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Fredrik Carlsson, Gunnar Jacobsson, Elina Lampi and Björn Rönnerstrand

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UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Peers, policy, and attitudes as drivers of antibiotic prescribing*

Fredrik Carlsson[a,b,c], Gunnar Jacobsson[b, d]Elina Lampi [b,c,e], and Björn Rönnerstrand [b,f]

Abstract: In this study we investigated how treatment norms about antibiotic use affect a doctor´s decision to prescribe antibiotics. We also investigated the attitudes and behavior of the same physicians as private persons. We find that compared with ordinary citizens, physicians are more worried and more well-informed about antibiotic resistance and use, yet they consume more antibiotics and are less willing to limit their personal use of antibiotics. There is a strong correlation between a doctor´s decision not to prescribe and the treatment norms, i.e., the perception of the common choice among physicians considering antibiotics prescription and the guidelines of antibiotics use. We also find a strong connection between professional and private attitudes: Although physicians themselves on average use more antibiotics than the general public, those who are willing to abstain from using antibiotics as a private person are also more willing not to prescribe antibiotics to their patients.

JEL-classifications: I11, I18

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[b] Center for Antibiotic Resistance Research (CARe), University of Gothenburg, Gothenburg, Sweden
[c] Centre for Collective Action Research (CeCAR), University of Gothenburg, Gothenburg, Sweden
[d] Department of Infectious Diseases, Institute of Biomedicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden. gunnar.jacobsson@vgregion.se
[e] Department of Economics, University of Gothenburg, Gothenburg, Sweden. elina.lampi@economics.gu.se
[f] The SOM Institute, University of Gothenburg, Gothenburg, Sweden. bjorn.ronnerstrand@som.gu.se

1. Introduction

Health experts point to the devastating health and economic consequences of uncontrolled antibiotic resistance. Estimations suggest that antibiotic resistance could become responsible for 10 million deaths annually by 2050 if left unchecked (O'Neill, 2014), and the economic consequences may become as severe as the financial crisis of 2008/2009 (Jonas et al., 2017).

Since human antibiotic overuse is a key driver of antibiotic resistance (Goossens et al., 2005), changing the attitudes and behaviors of prescribers is at the heart of strategies to limit the problem. Attempts are being made to promote rational antibiotic prescribing by implementing antibiotic stewardship programs (Sanchez et al., 2016). However, for such behavioral interventions to be effective, attention must be paid to the multitude of factors that govern prescription decisions by medical doctors (Bradley 1992; Freeman & Sweeney 2001; Natsch & Van Der Meer 2003; Broom et al., 2015).

We consider the relationship between the doctor and the patient as a principal-agent relationship. In the simplest version of this the doctor – the agent – makes informed decisions so that the health/welfare of the patient – the principle– is maximized (Mooney & Ryan 1993). According to Hippocratic ethics, the health of their patients should be the sole objective of doctors (Kesternich et al., 2015). In practice, however, other factors also play a role (Mooney & Ryan 1993). Economic profit of doctors is documented to influence not just doctors' decision-making in general but also their antibiotic prescribing specifically (Iversen 2000; Currie 2014). In this paper we focus on yet another reason why the interests of the "principle" may be side-stepped. Because of the collective nature of the antibiotic resistance problem, prescription of antibiotics is an example of decision-making that compels doctors to balance the health benefit of the individual patient against broader public health interests (Roope et al., 2019). This balancing act gives leeway for professional discretion and creates an ethical dilemma that needs to be resolved in clinical practice (Broom et al., 2014; Littmann & Viens 2015; Broom et al., 2016).

Many professions enjoy ample space for discretion in their daily work. Michael Lipsky defines frontline bureaucracy workers as ”[p]ublic service workers who interact directly with citizens in the course of their jobs, and who have substantial discretion in the execution of their work” (Lipsky, 2010 p. 3). Street-level bureaucracy theory concerns how judgments, convictions, and decisions can be described and explained as well as how they contribute to outcomes.

The prior research that investigates medical doctors' antibiotic prescription behavior points to the relevance of analyses of discretion also in medical practice, as this literature shows the relevance of non-medical factors for antibiotic prescribing. For example, many studies demonstrate the relevance of social factors for antibiotic prescribing. These factors include the wish of doctors to sustain a good relationship with the patient (Butler et al., 1998; Sanchez et al., 2014) and that the physicians believe that patients expect a physician to prescribe medications (Cockburn and Pit, 1997; Macfarlane et al., 1997; Coenen et al., 2002; 2006; Björkman et al., 2011; Lopez-Vazquez et al., 2012).

In this paper we make use of an online panel survey with a hypothetical prescribing decision case to study factors linked to Swedish doctors' decision to treat tonsillitis with antibiotics. We contribute to the existing literature by paying attention to the way in which professional norms and private attitudes shape how doctors handle the prescribing dilemma. We also control for experience with prescribing antibiotics and concern about antibiotic resistance among doctors.

Professional norms are conceptualized and empirically measured in two separate ways. First, we look at the perceived descriptive social norms regarding antibiotics among peer physicians. In order to measure this we asked doctors about how they think colleagues would decide in the tonsillitis hypothetical prescribing dilemma. Second, we look at the professional prescriptive norm set by written clinical treatment guidelines about “best practice” for antibiotic treatment. Treatment guidelines are often referred to as core aspects of antibiotic stewardship programs (Sanchez et al., 2016; Dyar et al., 2017). Thus, we are interested in the extent to which doctors self-reported adherence to antibiotic treatment guidelines is linked to the decision in the hypothetical tonsillitis prescribing dilemma.

