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Original Article

Factors influencing antibiotic prescribing (EVA Study) among office-based physicians in Hesse, Germany, 2026 – evolution of influencing factors over time, frequency of antibiotic therapy, and suggestions for improvement (2008–2026)

Abstract

Background and objective: Antibiotic-resistant pathogens (MDROs) are an urgent public health problem. Surveys on the factors influencing antibiotic prescribing among office-based physicians (EVA Study) were conducted in Germany in 2008 and in the state of Hesse in 2016. The EVA survey was repeated in Hesse in 2026 in order to analyze trends in the prescribing behavior of office-based physicians.

Material and methods: The online survey included all office-based physicians in Hesse and contained questions on the factors influencing the respondent's decision to prescribe antibiotic therapy, the relevance of antibiotic resistance, the respondent's own expertise, and proposals for improving antibiotic therapy. The data were compared to the surveys in 2008 and 2016.

Results: Of the 7,913 individuals contacted, 892 (11.3%) responded. 49.2% of respondents reported making daily decisions regarding antibiotic therapy (2016: 54.2%; 2008: 63.3%). The survey found a decrease in the non-medical reasons for prescribing. These included "to be on the safe side" 19.1% (2008: 27%), fear of legal consequences 11.2% (2008: 15.4%) and the patient's desire to continue working 7.8% (2008: 19.1%). Perception of the relevance of antibiotic resistance rose from 66.8% (2008) to 82.8% (2026) and the awareness that one's own prescribing behavior influences regional resistance increased from 51.1% to 62%.

Conclusion: Office-based physicians reported that they prescribed antibiotics on a daily basis less frequently in 2026 than previously. The decline in psychological factors suggests an increased confidence in prescribing; however, organizational barriers are on the rise and should be specifically addressed.

Keywords: antibiotic prescription, antibiotic stewardship, psychological and organizational influencing factors, office-based physicians

Ursel Heudorf[1]
Iris Natanzon[2]
Rolf Tessmann[1]
Katrin Steul[1]
Klaus-Peter Hunfeld[3,4]

1 Multidrug Resistant Organism (MDRO) Network Rhine-Main, Dietzenbach, Germany

2 The Medical Association of Hesse, Frankfurt/Main, Germany

3 Institute for Laboratory Medicine, Microbiology & Infection Control, Northwest Medical Centre, Frankfurt/Main, Germany

4 Society for Promoting Quality Assurance in Medical Laboratories (INSTAND), e.V., Düsseldorf, Germany

Introduction

Antibiotic-resistant bacteria (MDROs) are classified as an urgent problem for the healthcare system [1], [2]. An increase in these pathogens in recent decades has led to the development of strategies and measures around the world to counteract the rise in resistance through the appropriate and, where possible, restrained use of antibiotics. The German Antibiotic Resistance Strategy (DART) was developed in 2008 and updated in 2015 [3], [4]. In addition, regional MDRO networks have been established throughout Germany to better prevent MDROs and to improve the management of patients colonized or infected with these pathogens in both inpatient and outpatient medical and nursing care settings.

The MDRO Network Rhine-Main was founded in 2010 (https://www.mre-rhein-main.de) in the Rhine-Main region of Hesse, Germany. In its early years, the network focused on the use of proper hygiene methods when dealing with MDRO patients; in 2015 the network began focusing on the appropriate use of antibiotics. Informational flyers were developed for patients with respiratory, urinary tract, and ear nose throat (ENT) infections [5], an Antibiotic Stewardship working group was established [6], and continuing education courses were organized for office-based physicians. In 2016, the MDRO Network Rhine-Main and the Medical Association of Hesse jointly con-

ducted the EVA Study Hesse 2016 (Factors Influencing Antibiotic Prescribing in Hesse 2016) [7], [8], [9]. This involved replicating the EVA survey that the Robert Koch-Institute (RKI) had conducted in 2008, which contained a representative sample of hospital physicians and office-based physicians in Germany [10], [11]. Its aim was to examine the personal, psychological, and organizational factors influencing antibiotic prescribing, to determine the frequency of decisions on initiating antibiotic therapy, and to collect the physicians' suggestions for improvement; questions were also asked about the most commonly treated infections and the corresponding antibiotic therapies [10], [11].

