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ORIGINAL ARTICLE

Corruption and population health outcomes: an analysis of data from 133 countries using structural equation modeling

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Abstract
Objectives The current study aims to develop a theoretical framework for understanding the antecedents of corruption and the effects of corruption on various health indicators.
Methods Using structural equation models, we analyzed a multinational dataset of 133 countries that included three main groups of variables—antecedents of corruption, corruption measures, and health indicators.
Results Controlling for various factors, our results suggest that corruption rises as GDP per capita falls and as the regime becomes more autocratic. Higher corruption is associated with lower levels of health expenditure as a percentage of GDP per capita, and with poorer health outcomes. Countries with higher GDP per capita and better education for women have better health outcomes regardless of health expenditures and regime type.
Conclusions Our results suggest that there is no direct relationship between health expenditures and health outcomes after controlling for the other factors in the model. Our study enhances our understanding of the conceptual and theoretical links between corruption and health outcomes in a population, including factors that may mediate how corruption can affect health outcomes.

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Introduction

Corruption has a vast impact on people's lives, especially in countries where it is widespread. High levels of corruption are associated with lower rates of economic growth, inferior public infrastructure, increased public spending, higher income inequality and poverty, and risks to national security (Gupta et al. 1998; Louise 2005; Mackey and Liang 2012; Tanzi 1998). Corruption tends to distort the motivations and incentives of decision-makers, service providers, and beneficiaries (Gupta et al. 2002; Mackey and Liang 2012; Scott et al. 2011). Moreover, the cost of corruption is substantial. Bribery alone, excluding embezzlement of public funds and theft of public assets, is estimated to total at least $1 trillion a year worldwide (Batley and Mcloughlin 2010; Kaufmann et al. 2007), while bribes received by public officials in developing countries are worth between $20 billion and $40 billion annually (Stolen Asset Recovery 2007).

A large body of literature attests to the negative consequences of corruption in the health sector (Jain 2001; Muldoon et al. 2011; Novignon 2015; Schaaf and Freedman 2015; Scott et al. 2011; Stipčić et al. 2015). For instance, Gupta et al. (2002), drawing on data from 89 countries over more than a decade (1985–1997), found a significant link between corruption and child and infant mortality, low birth weight, lower likelihood of an attended birth, and lower rates of immunization. Studies have repeatedly shown that corruption influences government spending on education and health (Gupta et al. 1998). A higher level of corruption

was shown to be correlated with lower investment in human development, as measured by life expectancy, educational attainment, and standard of living (Akçay 2006). More recently, Rajkumar and Swaroop (2008) found that lower levels of corruption were associated with greater efficacy of health spending in reducing child mortality.

While these findings on the link between corruption and population health outcomes are enlightening, they are also limited in scope, and raise a number of issues that need further investigation (Judge et al. 2011). The relative impact of corruption on various health indicators has not yet been extensively explored. In addition, studies on corruption and health outcomes have largely been atheoretical in nature. As a result, there is serious need for a more thorough inquiry into the conceptual and theoretical links between corruption and population health outcomes, such as factors that mediate how the former can affect the latter. For instance, Judge's (2011) recent meta-analysis of 42 empirical studies, which drew on the theoretical model of Collier (2002), identified political, economic, and social factors that are correlated with corruption at the national level. However, it is not yet clear how the link between corruption and health outcomes is influenced by various antecedents that affect the country's capacity to control corruption and to allocate resources to the healthcare sector.

In the current study, we applied Collier's (2002) interdisciplinary theoretical framework to create a global holistic understanding of the relationship between key antecedents of corruption—including political, economic, and socio-cultural factors—and the effects of corruption on various health indicators in 133 countries around the world. Our simultaneous examination of these factors adds to the literature on the antecedents of corruption, while also providing a preliminary assessment of how these antecedents affect health outcomes.

It should be noted that corruption is most commonly defined as the abuse or misuse of public office for private gain (Dietrich 2011; Rothstein and Teorell 2008; Vian 2008). However, the delivery of healthcare services and the allocation of healthcare resources involve not only public officials, but also agents in the private sector, including physicians, hospital managers, and other healthcare professionals, who are expected to exercise their professional judgment unbiased by their own financial interests or those of the private institutions they belong to (Savedoff and Hussmann 2006). In this study, we therefore adopt a broad definition of corruption, one that encompasses misuse of one's position or office in either the public or private sector.