There are many barriers to the implementation of treatment guidelines in clinical practice (Carlsen et al., 2007). Prior research has documented that norms among peers influence doctors' prescribing decisions (Carthy et al., 2000) and that prescription of antibiotics is by no means different in this respect (Charani et al., 2011; Broom et al., 2016). Moreover, previous studies have shown that the influence of senior colleagues on antimicrobial prescribing behavior is likely to be significant (Cortoos et al., 2008). One problem with the implementation of guidelines is thus that they tend to fall short when they contradict existing non-written social norms among peers (Burges et al., 2003). For example, in their study of antibiotic prescribing by hospital doctors in Australia, Broom et al., (2016) found that social norms regarding antibiotic prescribing tend to trump written guidelines.

Apart from the role of professional norms, we also take interest in how private behavior regarding antibiotics may influence doctors' antibiotic prescribing. While the literature on why doctors sometimes fail to implement evidence points to the role of private experiences (Freeman & Sweeney 2001), very few studies have investigated the extent to which doctors practice what they preach. An exception is a study indicating that general practitioners (GPs) would accept different types of medical treatment for themselves compared with what they would offer their patients (Gardner & Ogden, 2005). A study close to ours, and the only other paper we are aware of that investigates both private and professional preferences of physicians, is the one by Irvine et al., (2019). They investigated whether Scottish GPs' time preferences for their own health (as private persons) differ from their professional time preferences for a patient (as physicians). Interestingly, they did not find any significant differences in the time preferences.[1] However, they used a split sample design, while we sampled thee same physicians twice, each time in a specific role.

There is also a literature on whether bureaucrats or public officials, in areas other than the medical, make decisions at work based on their private norms and

[1] Other previous studies have investigated and compared physicians' and patients' *private* preferences. For example, Galizzi et al., (2016) found that there is no statistically significant difference in risk preferences in the health domain between patients and physicians, while physicians are more patient than their patients.

preferences or whether their private norms and preferences are just private. For example, Nilsson et al., (2004) found that bureaucrats working in the public sector (local government officials) often based their decisions on their private norms regarding environmental values. Eggert et al., (2018) found that bureaucrats at the Swedish Environmental Protection Agency were likely to bring their private preferences into their workplace.

In this study, we investigate the possible connection between private and professional behavior by connecting responses from two separate waves of the survey panel. In the first wave we surveyed doctors in the panel about their privately held attitudes to and use of antibiotics, without making any connection to their profession. We connect their answers to the responses in the second doctor survey wave, in particular the hypothetical question about their willingness to treat tonsillitis with antibiotics.

If doctors do bring their private behavior and attitudes regarding antibiotics to work, the question is whether this is good or bad news for prescription rates. Thus, before the analysis of determinants of doctors' prescribing decisions, we shed light on the question of whether medical doctors' and regular citizens' attitudes and behaviors regarding antibiotics use and antibiotic resistance differ when both samples answered as private persons. With that comparison we can find whether the doctors´ antibiotics use and attitudes differ from others´ ditto, and if so, how. While many prior studies have investigated behaviors and attitudes concerning antibiotics among both prescribers and patients separately (Coenen et al., 2006; McNulty et al., 2007; Rodrigues et al., 2013, 2016), few studies have systematically compared the groups.

2. Survey design and data

The data from this paper comes from two separate waves of the Swedish online Citizen Panel, administered by the Laboratory of Opinion Research (LORE), University of Gothenburg, in Sweden. The first wave was carried out in 2018 and the second in 2019–2020. Note that the medical doctors were the same persons in both waves.

Survey wave 1

The first wave of the survey was conducted March 22–April 16, 2018. The study consisted of two sub-samples. One sub-sample comprised 3,300 respondents pre-stratified to mirror the Swedish population in terms of age, education, and gender. With a response rate of 58.2 percent, this sub-sample yielded 1,920 responses. The second sub-sample consisted of panelists in the Citizens panel who previously indicated that they worked in the healthcare sector. The total number of invited respondents in this group was 2,372. With a response rate of 82.8 percent, we ended up with 1,964 responses in total. Three-hundred-seventy-one respondents answered that they currently worked as physicians. In total, 357 of the 371 respondents answered all questions necessary to be included in the analysis. Importantly, in this first wave, both sub-samples, i.e., all respondents, were contacted as private persons and asked to answer as such.

The first wave consisted of questions about the respondent's contact with the healthcare sector, their use of antibiotics, and knowledge questions about antibiotics and antibiotic resistance. The survey also included questions about the respondent's demographics and socio-economic status, as well as questions about trust in healthcare.

In the present analysis we make use of a question about the willingness to abstain from treatment with antibiotics in a situation where this would not cause any serious threats to the individual. We asked the following question to both samples (citizens and physicians):

> "For a number of bacterial infections, for example tonsillitis, we know that the use of antibiotics will quicken your recovery. If you do not take antibiotics, you will remain ill for several additional days. How willing or unwilling are you to abstain from using antibiotics when possible, even if it means that you will be sick for some extra days?"

The respondents were told to answer on a scale from 1 (very willing) to 5 (very unwilling). Similar questions have previously been used to investigate attitudes to

antibiotics using the Swedish Citizens panel (Rönnerstrand and Andersson Sundell, 2015; Robertson et al., 2018; Carlsson et al., 2019).

