe conducted by the author (and colleagues) in 2021. These data allow for more detailed examinations of how several elements of AMR governance works *de facto*.

The expert survey, conducted between October 2020 and March 2021, focused specifically on governance aspects of AMR in Europe, and this topic was clearly communicated to respondents. As a result, the data aligns with the recommended practice of including at least a one-year lag in contextual variables for multilevel models (Mehmetoglu and Jakobsen, 2022). It followed a snowballing sample method to attract experts and senior civil servants in national authorities working on AMR in their respective country. We identified 205 direct addresses, with an addition of 17 intra-distributed surveys in the respondent's own organization. It resulted in 117 complete responses, roughly 30–40 percent response rate, and covering a host of issues relating to the governance of AMR in Europe.

Conducting a survey among health experts on AMR during the Covid-19 pandemic offers advantages of timeliness, heightened awareness, and a global perspective. The relevance and real-time insights garnered during the pandemic contribute valuable data, while the global mobilization of health resources allows for diverse perspectives. However, potential disadvantages include diverted priorities and resources, as health systems primarily focus on the pandemic, leading to a lack of attention to antibiotic resistance issues. Response bias may occur, with health experts prioritizing pandemic-related concerns, and overwhelmed expertise could result in survey fatigue, impacting the depth and quality of responses. Striking a balance between leveraging the current context and recognizing these challenges is essential for interpreting and applying the survey findings effectively.

The present analysis uses country means based on nine items, ranging on a Likert scale from 1 to 7, and which posed the following question: "Please indicate how well each factor is handled in the country where you work". These data are reported in Table 2 and more fully described in the Appendix. In essence, the data thus reports average country scores according to AMR experts in both human and veterinarian sectors in Europe. It represents expert judgments of how well each respective country is currently managing the issue in light of several core activities of AMR governance, such as raising awareness-campaigns, monitoring antibiotic consumption, surveilling bacteria, following prescription guidelines, and summoning relevant stakeholders into a coherent governance framework.

In addition to these data, a measure of GDP per 1000 inhabitants for 2021 is included from the World Bank. A perception-based measure of public sector corruption is gathered from the Varieties of Democracy Institute (V-Dem) (McMann et al., 2016). The variable is defined as the following "To what extent do public sector employees grant favors in exchange for bribes, kickbacks, or other material inducements, and how often do they steal, embezzle, or misappropriate public funds or other state resources for personal or family use?" While encompassing diverse aspects of public sector corruption and acknowledging the inherent challenge of relying on expert perceptions, this item stands out as the most comprehensive measure of public sector corruption to date. It adheres to conventional conceptual foundations akin to other established measures, including Transparency International (McMann et al., 2016).

Several individual-level control variables are included to improve the model. These are: Antibiotic consumption in the last 12 months; University education (bachelor's degree and upwards); Age; Gender (1 = man, 2 = woman); and a Political interest index constructed on three items from the question "do you frequently, occasionally or never discuss (1) national, (2) European, and (3) local political matters?" The index ranges from 1 = strong political interest to 4 = not at all. Finally, I use an index to proxy the individuals' institutional trust. It ranges from 0 to 6 and consists of questions whether the respondent thinks doctors, nurses, pharmacies, hospitals, other health care facilities, or official health websites are trustworthy sources of information regarding antibiotics. The individual-level variables are summarized in Table 3.

4.3. Estimation strategy

I employ random intercept multilevel models to investigate the hypotheses (see Table 4). The dependent variable yields an ICC of 6.6 which recommends estimating the data with hierarchical modelling, i.e., that level-2 variables may have a meaningful impact on the distribution of the individual-level data (Liljequist et al., 2019).

Four models are analyzed. First, I test the bivariate relationship between AMR awareness and collaborative governance. Second, I incorporate additional governance variables from the expert survey, along with the measure of corruption. Third, I re-examine the bivariate relationship while introducing individual-level control variables. Finally, the full model is tested, including all control variables. As a robustness

Table 2
Summary of level 2 variables.

Variable	N	Mean	SD	Min	Max
Raising awareness	27	4.5	1.2	2.5	7
AMR surveillance	27	5.2	1.1	3	7
Implementing guidelines	27	4.8	1.1	2.7	7
Implementing national action plans	27	4.6	1.3	2.3	7
Provision of relevant guidelines	27	4.9	1.0	2.5	7
Prescription of antibiotics	27	4.7	1.1	2	7
Collaboration between actors	27	4.4	1.4	2	7
Allocation of resources	27	3.7	1.3	1.7	6
Political prioritization	27	3.6	1.3	1	6
GDP per 1000 inhabitants (USD)	27	38.5	24.3	11.6	135.7
AMR prevalence (E coli, MRSA, K pneu)	27	43.2	33.8	4.1	121.2
Public sector corruption	27	0.14	0.13	0	0.56

Table 3
Summary of level 1 variables.

