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Original article

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Impact of the COVID-19 pandemic on the behaviour and health status of patients with chronic obstructive pulmonary disease – results from the German COPD cohort COSYCONET

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ABSTRACT

Background Infection control measures for COVID-19 might have affected management and clinical state of patients with chronic obstructive pulmonary disease (COPD). We analysed to which extent this common notion is fact-based.

Methods Patients of the COSYCONET cohort were contacted with three recurring surveys (COVID1, 2, 3 at 0, 3 and 6 months). The questionnaires comprised behaviour, clinical and functional state and medical treatment. The responses to the questionnaires were compared amongst themselves and with pre-COVID information from the last visit of COSYCONET.

Results Overall, 594 patients were contacted and 375 patients (58% males, FEV_1 61±22 %predicted) provided valid data in COVID1 and COVID2. Five patients reported infections with SARS-CoV-2. Most patients – except for patients with higher education – reported compliance with recommended protective measures, whereby compliance to hygiene, contact and access to physicians slightly improved between COVID1 and COVID2. Also, patients obtained more information from physicians than from public media. In the majority of cases, the personal physician could not be substituted by remote consultation. Over time, symptoms slightly increased and self-assessed physical capacity decreased. Results of COVID3 were similar. Women and patients with more exacerbations and dyspnoea avoided medical consultations, whereas GOLD D patients were more amenable to tele-consultation.

Conclusion In well-characterized COPD patients, we observed on average slight deteriorations of clinical state during the period of COVID-19 restrictions, with high and partially increasing adherence to protective measures. The data suggest that in particular women and GOLD D patients should be actively contacted by physicians to identify deteriorations.

INTRODUCTION

On 11 March 2020, the COVID-19 infectious disease was declared a pandemic and on 22 March 2020 Germany declared the 1st lockdown. Even though no general curfew was enacted, restrictions regarding personal contacts were imposed. While treating COVID-19-positive patients and tracing relevant contacts, the public health system tried to uphold medical care as much as possible. Patients with chronic obstructive pulmonary disease (COPD) are considered a risk group for severe COVID-19 courses. [1, 2] At the same time, these patients regularly require care from specialised clinics or practices. Therefore, public infection control measures can have beneficial effects, but also adverse effects on COPD patients, especially when access to medical care, physiotherapy and pulmonary exercise groups is limited by such public measures. [3, 4]

A cross-sectional investigation of the experiences of COPD patients during the first lock-down in Spain indicated only a low impact of disease control measures on their disease. [4] However, with the prolongation and tightening of such measures as the pandemic progressed, effects on the disease status may have become more pronounced over time. A detailed analysis of long-term changes and their impact on individual clinical history is not available yet but may be useful to improve the management of COPD patients in a pandemic.

The aim of the present study was to monitor the impact of the COVID-19 pandemic on COPD patients through repeated surveys. The focus of the surveys was placed on patients' behaviour, potential limitations of medical treatment and burdens of the disease, including depression scores. The study was conducted within the COSYCONET framework (COPD and Systemic Consequences-Comorbidities Network) between May 2020 and February 2021 and comprised three consecutive

assessments. The relation to COSYCONET offered the opportunity to link questionnaire data to individual pre-COVID information on lung function, comorbidity profile and psychological status.

METHODS

Study population

Patients of the German COPD cohort COSYCONET, which is a multi-center study focusing on the role of comorbidities in COPD, [5] and participating at visit 6 (6 y after recruitment) were contacted by mail and asked to respond to a specifically designed COVID-19 questionnaire (see Supplement). The COVID-19 questionnaire included questions to capture patient behaviours such as hygiene measures, disease-specific behaviour, physician and physical therapy visits, use of video and telephone consultations, health status and physical activity. Details on COSYCONET, its inclusion/exclusion criteria and assessments have been published previously. [5] Fifteen study centres participated in this sub-study, whereas 5 could not participate due to logistic reasons during the pandemic. The COVID-19 questionnaire was at three instances (at 0, 3 and 6 months). The mailing of the COVID-19 questionnaire started from May to July 2020, August to October 2020, and November 2020 to January 2021 for the assessments scheduled at 0, 3 and 6 months, respectively. After return of the questionnaires, the data base was finalized in February 2021. The collection of data over a 6 month period aimed to map potential long-term behavioural and health status related changes during the evolving pandemic. The three consecutive questionnaires are referred to as COVID1, COVID2 and COVID3. The primary analysis focused on patients who returned at least COVID1 and COVID2, as the number of participants dropped from 564 in the first to 381 in the

second to 241 in the third iteration of the survey; the latter is only shown in a secondary analysis.

The COSYCONET study has been approved by the Ethical Committees of all study centers, and all patients gave their written informed consent. [5] The additional examination of patients with the COVID questionnaire was also approved by the Ethics Committee (COSYCONET study, Amendment 11, AZ 200/09). The COSYCONET study was conducted in accordance with the Declaration of Helsinki.

