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# CORRUPTION AND ANTIBIOTIC USE IN THE EUROPEAN REGIONS

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## ABSTRACT

**Objective:** To investigate the association between two measures of corruption – prevalence of corruption in the health sector and prevalence of bribes in the society – and antibiotic consumption in the European regions. **Methods:** Data on the dependent variable antibiotic consumption on the regional level comes from the 2009 Special Euro Barometer Survey. Measures of the two independent variables corruption in the health care sector and bribes in the society come from the European Quality of Government Index. Correlation coefficients were calculated to investigate the bivariate correlation between the independent variables health sector corruption and prevalence of bribes and the dependent variable antibiotic consumption. A multivariate regression model was built to investigate the association between corruption and bribes in relation to antibiotics, taking the potential confounders purchasing power standardized regional GDP, regional quality of health care, inhabitants per medical doctor, and age-standardized all case mortality rates into consideration. **Results:** Strong and significant bivariate correlations between both corruption in the health sector and prevalence of bribes in society and antibiotic consumption in the European regions were found. In a multivariate regression model including confounders, the associations were persistent and strong. **Conclusions:** This paper demonstrates that dysfunctional regulatory systems and poor enforcement mechanisms seem to be factors accounting for some of the between-region variation in antibiotic consumption in Europe.

**Keywords:** antibiotic use, corruption, bribery, Europe, regions

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## Introduction

Antibiotic resistance – an unavoidable side-effect of the consumption of antibiotics – is one of the greatest global challenges to public health. Increasing bacterial resistance to existing antibiotics causes substantial morbidity and mortality and increases health-care and societal costs. As the World Health Organization (WHO) points out, “a post-antibiotic era—in which common infections and minor injuries can kill—far from being an apocalyptic fantasy, is instead a very real possibility for the 21st century” (1). In Europe alone, antimicrobial resistance is estimated to cause 25,000 deaths each year, and result in related costs of over €1.5 billion in healthcare expenses and reduced productivity (2) while in America it is estimated to cause 2m illnesses and 23,000 deaths a year (3). If resistance is left unchecked, 10 million more people are expected to die every year by 2050 (4). Consequently, “governments around the world are beginning to pay attention to a problem so serious that it threatens the achievements of modern medicine” (1).

There is a growing recognition that limiting antibacterial resistance is far from just a medical concern, but rather a behavioural and social problem. Since antibiotic consumption is the main driver of the development of antibacterial resistance, large-scale behavioural change in relation to antibiotic consumption is urgently called upon. Intriguingly, in a European perspective, there is huge variation in outpatient antibiotic consumption, variation with regard to class of antibiotics, dosage, and treatment duration, and variation in the quality of outpatient antibiotic consumption between European countries (5-9). There is also striking regional variation in penicillin consumption patterns between European regions (10). This variation is unlikely to be the result of differences in frequency of bacterial infections (5). Take for instance, Belgium and the Netherlands, which exhibit remarkable differences in antibiotic use, with the former using them to a much larger extent than the latter. Researchers suggest that the differences noticed might instead be the result of differences in regulatory practices and health-care systems (5,6,11). For example, Goossens and colleagues (6) maintain that ineffective health-care systems and poor enforcement of regulations might explain the widespread non-prescription sales of antibiotics being prevalent in many European countries. Yet these factors may be insufficient to understand the pronounced differences across regions within the same country, such as the very high levels of antibiotic consumption in Spain’s Catalonia (or Italy’s Lazio) and the moderate levels in Spain’s Basque Country (or Italy’s Tuscany). What can account for such divergences across territories that, otherwise, share so many medical, economic and socio-cultural characteristics in common?

This paper brings factor that has been neglected in the existing literature to explain the puzzling territorial divergences in antibiotic use: the level of corruption. In doing so, we follow the increasing interest among health researchers and policymakers in how corruption affects health outcomes (12). Corruption has been found to be negatively associated with a large variety of health care outputs and outcomes (13-17). The effects of corruption may matter as much – or even more than – traditionally explored factors such as health-spending measures (18) or the level of democratization (19). Corruption is not only confined to developing countries, but “corrupt practices in the health-care plague many developed countries” (18).