Variable	N	Mean	SD	Min	Max
AMR knowledge	26.502	2.7	1.15	0	4
Consumed antibiotics last 12 months	26.413	1.76	0.43	1	2
University education	26.502	0.24	0.43	0	1
Age	26.502	51.4	17.9	0	98
Gender	26.502	1.53	0.5	1	2
Political interest	26.502	1.3	0.5	1	3
Trust	26.502	1.91	0.93	0	3

Table 4
Regression results.

DV: Public AMR awareness	Model 1: bivariate relationship	Model 2: governance controls	Model 3: individual-level controls	Model 4: all controls
Collaborative governance	0.087 (0.48)*	0.182 (0.41)***	0.087 (0.039)**	0.179 (0.035)***
Antibiotic consumption			0.104 (0.025)***	0.103 (0.025)***
Level of education			0.258 (0.037)***	0.258 (0.037)***
Gender			0.176 (0.026)***	0.176 (.026)***
Age			0 (0.001)	0 (0.001)
Political interest			−0.197 (0.02)***	−0.197***
Trust			0.065 (0.022)***	0.065***
Prevalence		0 (0.001)		−0.001 (0.001)
Prescription		−0.008 (0.045)		−0.024 (0.034)
Implementing NAP		−0.137 (0.054)**		−0.11 (0.046)**
Guidelines NAP		0.048 (0.044)		0.041 (0.039)
Professional guidelines		0.051 (0.047)		0.056 (0.041)
Surveillance		0.111 (0.047)**		0.053 (0.053)
Raising awareness		−0.068 (0.037)*		−0.011 (.038)
Political attention		−0.132 (0.034)***		−0.14 (0.035)***
Resources allocation		−0.019 (0.039)		−0.023 (0.036)
GDPc/1000		0.008 (0.002)***		0.006 (0.002)***
Corruption		−0.843 (0.42)**		−0.453 (0.398)
Constant	2.319 (0.205)***	2.178 (0.318)***	2.109 (0.183)***	2.116 (0.347)***
Var (constant)	0.078 (0.022)	0.011 (0.003)	0.062 (0.018)	0.008 (0.003)
Var (residual)	1.311 (0.053)	1.311 (0.053)	1.249 (.05)	1.249 (0.05)
ICC	0.056	0.0087	0.048	0.006
Observations	26502	26502	26413	26413
Number of groups	27	27	27	27

Note: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

control, I run a series of alternative regression analyses. These are presented in the Appendix.

5. Results

This section presents the results of the investigation. Model 1 reports on the bivariate relationship between the quality of collaborative AMR governance with the AMR awareness variable. In this model, the relationship is positive and significant, suggesting that citizens have more awareness of the issue when the general governance system integrates multiple stakeholders.

The finding is robust when adding the more direct measures of various aspects of AMR governance in Model 2. Several core variables of administrative governance, such as the implementation of guidelines and campaigns for raising awareness, yield no significant relationship with public awareness of the issue. The only variable that appears positively associated with public awareness except for collaborative governance is surveillance quality, i.e., the capacity of upholding surveillance systems for detecting bacterial outbreaks. This variable, however, loses its statistical significance when including individual-level controls in Model 4. The same pattern emerges for corruption, suggesting a rejection of H2.

Nonetheless, the four models support H1, indicating a positive relationship between collaborative governance and public awareness of AMR. On the contrary, somewhat unexpectedly, political attention is negatively linked with awareness, suggesting that high political priority is linked with low awareness levels. Even more puzzling is the finding that the quality of implementing actions outlined in the NAP appears negatively linked with AMR awareness. These results hold when adding several individual-level control variables and GDP per capita in Model 4. A one unit increase on the quality of implementing the NAP (range 1–7) yields a 0,1 reduction of AMR awareness (range 0–4). Increasing one unit of political attention correlates with a 0,14 reduction of awareness. By contrast, increasing one unit on the quality of upholding collaborative governance increases the public awareness with a 0,18-unit increase.

Moreover, in line with previous research, I find that several individual-level variables are significantly associated with AMR awareness. An individual who has consumed antibiotics in the last 12 months has, on average, 0,1 higher scores on AMR awareness. Having a university degree increases awareness with 0,26 units. Female respondents are, on average, 0,18 units more knowledgeable than men. Finally, trust and political interest are related with more awareness, 0,07 and 0,20 units respectively, but age yields a non-significant association.

In Appendix, I run several complementary models to control the robustness of the findings. These include conducting the analysis with outliers from the AMR expert survey excluded (Bulgaria and Spain); by adopting and omitting weights; and by omitting AMR prevalence and antibiotic consumption. The main results remain unchanged in these complementary analyses.

