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How Austrian primary care physicians evaluated their available resources and quality of care during the first year of COVID-19: a repeated cross-sectional survey study

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Abstract

Background In March 2020, Austria was among the first European countries to declare a national lockdown, responding to SARS-CoV-2 infections with a stringent ringfencing policy for inpatient beds. These interventions altered access to the Austrian healthcare system. This study aims to understand demand- and supply-side factors influencing Austrian Primary Care Physicians' (PCPs') assessment of their care quality during the first ten months of the COVID-19 pandemic.

Methods The study deployed a cross-section design based on stratified random sampling, where all Austrian PCPs (split into three disjointed random samples) were invited to participate in an online questionnaire (in May, September and November 2020, respectively). A multinomial logit model was used to analyse the three sets of cross-sectional survey data. The study subjects are all 6,679 Austrian PCP (2020) with a registered practice. The total sample size was 403 (corresponding to a net response rate of 6.3%).

Results The primary outcome was the PCPs' evaluation of their care quality. Secondary outcomes were "patient behaviour and wellbeing" (five questions), with Cronbach's alpha of 0.74, and the PCPs' "pandemic preparedness" (five questions) with a smaller internal consistency (0.69). 47% of the PCPs rated their care quality during the first ten months of the pandemic as worse than before the outbreak of COVID-19. The overall assessment correlates to the pandemic stage, lack of preventive care and mediocre information exchange/cooperation within the medical profession. Towards the end of the first lockdown, PCPs' care quality perception was exclusively shaped by the availability of SARS-CoV-2 tests at the practice.

Conclusions PCP quality assessments can serve as a real-time indicator, helping to anticipate the need for epidemiologic and diagnostic procedures. In Austria, supply-side factors, such as protective equipment and tests, were generally provided quickly by the public authorities. Findings suggest that perceptions of quality have changed considerably over time. Our results show that the understanding of quality changes during the first year. At the beginning, lack of resources or supply-side factors are the main driver for the assessment, while at the end of the first

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year, demand-side factors drive the quality assessment. In particular, the strong silo mentality and the separation between the care sectors have impacted the quality assessment of PCP.

Keywords Primary health care, Pandemic preparedness, Care quality of health care, Austria

Background

In most countries, primary care is the backbone of healthcare delivery [1, 2], where Primary Care Physicians (PCPs) ensure access to specialist services and orchestrate continuity of care [3], even during crises like a pandemic situation [4–6]. This undertaking is vital because continuity of care is strongly related to care quality, patient adherence to medical advice, patient satisfaction and patient mortality [4, 7–9]. The COVID-19 pandemic has, however, impaired this continuity and put unprecedented pressure on healthcare systems and the people within.

The study presented in this paper was conducted in a healthcare setting (Austria), where access to specialist services is barrier-free as predominantly delivered in public and private practices in primary care.Without any gatekeeping function, registering with a PCP is not mandatory. Still, most patients in rural areas choose a PCP as the first point of contact for all issues around disease and care [10]. In urban areas, however, medical specialists with public care practices are more commonly the first point of contact. This easy access to specialist services might have contributed to the resilience of Austria's healthcare system in the past. Also, sufficient "redundancies" in financial and personnel capacity should have prepared the Austrian healthcare system well to deal with a shock like the COVID-19 pandemic [11]. For example, with 6,679 PCPs with practices registered in 2020, the ratio of 1.5 PCP per 1,000 inhabitants was one of the highest of all OECD countries [12, 13]. The same applies to Austria's inpatient bed capacity. With 7.3 hospital beds per 1,000 inhabitants, Austria outranked most OECD countries in its 2020 survey (e.g., the UK provided 2.5 hospital beds per 1,000 inhabitants) [13]. Nonetheless, the structure of the Austrian healthcare system is based on federalism, whereof inpatient care is the responsibility of the federal states and outpatient care – irrespective whether of primary or secondary care – is the responsibility of the cooperative partners (chamber of Medicine and statutory health insurances) [10]. This means that Austrian federalism tends to have highly siloed thinking in inpatient, outpatient, and public health care [14]. Even more, the PCP sector is more dependent on the local public health authorities, who are located at the municipality level [10].

During the first year of the pandemic, responsibility for detecting and treating COVID-19-infected patients was taken away from the PCPs. It was handed over to public health authorities, especially to the 1450 hotline of the emergency service system and hospital facilities. Still, inpatient bed capacities were stretched thin during recurrent peaks in COVID-19-induced demand. Austria's primary care (sidelined by public health policy in the context of pandemic management) struggled with treating the non-infected [15–17]. I.e., the pandemic has revealed and aggravated structural deficits in the Austrian healthcare system (as opposed to exposing mere resource shortages). By the end of 2021, the Austrian Board of Auditors reported that in 2020, preventive check-ups in primary care had declined by 135,000 (−10%) compared to the previous year [18]. Also, screenings in secondary care were negatively impacted. For example, colonoscopies in outpatient departments decreased by 76% in April 2020, regained 2019 levels, and then collapsed again in November/December 2020 (−40% compared to 2019 levels) [18]. Austria's outpatient departments experienced a similar pattern for mammograms [18].

To provide a real-time assessment of the capability of a healthcare (sub)system to cope with a crisis, one would ask for comprehensive data on epidemiology, services provided, and diagnoses. However, Austria's primary care does not offer these data due to a lack of diagnostic coding for all healthcare services outside hospital walls. Consequently, the idea was born to draw upon the experience and (self)perception of PCPs to better understand the quality of care during a healthcare crisis. In this context, the assessment of PCPs seems to be a good opportunity for timely highlighting (potential) supply shortages (and their consequences) regarding the provision of high-quality medical care and community-oriented public health services [1, 19, 20]. The WHO framework conceptualises care quality as "*the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with evidence-based professional knowledge*" [21]. The Institute of Medicine pins down six quality domains: (1) effectiveness, (2) safety, (3) timeliness, (4) people-centeredness, (5) equity and (6) efficiency of health services. In primary care, *timely* care in a *safe* environment has received particular research attention during the COVID-19 pandemic to maintain healthcare *effectiveness* [6, 22–25].