Assessments

During the regular visits of the COSYCONET study, a detailed recording of all COPD-specific characteristics, demographics, comorbidities, medication, generic and disease-specific quality of life, and psychological disorders was performed. [5] Lung function was assessed following the standard operating procedures of COSYCONET in accordance with guidelines. [6, 7] The assessments included forced expiratory volume in one second (FEV_1) and its ratio (FEV_1/FVC) to forced vital capacity (FVC), as well as diffusing capacity for carbon monoxide (CO) in terms of transfer factor (TLCO) and transfer coefficient (KCO). Predicted values for spirometry and diffusing capacity were taken from the Global Lung Function Initiative (GLI). [8, 9] On the basis of the lung function at the time of recruitment, we also determined the annual decline of lung function over the follow-up visits prior to the COVID-19 pandemic, to be able to assess the potential link between the responses to the questionnaire and the decline in lung function.

Symptom burden was evaluated by using the disease-specific COPD Assessment Test (CAT) and the Modified Medical Research Council (mMRC) dyspnoea scale. [10, 11] The Patient Health Questionnaire Depression Scale 9 (PHQ-9) was used as a tool for screening depression. [12] Education was categorized in three groups

based on the number of years of education completed (basic education ≤9 years, secondary education 10-11 years, higher education >11 years). [13] We used data of the COSYCONET visit 6 for comparison with pre-pandemic measurements. The median time interval between visit 6 and the first COVID survey was 1.6 years.

COVID-19 restrictions in Germany

In Germany, the 1st lockdown was declared on 22 March 2020. The restrictions included control measures such as social distancing and limitations of personal contacts, accordingly hospitality, recreational and cultural facilities were shut. These restrictions were attenuated between May and October 2020 on a local basis, due to the decrease in the daily number of cases. From 29 April 2020 onwards, the wearing of face masks had become compulsory in public transport, schools and shops. During the 1st lockdown, non-urgent physician visits in both outpatient and inpatient settings were cancelled by the health care providers, postponed, or replaced by telephone visits. In the time between May and November 2020, the German healthcare system's capacity was at no time exhausted and all healthcare services could be offered to the fullest extent. The second wave of the pandemic led to a further lockdown (called „Lockdown Light") which was declared on 2nd November 2020. Several cultural and business institutions were shut down again, but the school system was initially kept open. These measures were tightened on 13th December 2021 and still in place at the end of our survey. However, the second lockdown did not lead to a general reduction in health care services, only in individual hot-spot areas elective surgical procedures had to be postponed due to increased utilization of intensive care units.

Statistical analyses

Regarding baseline characteristics of the study population and drop-outs, differences between groups were identified using chi-square tests for categorical variables and analysis of variance (ANOVA) for continuous variables. To analyse changes in CAT, PHQ-9 and mMRC prior to vs. during the pandemic and over the course of the pandemic, mean values were compared using pairwise t-tests. Additionally, the PHQ-9 categories “healthy to severe depression” [12] were compared using Wilcoxon signed-rank tests for dependent samples.

The questions in the COVID questionnaire had to be answered on a 5-item scale with the response options 1 = ”does not apply at all” to 5 =”fully applies”. Differences in the distribution of responses between COVID1 and COVID2 were analysed by histograms and Wilcoxon signed-rank test for dependent samples. To analyse the responses from COVID1 to COVID 3, the nonparametric Friedman test for repeated-measures was used. Furthermore, we investigated the dependence of responses in COVID1 on several patient characteristics using chi-square tests. Statistical analyses were performed using SAS software (SAS Institute Inc., Cary, NC, USA, version 9.4), and p-values of ≤ 0.05 were considered statistically significant.

RESULTS

Study population

Overall, 594 patients from 15 study centers were contacted, of whom 565 (95 %) responded to at least one questionnaire. In total, we received 1,186 complete COVID-19 questionnaires, 565 COVID1, 381 COVID2, and 241 COVID3. Complete responses to COVID 1 and COVID 2 were available for 375 patients, and 223

patients returned all three questionnaires. For purposes of the primary analysis, we defined the 375 patients as study population who returned both, the COVID1 and COVID2 questionnaire (see Figure 1, consort diagram). Five out of all 565 patients reported to have been diagnosed with COVID-19.

Table 1 shows patients' characteristics obtained at the COSYCONET visit 6, i.e. prior to COVID, and stratified according to the study population and the excluded patients. Significant differences between groups were found for the frequencies of gastrointestinal disorders, asthma and treatment with oral corticosteroids ($p<0.05$, each), whereas the distribution of sex, age, GOLD grades and groups, and educational status was not different.

Results of the repeated surveys

The comparison of COVID1 and COVID2 revealed a small increase in total CAT score ($p<0.05$), specifically CAT item 3 (chest tightness). The increase in mMRC was not statistically significant. For PHQ-9, COVID2 showed a higher proportion of the upper three categories, due to an increase in mild depression ($p<0.05$; Table 2).