In 2026, this survey was repeated in Hesse using the same methodology, with the aim of examining trends over time.

Materials and methods

Following an announcement in the Hessian Medical Journal, the Medical Association of Hesse conducted an online survey of all office-based physicians in Hesse in February 2026. The online questionnaire contained five main sections:

1. **Personal information** (age, gender, specialty)
2. **Questions on antibiotic use**, including the frequency of prescribing antibiotics (Likert scale: daily, weekly, monthly, less frequently, never)
3. **Questions on factors influencing the decision to prescribe antibiotic therapy**—preformulated questions with response options on a 5-point Likert scale
4. **Questions pertaining to the assessment of the problem of antibiotic resistance and the respondent's own expertise**
5. **Questions regarding proposals for improving antibiotic therapy** (4-point Likert scale)

An initial email was sent on February 2 to 7,913 office-based physicians, followed by a reminder email on February 9. Raw data were forwarded to the network in a tabular, anonymized format for evaluation; for data protection reasons, only aggregated data regarding age and gender were transmitted. The analysis was descriptive (prevalence rates) so that a comparison could be made with the earlier surveys in 2008 and 2016. A Z-test was used to detect significant differences between each pair of annual datasets. These Z-tests were exploratory and not adjusted for multiple comparisons.

Data on the most commonly treated infections and the antibiotics employed for this purpose were collected as well, the results are scheduled to be published in a future publication.

Results

Of the 7,913 office-based physicians contacted, 892 (11.3%) responded. These included 52% female and 48% male physicians. One-quarter of the participants were under 50 years old, 35% were between 50 and 59 years old, and 40% were over 59 years. This represents a significant increase in the proportion of female physicians, from 36.2% in 2008 to 51.5% in 2026. During the same period, the proportion of those over 59 doubled from 18.4% to 40%. In all surveys (2008, 2016, and 2026), general practitioners and internists accounted for more than half of the participants; the next most common specialist groups were gynecologists, pediatricians, and ENT specialists (Table 1).

49.2% of participants reported making daily decisions about antibiotic therapy. This represents a decrease over figures reported in 2016 (54.2%) and 2008 (63.3%) (Table 2).

The most frequently cited non-medical reasons for initiating antibiotic therapy in 2026 (strongly agree + agree) were: to be on the safe side (19.1%), because a return visit would be difficult due to long travel distances (12.0%), fear of legal ramifications if antibiotic therapy is not initiated (11.2%), because the patient demands an antibiotic, or because the patient insists on continuing to work (7.8% each); other reasons were cited less frequently. There were clear decreases compared to 2008: to be on the safe side (down from 27% to 19%), because the patient insists on continuing to work (down from 19.1% to 7.8%), out of fear of legal ramifications (down from 15.4% to 11.2%), and because the doctor thought that the patient would feel better if an antibiotic were to be prescribed (down from 12.9% to 4.4%). The decreases were generally much larger between 2008 and 2016 than between 2016 and 2026. In contrast, there was no downward trend among the more organizational reasons; the mention of reduced workload for staff actually increased from 2008 to 2026: from 1.3% to 2.9% (Table 3).

The perception that antibiotic resistance is relevant to one's workplace increased from 66.8% to 84.4% between 2008 and 2016, after which no further increase was observed (2026: 82.8%). Similarly, the perception that one's own prescribing behavior influenced regional resistance increased from 51.1% in 2008 to 61.9% in 2016 and remained at that level thereafter (2026: 62%). The number of respondents who considered themselves to be well-informed about antibiotic therapy rose steadily from 78.8% in 2008 to 81.7% in 2016 and 84.9% in 2026. In every survey year, three-quarters of participants consistently reported having experienced treatment failure and to adhering to the relevant guidelines (Table 4).

When asked for proposals for improvement, the most frequently cited suggestions were the monitoring of regional resistance patterns, guidelines for diagnosing and treating bacterial infections, and eliminating financial drawbacks for laboratory testing (Table 5).