The present study is designed to do three things. First, the study seeks to provide insight into what PCPs were thinking about the care situation of their patients over the

first ten months of the pandemic in Austria. Using their assessment to understand how a disease like COVID-19 alters the care quality of their patients is a novel approach to health service research. Second, this study seeks to understand better which factors shape PCPs' care quality assessment at what point in time. Thus, this study will provide some hints on how the concept of care quality, as perceived by PCPs, is formed and whether it immediately reflects the status quo. Third, the results of this study will allow us to infer whether, in a crisis, the PCP's quality assessment could be a real-time indicator of current and upcoming issues in primary care when epidemiological and diagnostics data is missing. Therefore, we use high-level retrospective data from the Austrian Board of Auditors, published in late 2021, to ex-post validate PCPs' evaluations and perceptions [18]. We also validate our results using qualitative insights derived from other studies [17]. The following questions guide our research:

1. How did PCPs perceive their level of preparedness for the COVID-19 pandemic at three different time points in 2020?
2. How did PCPs assess their patients' behaviour, access restrictions to specialist treatment and wellbeing over the first ten months of the COVID-19 pandemic?
3. How did PCPs assess the care quality of their patients over the first ten months of the COVID-19 pandemic?
4. How did PCPs' ratings on questions 1 and 2 affect their overall quality assessment (question 3)?

This study intends to contribute to identifying issues (like potential structural weaknesses) that should be addressed to strengthen the resilience of the Austrian and similar healthcare systems [26].

Methods

Study design and sampling method

We used a repeated cross-sectional research approach to capture the health service expertise of Austrian PCPs over the first ten months of the COVID-19 pandemic. Emanating from core questions about the respondents' perception of Austrian disease control management, we requested the PCPs to share their opinion about the care situation of their patients (extending their judgement to the provision of specialist outpatient and inpatient care). The questionnaire was based on the *Survey of Primary Care Physicians of the Commonwealth Fund*, tweaked to reflect COVID-19 conditions [27]. The questionnaire is available in the Supplementary files. We randomly selected three disjointed samples from the official mailing list of Austrian PCPs. We emailed the same questionnaire to the three stratified random samples at three distinct points in time. The first sub-sample (first third of addresses randomly drawn from the official mailing list) was approached in late May 2020, i.e., towards the end of the first COVID-19 lockdown in Austria. The second sample (second third of the randomly drawn addresses) was approached in September 2020, and the third randomly drawn sample was contacted in November 2020. Thus, we created three non-intersecting, independent cross-sections. We will refer to the first response period (late May until early July 2020) as "spring" to ease readability. The second response period, from early September to mid-October 2020, will be labelled as "summer" and the last one (from November to just before Christmas 2020) as "winter". The required sample size with a 5%-tolerance of the sampling error and a 95% confidence interval was $\overline{n} \geq 364$, based on the 2020 number of PCPs ($N = 6{,}679$; [12]).

Measures

Country experts developed the Commonwealth Fund survey, which includes 23 questions on the dimensions: expanded access to primary care, physicians' experiences with care coordination, coordination of patient care between primary care and other clinical providers, coordination with social services and other community providers, and physicians' use of health information technology [27]. The adaptation of the questions to the COVID-19 situation was carried out in consultation with four experts in the field of healthcare management and economics from Austria, who adapted the dimensions to the given situation in Austria at the beginning of the first lockdown in March 2020. In total, the Austrian coronavirus version included eight variables to assess the care situation and three socio-demographic variables (age, gender, and regional level). Job satisfaction was surveyed using a rating scale with the question: Especially during this pandemic, 'How satisfied are you with your practice as a general practitioner?' (1 = very satisfied to 4 = very unsatisfied). The assessment of over-/mis- or underuse by the survey was carried out using the question: 'When you think about the general medical care of your patients (incl. specialist, inpatient, nursing care), how would you currently assess the care, how would you currently assess the extent of treatment due to the pandemic situation?' This question was answered using a rating scale (1 = much too low to 5 way too much). The qualitative assessment of the lack of care was also linked to the number of patients and rated from 'almost all' (> 80% of patients did not get the treatment they needed) to 'few' (< 20% of patients did not get the treatment they needed).

The explanatory factors for the regression model are based on a joint agreement between four health experts, as there was no validated instrument for the

COVID-19-specific question at the time. The development of the ten questions was based on the six quality indicators of the Institute of Medicine [22]: (a) effectiveness, (b) efficiency, (c) equity, (d) patient-centeredness, (e) safety and (f) timeliness. The quality indicator (a) effectiveness was measured by coordination with government agencies and the coordination and exchange of information with other medical professionals. (b) Efficiency was addressed with the question of the availability of SARS-CoV-2 tests, as this became an important entry barrier to treatment in medical practices and thus had a massive impact on the economic behaviour of medical practices. (c) Equity was operationalised entirely in terms of low-threshold care by primary care providers, i.e. in preventive and early detection with the help of medical check-ups and screening, as well as the avoidance of medical care even in acute cases. An important factor that has emerged from the disease control measures and can be attributed to (d) patient-centeredness is the development of secondary diseases, particularly in the area of mental health. (e) Safety is operationalised as a quality indicator with the help of safety equipment and protective gear, and (f) timeliness is processed with longer waiting times in specialist care and elective hospital treatments. The ten questions were divided into supply-side and demand-side factors in order to structure the survey and make it clearer.

To assess the supply-side factors, the availability of protective equipment and SARS-CoV-2 tests, as well as the coordination with the most important stakeholders for disease control and patient safety and other healthcare providers, were summarised. These supply-side factors were measured with five items using a four-point rating scale (1 = very good to 4 = very poor). The demand-side factors were also operationalised with five items referring to medical checkups, avoided treatments, prolonged waiting times and cancelled treatments for secondary and tertiary care and secondary illnesses. These demand-driven factors were measured using a four-point rating scale (1 = strongly agree to 4 strongly disagree). A quality-of-care question was used as the dependent variable: 'How has the quality of care for your patients changed since the outbreak of COVID-19?' The answers were: "improved", "remained the same", or "deteriorated".