Antecedents of corruption

Corruption is typically considered to reflect problems at an institutional level (Akçay 2006). Tanzi (1998) cites a number of institutional factors that can affect the occurrence of corruption, including public sector payment levels; transparency of the system; norms and characteristics of the people who fill bureaucratic roles; and rules and regulations relating to taxation, spending, the provision of goods and services, and political financing.

Collier's (2002) interdisciplinary model of corruption combines game theory with an institutional choice analytic framework, which emphasizes how social behavior is bounded by social institutions. This model seeks to understand corruption through the corrupt agent's external and internal worlds, where the external world (the institutional structure) influences the internal world of agent decision-making. According to this theory, corruption is simultaneously an economic, socio-cultural, and political and legal phenomenon, meaning that its causes should be sought in all three domains. Economic institutions provide pecuniary incentives for corruption. Corruption is then enabled at the political and legal level by failures of government and regulatory mechanisms, and at the socio-cultural level by informal social norms (Collier 2002; Judge et al. 2011; Målqvist et al. 2012).

Based on Collier's model, Judge et al. (2011) conducted a meta-analysis of 42 empirical studies and quantitatively summarized the corruption literature within a holistic theoretical framework. As predicted by Collier's model, correlations between levels of national corruption and the three groups of macro-environmental antecedents—political/legal, economic, and socio-cultural—were all significant, and the impacts of the three sets of antecedents were similar in magnitude. More specifically, low levels of corruption were a function of political openness (the presence of liberal democracy, electoral rules, voicing by citizens, political freedoms and rights, and freedom of the press), economic wealth [relatively high gross domestic product (GDP), gross net product, GDP per capita, and income per capita, along with relatively low unemployment], and relatively high levels of education.

Corruption and the health sector

There are two ways of looking at corruption in relation to the health sector. The first concerns the effects of corruption in general on a nation's ability to provide quality healthcare. In this respect, corruption can reduce government revenue that could have been spent in the best interests of patients and of public health (Akçay 2006; Gupta et al. 1998). Higher rates of corruption are associated with lower spending on healthcare and education (Gupta et al. 1998) and higher military spending (Gupta 2001). Moreover, corruption tends to distort the way economic benefits are allocated between more and less powerful social groups, creating a more inequitable

society (Akçay 2006; Holmberg et al. 2009; Målqvist et al. 2012).

The second way of looking at corruption vis-à-vis the health sector is to consider the effects of corruption within the sector itself. Corruption in healthcare can occur at any point in the system, including payments, procurement, the pharmaceutical and medical supply chains, and health service delivery; and it may take many forms, including embezzlement, theft, bribes and kickbacks, and failure to deliver services (Novignon 2015; Schaaf and Freedman 2015; Scott et al. 2011; Transparency International 2006). Kirigia and Diarra-Nama (2008), discussing corruption in the health sector, highlight management failures in three areas: financial resources, medical supplies, and health worker/patient interactions (i.e., human resources). The first, financial resources, includes embezzlement or diversion of public funds during the transfer of allocated budgets (public funds leakage), or bribes and kickbacks made to influence key regulatory or purchasing/procurement decisions. The second area, medical supplies, includes the theft of pharmaceuticals during procurement or distribution (drug leakage). The third area, human resources, includes absenteeism (i.e., failure of providers to deliver services they are being paid for), or informal or under-the-table payments to individual or institutional providers by patients seeking to jump the queue, to receive better or more care, to obtain drugs, or simply to receive any care at all.

The healthcare sector is considered particularly vulnerable to corruption for several reasons (Kassirer 2006; Savedoff and Hussmann 2006; Vian 2008). First, corruption is known to occur "where public and private sectors meet" (Akçay 2006, p.1; Judge et al. 2011). Even public health systems involve many private actors, including doctors, hospitals, and pharmaceutical companies. At the same time, the high cost of advanced medical technologies means that the health sector absorbs large amounts of public money (Kassirer 2006; Savedoff and Hussmann 2006). Various characteristics of healthcare services and goods, such as information asymmetry, uncertainties and complexities in health markets, and involvement of many stakeholders, also make this sector more vulnerable to corruption (Savedoff and Hussmann 2006).