This paper uses a novel data from the European Quality of Government Index (20) that collects perceptions on the prevalence of bribes in the public sector in general, and the prevalence of corruption in the health sector in the regions of Europe. This data shows a large variation of the prevalence of corruption across regions within the European Union. Also, there is a strong bivariate association between these measures of corruption at regional level and antibiotic consumption in the European regions – with data from a special 2009 Euro-Barometer survey on antibiotic consumption. When controlling in multivariate regression models for multiple confounders – e.g. purchasing-power standardized regional GDP per capita, inhabitants per medical doctor, age-standardized mortality rates – the associations between regional corruption and antibiotic consumption remain persistent and strong.

## **Methods and data**

### **Independent variables**

We test two measures of corruption aimed at capturing the two main types of corruption according to the corruption research: grand corruption and petty corruption. Grand (high or political) corruption refers to the degree of public sector capture by parts of the corporate sector. Petty (low or bureaucratic) corruption refers to prevalence of bribery in the day-to-day relationships between citizens and public service providers. These two types of corruption may obey to different causes. Thus, it is reasonable to test proxies for both types of corruption: the perception of corruption in

the health care sector as a measure of grand corruption; and citizens' reported experience with bribery as a measure of petty corruption

To measure grand corruption in the health sector and petty corruption in the society in general, we utilize survey data of about 85 000 EU citizens distributed in all the 206 NUTS-1 and NUTS-2 (Nomenclature des Unités Territoriales Statistiques) regions in Europe. Making use of telephone interviews in the local language of each region, randomly drawn respondents from 18 years of age or older were asked questions relating to Quality of government on the one hand, and questions about demographics, on the other. The survey was administered beginning in February 2013 and sampled 400 or more respondents in each region. The robustness and external validity of the data has been verified thoroughly (20).

To measure the perception of corruption in the health care sector (grand corruption), respondents were asked to rate on a 10-point-scale to which extent they agreed or disagreed with the following statement: 'Corruption is prevalent in the public health care system in my area' (agree/disagree 0-10). To measure citizens' reported experience with bribery (petty corruption), the following question was asked: 'In your opinion, how often do you think other citizens in your area use bribery to obtain public services?'. Respondents were asked to answer on a 10-point scale (never/often, 0-10). The indicators of corruption in the health care sector and prevalence of bribes in the society were aggregated from the individual-level to the regional level as the mean score. In addition, to increase comparability, the measures were standardized.

The measure of corruption in the health care sector ranges from the Hovedstaden region in Denmark (1.825, very low levels of health care sector corruption) to the region of Yugozapaden in Bulgaria (-2.268, very high levels of health care sector corruption). The measure of bribery in society ranges from the region of Midtjylland in Denmark (0.926, very low levels of bribery) to the region of Bucuresti-Ilfov in Romania (4.624, very high levels of bribery).

## Dependent variable

*The Special Eurobarometer 338 was in field between 13 November and 9 December 2009 and included residents aged 15 years or above in all the 27 EU member states. The survey concerned the use of antibiotics by Europeans, public knowledge and perceptions about antibiotics, and the impact of antibiotic awareness campaigns on the knowledge and practices of Europeans related to antibi-*

*otics. The measure antibiotic consumption, following question was asked in the survey: 'Have you taken any antibiotics orally such as tablet, powder or syrup in the last 12 months?' In totality, about 40 per cent of all respondents answered that they had taken antibiotics during the past year. The answers to the question were aggregated to the regional level by using the survey question regarding respondents' region of residence.*

## **Confounders**

In the multivariate analysis, the confounders purchasing power standardized regional GDP, regional quality of health care, inhabitants per medical doctor, and age-standardized all case mortality rates. They were included in the model because they are likely to be correlated with both the main independent variable corruption and the main depended variable antibiotic consumption (21).