6. Concluding discussion

The results provide evidence that there are significant associations between the quality of administrative governance and public AMR awareness. However, this relationship is not uniformly significant across all variables. For example, while the adherence of doctors and veterinarians to professional prescription guidelines does not significantly correlate with public awareness, the general perception of how well the NAP is implemented shows a negative association with public AMR awareness. This finding suggests that in areas where public administration effectively manages issues, citizens might adopt a more passive stance, especially in contexts characterized by low political salience and high administrative autonomy. In such scenarios, public administrations may take the lead in both policy formation and implementation (cf. Carelli and Pierre, 2024).

Similarly, the negative association between political attention and awareness levels could indicate that citizens feel less urgency to be informed when they perceive that political representatives are actively addressing the issue. Alternatively, it may suggest that low public awareness prompts greater political action. Although the current research does not definitely resolve this question, it highlights the need for further investigation. The key question remains: why do we observe negative associations between awareness levels and political attention or NAP governance, but not with other activities?

Moreover, the non-significant impact of awareness-raising campaigns on public awareness, while counterintuitive, may be attributed to the phrasing of the survey question. Experts were asked to evaluate the effectiveness of these campaigns, which might not directly correlate with actual outcomes. A campaign can be well-executed and target a large audience, yet still fail to significantly increase public awareness.

Taken together, a first conclusion is that administrative activities can directly influence individual behaviors, which in turn can significantly impact large-scale behavioral patterns in societies. The policy feedback literature (cf. Béland et al., 2022) captures this notion to a certain extent, where citizens' reactions to policies feed back to policymakers during the implementation phase. However, such scenarios presuppose an active citizenry and high levels of public awareness, which are often limited for issues lacking political salience. Consequently, the link between administrative governance and public behavior on issues that operate 'behind the scenes' of more prominent political matters cannot be fully understood through the policy feedback framework alone.

Issues that struggle to gain traction on the political agenda, such as those involving scarce public goods like antibiotics, climate change, or biodiversity loss, require a nuanced understanding of the link between administrative governance and public awareness. Individual behavior plays a critical role in both the nature of these problems and the effectiveness of their potential solutions. Thus, it is essential to explore how administrative governance shapes issue awareness.

At the most basic level, public administration must be configurated to uphold routine governance mechanisms, ensuring policy regularity and public compliance. However, at a more advanced level, the design and innovation capacity of the administration can actively promote public knowledge and engagement. By viewing public administration through this lens, we can rethink normative positions of the state's tasks, broadening our expectations of what it can and should accomplish.

In the case of AMR in Europe, the key factor that enhances public awareness is collaborative governance, as postulated in H1. Collaborative governance involves sharing the policy issue at hand with multiple stakeholders. While this approach can increase societal exposure to the issue, it does not imply that all issues would benefit from being shared. As noted by theorists of collaborative governance (e.g. Peters, 2015), collaboration can sometimes come at the expense of specialization. Investing significant resources in training personnel to coordinate with specialists outside their own expertise may lead to suboptimal outcomes. The critical factor for collaborative governance to be effective is the extent to which an issue inherently requires coordination.

The One Health framework is primarily designed to mitigate the spread of antibiotic-resistant bacteria, but as the findings of this paper suggests, adopting a One Health approach may also enhance public awareness of AMR and contribute to reduced antibiotic consumption. By fostering coordination among diverse health sectors, One Health can help integrate knowledge and communication efforts, thereby amplifying the public's understanding of AMR and encouraging more responsible use of antibiotics. A fruitful avenue for future studies is to examine how One Health can be established and optimized in practice. Specifically, research should focus on how to best configure the interconnection of these specialized sectors into a cohesive and effective form of governance.

Although previous studies have linked corruption with antibiotic consumption (e.g., Collignon et al., 2018; Rönnerstrand and Lapuente, 2017), this study found no significant evidence to support the hypothesis that corruption moderates awareness levels. This result may be due to the research design and case selection, indicating the need for more refined measurements of corruption and awareness, ideally at a subnational level. Furthermore, future iterations of an expert AMR survey, similar to the one used here, will allow for time-series analyses, offering deeper insights into the dynamic relationship between administrative governance and awareness.

Despite this, the present study has leveraged a unique opportunity to examine whether AMR awareness, which is closely tied to behaviors related to antibiotics, is influenced by the quality of the state apparatus. Additionally, this study provides comparative evidence that individuals who have used antibiotics in the past year are more aware of AMR, and that awareness is also higher among educated, politically engaged individuals and those who have faith in public institutions.

To conclude, the findings of this article suggests that, in general, effective administrative governance tends to be negatively associated with public issue awareness. However, collaborative governance can counteract this trend by making the issue more prominent across different sectors of society. Thus, citizens are likely to remain passive in the administrative phase 'after politics' unless the public administration effectively highlights the issue through concerted action in the public sector.

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CRediT authorship contribution statement

Daniel Carelli: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2024.117404.

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