The effects of corruption within the health sector are pernicious. As described above, corruption can affect the efficacy of health spending and interventions (Rajkumar and Swaroop 2008). Corruption creates barriers to care for those who are least able to pay by increasing the cost of key services, and it can incentivize officials to deliberately create delays or bottlenecks to extract bribes from patients, thus reducing all patients' access to timely diagnosis and treatment (Gupta et al. 2002). And even where individual providers do their best to provide decent care, they may be hamstrung by leakage of drugs and medical supplies.

Corruption measurements

Increasing research interest in corruption, and especially in efforts to fight corruption and to monitor progress in reducing it, has raised the question of how best to measure corruption levels (Kaufmann et al. 2007). Corruption is difficult to measure for several reasons. For one, while most stakeholders agree on the basic definition of corruption as abuse/misuse of power for private gain, the specific acts that fall under this definition can be a matter of dispute (e.g., distributing political favors may be considered corrupt by some observers and acceptable by others). For another, people who are involved in corruption generally hide their behavior (Sequeira 2012). Given these constraints, researchers and policy makers have developed different means of assessing corruption levels.

Corruption measures may be either objective or subjective. The most accurate objective method is auditing specific projects, whether through simple financial audits or more detailed comparisons of spending with the project's physical output. However, while this method is helpful for assessing corruption in a particular context, it is not useful for multi-country comparisons or monitoring over time (Kaufmann et al. 2007). For those purposes, broader measures are needed, such as the Public Expenditure and Financial Accountability (PEFA) initiative—a partnership between various donor agencies and international financial institutions that collects data on institutional features (e.g., procurement practices or budget procedures) that may create opportunities for corruption.

Subjective indicators are based on perceived corruption scores drawn from surveys of citizens, public officials, NGOs, multilateral donors, the private sector, and investment rating agencies. Perception-based measures have been criticized for potential bias in sampling and reporting (Sequeira 2012). Nevertheless, such measures play a critical role in assessing and measuring corruption in cross-sectional and longitudinal comparative studies. Subjective (or mainly subjective) corruption measures include, among others, the World Bank's Control of Corruption Index; the Corruption Perceptions Index prepared annually by Transparency International; and the Corruption Index and International Country Risk Guide developed by the Political Risk Services (PRS) Group.

Methods

Data sources

To test our research model, we created a unique multinational dataset of 133 countries, including 2 from North America, 23 from Latin America and the Caribbean, 24

from sub-Saharan Africa, 46 from Europe and Central Asia, 19 from the Middle East and North Africa, 4 from South Asia, and 15 from East Asia and the Pacific (the full list can be obtained from the authors upon request). The sample comprises all countries with available data for both years of the study (see below). In some analyses, we divided the sample into two groups according to the World Bank's criteria in 2009 (World Bank 2011). Low- and middle-income countries [gross national income (GNI) per capita up to $12,195] were classified as developing countries, while high-income countries (GNI per capita of $12,196 or more) were classified as developed countries. According to this classification, there are 46 developed countries and 87 developing countries in our dataset—a proportion similar to the proportion of developed and developing countries worldwide.

The dataset draws from a number of reliable and well-known sources, namely the World Bank's World Development Indicators (World Bank 2011) and Worldwide Governance Indicators (Kaufmann et al. 2009); the Institute for Health Metrics and Evaluation (Gakidou et al. 2010); the Polity IV Project (Marshall et al. 2011); the World Health Organization (2011); Transparency International (2012); and the PRS Group (2012).

Variables

To produce robust results and following Ko and Samajdar's recommendation (2010), we use three antecedents of corruption, three corruption measures, and several health outcomes. The two sets of corruption variables are based on data from 2003, and the health outcomes were measured in 2009. An additional antecedent of health outcomes, namely total health expenditure, was also measured in 2003. The descriptive statistics of the research variables are presented in Table 1.

Antecedents of corruption

We used three measures—GDP per capita (GDP), women's education (weduc), and democratic regime (regime)—as antecedents of corruption. We chose these variables because they represent the three main domains within which conditions may give rise to corruption according to Collier's (2002) model (economic, socio-cultural, and political/legal), and because they were previously found to be strongly related to corruption (Judge et al. 2011).