Survey wave 2

The second wave of the survey was carried out December 11, 2019–January 16, 2020. The target was the same 371 medical doctors who had completed the questionnaire in the first wave in 2018. A screening question asked them to verify that they still works as physicians. In total, 287 verified this and completed the survey (response rate = 77.4%).

Apart from background questions related to education, employment, and professional experience, the topic of this survey was attitudes to antibiotics and antibiotic resistance, clinical guidelines, prescribing patterns among colleagues, and personal experience of prescribing antibiotics.

In particular, the survey included a question mirroring the wave 1 question about willingness to abstain from taking antibiotics. However, the question in wave 2 was focused on physicians' decisions to treat tonsillitis in patients with antibiotics:

> "For a number of bacterial infections, for example tonsillitis, we know that prescribing antibiotics might quicken a patient´s recovery. If you do not prescribe antibiotics, there is a risk that a patient will remain ill for several additional days. How willing or unwilling are you as a physician to abstain from prescribing antibiotics when possible, even if it means that a patient will remain sick for some extra days?"

The respondents were instructed to answer on a scale from 1 (very willing) to 5 (very unwilling).

We also used a similar question, with the same answer scale (1–5), to capture beliefs about others behavior considering from abstaining antibiotics as a private person and other physicians not prescribing antibiotics. For example, in the case of a physician, the question read:

"How willing or unwilling do you think other physicians are to abstain from prescribing antibiotics when possible, even if it means that a patient will remain sick for some extra days?"

3. Conceptual model and econometric analysis

3.1 Prescription behavior

We build on the literature of treatment choice and physicians' agency (Ellis and McGuire, 1986; Chandra et al., 2012) to illustrate how doctors make prescription decisions and how these decisions depend on factors such as patient benefit, prescribing norms, and the risk of development of antibiotic resistance, but also privately held attitudes about antibiotics use.

Let us illustrate with a prescriber *k* who can choose between two treatments $i = \{a, na\}$, where the first is to prescribe antibiotics and the second is to not prescribe antibiotics. A treatment *i* results in a benefit to the patient, B_i, which is a function of factors such as health status (*X*) for patient *j*, X_j. In addition, a treatment results in a set of factors that the physician directly or indirectly cares about. These are factors related to the healthcare center and the relationship with the patient. V_i denotes the value of these factors for the physician A treatment also results in a social cost, S_i. In our case, the focus is on antibiotic resistance and the social cost is therefore *only* relevant for the treatment with antibiotics. Therefore, the social cost parameter is not included when *i=na*, e.g., when the physician decides not to prescribe antibiotics.[2] Third, we assume that the physician cares about a treatment norm (*N*) among their peers (Manski, 1993; Kwon & Jun, 2015). In particular, we assume that there is a negative utility from deviating from the norm, where the norm is the common choice among physicians (see e.g. Broom et al., 2016), indicated by $\bar{\imath}_{-k}$. The utility of the physician, W_k, consists of these three factors and an error term capturing other factors. We assume that utility is linear in these factors so that

[2] This is a simplification, and it is easy to imagine situations where there are social costs of not prescribing antibiotics, when antibiotics should have been prescribed.

we can write the utility of prescriber *k* in the cases where he/she decides to prescribe and not prescribe antibiotics as:

$$W_k(i = a) = V_a + \beta_k B_a(X_j) - \gamma_k S_a + \delta_k N(i_k, \bar{\imath}_{-k}) + \varepsilon_{ka}$$
$$W_k(i = na) = V_{na} + \beta_k B_{na}(X_j) + \delta_k N(i_k, \bar{\imath}_{t-k}) + \varepsilon_{kna},$$

respectively, where β_k is a measure of the weight the physician puts on the benefit of the patient, $\gamma_k$is the weight put on the social cost of the treatment, and δ_k is the weight put on acting in accordance or against the norm. The probability that the physician chooses the treatment without antibiotics is then:

$$P[i = na] = P[V_{na} + \beta_k B_{na}(X_j) + \delta_k N(na_k, \bar{\imath}_{t-k}) + \varepsilon_{kna} > V_a + \beta_k B_a(X_j) - \gamma_k S_a + \delta_k N(a_k, \bar{\imath}_{t-k}) + \varepsilon_{ka}] = P[\Delta V + \beta_k \Delta B(X_j) + \gamma_k S_a + \delta_k [N(na_k, \bar{\imath}_{t-k}) - N(a_k, \bar{\imath}_{t-k})] > \eta_k],$$

where ΔV is the difference in benefit to the physician between the two treatments, ΔB the difference in patient benefit between the two treatments, and η_k the difference in error terms. Thus, the probability of choosing the treatment without antibiotics depends on the difference in benefits for the physician and patient between the two treatments, the social cost of prescribing antibiotics and the cost of deviating from the norm, the weights that the individual physician puts on these three elements, and a set of unobservable factors. Note that with this formulation, a physician can decide not to prescribe antibiotics even if the difference in benefits is negative. The probability of not prescribing antibiotics is increasing in the benefit difference and the social cost. It also increases if other physicians, too, are more likely not to prescribe antibiotics.