The data on purchasing power standardized regional GDP 2011, inhabitants per medical doctor and age-standardized all case mortality rates 2008-2011 were obtained from Eurostat's statistical depository. Data on the regional quality of health care was obtained from the European Quality of Government Index.

## **Statistics**

In the bivariate analysis, scatter plots were built to illustrate the association between the two depended variables prevalence of corruption in the health care sector and prevalence of bribes, in relation to antibiotic consumption in the European regions.

To investigate the association between these variables, Pearson's R were calculated. In the multivariate analysis, OLS regression models were analysed, so as to investigate the link between the independent variables and antibiotic consumption, while controlling for regional measures purchasing power standardized regional GDP, inhabitants per medical doctor, and age-standardized all case mortality rates.

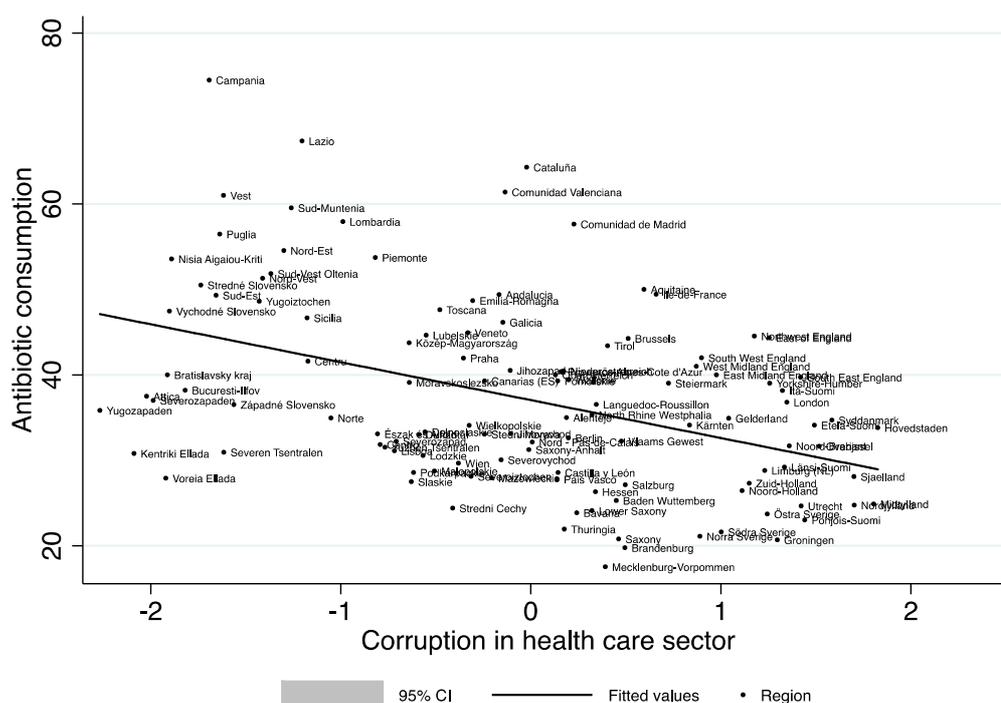
The correlations between the independent variables were generally low or moderate in strength. The correlation between regional GDP and mortality rates turned out to be the strongest (0.692). However, multicollinearity diagnostics show that all Variance Inflation Factors (VIFs) were below 2.5.

To limit the residual from biased estimations of antibiotic consumption from regions with very few respondents in the Eurobarometer survey, regions in which less than 50 answers were excluded from the analysis. However, all analyses have also been carried out including all regions, and the difference between the restricted sample and the full sample is limited.