GDP per capita (log transformed) was calculated by dividing the country's GDP by its midyear population, and is presented in US dollars (World Bank 2011). The women's education variable represents the mean years of education for women aged 25 and above (Gakidou et al. 2010). The democratic regime score was obtained from the Polity IV Project's Indicators of Democracy scale, where the indicators reflect the competitiveness of political participation; openness and competitiveness of executive recruitment; and constraints on the chief executive. The scale ranges from 0 to 10 (fully democratic) (Marshall et al. 2011).

Corruption variables

To estimate each country's corruption level, we used three well-known indices identified by Judge et al. (2011) in comparative corruption studies: the Control of Corruption Index, the Corruption Perceptions Index, and the PRS Group's Corruption Index. The Control of Corruption Index (CC, log transformed) comprises one of the six dimensions of the World Bank's "control of corruption" measure. It is a subjective measure updated annually for countries throughout the world, and includes items such as effects of corruption on the business environment, frequency of additional payments required to get things done, and tendency of elites to control the state. The CC ranges from −2.5 to +2.5 with a mean of 0 and a standard deviation of 1 (before transformation). Higher or positive values indicate greater corruption control (Kaufmann et al. 2009).

Transparency International's Corruption Perceptions Index (CPI, log transformed) is a composite of up to 12 individual surveys and ratings by business people, risk analysts, and the general public. Scores range from 0 to 10 (before transformation), and higher scores reflect low levels of corruption (Transparency International 2012).

The PRS Group's Corruption Index (CI) ranges from 0 to 6 and is based on items such as the ability of business to influence the political process, frequency of bribes used to transact business, and awarding of business due to patronage (The PRS Group 2012). The three indices were recoded so that higher values represent higher levels of corruption.

Health indicators

Four health outcomes were measured using data from 2009: life expectancy at birth for women and men (LE); infant mortality rate per 1000 live births (IMR); percent of diphtheria, pertussis, and tetanus immunization among children aged 12–23 months (DPT); and road traffic crash age-standardized death rates per 100,000 (RTA). The health outcomes were log transformed to allow for normality of the distribution; and infant mortality and road crash death rates were reverse-coded, thus representing better health outcomes as the rate increases.

As noted above, total health expenditures (health expend) from 2003 was introduced as an antecedent of the

Table 1 Descriptive statistics of the research variables among 133 countries in the years 2003 and 2009

Variables[a]	*N*	Range	Mean	Std. deviation
Antecedents of corruption and health outcomes				
GDP per capita (in 2003)	131	124.13–48,640.84	7725.84	10,616.85
Women's education (in 2003)	130	0.5–13.7	7.35	3.54
Democratic regime (in 2003)[b]	123	0–10	5.95	3.85
Corruption measures				
Control of Corruption Index (in 2003)[c]	133	(−1.79) to 2.31	0.08	1.05
CPI index (in 2003)[d]	133	1.3–9.7	4.22	2.28
Corruption Index (in 2003)[e]	124	0–6	2.60	1.18
Intermediate variable				
Health expenditures (in 2003)	129	2.28–14.64	6.36	2.27
Health indicators				
Life expectancy (in 2009)[f]	132	45.44–82.93	70.83	9.47
Infant mortality rate (in 2009)[g]	131	1.5–122.8	25.76	26.72
DPT immunization % (in 2009)	130	42–99	89.92	10.39
Road crash age-adjusted death rate (in 2009)[h]	130	3.81–53.41	18.12	11.11

GDP gross domestic product, *DPT* diphtheria, pertussis, and tetanus

[a] The variables are presented in their original scales

[b] Range from 0 to 10 (fully democratic)

[c] Range from −2.5 to +2.5 (higher corruption)

[d] CPI = Transparency International's corruption perceptions index, range from 0 to 10 (higher corruption)

[e] PRS Group's Corruption Index, range from 0 to 6 (higher corruption)

[f] Life expectancy at birth for women and men

[g] Rate per 1000 live births

[h] Road traffic crash age standardized death rates per 100,000

health outcomes. This was measured as a percentage of GDP and log transformed.