What about guidelines? The prescribing of antibiotics according to guidelines enhances the overall quality of the prescribing (Oliveira et al., 2020). Therefore, strategies to increase compliance with guidelines are crucial in efforts to tackle antibiotic resistance. There is a vast literature on why clinicians do not prescribe according to guidelines (O´Connor et al., 2018; Rodrigues et al., 2013; Reyes-Morales et al., 2009; Hamm et al., 1996), and patient expectations to obtain medications (see, e.g., Cockburn and Pit, 1997; Macfarlane et al., 1997; Coenen et al., 2006; Björkman et al., 2011), time pressure, and uncertainty of the best clinical

management are factors often highlighted. There are several ways to let the role of guidelines enter in our framework. The first is that they give information about the benefits for the patients and the social costs of the treatment choices. That is, in the standard case, the physician actually does not know the true values of *B* and *S*, and guidelines provide information about that. With this perspective, the impact of the guidelines depends on the initial expectations and information. One would therefore have to look at very specific cases to understand the effect of guidelines, and in particular know the purpose of the guidelines. Another way to think about guidelines is that they directly affect the weights in the utility function. Again, exactly how depends on the purpose of a guideline. Finally, one could also see guidelines as something providing information about what others do, and that the provision of guidelines would increase the cost of deviating from this norm.

One interesting aspect of the model we explore in this paper is to what extent the privately held attitudes about the use of antibiotics and own behavior affects prescription behavior. To investigate this, we include the physicians' own antibiotics use and their willingness to abstain from taking antibiotics as additional explanations of prescription behavior. The probability that a doctor prescribes antibiotics is now expressed as

$$P[i = na] = P[\Delta V + \beta_k \Delta B(X_j) + \gamma_k S_a + \delta_k [N(na_k, \bar{\iota}_{t-k}) - N(a_k, \bar{\iota}_{t-k})] + \theta_k M_k > \eta_k],$$

where M_k is the privately held attitude about the importance of not prescribing antibiotics.

To investigate prescription behavior, we use the question about the likelihood to prescribe antibiotics posed in the survey. We use an OLS model where the dependent variable is a scale from 1 to 5, where 1 indicates that a physician is very likely to prescribe antibiotics and 5 that a physician is very unlikely to do so. In the first model we include various aspects of being a medical doctor, namely whether a physician has regularly prescribed antibiotics, is a GP, and has received their medical license from Sweden or abroad, as well as a dummy capturing those who have long experience of their work, i.e., those who have worked as a doctor for at least 20 years. In Model 2, we add socio-economic controls such as gender, the size

of the city a physician lives in, and self-rated health status, as well as a dummy variable capturing whether the medical doctor is worried about antibiotics resistance. In Model 3, we add variables capturing their knowledge and relation to medical guidelines, and their perception about other doctors' willingness to abstain from prescribing antibiotics. Finally, in Model 4 we add two variables relating to the personal behavior of a doctor: willingness to abstain from using antibiotics as a patient and use of antibiotics in the past 12 months.

4. Results

In the first wave survey, doctors and citizens expressed their willingness to abstain from taking antibiotics and reported on their use of antibiotics. Do remember that at this stage, all respondents answered the survey as private persons and not as professionals, and therefore we interpret their answers as such private persons. In this dataset, we have 357 doctors. After comparing doctors and ordinary citizens, we investigate the behavior of doctors as prescribers. We then primarily rely on the data from the second wave, where 266 of the 357 doctors who answered the first survey also completed the second survey where they were asked to respond as professional prescribers.

4.1 Doctors as private persons versus citizens

Based on the first wave survey, we investigate whether a person has used antibiotics in the past 12 months, is willing to abstain from using antibiotics in the case of a non-life-threatening respiratory illness although doing so will increase the number of sick days, and beliefs about other people's willingness to abstain from using antibiotics in the same situation. Table 1 shows the distribution of responses to these questions for citizens and for doctors as private persons.

Table 1. Distribution of responses for regular citizens and doctors as private persons. Standard deviations in parentheses.

	Doctors as private persons		**Citizens**	
	Willing to abstain from using antibiotics	Belief about other people's willingness to abstain	Willing to abstain from using antibiotics	Belief about other people's willingness to abstain
Very unwilling	8.5%	19%	5%	12%
Unwilling	22%	52%	14%	52%
Neither	12%	16%	16%	20%
Willing	34%	12%	35%	14%
Very willing	24%	1%	30%	2%
Mean	3.43	2.23	3.71	2.41
	(1.30)	(0.93)	(1.17)	(0.93)
Have used antibiotics during the last 12 months	29%		20%	
Number of obs.	356	355	1,918	1,916

The distribution of the extent of willingness not to use antibiotics is wide, with a considerable share of individuals in both samples who are willing to abstain. However, there are significant differences between the samples. We can reject the null hypothesis that the distributions of responses are equal between doctors and citizens (two-sample Wilcoxon rank-sum test; p-values<0.000 for all comparisons). Nineteen percent of the citizens are very or quite unwilling to abstain from using antibiotics, while among doctors this share is about 31 percent. Thus, doctors are less likely to abstain from using antibiotics. Doctors as private persons are also less optimistic than others about other people´s willingness to abstain (rank-sum test; p-value < 0.000).[3] Finally, a significantly larger share of doctors (29% vs. 20%) have used antibiotics in the last 12 months compared with the general public (two-sample proportions test; p-value < 0.000).