Table 1: Survey participants by age and gender – comparison of Hesse 2026, Hesse 2016 [7], and Germany 2008 [10]

		Germany 2008		Hesse 2016		Hesse 2026	
		n	%	n	%	n	%
Participants	**Contacted, all**	**n.r.**		**6,333**		**7,913**	
	Participated	**1,861**	**n.r.**	**858**	**13.5**	**892**	**11.3**
Age group	<30 years old	2	0.1	6	0.7	0	0
	30–39 years old	127	6.8	92	10.7	29	3.3
	40–49 years old	699	37.5	235	27.4	192	21.6
	50–59 years old	690	37.0	345	40.2	312	35.1
	>59 years old	343	18.4	180	21.0	355	40.0
	Total	1,861		858		888	
Sex	Male	1,168	63.8	444	52.5	426	48.3
	Female	662	36.2	401	47.5	454	51.5
	Diverse	n.r.		n.r.		2	0.2
	Total	1,830		845		882	
Specialization	General medicine	950	51.4	333	39.6	306	34.8
	Internal medicine (all areas)			120	14.3	197	22.4
	Gynecology and obstetrics	233	12.6	66	7.8	79	9.0
	Pediatrics and adolescent medicine	184	9.9	50	5.9	76	8.6
	Ear, nose and throat medicine	81	4.3	33	3.9	41	4.7
	Orthopedics and trauma surgery	n.r.	n.r.	33	3.9	32	3.6
	Psychiatry, psychotherapy and psychosomatics	n.r.	n.r.	28	3.3	28	3.2
	Urology	61	3.3	18	2.1	20	2.3
	Dermatology and venereology	79	4.2	22	2.6	19	2.2
	Other specializations	n.r.	n.r.	n.r.	n.r.	19	2.2
	Ophthalmology	n.r.	n.r.	14	1.7	15	1.7
	Surgery	n.r.	n.r.	34	4	12	1.4
	Anesthesiology	n.r.	n.r.	21	2.5	9	1.0
	Oral and maxillofacial surgery	n.r.	n.r.	4	0.5	3	0.3
	Radiology	n.r.	n.r.	8	1	2	0.2
	No specialization	9	0.5	57	6.8	**22**	2.5
	Total	1,847		841	100	880	100

n.r.=not reported

Table 2: Frequency of decisions to start antibiotic therapy – comparison between Hesse in 2026, Hesse in 2016 [7], and Germany in 2008 [10]

How often do you decide to start antibiotic therapy for a patient?	Germany 2008		Hesse 2016		Hesse 2026	
	n	%	n	%	n	%
Daily #, ##	1,164	63.3	439	54.2	439	49.4
Weekly	493	26.8	208	26.3	270	30.4
Monthly	105	5.7	53	6.7	71	8.0
Less frequently	63	3.4	67	8.5	64	7.2
Never	14	0.8	35	4.4	45	5.0
Total	1,839		802		889	

difference 2008–2016 p <0.01; # difference 2016–2026 p<0.05

Discussion

The increase in the proportion of female physicians and physicians over the age of 60 among the participants reflects the general trend [12]. However, the gender distribution (48% male; 52% female) of the participants differed from the percentages of those who were contacted (57% male, 43% female).

Comparison of EVA studies from 2008 to 2026

In 2026, office-based physicians were found to **make daily decisions about prescribing antibiotic therapy** much less frequently than in 2008. This could be an indication that the information and training on antibiotic stewardship are beginning to bear fruit. However, since we have no data on these factors, we cannot draw this conclusion from our study; in particular, we cannot rule out that the

Table 3: Factors influencing antibiotic prescriptions – comparison between Hesse in 2026, Hesse in 2016 [7], and Germany in 2008 [10]