Analytic model

The research model was tested using structural equation modeling (SEM). SEM has several features that make it attractive for the current study. Specifically, SEM (1) allows analysis of both latent and observed variables; (2) provides estimates of measurement errors; (3) allows for observing intermediate effects; and (4) allows for testing several dependent variables simultaneously (Byrne 2009).

As can be seen in Table 1, some variables in our model included a small proportion of observations with missing data (0.8–7 %). In order not to lose these observations, we employed maximum likelihood estimation, which is a direct and theoretically based estimation (Arbuckle 1996; Byrne 2009).

Results

The SEM model is shown in Fig. 1. The model indicates a good fit to the data, with $\chi^2_{33} = 86.688$, comparative fit index (CFI) = 0.962, and root mean square error of approximation (RMSEA) = 0.111 (Byrne 2009; Chen et al. 2008).

The upper portion of Table 2 presents the measurement model. As the table shows, the three items of the latent corruption variable and the four items of the latent health outcomes variable load significantly on their corresponding factors, validating the factorial structure of the latent variables.

In agreement with previous studies, the results indicate that controlling for the other variables in the model, greater corruption in a country is associated with lower GDP per capita and a less democratic regime. Health expenditure as a percentage of GDP was significantly explained by corruption, regime type, and women's education: the more corrupt a country, the lower the share of GDP expended on healthcare. Meanwhile, health expenditure as a share of GDP rises as a regime becomes more democratic and as education for its female citizens improves.

Among the antecedents of health outcomes in 2009, the strongest significant factors were GDP per capita, women's education, and corruption in 2003. An increase of one standard deviation in GDP per capita and women's education leads to increases in the health outcomes of 0.48

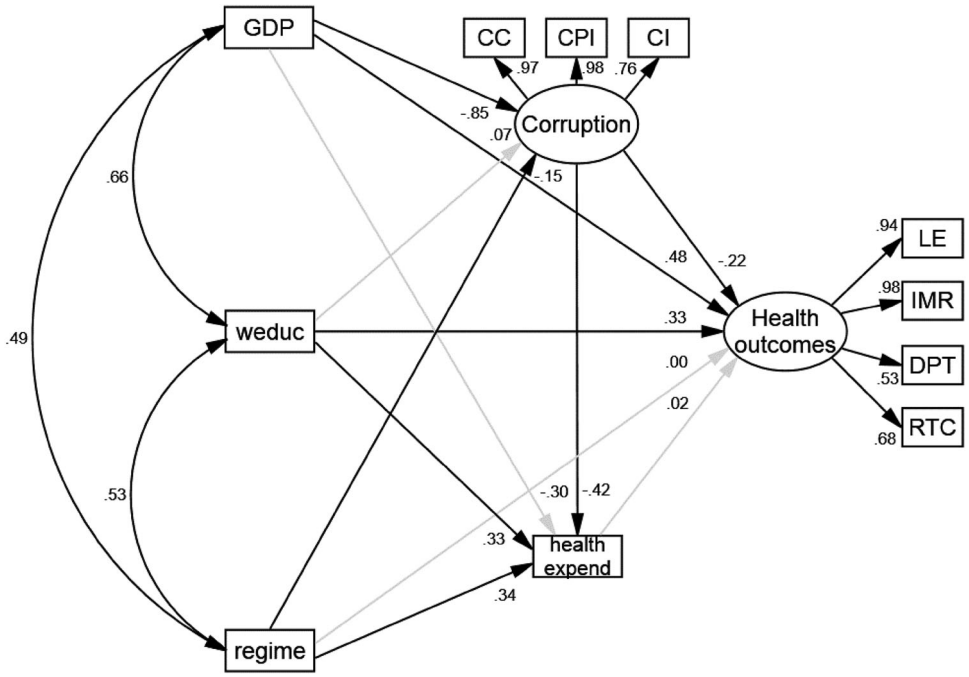

Fig. 1 Structural equation model for health outcomes on corruption, health expenditures, and antecedents of corruption and health outcomes among 133 countries in 2003 and 2009. Standardized regression estimates; error terms are not shown; significant paths ($p < 0.05$) are shown in *black arrows*; *GDP* gross domestic product per capita log transformed; *weduc* women's education; *regime* democratic regime, range from 0 to 10 (fully democratic); *CC* control of corruption index log transformed, range from −2.5 to +2.5 (higher corruption, before transformation); *CPI* corruption perceptions index log transformed, range from 0 to 10 (higher corruption, before transformation); *CI* corruption index, range from 0 to 6 (higher corruption, before transformation); *health expend* total health expenditures log transformed; *LE* life expectancy at birth for women and men log transformed; *IMR* infant mortality rate per 1000 live births log transformed; *DPT* percent of diphtheria, pertussis, and tetanus immunization log transformed; *RTC* road traffic crash age standardized death rates per 100,000 log transformed