However, doctors differ from the general public in terms of many socio-economic and personal characteristics. In the appendix (Table A1), we report descriptive statistics of the sample of doctors and the sample of the general public. As expected, doctors are on average more educated and have a higher income than

[3] Both groups are significantly more positive about their own willingness to abstain than other people´s willingness to do so: 71 percent of doctors believe that other people are not willing to abstain, while 64 percent of the general public believes this. The differences in distributions are statistically significant in both cases (Wilcoxon signed-rank test, p-values< 0.000).

the general public. Moreover, Table A2 in the appendix shows a comparison between the doctors included in our sample and doctors in general in Sweden.[4]

Doctors also work professionally with antibiotics and an average doctor should therefore be more knowledgeable about correct antibiotics use and antibiotic resistance than an average ordinary citizen. In the appendix (Table A3), we present responses to a set of questions about being worried about antibiotic resistance and the results from the set of knowledge questions about the use of antibiotics that we included in the survey. As expected, doctors have better knowledge about antibiotics, with almost 100 percent correct answers. However, the difference between them and regular citizens is rather small, probably because of the high level of public knowledge (around 89% correct answers). Doctors are also more worried about antibiotic resistance, and feel that they are well informed. All these differences are statistically significant at the conventional level.

As already mentioned, doctors are more educated and have a higher income compared with the general public. They are also more likely to have children, and self-report a higher health status, and there are fewer women in the sample of doctors compared with the sample of the general public. The differences in attitudes and behavior could be due to these differences in observable characteristics. Hence, the comparison between the doctors and the general public should take into consideration that the two groups differ in many ways. To control for differences in observable characteristics, we apply a propensity score matching method (Joffe and Rosenbaum, 1999; Rubin and Thomas, 2000). We create a matched sample from the general public using the nearest neighbor method with 1,000 bootstrap draws, where the treatment variable is *being a doctor*.[5] We base the matching on the following characteristics: university education, working full time, income level, area of residence, having children, and gender. This results in a sample with 836

[4] If we compare individual and work-related characteristics of the doctors in our sample (n=266) with doctors in Sweden in general, we can observe some differences and some similarities (Table A1 in Appendix). In terms of the share of GPs and mean age, our sample matches the total population of doctors very well. However, we have an overrepresentation of male doctors and doctors who obtained their medical license from Sweden

[5] The propensity score ranges from 0.091 to 0.8

observations (356 doctors and 480 from the general public).[6] We then estimate regression models based on this matched sample, and then add a set of control variables capturing own health status, knowledge about antibiotics, and being worried about antibiotic resistance. We estimate three models where the dependent variable in model 1 is whether a respondent has taken any antibiotics in the last 12 months, in model 2 it is the willingness to abstain from using antibiotics, and in model 3 it is the individual´s beliefs about others' willingness to abstain from using antibiotics. Table 2 below shows results from the matched regression models.

[6] A probit model where the dependent variable is one if a respondent is a doctor shows that doctors are less likely to be females, more likely to have a higher income, and more likely to have children than the general public. The results are available on request.

Table 2. Regression results (OLS), dependent variables are having taken antibiotics the last 12 months, own willingness to abstain from antibiotics, and belief about other people's willingness to do so. Standard errors in parentheses. Matched sample.

	Taken antibiotics in the past 12 months	**Willingness to abstain**	**Belief about other people's willingness to abstain**
Doctor	0.150***	-0.427***	-0.223**
	(0.037)	(0.105)	(0.083)
Female	0.053	0.129	-0.043
	(0.030)	(0.084)	(0.066)
Age	0.013	-0.062	0.090**
	(0.012)	(0.034)	(0.027)
Large city	0.024	-0.177**	-0.071
	(0.029)	(0.081)	(0.064)
Working fulltime	-0.074	-0.105	0.023
	(0.038)	(0.108)	(0.085)
1Income	0.005	-0.024	-0.003
	(0.007)	(0.019)	(0.015)
Not reported	-0.070	-0.026	-0.080
income	(0.086)	(0.247)	(0.194)
Have child(ren)	0.051	0.034	0.071
	(0.034)	(0.097)	(0.077)
Health status	-0.067**	0.207***	0.066
	(0.019)	(0.055)	(0.043)
Correct	0.037	0.149	0.067
knowledge	(0.123)	(0.349)	(0.277)
Well informed	-0.014	0.095	-0.101
about resistance	(0.035)	(0.100)	(0.079)
Worried about	-0.030	0.315***	0.046
resistance	(0.018)	(0.051)	(0.040)
Constant	0.453**	2.046***	1.734***
	(0.150)	(0.426)	(0.337)
Number of obs.	833	834	833
Adjusted R2	0.039	0.085	0.019

***<0.001, **<0.01, and *<0.05 significance levels

Our main interest is the size and statistical significance of the dummy variable *Doctor*. We see that it is sizeable and statistically significant in all three models. The likelihood of having taken antibiotics in the past 12 months is 15 percentage points higher for a doctor, and the willingness to abstain from taking antibiotics is 0.43 units lower. Compared with the mean value in the matched sample of 3.58 (on a scale from 1 to 5), this is a sizeable effect. Similarly, the belief about other people's willingness to abstain in the same situation is about 0.22 units lower for a doctor. The mean value for the belief about others is 2.34 in the matched sample. Among the other control variables, only self-reported health status is correlated

with antibiotics use: a better health status is associated with a lower likelihood of antibiotics use in the last 12 months. A better health status is also associated with a higher willingness to abstain from taking antibiotics. Respondents who are worried about antibiotic resistance are also more willing to abstain.