		Germany 2008		Hesse 2016		Hesse 2026	
		n	%	n	%	n	%
When a patient demands antibiotics	Strongly agree	6	0.3	4	0.5	3	0.4
	Agree	138	7.5	51	6.7	63	7.4
	Neutral	218	11.8	74	9.8	107	12.6
	Disagree	794	42.9	350	46.3	378	44.7
	Strongly disagree	694	37.5	277	36.6	295	34.9
	Total	1,850		756		846	
When, as a doctor, I have the impression that the patient feels well looked after	Strongly agree #	32	1.7	12	1.6	3	0.4
	Agree #, ##	206	11.2	56	7.5	34	4.0
	Neutral	319	17.3	129	17.2	159	18.8
	Disagree	741	40.2	319	42.5	334	39.5
	Strongly disagree	543	29.5	235	31.3	315	37.3
	Total	1,841		751		845	
When a patient absolutely wants to work	Strongly agree	14	0.8	6	0.8	2	0.2
	Agree ##	337	18.3	64	8.5	64	7.6
	Neutral	390	21.2	146	19.4	141	16.7
	Disagree	646	35.1	289	38.5	361	42.7
	Strongly disagree	452	24.6	246	32.8	277	32.8
	Total	1,839		751		845	
To shorten the duration of the consultation	Strongly agree	10	0.5	2	0.3	5	0.6
	Agree	66	3.6	21	2.8	35	4.2
	Neutral	151	8.2	52	6.9	84	10.0
	Disagree	658	35.7	258	34.4	323	38.4
	Strongly disagree	956	51.9	416	55.5	394	46.8
	Total	1,841		749		841	
When a follow-up examination is difficult due to a long journey	Strongly agree	6	0.3	4	0.5	3	0.4
	Agree	230	12.5	67	8.9	98	11.6
	Neutral	268	14.6	97	13.0	155	18.4
	Disagree	733	39.8	305	40.7	311	36.8
	Strongly disagree	604	32.8	276	36.8	277	32.8
	Total	1,841		749		844	
When I want to avoid additional work for myself or my employees	Strongly agree	3	0.2	3	0.4	2	0.2
	Agree	19	1.1	12	1.6	23	2.7
	Neutral	19	1.1	37	4.9	54	6.4
	Disagree	583	32.5	229	30.5	309	36.7
	Strongly disagree	1,169	65.2	471	62.6	455	54.0
	Total	1,793		752		843	
When I decide not to carry out further laboratory tests due to the costs involved	Strongly agree	11	0	9	1.2	8	0.9
	Agree	96	5.2	29	3.9	38	4.5
	Neutral	146	7.9	63	8.4	70	8.3
	Disagree	684	37.2	241	32.0	327	38.7
	Strongly disagree	901	49	410	54.5	401	47.5
	Total	1,838		752		844	
To be on the safe side	Strongly agree ##	22	1.2	16	2.1	9	1.1
	Agree	472	25.8	145	19.3	152	18.0
	Neutral	545	29.8	215	28.6	218	25.8
	Disagree	567	31	218	29	274	32.4
	Strongly disagree	221	12.1	159	21.1	193	22.8
	Total	1,827		753		846	
When I am concerned about the legal ramifications of not providing treatment	Strongly agree	28	1.5	19	2.5	11	1.3
	Agree	255	13.9	75	10	84	9.9
	Neutral	358	19.6	126	16.7	135	16.0
	Disagree	722	39.5	266	35.3	309	36.6
	Strongly disagree	465	25.4	267	35.5	306	36.2
	Total	1,828		753		845	

difference 2016–2026 $p<0.05$; ## difference 2008–2016 $p<0.01$

Table 4: Assessment of the problem of antibiotic resistance and appraisal of one's own knowledge of antibiotic therapy – comparison between Hesse 2026, Hesse 2016 [7], and Germany 2008 [10]

	Germany 2008	Hesse 2016	Hesse 2026
Participants	1,773–1,837	717–722	847–850
	%	%	%
Do you consider the issue of antibiotic resistance to be relevant to your workplace?	66.8	84.4	82.8
Have you had any experience with treatment failure in cases of resistant pathogens?	77.1	76.6	78.0
Do you believe that your prescribing behavior has an impact on the antibiotic resistance situation in your region?	51.1	61.9	62.0
Do you feel well informed about antibiotics and the aspects to be considered when prescribing them?	78.7	81.7	84.9
Do you follow recommendations or guidelines on antibiotic therapy in your daily work?	77.7	76.6	79.3

increase in female and older participants may have, at least partially, influenced the reported decrease in prescriptions (see below). It also cannot be ruled out that, given the low response rate, the respondents were primarily physicians with a particular interest and expertise in antibiotic therapy, which may have led to a bias toward positive responses compared to the representative study conducted by the Robert Koch Institute in 2008. However, surveys on the use of antibiotics in the office-based physicians also show a decline in prescriptions over the years in Germany and in Hesse [13], [14], [15], [16], [17]. During the SARS-CoV-2 pandemic in 2020 and 2021, antibiotic prescriptions for people with public health insurance in Germany had decreased by approximately 30% compared to 2019 [15], [17]. However, starting in 2023, they rose again to nearly pre-pandemic levels [15], [17]. Since our survey took place in the spring of 2026, it no longer seems likely that the pandemic continues to influence prescriptions, although this cannot be ruled out with certainty.