## Results

### Bivariate analysis

FIGURE 1, CORRUPTION IN IN THE HEALTH SECTOR AND ANTIBIOTIC USE IN THE EUROPEAN REGIONS. N=117



**Comment:** Source: European Quality of Government Index 2013 and Special Eurobarometer 338. Regions with less than 50 respondents were excluded.



viduals experimenting bribery is common in their region report to consume more antibiotics than individuals in regions where bribery is less prevailing.

## Multivariate analysis

TABLE 1, MULTIVARIATE REGRESSION COEFFICIENTS AND STANDARD ERRORS OF ANTIBIOTIC CONSUMPTION IN THE REGIONS ACCORDING TO CORRUPTION IN THE HEALTH CARE SECTOR, PURCHASING POWER STANDARDIZED REGIONAL GDP, INHABITANTS PER MEDICAL DOCTOR, AND AGE-STANDARDIZED ALL CASE MORTALITY RATES.

Variable	Beta	S.E.	95 % conf. int.
Corruption in health care sector	-10.314***	1.491	-13.280 – -7.348
GDP in the regions (ln €1000)	-0.075	0.162	-0.398 – 0.247
Inhabitants per medical doctor	0.021	0.117	-0.002 – 0.443
Age-adjusted all case mortality rates	-0.026***	0.006	-0.004 – 0.002
Constant	61.065***	9.409	42.351 – 79.779
N	88		
R <sup>2</sup>	0.398		

*Table comment:* levels of significance \*:P < 0.05; \*\*:P < 0.05; \*\*\*: P < 0.005. Source: European Quality of Government Index 2012, Special Eurobarometer 338, and Eurostat. Regions with less than 50 respondents were excluded.

In order to check if the bivariate correlation between corruption (or bribery) and antibiotic consumption is spurious, we perform a multivariate analysis where we control for alternative factors that could explain divergences in antibiotic consumption, according to the existing literature (21). Table 1 shows that the negative association between corruption in the health care sector and anti-

biotic consumption is highly significant even when we control for the level of regional economic development (per capita *GDP in the regions*) and measures of the quantity (*Inhabitants per medical doctor*) and the quality (*Age-adjusted all case mortality rates*) of the health care system. It is noteworthy that there was no significant association between medical doctors per capita and antibiotic consumption. Yet there was a significant negative association between age-adjusted all case mortality rates and antibiotic consumption. Moreover, there was no significant association between the regional per capita GDP and antibiotic consumption.

TABLE 2, MULTIVARIATE REGRESSION COEFFICIENTS AND STANDARD ERRORS OF ANTIBIOTIC CONSUMPTION IN THE REGIONS ACCORDING TO BRIBERY, PURCHASING POWER STANDARDIZED REGIONAL GDP, INHABITANTS PER MEDICAL DOCTOR, AND AGE-STANDARDIZED ALL CASE MORTALITY RATES.

Variable	Beta	S.E.	95 % conf. int.
<b>Bribery</b>	-7.125***	1.089	-9.29 – -4.960
<b>GDP in the regions (ln €1000)</b>	-0.375*	0.158	-0.690 – -0.060
<b>Inhabitants per medical doctor</b>	0.001	0.011	-0.221 – 0.234
<b>Age-adjusted all case mortality rates</b>	-0.026***	0.006	-0.038 – -0.014
<b>Constant</b>	75.915***	9.990	56.045 – 95.784
<b>N</b>	88		
<b>R<sup>2</sup></b>	0.374		

**Table comment:** levels of significance \*:P < 0.05; \*\*:P < 0.05; \*\*\*: P < 0.005. Source: European Quality of Government Index 2012, Special Eurobarometer 338, and Eurostat. Regions with less than 50 respondents were excluded.

Table 2 replicates Table 1, but this time using the measure of bribery as an independent variable. Results are similar. There is a highly significant and strong negative association between bribery and antibiotic consumption, even when controlling it for the prevailing confounders in the literature for which we have data at regional level. In this case antibiotic consumption is not only significantly and negatively associated with the quality of the health at regional level (*Age-adjusted all case mortality rates*), but also with the level of economic development (per capita *GDP in the regions*), although the level of significance is lower. No significant association between *Inhabitants per medical doctor* and antibiotic consumption was found.