Statistical methods

We started the analysis by calculating the descriptives and investigating the statistical differences via the Mann–Whitney-U test for comparing two samples and the Kruskal–Wallis-H test (χ^2) for comparing more than two samples. To test internal consistency, we computed Cronbach's alpha. Further, we used a multinomial logistic regression (logit) model to understand which factors, viz. variables, mattered for the *PCPs' care quality assessment* throughout the first ten months of the COVID-19 pandemic. This statistical classification model extended the logistic regression from binary to multiclass problems, i.e., problems with a dependent categorical variable with more than two possible outcomes k. In our case, the dependent categorical variable (y) was care quality with the potential outcomes "Improved ($k = 1$)", "Remained the same ($k = 2$)", and "Deteriorated ($k = 3$)".

Choosing "Remained the same" as the reference category, we arrived at the following multinomial logit model consisting of two independent binary regression models, where the other two outcomes, "Improved" and "Deteriorated", were regressed against the reference category, i.e.,

$$\log\left(\frac{\mathbb{P}(y=k)}{\mathbb{P}(y-k)}\right) = \alpha_k + \beta_{k,1}x_1 + \cdots + \beta_{k,15}x_{15} \quad (k = 1,3) \qquad (1)$$

where α_k indicated the intercept with the ordinate. The terms $\beta_{k,j}$ $(k = 1{,}3; j = 1,\ldots,15)$ represented the change in the odds of the care quality being in category k compared to being in the reference category ($k = 2$), associated with a one-unit change of the corresponding explanatory variable x_j $(j = 1,\ldots,15)$. The variables $x_1,\ldots,x_5$ operationalised pandemic preparedness to understand the influence of resource supply in healthcare on the variable *care quality*. The variables $x_6,\ldots,x_{10}$ covered demand-side issues like patient behaviour, access to treatment and patient wellbeing to reveal their potential relationship with *care quality*. Finally, $x_{11},\ldots,x_{15}$ addressed various variables like the number of (COVID-19) patients, the number of PCPs in the practice, and the period of responding to the survey.

We used SPSS (IBM, version 28.0.1) for statistical analyses throughout the paper. The cut-off level for statistical significance was 0.05. For model-fit evaluation, we used Cohen's recommendations [28]. Reporting followed the STROBE statement for cross-sectional studies (see Supplementary file).

Results

Sample

During the first survey period (late May until early July 2020), we collected $n_1 = 104$ responses. During the second period (early September until mid-October 2020), we accumulated $n_2 = 147$ answers. During the third survey period (coinciding with the second COVID-19 lockdown in Austria), we obtained $n_3 = 169$ responses. I.e., we received a total of $420 > \overline{n}$ responses, corresponding to a net response rate of 6.3%. Data cleansing forced us to remove 12 responses due to a missing indication of physician age. We used official 2020 Austrian Physician Statistics data to check the sample for external validity [12]. The sample share of female PCPs of 43.6% and

the average quarterly number of patients of 1,285 (see Table 1) mimicked the characteristics of the 2020 statistics. However, as underpinned by Table 2, we observed a minor overrepresentation of respondents in the 45–64-year bracket. Younger doctors between 35 and 44 and PCPs over 64 were somewhat underrepresented in our sample. We, therefore, used the relative differences in physician age (see Table 2) as weights to correct the sample data for age disparities.

Descriptive results regarding some of healthcare's supply- and demand-side factors

Asking PCPs about their level of preparedness for the pandemic provided a proxy for actual healthcare capacity, as it seized primary care's capability of serving non-COVID-19-related (elective and emergency) requests. We derived insight into the PCPs' level of preparedness by analysing the responses to a set of five questions (see Fig. 1).

We found that, throughout 2020, PCPs' evaluations of *coordination and information exchange within the medical profession regarding COVID-19 measures and treatment* were mediocre. Also, these evaluations did not significantly improve throughout the first pandemic year (see row 1, Fig. 1). The *support of agencies acting on behalf of the Austrian government (regarding implementing protective disease control measures)* was evaluated as very poor early in the pandemic. A small recovery was observed after June 2020. Despite the statistical significance of the improvement, the PCP's satisfaction with governmental support remained at a low level throughout 2020 (see row 2, Fig. 1).

The gap between the lines in Fig. 1 visualises that procuring and distributing safety equipment within Austria's primary care sector was not rated satisfactory by the study participants until mid to late autumn 2020. The internal consistency of the five questions on a PCP's preparedness for a pandemic crisis (as depicted by Fig. 1) was nearly acceptable, with a Cronbach's alpha of 0.69. The descriptives over the time course of 2020 are shown in Tables 3 and 4.

After this look at healthcare's supply side, we now examine aspects of healthcare's demand side by analysing bchanges in patient behaviour perceived throughout 2020, which were operationalised by the two top survey questions in Fig. 2. Two more questions collected the PCPs' assessment of accessibility to specialist services. The last question delivered a proxy for the wellbeing of their patients. The internal consistency of these five questions was validated by a Cronbach's alpha of 0.74.

On the one hand, Fig. 2 shows that PCPs consistently reported that their patients were *skipping medical check-ups and screenings* (row 1, Fig. 2). On the other hand, patients *who did not seek medical attention (even when acutely unwell, in case of an accident or an injury)* seemed to be a matter of concern only during the first COVID-19 wave (row 2, Fig. 2). Next, PCPs agreed that *patients must accept long waits for specialist diagnostics/treatment* (in Austria, mainly provided outside hospital walls) with a significant recovery after the first pandemic wave, i.e. compared to the May 2020 sub-sample (Spring). (see row 3, Fig. 2). Similarly, study participants agreed that their patients had to accept that *necessary elective inpatient care was being cancelled.* An improvement was observed in the evaluations of the September 2020 sub-sample (Summer), while perceptions deteriorated in the November 2020 sub-sample (Winter) (see row 4, Fig. 2). Furthermore, PCPs' agreement level with patients experiencing drawbacks was more pronounced for secondary than specialist care [29]. The concluding question in Fig. 2 concerns PCPs' assessment of patient wellbeing. Throughout 2020, PCPs confirmed that their *patients develop psychiatric disorders that can be traced back to disease control measures*.

Regarding study participants' perceptions of the impact of the pandemic on the quality of care, 47% of the survey respondents reported that their patients' *care quality* had deteriorated since the pandemic's onset, 7% responded that *care quality* improved, and 46% answered that the *quality* remained the same. Table 4 presents an overview of the responses for the demand-side factors.