and 0.33 standard deviations, respectively, while an increase of one standard deviation in corruption reduces the health outcomes by 0.22 standard deviations. However, it appears that controlling for the other factors in the model, health expenditures and type of regime were not correlated with the health outcomes. The results on the direct and indirect effects of different variables as a share of their total effects on health outcomes are interesting in this regard. Notably, the entire effect of women's education on health outcomes is direct, 73 % of the total effect of GDP per capita is direct, and the entire effect of regime type is indirect.

The squared multiple correlations present the percentage of variance for any variable explained by the other variables in the model. According to this analysis, the antecedents of corruption explain 78 % of its variance, and the predictors of the health outcomes variable explain 88 % of its variance. Thus, the variables in our model predict a large share of the variance in these two key factors.

After completing the analyses, we repeated them for the developing and developed countries separately. The resulting models are quite similar to the full model, though for the developed countries some associations become insignificant or marginally significant ($p < 0.1$; these results are available from the authors upon request). However, the sample size in both groups—and particularly in the developed countries group—is lower than the minimum sample size required for the current model (Bentler and Chou 1987; Quintana and Maxwell 1999; Westland 2010). Thus, the results of these models should be analyzed cautiously.

Discussion

It is well established that corruption in any country has a negative impact on that country's health outcomes. However, our understanding of the link between this complex social behavior and population health measures is still in an early stage (Judge et al. 2011).

The current study sought to develop a theoretical global holistic framework for understanding the antecedents of corruption—including political, economic, and socio-cultural factors—and their effect on various health outcomes, such as life expectancy, infant mortality, and DPT immunization rates, while evaluating the relative impact of the

Table 2 Structural equation model regression estimations for 133 countries in 2003 and 2009

		Regression estimations			
		Unstand.	Stand.	SE	*p*
Measurement model					
CPI index (log, in 2003)[a]	→ Corruption (in 2003)	1.00	0.98		
Control of Corruption Index (log, in 2003)[b]	→ Corruption (in 2003)	0.72	0.97	0.02	0.00
Corruption Index (log, in 2003)[c]	→ Corruption (in 2003)	4.13	0.76	0.33	0.00
Life expectancy (log, in 2009)[d]	→ Health outcomes (in 2009)	1.00	0.94		
Infant mortality rate (log, in 2009)[e]	→ Health outcomes (in 2009)	1.51	0.98	0.06	0.00
DPT immunization % (log, in 2009)	→ Health outcomes (in 2009)	0.79	0.53	0.12	0.00
Road crash age-adjusted death rate (log, in 2009)[f]	→ Health outcomes (in 2009)	0.61	0.68	0.06	0.00
Structural model					
GDP per capita (log, in 2003)	→ Corruption (in 2003)	−0.27	−0.85	0.02	0.00
Women's education (log, in 2003)	→ Corruption (in 2003)	0.00	0.07	0.00	0.28
Democratic regime (in 2003)[g]	→ Corruption (in 2003)	−0.01	−0.15	0.00	0.01
GDP per capita (log, in 2003)	→ Health expenditures (log, in 2003)	−0.07	−0.30	0.04	0.05
Corruption (in 2003)	→ Health expenditures (log, in 2003)	−0.31	−0.42	0.11	0.00
Democratic regime (in 2003)[g]	→ Health expenditures (log, in 2003)	0.01	0.34	0.00	0.00
Women's education (log, in 2003)	→ Health expenditures (log, in 2003)	0.02	0.33	0.00	0.00
Corruption (in 2003)	→ Health outcomes (in 2009)	−0.32	−0.22	0.12	0.01
GDP per capita (log, in 2003)	→ Health outcomes (in 2009)	0.23	0.48	0.04	0.00
Women's education (log, in 2003)	→ Health outcomes (in 2009)	0.03	0.33	0.01	0.00
Health expenditures (log, in 2003)	→ Health outcomes (in 2009)	0.03	0.02	0.09	0.76
Democratic regime (in 2003)[g]	→ Health outcomes (in 2009)	0.00	0.00	0.00	0.99