4.2 Doctors as private persons and as prescribers

By using the second wave of the survey, we first compare the same sample of doctors in two different roles, i.e., as a private person and as a prescriber.[7] Table A4 of the appendix shows the distributions of answers to the main questions concerning antibiotics use and prescribing for doctors both as private persons and as prescribers. We find that the distribution of the answers to the question about own willingness to abstain from using antibiotics is not statistically different from the distribution for the question about abstaining from *prescribing* antibiotics (Wilcoxon signed-rank test; p-value = 0.947). The mean values of the responses (based on an ordinal scale from 1 to 5) are actually very similar between the two questions and not significantly different from each other. Thus, the private and professional norms are on average very similar.[8] On the other hand, distributions to the questions about own behavior and beliefs about others´ behavior when it comes to abstaining from antibiotics as a private person are significantly different. Similarly, the own prescription behavior as a physician compared to beliefs about other physicians´ prescription behavior are also significantly different from each other. (Wilcoxon signed-rank test; p-value < 0.000 for both comparisons). In both questions, physicians in our sample believe that they are more likely to abstain from taking antibiotics and prescribing antibiotics than what others do. Thus, we do not find that physicians in our sample think that others in general have similar preferences as themselves considering both antibiotics use and antibiotics prescriptions.

[7] Our sample of doctors now consists of those who responded in both the first and the second wave of our survey. Thus, the sample size has decreased from 357 to 266 observations.

[8] A Wilcoxon signed-rank test shows a significant difference in the distribution of the answers to the question about others willingness to abstain (p-value= 0.000), but that comparison is less relevant since it compares beliefs about other people's willingness to abstain from using antibiotics with beliefs about other doctors' willingness to prescribe antibiotics.

We now turn to the regression analyses and investigate what can explain a doctor´s decision not to prescribe antibiotics to a patient in the case of tonsillitis. Table 4 shows results from OLS regression models, with the decision to abstain from prescribing antibiotics as the dependent variable.[9]

Table 4. Regression results (OLS) where the dependent variable is doctors' decision to abstain from prescribing antibiotics for a patient.

	(1)	**(2)**	**(3)**	**(4)**
Regularly prescribe antibiotics	-0.017	-0.027	-0.000	0.010
	(0.160)	(0.159)	(0.128)	(0.127)
Medical license from abroad	-0.246	-0.254	-0.443*	-0.408
	(0.289)	(0.289)	(0.224)	(0.222)
Long experience	-0.323*	-0.249	-0.190	-0.137
	(0.161)	(0.165)	(0.130)	(0.130)
General practitioner	0.723***	0.749***	0.275	0.213
	(0.206)	(0.205)	(0.164)	(0.164)
Negative reactions when not prescribing	-0.536	-0.556	0.116	0.021
	(0.363)	(0.362)	(0.286)	(0.287)
Female		0.021	-0.166	-0.137
		(0.159)	(0.123)	(0.122)
Big city		-0.057	-0.067	-0.025
		(0.148)	(0.114)	(0.114)
Health status		0.157	0.112	0.075
		(0.115)	(0.090)	(0.094)
Worry about resistance		0.257*	0.170*	0.130
		(0.107)	(0.084)	(0.084)
Perceived willingness of other doctors not to prescribe			0.808***	0.755***
			(0.066)	(0.068)
Follow guidelines strictly			0.343**	0.301*
			(0.128)	(0.128)
Stated good knowledge about guidelines			0.015	0.032
			(0.131)	(0.130)
Willingness to abstain as private person				0.136**
				(0.052)
Taken antibiotics past 12 months				-0.078
				(0.141)
Constant	3.646***	2.020**	-0.133	-0.139
	(0.152)	(0.642)	(0.532)	(0.563)
Observations	230	230	230	229
R-squared	0.072	0.106	0.477	0.498

Standard errors in parentheses.*** p<0.001, ** p<0.01, * p<0.05

For Model 1, we see that GPs are much more likely not to prescribe antibiotics: the willingness to abstain from prescribing antibiotics is 0.72 units higher if the doctor is a GP. The mean value of abstaining is 3.5 (on a 1–5 scale) among all

[9] We report estimates from standard regression models. All models have also been estimated as ordered logit models, and the results in terms of statistical significance are very similar.

doctors, so the effect of being a GP is large. How regularly a doctor prescribes antibiotics does not have a significant effect, but the experience in terms of number of years has a negative effect on the likelihood of not prescribing antibiotics.

The large impact of being a GP persists in Model 2, where we include individual characteristics. In this model, those who are worried about antibiotic resistance are also more likely not to prescribe antibiotics. The gender of the doctor does not have a statistically significant impact on the willingness to prescribe.[10]

For Model 3, where we add the perceived treatment norm, i.e., beliefs about other doctors´ willingness not to prescribe and whether they strictly follow guidelines, we see that there is no longer a statistically significant direct effect of being a GP[11]. On the other hand, doctors with a license from abroad are less willing to abstain from prescribing antibiotics.[12] Most importantly, there is a strong positive correlation between own willingness not to prescribe and the treatment norm, i.e., the perception of other doctors' willingness not to prescribe. Interestingly, those who state that they strictly follow guidelines are more likely to abstain from prescribing antibiotics. Thus, both the perceived norm and the guidelines seem to decrease the likelihood of prescribing antibiotics.

In Model 4, we include the willingness of a doctor to abstain from using antibiotics as a private person. Since there is a statistically significant coefficient for willingness to abstain as a private person, this is an indication of an influence of own behavior as a citizen on decision-making as a doctor. The size of the correlation for the perception of other doctors' behavior remains largely the same in Model 4. Since the variables measuring the willingness to abstain as a private person and the perception of other doctor's behavior are measured with the same scale, we can compare the coefficients with each other. The coefficient of

[10] This indicates that our underrepresentation of female doctors (32% in the sample vs. 48% at national level, see Table A2 in the Appendix) does not bias our results.