The following section will investigate whether a systematic relationship within the data can explain PCP assessment of care quality. Thus, we seek to determine which of the facets of preparedness for the pandemic (see Fig. 1), patient behaviour, access restrictions to specialist care, and patient wellbeing (see Fig. 2) correlate to the PCPs' quality assessment. The analysis will help understand what shapes PCPs' perceptions of care quality and whether a particular pattern or focus of attention (like safety or effectiveness) can be read off that varies with the course of the pandemic.

Results from the analysis of care quality drivers

Figure 3 shows the results of our multinomial logistic regression model. We estimated the model stepwise to identify which variables accurately explain the variable care quality. As differentiated in Fig. 3, we split the estimations into the supply-side model (1), the demand-side model (2), and the mixed model (3). I.e., the supply-side model (1) incorporates the explanatory variables $x_1, \ldots, x_5, x_{11}, \ldots, x_{15}$ and the demand-side model (2) includes $x_6, \ldots, x_{15}$. Finally, the mixed model (3) integrates all 15 explanatory variables into the regression. We cross-validated the model with an 80/20 random sample and found high cross-validity for model (3) explanatory variables.

Table 1 Sample characteristics

Gender (*N* = 409)	
Female	186 (45.5%)
Male	220 (53.8%)
Other	3 (0.7%)
Age (*N* = 403)	
Under 35 years	8 (2.0%)
35 to 44 years	74 (18.4%)
45 to 54 years	123 (30.5%)
55 to 64 years	165 (40.9%)
Over 64 years	33 (8.2%)
Patient's visits	
Average number of patients per quarter (*N* = 383)	Mean: 1,285 (SD: 799)
Average number of Covid-19 patients (*N* = 377)	Mean: 32 (SD: 54.9)
Employees in practice	
MD in office (*N* = 397)	Mean: 1.43 (SD: 1.60)
Nurses and/or assistance (*N* = 398)	Mean: 2.99 (SD: 4.27)
Job satisfaction since Covid-19 (*N* = 420)	
Very satisfied	66 (15.7%)
Satisfied	232 (55.2%)
Unsatisfied	102 (24.3%)
Very unsatisfied	20 (4.8%)
Practice setting (*N*= 410)	
Rural region (up to 15,000 inhabitants)	344 (83.9%)
Urban region (15,000 inhabitants or more)	66 (16.1%)
Type of practice (*N* = 413)[a]	
Privately owned (with public insurance contract)	279
Privately owned (non public insurance contract)	88
Group practice (with public insurance contract)	28
Group practice (non public insurance contract)	11
Primary Health Care Centre	7
Network	5
Other	13
Amount of care (Overuse, underuse, or misuse) (*n* = 420)	
Much too low	51 (12.1%)
Too low	253 (60.2%)
Just right	75 (17.9%)
Too much	5 (1.2%)
Way too much	1 (0.2%)
Can not judge	35 (8.3%)
Amount of people not receive needed care (*n* = 420)	
Almost all (> 80%)	7 (1.7%)
Most (60–80%)	25 (6.0%)
About Half (~ 50%)	69 (16.4%)
Some (20–40%)	175 (41.7%)
Few (< 20%)	124 (29.5%)
Can not judge	20 (4.8%)
Depended Variable: How did the quality of care changed for your patients since the breakout of Covid-19?	
Overall (N = 420)	
'Getting better'	27 (6.4%)
'Remain the same'	198 (46.4%)
'Deteriorate'	195 (47.2%)

Table 1 (continued)

Spring (n= 104)	
'Getting better'	4 (3.8%)
'Remain the same'	47 (45.2%)
'Deteriorate'	53 (51.0%)
Summer (n = 147)	
'Getting better'	7 (4.8%)
'Remain the same'	75 (51.0%)
'Deteriorate'	65 (44.2%)
Winter (n = 169)	
'Getting better'	16 (9.5%)
'Remain the same'	73 (43.2%)
'Deteriorate'	80 (47.3%)

[a] multiple answers possible

Table 2 Comparison of the sample age distribution and the 2020 Austrian physician statistics

Age	Sample % (*n* = 403)	Physician Statistics % (*N* = 6,679)	Difference
up to 34	2.0	2.0	−0.0
35 to 44	18.4	19.2	−0.8
45 to 54	30.5	29.2	+1.3
55 to 64	40.9	36.1	+4.8
65 and older	8.2	13.5	−5.3

We analysed two more models since we found that the response period was relevant for explaining care quality according to model (3). The resulting spring (4) and winter (5) models then allowed for gathering extra insight into potential shifts of the quality indicators, depending on the current stage of the pandemic. The winter model (5) showed that demand-side variables explained care quality towards the end of 2020, while (a) supply-side variable(s) showed a better fit in the early days of the pandemic. Specifically, *skipped check-ups and screenings* are the primary explanation for the deterioration in *care quality* in the winter model (OR = 1.956, 95%CI = [1.081,3.540]).

All models showed a good fit based on Cohen's recommendation [28]. Specifically, the model fit is satisfactory for the mixed model (3) with a log-likelihood of 377.620 ($\chi^2 = 89.377$ $p < 0.001$), an AIC of 441.620 and a Nagelkerke's Pseudo R^2 of 0.351. The spring model (4) showed a good model fit with a log-likelihood of 21.585 ($\chi^2 = 48.702$ p = 0.004), AIC of 77.585 and Nagelkerke's Pseudo R^2 of 0.853. The winter model (5) exhibits a model fit of 195.383 ($\chi^2 = 60.379$ $p < 0.001$), AIC = 251.383 and a Pseudo R^2 of 0.424.

Whenever *coordination and exchange of information within the medical profession (regarding COVID-19 measures and treatment)* had been evaluated as poor, models (1) and (3) revealed slightly higher odds that PCPs assessed *care quality* as deteriorating than PCPs evaluating *care quality* as unchanged (OR: 1.455; 95%CI = [1.009, 2.097]). Interestingly, neither *support from government agencies* nor the *availability of (general and COVID-19-specific) equipment* impacted the PCPs' overall assessment of care quality. However, models (4) and (5) disclosed that in June 2020, PCPs evaluated *care quality* as deteriorating when the *availability of SARS-CoV-2 tests in their practice* was poor or very poor (OR: 14.838, 95%CI = [1.349, 163.199]). Later in the year, the availability of SARS-CoV-2 tests did not show any significant effect on the quality assessment anymore.