In 2026, **personal and psychological reasons** for prescribing antibiotics (a desire to be on the safe side, fear of legal ramifications, the impression that patients feel they are receiving better treatment when antibiotics are prescribed, or because patients have a strong desire to return to work) were cited less frequently than in 2008, which could indicate greater certainty on the part of physicians on whether or not to prescribe treatment. In contrast, **organizational reasons** (difficulty in conducting follow-up examinations due to long travel distances, shortening consultation time) remained the same or even increased (workload reduction for staff). This could indicate an increase in work pressure in medical practices.

In 2026, the **perceived importance of resistant pathogens** and one's own behavior on regional resistance development, as well as the perception of being **well-informed** about antibiotic therapy was higher than in 2008. **Adherence to guidelines** remained largely unchanged among three-quarters of the physicians over this period. No conclusions or hypotheses regarding the causes can be drawn from on our survey alone.

The most frequently cited **proposals for improvement** (>90%) across all years included **guidelines for the diagnosis and treatment of bacterial infections** as well as the monitoring of regional resistance patterns. Several guidelines have been published in Germany since 2016 (i.e. [18], [19], [20], [21]). In particular, the Guidelines on Urinary Tract Infections were imparted in a practice-oriented way by DEGAM [21]. RKI has been operating the Antibiotic Resistance Surveillance and Antibiotic Use Surveillance systems for many years [22], [23]. Resistance data can be accessed interactively for inpatient and outpatient settings, in some cases by specialty groups (general practice, internal medicine, ENT, pediatrics, urology); however, queries are only possible for aggregated regions in Germany (northeast, northwest, southeast, southwest), i.e., no regional resistance data (ARE) are available. For office-based physicians, the interactive online query on the resistance situation (https://amr.rki.de/Content/Datenbank/ARS/ResistanceOverview.aspx) appears to be both very time-consuming and relatively ineffective due to the lack of more detailed, regional data. Here, office-based physicians should be provided with simple, up-to-date information on the most common infections and their typical pathogens, e.g., through the medical associations or the state associations of panel physicians.

Over the years, **eliminating the financial drawbacks** associated with laboratory tests has been mentioned more and more frequently; in 2026, this ranked third among the top wishes. According to the Association of Panel Physicians Hesse (KV Hessen), this may be the result of a misunderstanding, as office-based physicians do not incur any direct financial costs for laboratory tests related to infections; at most, they lose the laboratory bonus of 90 cents per patient. According to the current guideline on the treatment of adult patients with community-acquired pneumonia, microbiological diagnostic testing is generally not required for mild cases of pneumonia that can be treated on an outpatient basis [18]. Similarly, if clinical symptoms are clear, microbiological testing is not required for uncomplicated, non-recurrent, and non-treatment-resistant cystitis in non-pregnant premenopausal women without other relevant comorbidities [19].

The request for more **practice-oriented training** increased significantly between 2016 and 2026. The online courses on Rational Antibiotic Therapy through Information and Communication [24], [25] were unfortunately only

Table 5: Proposals for improving antibiotic therapy – comparison between Hesse 2026, Hesse 2016 [7] and Germany 2008 [10]