[11] We also create interactions variables between being GP and our main variables capturing treatments norms and private attidues. All the interaction terms are insignificant indicating that GPs are not significantly different from other physicians in our sample, considering professional norms and private attitudes.

[12] Remembering that our sample has a lower share of doctors with a license from aboard (7% vs. 28% at national level, see Table A2 in the Appendix), the impact of where the license was obtained could be an underestimation.

perceived behavior of other doctors is close to six times larger than the coefficient of willingness to abstain as a private person. Thus, we find that the professional norm measured as other doctors´ prescription behavior seems to be stronger than the private attitude regarding prescription of antibiotics.

5. Conclusions and Discussion

In the case of antibiotic prescribing, the simple principle-agent aspect of the relationship between patients and medical doctors is complicated by the collective dynamic of antibiotic resistance and the need to limit overall levels of antibiotic prescribing. In particular, the balancing of individual vs. collective interest in the prescribing decision gives rise to leeway for professional discretion that needs to be resolved in clinical practice Prior studies point to the difficulty of changing clinical practices, as concerns about the long-term consequences of antibiotic resistance fall short when compared with the short-them risk of the individual patients. By exploring the role of professional norms and private attitudes, this paper extends the knowledge about how doctors handle the prescribing dilemma.

More specifically, this paper studies how professional treatment norms in the form of guidelines for correct antibiotics use and expectations of other medical doctors´ prescription behavior is linked to a doctor´s prescription behavior. In addition, we studied the connection between doctors' prescribing behavior and their personal behavior and attitudes measured as own consumption of antibiotics and personal willingness to abstain from using antibiotics as a private person. This of course also begs the question, what are the determinants of doctors' willingness to abstain from taking antibiotics as a private person, and are they similar or different compared with other citizens? As for the latter question, our results show that doctors differ from other citizens in that they consume significantly more antibiotics as private persons than the general public and they are on average less willing to abstain from taking antibiotics.

When it comes to doctors´ professional role, there is a strong correlation between a doctor´s decision not to prescribe and 1) the treatment norm, i.e., the perception of the prescription decisions of other physicians and 2) adherence to antibiotics

guidelines. We interpret the connection between own prescription decisions and the perceived prescribing among peers as the result of the norm set by what others do, but it is important to point out that we do not have a strict identification of such a causal relation. As others have pointed out (Sundvall et al., 2020), in order to improve the quality of prescribing of antibiotics, it is favorable to use peers, but also to take into consideration the impact of other healthcare categories, for example nurses (Strandberg et al., 2016). Our results also point to the importance of guidelines adherence, although the strategy to achieve this is challenging (Meeker et al., 2014; Oliveira et al., 2020). The findings of the influence from peers highlight the importance to choose properly to intervene on the individual prescriber or the prescribers sharing the same "antibiotic etiquette". Interventions on the individual level will fall short not taking into account the impact from peers. Besides, with respect to doctors' different personal attitudes to prescribing, a tailored, individual intervention is challenging.

The influence of the perceived prescribing decision of peers is interesting also in the light of previous studies on how the social norm set by senior doctors often trumps written prescription guidelines (Broom et al., 2016). In their study of antibiotic prescribing at an Australian hospital, Broom and co-workers show that deviations from existing guidelines – often motived by adjustments to "local demands" – were often the result of the prescribing norm of groups at the hospital. For many junior doctors, senior doctors' practices were much more important than the minimal reputational stake of overprescribing. The present study extends these findings by indicating that peers may influence doctors' prescribing decision also in the absence of the risk of social disapproval.

In addition to the role of professional norms, we also found a strong connection between private antibiotics behavior and antibiotic prescribing. Physicians who were less willing to abstain from using antibiotics as private persons also prescribe more, and vice versa. A paper by Nilsson et al., (2004) points to the influence of the private on the professional: bureaucrats tend to bring their private norms to work. Other studies have instead found that private and professional preferences of physicians (Irvine et al., 2019) or of bureaucrats (Eggert et al., 2018) are very much

the same. Irvine et al., (2019) also showed that doctors perceive a health condition as more severe when experienced by a patient rather than themselves, and conclude that this is important since a medical treatment recommendation may vary depending on whether the GP is using professional or private health condition values. The connection between physicians' professional and private behaviors is therefore interesting both from a policy perspective and theoretically. Awareness of the importance of private attitudes and behaviors among physicians should be acknowledged, especially in interventions to encourage proper antibiotic prescribing. However, when comparing the private attitudes and professional norms, we find that the professional norm in terms of expected peer behavior has a six time stronger impact than the private attitude towards antibiotic prescription.

The conclusions of this paper should be viewed in light of the Swedish context. Overprescribing of antibiotics remains a problem in Sweden, but compared with other European counties, and due to a steady decrease in antibiotic prescribing in the past decades, the present level of antibiotic use is low. One reason for this is the early introduction of antibiotic stewardship programs, including treatment guidelines (Mölstad et al., 2017). It is likely that the awareness of antibiotic resistance is higher among Swedish doctors and that they prescribe more in line with what is clinically motivated, compared with colleagues in other counties. This implies that the influence of norms may differ between the Swedish context and other country settings.