From models (2) and (3), overall, the odds of assessing *care quality* as deteriorating were high when PCPs had observed that their *patients skipped medical check-ups and screenings* (OR = 2.147, 95%CI = [1.363, 3.383]). At the same time, *elective inpatient treatments not taking place* and *patients developing psychiatric disorders* were irrelevant to the overall *care quality* assessment of PCPs. *Long waiting times for specialist treatment* (OR = 1.444, 95%CI = [1.038, 2.008]) seemed relevant for the *care quality* assessment of PCPs only in the context of the demand-side model (2). Interestingly, the relevance of *patients no longer seeking medical attention (even in acute illnesses, accidents, or injuries)* disappeared as a driving force for PCPs' *care quality* assessment when moving from model (2) (OR = 1.541, 95%CI = [1.065, 2.230]) to model (3).

Discussion

This study analysed PCPs' survey responses to understand how COVID-19 and the public health measures to fight the disease have affected Austria's primary care sector and how the status quo shaped physicians' concept of

Supply-side factors	Difference and p-value	very good (1)	good (2)	poor (3)	very poor (4)
How would you describe the coordination and the exchange of information within the medical profession regarding COVID-19 measures and treatment? (n=411)	$\chi^2(2)=4.300$, p=0.116				
How would you describe the support of government agencies (like the Health Department or AGES) concerning the implementation of protective measures? (n=403)	$\chi^2(2)=10.45$, p=0.005				
How would you describe your practice's stock of general safety equipment (virucidal disinfectants and mouth-nose protection)? (n=419)	$\chi^2(2)=30.292$, p<0.001				
How would you describe your practice's stock of specific safety equipment (FFP2 or FFP3 masks and Personal Protective Equipment (PPE) like clothing)? (n=418)	$\chi^2(2)=44.640$, p<0.001				
How would you describe your practice's stock of SARS-CoV-2 tests (PCR, antibody and rapid tests)? (n=398)	$\chi^2(2)=94.515$, p<0.001				

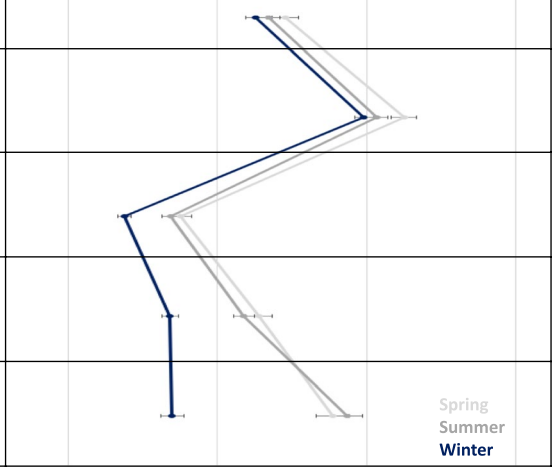

Fig. 1 Supply-side factors for care quality assessment

Table 3 Descriptives for supply-side factors

Supply-side factors	Oberservation periode	Very good (%)	Good (%)	Poor (%)	Very poor (%)	Can not judge (%)
How would you describe the coordination and the exchange of information within the medical profession regarding COVID-19 measures and treatment?	Overall (*n*=420)	72 (17.1)	171 (40.7)	128 (30.5)	39 (9.3)	10 (2.4)
	Spring (*n*=104)	16 (15.4)	36 (34.6)	40 (38.5)	10 (9.6)	2 (1.9)
	Summer (*n*=147)	21 (14.3)	66 (44.9)	42 (28.6)	13 (8.8)	5 (3.4)
	Winter (*n*=169)	35 (20.7)	69 (40.8)	46 (27.2)	16 (9.5)	3 (1.8)
How would you describe the support of government agencies (like the Health Department or AGES) concerning the implementation of protective measures?	Overall (*n*=420)	21 (5.0)	66 (15.7)	175 (41.7)	140 (33.3)	18 (4.3)
	Spring (*n*=104)	6 (5.8)	10 (9.6)	41 (39.4)	45 (43.3)	2 (1.9)
	Summer (*n*=147)	7 (4.8)	24 (16.3)	57 (38.8)	51 (34.7)	8 (5.4)
	Winter (*n*=169)	8 (4.7)	32 (18.9)	77 (45.6)	44 (26.0)	8 (4.7)
How would you describe your practice's stock of general safety equipment (virucidal disinfectants and mouth-nose protection)?	Overall (*n*=420)	215 (51.2)	176 (41.9)	19 (4.5)	8 (1.9)	2 (0.5)
	Spring (*n*=104)	42 (40.4)	52 (50.0)	7 (6.7)	3 (2.9)	0 (0.0)
	Summer (*n*=147)	60 (40.8)	73 (49.7)	9 (6.1)	3 (2.0)	2 (1.4)
	Winter (*n*=169)	113 (66.9)	51 (30.2)	3 (1.8)	2 (1.2)	0 (0.0)
How would you describe your practice's stock of specific safety equipment (FFP2 or FFP3 masks and Personal Protective Equipment (PPE) like clothing)?	Overall (*n*=420)	121 (28.8)	197 (46.9)	79 (18.8)	20 (4.8)	3 (0.7)
	Spring (*n*=104)	20 (19.2)	50 (48.1)	24 (23.1)	10 (9.6)	0 (0.0)
	Summer (*n*=147)	28 (19.0)	69 (46.9)	38 (25.9)	9 (6.1)	3 (2.0)
	Winter (*n*=169)	73 (43.2)	78 (46.2)	17 (10.1)	1 (0.6)	0 (0.0)
How would you describe your practice's stock of SARS-CoV-2 tests (PCR, antibody and rapid tests)?	Overall (*n*=420)	125 (29.8)	114 (27.1)	46 (11.0)	112 (26.7)	23 (5.5)
	Spring (*n*=104)	11 (10.6)	34 (32.7)	17 (16.3)	34 (32.7)	8 (7.7)
	Summer (*n*=147)	24 (16.3)	31 (21.1)	23 (15.6)	61 (41.5)	8 (5.4)
	Winter (*n*=169)	90 (53.3)	49 (29.0)	6 (3.6)	17 (10.1)	7 (4.1)

"care quality." Multinomial logistic regression uncovered distinctive differences in this concept across the pandemic stages in 2020.