		Germany 2008		Hesse 2016		Hesse 2026	
		n	%	n	%	n	%
Recording of individual antibiotic prescriptions with appropriate feedback for attending physicians	Very important	268	14.8	169	24.7	216	25.7
	Important	837	46.2	328	48.0	422	50.3
	Less important	555	30.6	146	21.3	169	20.1
	Not important	151	8.3	41	6.0	32	3.8
	Total	1,811		684		839	
Recording of regional antibiotic resistance with appropriate feedback for attending physicians	Very important	907	49.4	382	55.4	447	52.8
	Important	823	44.9	276	40.0	353	41.7
	Less important	87	4.7	25	3.6	39	4.6
	Not important	18	1.0	7	1.0	7	0.8
	Total	1,835		690		846	
Guidelines on the diagnosis and treatment of bacterial infections for physicians in private practice	Very important	884	47.9	352	50.6	450	53.3
	Important	831	45.0	290	41.7	351	41.6
	Less important	116	6.2	40	5.7	37	4.4
	Not important	13	0.7	14	2.0	6	0.7
	Total	1,844		696		844	
Restriction of the selection of antibiotics via a positive list	Very important	308	16.7	166	24.1	212	25.1
	Important	641	34.7	258	37.4	398	47.2
	Less important	648	35.1	188	27.2	180	21.3
	Not important	248	13.4	78	11.3	54	6.4
	Total	1,845		690		844	
More practice-oriented training courses offered by the medical association/insurance company on rational antibiotic therapy for doctors in private practice	Very important	n.r.		131	18.1	199	23.6
	Important			367	50.7	479	56.9
	Less important			183	25.3	145	17.2
	Not important			43	5.9	19	2.3
	Total			724		842	
More support (including financial) for utilizable and financeable "point of care" testing such as CRP in daily practice	Very important	n.r.		253	37.1	342	40.7
	Important			234	34.3	324	38.5
	Less important			167	24.5	152	18.1
	Not important			28	4.1	23	2.7
	Total			682		841	
Continuous improvement of the quality of antibiotic therapy by antibiotic experts (consulting/ audits and feedback)	Very important	431	23.6	131	18.1	166	19.7
	Important	1,012	55.3	367	50.7	440	52.2
	Less important	324	17.7	183	25.3	210	24.9
	Not important	62	3.4	43	5.9	27	3.2
	Total	1,829		724		843	
Development of a medical association/insurance company internet portal for physicians for antibiotic therapy and infectiology	Very important	496	27.0	136	19.6	168	20.0
	Important	880	47.9	306	44.1	390	46.4
	Less important	383	20.8	205	29.5	237	28.2
	Not important	79	4.3	47	6.8	46	5.5
	Total	1,838		694		841	
Elimination of financial disadvantages resulting from laboratory tests for infections	Very important	713	39.0	351	50.6	475	56.3
	Important	723	39.6	201	29.0	250	29.7
	Less important	348	19.0	113	16.3	96	11.4
	Not important	43	2.4	28	4.0	22	2.6
	Total	1,827		693		843	

n.r. not reported

sparsely attended in 2020 due to the SARS-CoV-2 pandemic, and the accompanying planned in-person courses had to be cancelled. (The course is still available on the MRE-Netz Rhein-Main website: https://www.mre-rhein-main.de). The Academy for Advanced Medical Training and Continuing Education of the Medical Association of Hesse has so far offered ABS courses primarily for hospital physicians, but it has expressed an interest in organizing ABS courses for office-based physicians as well. Another good option would be to address the topic in networks and quality circles.

Over the years, improvement proposals such as **tracking individual antibiotic prescriptions** and **limiting the range of prescribed antibiotics** have increased. However, the Association of Statutory Health Insurance Physicians in Hesse has been regularly providing its members with their individual prescription data—including on antibiotics—on a quarterly basis for years. It is likely that these individual quarterly reports are too comprehensive or too confusing,

resulting in insufficient awareness and use among physicians. A concise, visual illustration of antibiotic prescriptions could potentially enhance their utility.

Comparison with external studies and reviews

Our data on the influence of non-clinical—i.e., psychosocial and organizational—factors on prescribing antibiotics can be compared with a major review published in 2024 [26]. Its authors included 35 articles from 23 countries, three of which were from Germany. They examined personal and psychological factors such as work experience, knowledge, use of guidelines, and uncertainty avoidance, as well as organizational factors such as time and work pressure, and diagnostic tests/follow-up. However, most studies involving office-based physicians had significantly fewer than 50 participants [26]. In an international comparison, the representative EVA study conducted by RKI in 2008, involving 3,492 physicians (including 1,861 office-based physicians), was the second-largest study [10], [11], and the German study by Salm et al., with 340 participants, was the third largest [24]. In comparison, our study involving 892 participants, was quite extensive, although it was not representative of Hesse, and given the overall low participation rate, we are unable to rule out participation bias.

The studies in the review were published between 2002 and 2023 and no apparent temporal trend showed up in the results of the review [26]. Our study, however, found an overall decrease in the frequency of antibiotic prescriptions and in the influence of (non-clinical) psychological factors, as well as a slight increase in the influence of organizational factors on prescribing behavior.