## Discussion

If previous research found great variation in antibiotic use across European countries (5-9), this study finds a great variation also at sub-national level (10). Similarly, this variation is unlikely to be explained by differences in frequency of bacterial infections. Take, for instance, the remarkable divergences between the neighbouring regions of Lazio and Toscana, or between Wallonie/Brussels and Flanders. Their pronounced differences in antibiotics consumption cannot either be accounted for national cultural dimensions, as previously suggested (22), since regions within the same country perform very differently. Consequently, this study tests a variable that has been found as relevant for explaining other health outcomes (12) and for which there is ample evidence of remarkable sub-national differences in Europe: corruption (20).

In particular, this study explores the statistical association between antibiotic consumption and two measures corruption in the health sector of the region – one aimed at capturing grand corruption (i.e. up to which extent the health care system benefits entrenched interests) and petty corruption (i.e. up to which extent patients are asked to pay a bribe in their relations with health professionals). The analysis shows a significant and strong negative association between these measures of corruption and antibiotic consumption. The percentage of the population stating that they have consumed antibiotics last year was significantly lower in regions with low levels of corruption, both when corruption is measured as perception of corruption in the health sector as well as when corruption is measured as direct experience with bribes.

To minimize the possibility of a spurious relationship, we include multivariate OLS regression models controlling for potential confounders, such as the level of economic development (measured by the regional GDP per capita) and the quality of the health care in the region (measured by the number of inhabitants per medical doctor and age-standardized all case mortality rates). The association between the two independent variables (corruption in the health sector and bribery) and the dependent variable (antibiotic consumption) is found to be persistent and strong also subjecting it to these controls. Indeed, the association between corruption and antibiotic use is stronger among wealthy regions than among poorer regions. In the later, the lack of economic resources may limit the ability to abuse antibiotics when corruption is widespread. That would be the case in the, relatively speaking, economically poor and high corrupt regions in East Europe and Greece, where antibiotic use is moderately low. On the contrary, in wealthier regions corruption seems to drive antibiotic consumption more neatly. That would be the case of wealthy regions in France, Spain or Italy that, nonetheless, have relatively high levels of corruption. These regions have the highest use of antibiotics in Europe, remarkably higher than in other Western European regions, which are the ones with the lowest antibiotic consumption.

Which are the mechanisms connecting high levels of corruption and high antibiotic consumption? The data presented here cannot identify the particular mechanisms, but a growing body of research provides some tentative answers. In general, several scholars have noted that a characteristic of health-care is the prevalence of problems of asymmetric information that give opportunities for abuse (18). Different players may take advantage of their privileged position for personal gain, including the government regulator, the payer (social security, private or public health insurance), the provider (public or private), the drug and equipment suppliers, and the patients (23).

In the first place, researchers have remarked that corruption in the supply of pharmaceutical could explain the connection between overall levels of corruption in a country and its health outcomes (18). The existence of an influential market of vendors and pharmaceutical firms creates a risk of bribery (24), and the discretion health professionals have to decide what medicines, and in what quantities, are needed increases the opportunity to abuse (12). These mechanisms may help to explain the link between measures of corruption in the health sector and antibiotic abuse; that is, the connection between the proxy for grand corruption and antibiotic use. In addition, scholars also note that the relation between patients and health professionals also presents risks of bribery, as a result of information asymmetries and a demand for health services which is largely inelastic (12).

Consequently, patients can ask, or be asked to, follow inappropriate procedures (e.g. antibiotics) in exchange for under-the-table payments (25). These mechanisms may help to explain the link between measures of patients' direct experience with corruption (i.e. bribery) and antibiotic abuse; that is, the connection between the proxy for petty corruption and antibiotic use.

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