In general, the more non-medical factors influence prescribing, the more space there is for the influence of private attitudes regarding antibiotic prescribing. Furthermore, in the context of large variation in prescribing patterns among individual doctors, which is likely in a high-prescribing setting, adherence to guidelines may be an even more decisive factor. But while both these factors may suggest that norms may matter even more in settings other than the Swedish, the influence of the prescription habits of peers may point in the opposite direction. This stigma of non-conformity with prescribing norms among peers is likely to be higher in a setting where the awareness of antibiotic resistance is widespread. Nevertheless, a study on the influence of professional and private norms on

antibiotic prescribing in a high-prescribing context could complement the findings in this paper.

Another factor to consider is how the hypothetical prescribing situation utilized in this paper compares to "real world" prescribing. Our research strategy removes all case-specific details, as well as the interpersonal, relational aspect of prescribing, known to influence the decision-making of doctors (Strivers 2002). But the other side of the coin is that holding these factors constant makes is possible to consider novel explanatory factors, such as the link between private norms and antibiotic prescribing.

To conclude, the current paper demonstrates the importance of norms for antibiotic prescribing. Using data from a unique two-wave survey panel consisting of Swedish doctors, we show that the prescription behavior of peers, prescription policy, as well as personal attitudes regarding antibiotics all matter for what doctors decide in a hypothetical tonsillitis prescribing dilemma.

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Appendix

Table A1. Socio-economic characteristics of doctors and regular citizens. The whole samples; standard errors in parentheses.

		Doctors first wave	Doctors second wave	Citizens
Regularly prescribing	=1 if a physician regularly prescribes antibiotics (weekly).		0.47	
General practitioner	=1 if a physician is a general practitioner.		0.14	
License from abroad	=1 if a physician obtained their medical license from abroad and not in Sweden.		0.07	
Long experience	=1 if a physician has worked over 20 years as a medical doctor.		0.42	
Female	=1 if respondent is female.	0.35	0.32	0.48
Age category	= 1=<30, 2=30–39, 3=40–49, 4= 50–59, 5=60–69, 6=>70 years.	3.50 (1.50)		3.49 (1.46)
University	= if university education > 3 years	1.00	1.00	0.25
Income	= Household income level in SEK/month after taxes	64,913 (24,648)		40,383 (21,518)
Large city	=if respondent lives in a large city.	0.43	0.43	0.38
Heath status	= subjective rating of own health status where 1 is very bad and 5 is very good.	4.37 (0.72)	4.38 (0.69)	3.90 (0.86)
Correct knowledge	= fraction of correct answers to a set of questions about antibiotics	0.98 (0.19)		0.89 (0.11)
Well informed about resistance	=1 if a respondent feels well informed about antibiotic resistance	0.92		0.34
Worried about resistance	= scale between 1 and 4 where 1 means do not agree at all and 4 means totally agree.	3.61 (0.70)	3.60 (0.69)	3.09 (0.98)
Willingness to abstain as a citizen	= scale between 1 and 5, where 1 is very unwilling and 5 is very willing to abstain from using antibiotics.	3.43 (1.30)	3.47 (1.26)	3.71 (1.17)
Willingness to abstain from prescribing	= scale between 1 and 5, where 1 is very unwilling and 5 is very willing to abstain from prescribing antibiotics.		3.5 (1.13)	
Belief about other people's willingness to abstain		2.23 (0.93)	2.27 (0.92)	2.41 (0.93)
Taken antibiotics past 12 months		0.29	0.26	0.20
Number of obs.		357	266	1,916

Table A2. Work-related and demographic characteristics of doctors in sample and all doctors in Sweden 2017

		Sample	Doctors in Sweden
General practitioner	=1 if a physician is a general practitioner.	0.14	0.16
License from abroad	=1 if a physician obtained medical license abroad and not in Sweden.	0.07	0.28
Female	=1 if respondent is female.	0.32	0.48
Age category	= 1 < 50 year	0.54	0.51
Number of obs.		266	43,225

Note: Data on age, gender, and share of general practitioners comes from the Swedish Board of Health and Welfare. Data on medical license from abroad comes the OECD.

Table A3. Mean values and p-values of knowledge/worriedness questions. Standard deviations in parentheses.

Variable	Doctors	Citizens	P-value, H0: Doctors = Public[a]
Share correct answers about antibiotics	0.978	0.885	0.000
	(0.107)	(0.188)	
Feel worried about antibiotics resistance	3.608	3.089	0.000
	(0.701)	(0.979)	
Feel well informed about resistance	3.891	3.067	0.000
	(0.406)	(0.839)	
Risk that people take home resistance bacteria from abroad	3.853	3.176	0.000
	(0.465)	(0.881)	
The more antibiotics we use, the more resistance we get	3.854	3.798	0.015
	(0.482)	(0.534)	
Number of obs.	357	1,920	

[a] Two-sample Wilcoxon rank-sum test (categorical variables) and Proportion tests (dummy variables)

Table A4. Distribution of responses for doctors as private persons versus doctors as prescribers. Standard deviations in parentheses.

	Doctor as prescriber		**Doctor as private person**	
	Willing not to prescribe antibiotics	*Belief about others' willingness not to prescribe antibiotics*	*Willing to abstain from antibiotics*	*Belief about others' willingness to abstain*
Very unwilling	3%	1%	7%	16%
Unwilling	21%	32%	22%	56%
Neither	19%	33%	12%	14%
Willing	36%	29%	35%	13%
Very willing	21%	5%	24%	1%
Mean	3.5	3.05	3.47	2.27
	(1.30)	(0.93)	(1.26)	(0.92)
Number of obs.	254	256	266	265