Arrows indicate a direct path (association) from the variable at the first column to the variable at the second column

DPT diphtheria, pertussis, and tetanus, *GDP* gross domestic product

[a] CPI = Transparency International's corruption perceptions index, range from 0 to 10 (higher corruption, before transformation)

[b] Range from −2.5 to +2.5 (higher corruption, before transformation)

[c] PRS Group's Corruption Index, range from 0 to 6 (higher corruption, before transformation)

[d] Life expectancy at birth for women and men

[e] Rate per 1000 live births

[f] Road traffic crash age standardized death rates per 100,000

[g] Range from 0 to 10 (fully democratic)

different factors. To do so, we followed Collier's (2002) interdisciplinary theoretical framework for corruption and created a unique multinational dataset of 133 countries that combines various well-known data sources.

Our results indicate that across 133 countries, corruption rises as GDP per capita falls and the regime becomes less democratic. In turn, higher corruption is associated with lower levels of health expenditure as a percentage of GDP per capita, and with poorer health outcomes. In addition, better health outcomes are achieved in countries with higher GDP per capita and better women's education, but these outcomes are not significantly affected by levels of health expenditure and regime type (controlling for the other factors in the model).

The most obvious implication of the current study is that, controlling for various factors, corruption seems to have a strong effect on health outcomes globally. This means, in turn, that reducing corruption levels should have the effect of improving the health of a country's population. Our model further suggests that interventions which have the effect of increasing a country's prosperity and making it more democratic may reduce corruption, which in turn is expected to improve health outcomes.

Another important implication of the current findings is that of all the factors in the model, corruption has the strongest association with health expenditure as a percentage of GDP. Thus, leaving all other factors unchanged, reducing corruption may significantly increase health expenditures. However, alongside this finding, our results suggest that health expenditures are not directly associated with health outcomes after controlling for the other factors

in the model. Further investigation is required to elucidate this interesting set of results (Aísa et al. 2014).

The findings of the current study should be interpreted in light of its limitations. First, the concept of corruption is complex. We cannot discount the possibility that some antecedents of corruption considered here may also be affected by corruption itself. Nor can we be certain that health expenditures do not affect corruption. In this respect, it should be noted that Judge et al. (2011), in their meta-analysis, found general agreement that political/legal and socio-cultural constructs are considered to be antecedents of corruption, but there is less agreement concerning economic constructs, which are considered to be both antecedents and effects of corruption.

Second, the corruption measures used in the study, though drawn from a variety of different indices, are mostly based on subjective indicators involving potential biases. However, the measures we chose are the three measures most commonly used in comparative corruption studies, and they appear to be the most suitable for longitudinal comparative studies, given that objective measures are generally rare and tend to be country- or project-specific. In this vein, we used general indicators of corruption and not health-specific corruption measures. Future studies should seek to create global measures of corruption in the health system, which might include, for example, corruption in payment systems, theft, and corruption in different stages of the production/supply chains.

Third, although we used a longitudinal design covering 6 years (the antecedents were measured in 2003 and the outcomes in 2009), there is no assurance that this gap is long enough to see the full implications of corruption. However, we did find significant effects within this time frame.

Fourth, our data did not allow us to measure the agent's internal world as defined by Collier's model (2002). Future studies should collect data that would make it possible to add factors at the agent level to the current model. Finally, given evidence about health disparities within countries (Factor et al. 2013), the current model might also be elaborated to explore the effect of corruption on different deprived populations, such as minorities within and across countries.

All in all, corruption seems to be a complex phenomenon that has a negative effect on public health. Future research efforts should continue to improve the current holistic model to better understand the underlying mechanisms of corruption, and to develop and evaluate interventions that will reduce countries' corruption levels and improve health outcomes.

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Conflict of interest No conflicts of interest.

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