Towards the end of the first COVID-19 wave in late spring 2020, PCPs associated care quality with the availability of SARS-CoV-2 tests within practice walls [17]. PCPs confirmed that the supply of *general* and *COVID-19-specific safety and hygiene equipment* did not improve significantly before the second lockdown started on 17 November 2020 (see rows 3 and 4, Fig. 1). The same was observed regarding the *availability of SARS-CoV-2 tests in PCP practices* (see row 5, Fig. 1). Austrian PCPs also

Table 4 Descriptives for demand-side factors

Demand-side factors	Oberservation periode	Strongly agree (%)	Agree (%)	Disagree(%)	Strongly Disagree (%)	Can not judge (%)
Due to the pandemic, patients no longer undergo medical check-ups and screenings	Overall (*n*=420)	125 (29.8)	178 (42.4)	78 (18.6)	32 (7.6)	7 (1.7)
	Spring (*n*=104)	53 (51.0)	33 (31.7)	14 (13.5)	3 (2.9)	1 (1.0)
	Summer (*n*=147)	29 (19.7)	69 (46.9)	33 (22.4)	11 (7.5)	5 (3.4)
	Winter (*n*=169)	43 (25.4)	76 (45.0)	31 (18.3)	18 (10.7)	1 (0.6)
Due to the pandemic, patients no longer seek medical attention, even in cases of acute illnesses, accidents or injuries	Overall (*n*=420)	45 (10.7)	127 (30.2)	158 (37.6)	81 (19.3)	9 (2.1)
	Spring (*n*=104)	21 (20.2)	39 (37.5)	30 (28.8)	14 (13.5)	0 (0.0)
	Summer (*n*=147)	13 (8.8)	36 (24.5)	58 (39.5)	33 (22.4)	7 (4.8)
	Winter (*n*=169)	11 (6.5)	52 (30.8)	70 (41.4)	34 (20.1)	2 (1.2)
Due to the pandemic, patients must accept long waiting times for specialist treatment	Overall (*n*=420)	134 (31.9)	145 (34.5)	91 (21.7)	40 (9.5)	10 (2.4)
	Spring (*n*=104)	48 (46.2)	36 (34.6)	11 (10.6)	6 (5.8)	3 (2.9)
	Summer (*n*=147)	42 (28.6)	45 (30.6)	33 (22.4)	21 (14.3)	6 (4.1)
	Winter (*n*=169)	44 (26.0)	64 (37.9)	47 (27.8)	13 (7.7)	1 (0.6)
Due to the pandemic, patients must accept that necessary elective inpatient treatments do not take place	Overall (*n*=420)	186 (44.3)	160 (38.1)	47 (11.2)	18 (4.3)	9 (2.1)
	Spring (*n*=104)	64 (61.5)	32 (30.8)	5 (4.8)	1 (1.0)	2 (1.9)
	Summer (*n*=147)	39 (26.5)	62 (42.2)	29 (19.7)	12 (8.2)	5 (3.4)
	Winter (*n*=169)	83 (49.1)	66 (39.1)	13 (7.7)	5 (3.0)	2 (1.2)
Patients develop psychiatric disorders that can be traced back to disease control measures	Overall (*n*=420)	134 (31.9)	164 (39.0)	84 (20.0)	24 (5.7)	14 (3.3)
	Spring (*n*=104)	32 (30.8)	41 (39.4)	20 (19.2)	7 (6.7)	4 (3.8)
	Summer (*n*=147)	38 (25.9)	66 (44.9)	28 (19.0)	8 (5.4)	7 (4.8)
	Winter (*n*=169)	64 (37.9)	57 (33.7)	36 (21.3)	9 (5.3)	3 (1.8)

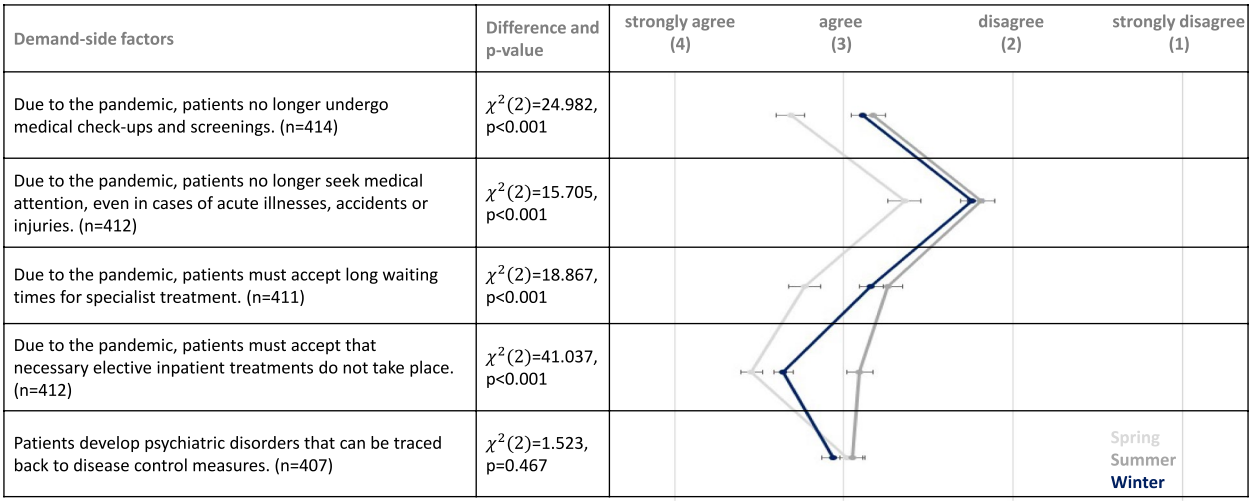

Fig. 2 Demand-side factors for care quality assessment

raised severe concerns about the lack of proper allocation of protective equipment across the healthcare system [17, 30, 31]. So, there was a focus on healthcare's supply side, reflecting a system struggling to provide necessities to handle patient flows in an unprecedented situation. In this context, it is plausible that the assessment of PCPs focused on the safety dimension of healthcare quality [22]. Resource supply (safety equipment, SARS-CoV-2 tests) improved towards the onset of the second wave in November 2020. Later in the first pandemic year, the *availability of SARS-CoV-2-tests* no longer shaped the quality concept of PCPs. In other words, what defines *care quality* for physicians has morphed alongside the phenotype of the pandemic problem. Thus, "quality" was perceived (by PCPs) as a demand-driven concept (i.e., determined by patient behaviour). Austria's PCPs were