Person-related factors: In various studies, older physicians tended to prescribe fewer antibiotics than younger ones. In many studies, approximately 70% of physicians reported that antibiotic resistance affected their work (see [26]); the figure in our survey was 82.8%. In the German study by Salm et al. [24], older physicians with longer clinical experience were less likely to believe that their prescribing behavior influenced the resistance situation than younger physicians. In the same study, adherence to guidelines among those under 40 was nearly four times higher than among those over 60 [24]. Since we were not provided with individually identifiable data on age and gender, we are unfortunately unable to make any statements on this matter in our study.

Psychological factors: Avoiding uncertainty was most frequently cited in both our survey and in the studies. Non medically necessary antibiotic therapy was initiated "to be on the safe side", or broad-spectrum antibiotics were prescribed. In contrast, the perceived pressure from patients or their parents to prescribe antibiotics varied greatly across the different countries; there was also a tendency for this pressure to be greater among physicians working in outpatient settings than in hospitals [26].

Organizational factors: Many other studies have shown that organizational factors, such as time pressure and stress, lead to more antibiotic prescriptions, whereas easier access to rapid diagnostic testing and the possibility of a short-term follow-up can lead to fewer antibiotic prescriptions [26].

Improvements were achieved through more personalized training as well as feedback on individual antibiotic use [26]. The authors generally recommended a multifaceted strategy to improve the prescribing of antibiotics that encompassed "education, self-reflection, and systemic support, e.g., minimizing perceived time pressure and optimizing the availability of rapid diagnostic testing" [26]. In Germany, there are various projects to improve the use of antibiotics in outpatient care: CHANGE-3 focuses on respiratory tract infections [27], RedAres addresses uncomplicated urinary tract infections in women [28], [29], [30], RAI uses the "One Health" approach [24], [25], ABS networks/projects of the Association of Statutory Health Insurance Physicians, and AnTiB with a focus on pediatrics [31]. The AnTiB project is characterized by an interdisciplinary bottom-up approach. It consists of a network that develops regional antibiotic guidelines while taking into account the aforementioned organizational and psychological aspects. Given its success, the project has since been rolled out to the Association of Statutory Health Insurance Physicians Westphalia-Lippe and the pediatric section ABSaP (Antibiotic Stewardship in Ambulatory Pediatrics). It has even been adopted nationwide by the BVKJ (Professional Association of Pediatricians) [32]. Delayed prescribing of antibiotics has proven to be especially effective [33].

Strengths and limitations

One strength of our survey is its high number of participants compared to a review of 35 studies from 23 countries [26]. Another strength is that it was conducted using the same methodology as previous surveys, allowing for a comparison of data over the years in terms of psychological and organizational factors, as well as problem assessment and suggestions for improvement. We are unaware of any other study that provides this. Our study is based on a comprehensive survey of all office-based physicians in Hesse—both those in public settings and in private practices; however, the response rate was very low at just over 10%, so response bias cannot be ruled out and must even be assumed. In contrast to the first EVA study in Germany [10], [11], our study thus is not representative. Another limitation is that, for data protection reasons, no individual data on age and gender were provided for further analysis, so the impact of these individual factors could not be examined.

Conclusion

Our study shows that office-based physicians in Hesse, Germany, are less likely to prescribe antibiotic therapy to their patients on a daily basis than in previous surveys (2016 and 2008). The decline in the reporting of psycho-

logical factors, such as the desire to be on the safe side or fear of legal ramifications for not prescribing antibiotics, can be interpreted as an indication of growing confidence among office-based physicians in prescribing antibiotics. In contrast, the increasing number of mentions of organizational factors, such as saving time or lack of time, should be viewed critically. Suggestions for improvement, such as the publication of regional resistance data, (better) feedback about individual prescribing data, and information on antibiotic use and continuing education programs on this topic, etc., should be implemented and their impact should be evaluated further.

Notes

Ethics statement

Approval by an ethics committee was not necessary for a study which does not involve patient and personal data.

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Competing interests

The authors declare that they have no competing interests.

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Corresponding author:
Prof. Ursel Heudorf
Multidrug Resistant Organism (MDRO) Network Rhine-Main, Gottlieb-Daimler-Straße 10, 63128 Dietzenbach, Germany
mre-rhein-main@kreis-offenbach.de

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