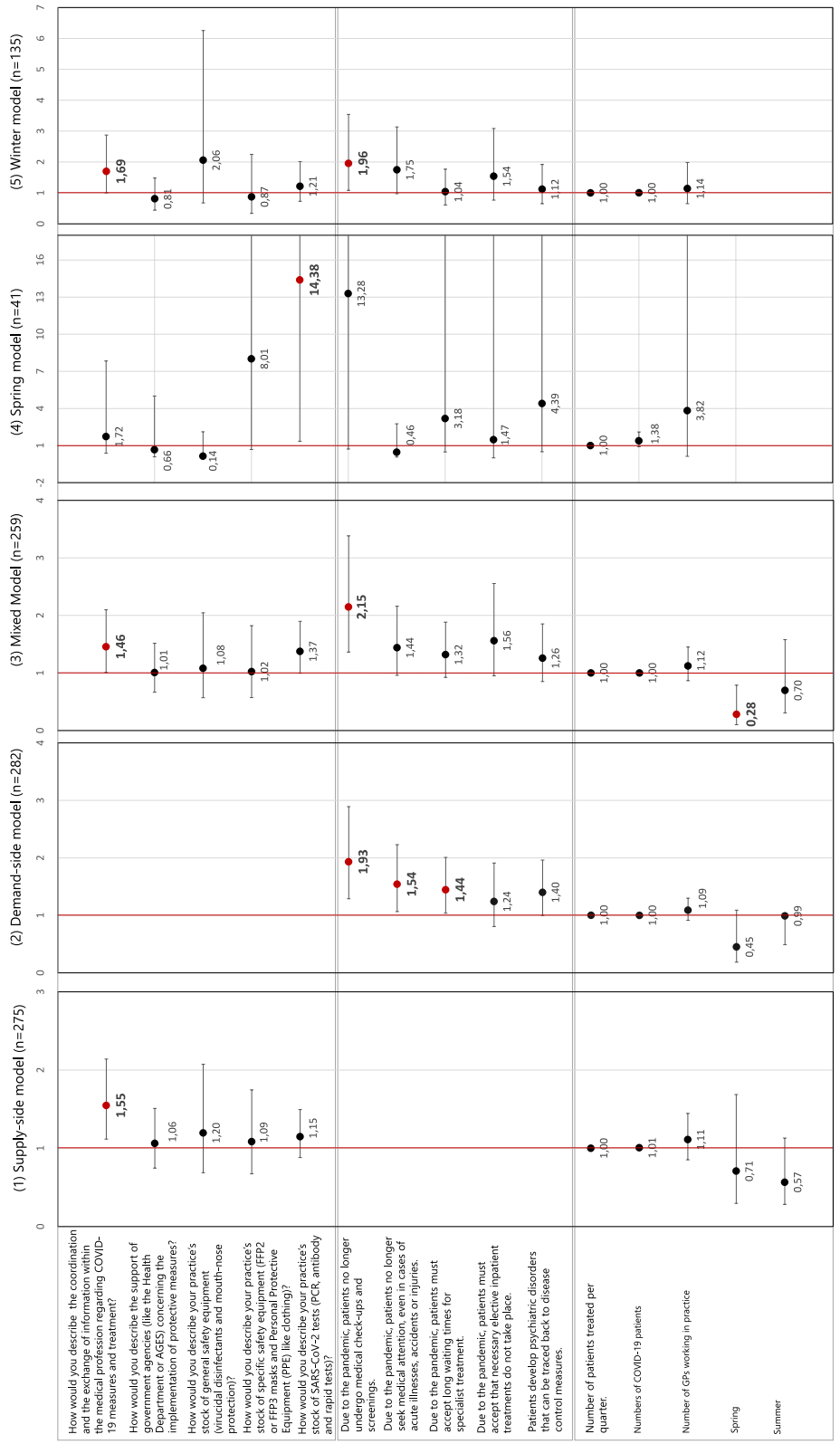

Fig. 3 Multinominal regression analyses

deeply concerned about their patients no longer undergoing medical check-ups and screenings, significantly influencing PCPs' real-time quality assessment.

Follow-up effects are still unclear, with data not yet lending themselves to statistically significant results about long-term effects on healthcare's effectiveness (a core dimension of healthcare quality). Still, researchers have expressed concerns regarding inadequate healthcare provision for the non-infected, especially vulnerable populations [17, 32–36]. Additionally, the prioritisation of Austria's secondary care in the form of ringfencing beds to prepare for an expected increase of COVID-19 inpatients potentially aggravated chronic health conditions of primary care patients due to a lack of care continuity [6, 37]. The latter correlated with dodging acute treatment and increasing societal mental health problems [38, 39]. These arguments support the notion that persons with more substantial healthcare needs have experienced restrictions in access to care, thus eroding the principle of equity in healthcare (another core dimension of healthcare quality) [40].

Throughout 2020, Austria's PCPs also worried (significantly more during the first wave than the second) about delayed or cancelled elective treatment in hospitals. Indeed, bed days in funds hospitals dropped by 1.8 million (−15%), with hip and knee replacements declining by 19% compared to 2019 [18]. Inpatient stays with a cancer diagnosis in Austria experienced the most substantial decline in April and May 2020, with −24% compared to the previous year; in November and December, it was up to −16% [18]. Nonetheless, the timeliness of care (another core quality dimension) did not contribute to explaining the overall quality assessments of Austrian PCPs. A potential reason is that secondary care did not inform the PCPs directly about cancelling an elective operation. So, PCPs would not have instantly known that one of their patients was (potentially negatively) affected. Then, it would make sense that, during a pandemic, PCPs did not include timeliness in their quality perceptions.

Except for the impact of the short supply of SARS-CoV-2 tests, even in the early phase of the pandemic, the safety dimension of quality seemed less critical for PCPs in their quality assessment than expected. This correlated with the observation that *fear of infection keeping patients away from acute healthcare* (a concern during the first COVID-19 wave) was no driver of the assessment of care quality either. A possible reason is that the delivery of primary care services changed remarkably throughout 2020 [2, 30, 41–43]. Face-to-face contacts declined from 70 to 23%, while the number of telemedicine contacts increased broadly [44]. An Austrian study specifically reported that 77% of 606 contacted physicians who responded to their survey considered "telemedicine as the one key element for maintaining care in the current healthcare crisis" [45]. Telemedicine enabled effective and safe (and often timely) care and assisted primary care's pandemic-induced focus on chronic disease management, medical screenings and check-ups [37, 39].

PCPs' quality perception adjusted over time and reflected the most pressing issues in primary care in real time. Therefore, it is even more remarkable that throughout 2020, PCPs perceived proper coordination (and information exchange) within the medical profession as one of the key resources preventing even further decline in the care quality of their patients. There is, however, room for improvement. For example, the Austrian Board of Auditors recommended a well-established (bidirectional) exchange of information and the obligated cooperation of national health insurance institutions, hospitals and public health agencies to provide the best possible use of resources in a health crisis [18]. As a best-practice example, Australia's successful response to the pandemic included regular webinars and teleconferences with primary care professionals to enable continuous and two-way communication with the primary care workforce [46].

Early in the pandemic, the Austrian Ministry of Health allegedly presumed that the health insurance institutions would continue to regulate primary care but did not systematically integrate them at the state level into national disease management. At the federal level, health insurance institutions were not integrated at all, and their resources were not used for disease control. Hence, it is no surprise that PCPs' evaluations of the support from governmental public health agencies did poorly, and the public's compliance with disease control measures eroded over time [15]. Undeniably, the strong siloed separation between care services and public health authorities has been a weakness of the Austrian healthcare system, as revealed by the pandemic [20, 47]. This study emphasises the necessity of better integrating primary care and public health to bolster the resilience of the Austrian healthcare system and safeguard care quality in case of crises or disasters [19]. Specifically, the study's findings advocate a more substantial involvement of PCPs in Austria's public health planning.

Strength and limitations

Unlike most studies on shifting and rearranging duties and responsibilities during the COVID-19 pandemic, our study is quantitative with a good sample size. It resonates with several qualitative studies and confirms their results [17, 25, 42, 44, 48, 49]. Additionally, independent data validate the quality perception of PCPs discussed in this paper [18]. However, since we have analysed the quality concept at different pandemic stages, a panel

design would have been superior to our cross-sectional design. Nonetheless, the insight into the pandemic waves (first lockdown, summer recess, and second lockdown) and perceptions of care quality constitute an asset and show the capability of primary care to adapt. It should also be borne in mind that this survey only includes the quality assessment of primary care physicians. From the perspective of quality research, we know that the evaluation of the quality of care can vary between doctors and patients [50]. Unfortunately, this could not be covered within the scope of the study.

Statistically, there are some limitations regarding the generalisability of our data. For example, the multinomial logistic regression results have a good model fit (suggesting internal validity). However, there is an issue within the dependent variable (the assessment of "care quality"). For example, answers are limited to the subjective evaluation of overall care quality without any refined explanation of whether this improvement/deterioration is rooted in outpatient or inpatient care. Also, quality domains (effectiveness, safety, timeliness, people-centeredness, equity and efficiency) were not operationalised by standardised survey questions as we focused on adapting the *Survey of Primary Care Physicians of the Commonwealth Fund* for COVID-19. Also, some variables that affect PCP assessment of care quality might not be included in our regression model. For example, an analysis of open questions from the survey revealed that PCPs were highly concerned about delayed medical examinations by specialists and in specialised outpatient clinics as they caused delays in the diagnostics and treatment of their patients [29].

Conclusion

In summary, many survey participants reported a deterioration in the quality of care for their patients. This quality concept (analysed in a pandemic context) focuses on the effectiveness and safety of healthcare provision. The findings suggest that PCPs' quality assessments were influenced by supply-side factors (such as the availability of tests and protective equipment) after the first wave of the pandemic. During the following waves, quality perceptions were more influenced by demand-side factors (e.g., patients no longer undergoing medical check-ups and screenings). Poor quality assessments can be attributed to the strong separation of care sectors across federal structures, and responses from study participants indicated concerns about the continuity of care for their patients.

The study suggests that PCPs' quality perceptions adapt in real time to the most pressing issues. PCPs, at the forefront of Austria's fragmented healthcare system, likely have the most comprehensive understanding of their patients' health. Their insights should be used for timely, needs-based public health planning. As such PCPs' quality assessments could serve as real-time indicators of issues in primary care and act as proxies for missing data on epidemiology, services, and diagnostics.

Supplementary Information

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Supplementary Material 1.
Supplementary Material 2.

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Authors' contributions
AB and EK developed the study design and the analysis. AB was responsible for data analysis and statistics. EK developed the theoretical framework and conducted the sampling plan. DB was responsible for data analysis, discussion, and cross-checking of the results with the epidemiological data from the public authorities. Writing the manuscript was undertaken by all three authors at varying extent. All three authors contributed substantially towards the inter-pretation of results.

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Data availability
The survey participants have explicitly agreed to restrict the use of their responses solely for this research, thereby denying public access to the raw data.

Declarations

Ethics approval and consent to participate
The study followed the ethical guidelines of good scientific practice, the EU-General Data Protection Regulation, and the Declaration of Helsinki. The regulations of the Austrian Board of Ethics Committees require authorisation to investigate vulnerable groups, conduct intervention studies, and conduct pharmaceutical trials. None of these criteria applies to the study presented here. Furthermore, the study does not qualify for healthcare or medical research, focusing on generating new knowledge about disease or health. Thus, this study was exempt from ethical approval under Austrian Health Research regulations. Under Austrian law, a waiver is given only for approved research and not if no ethical approval is needed. Written information was provided to participants before the distribution of the surveys. Participants provided informed consent as online surveys contained the following statement for the participants: "By clicking to move forward to complete this survey, I agree to participate in this study." Data collection was anonymous.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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