Individual measures of hygiene

Figure 2a shows the results regarding individual measures of hygiene, i.e. hand disinfection, use of face-masks, social distancing and dispensing with travels. The only apparent change between COVID1 and COVID2 was the higher adherence to hand disinfection in the second questionnaire; there was an increase of 7% in the answer "fully applies" for "regular hand disinfection".

Disease-specific behaviour

Figure 2b shows the results relating to the avoidance of physicians' practices, physiotherapy, breathing therapy and pulmonary exercise groups. Interestingly, the

level avoidance of physicians' practices decreased in COVID2. While, 16% of patients gave their full agreement for "avoidance of contact to practices" in COVID1, only 10% of patients gave this answer in COVID2.

Access to practices

Figure 2c shows the results regarding the availability of physicians and specialists as well as the possibility to arrange for appointments at practices. Most patients reported a high accessibility to general practitioners and pulmonologists. Only a minority of patients and practices cancelled scheduled visits, and the number of cancelled visits (answer "fully applies") decreased from 13% in COVID1 to 8% in COVID2.

Video or telephone consultation

Figure 2d shows the results regarding the frequency of tele-consultation, the attitude towards such consultation and its estimated effectiveness. The majority of patients did not use tele-consultation (68% in COVID1 and 74% in COVID2), did not consider tele-consultation as a suitable substitute for consultation in person (69% in COVID1 and 75% in COVID2) and did, generally, not favour tele-consultation (88% in COVID1 and 91% in COVID2).

Information on infection control measures

Figure 2e shows the results regarding the source of information on infection control measures. Whereas the percentage of patients relying on public media has been high throughout and only slightly decreased in COVID2, the reliance on general practitioners, pneumologists and pneumological clinics as sources of information increased from COVID 1 to COVID2.

Course of COPD

Figure 3a shows symptoms and clinical state. Overall, from COVID1 to COVID2 patients reported increased dyspnoea (cough and deteriorations in form of exacerbations), as well as a deterioration of their general clinical state. The number of patients who reported no increase in dyspnoea decreased from 56% to 46% and the number of patients who reported low cough complaints decreased from 64% to 56%. Furthermore, the proportion of patients reporting a stable general health status decreased from 76% to 71%.

Physical activity

Figure 3b shows physical activity as self-reported in COVID1 and COVID2. Reductions of general physical activity were attributable to the restrictions on free movement and scheduled physiotherapy. However, there were only minor changes between COVID1 and COVID2 with an increase of 3% of patients reporting low general physical capacity. Regardless, general physical capacity was generally considered lower by patients.

Additional changes in the COVID3 assessment

When extending the scope of assessments to COVID3, we observed stable results for most of the items presented above, except for general physical capacity and physical condition, which significantly deteriorated, as reflected in increased cough and dyspnoea (see Figure 4).

When repeating the comparison of COVID1 and COVID2 responses for this subpopulation, the results were compatible with those initially reported, especially for higher adherence to hand disinfection, less avoidance of contact to practices and increasing level of accessibility to general practitioners and pulmonologists for COVID2 compared to the COVID1 answers.

Relationship between pre-COVID state and COVID1 results

Comparison of standardized instruments CAT, PHQ-9 and mMRC

Responses to COVID1 were in a first step compared with the last COSYCONET visit and in a second step with the responses to COVID2 (Table 2). The comparison between pre-COVID and COVID 1 showed a slight increase of total CAT score ($p<0.05$), corresponding to increases in CAT items 4, 6, 8 (dyspnoea/stairs, confidence leaving home, energy), and a decrease in CAT item 3 (chest tightness). Accordingly, mMRC was higher and the relative frequency of elevated PHQ-9 scores (upper three categories) was higher, as reflected in higher rates of moderate and severe depression (Table 2). Further information on the comparison of physical characteristics and specific COVID survey items, as well as their relationship to the annual decline of lung function can be found in the supplement.

DISCUSSION

In the present study, we assessed the impact of infection control measures against COVID-19 on medical treatment, protective behaviour, symptoms, exacerbations and clinical state of COPD-patients. We also analysed whether the results depended on the individual clinical history, which was possible as the study was performed within

the long-term COSYCONET follow-up framework. Overall, patients showed high adherence to protective measures and over time increasingly relied on information from medical professionals. Generally, adherence was higher in women, but interestingly, adherence was lower in patients with higher education. Symptoms slightly increased and self-estimated physical capacity decreased over time. The negative impact of infection control measures on the clinical state was stronger in patients with a history of frequent exacerbations, while the adherence of such patients to the measures partially even decreased. Similar results were observed for patients with comorbidities described as risk factors for COVID-19, such as diabetes, obesity or coronary artery disease. Although changes were small, these findings indicate deteriorations of self-reported clinical state in patients with COPD despite an increasing adherence to protective measures against COVID-19.

In our study cohort, only a small fraction of patients was amenable to tele-consultations. For the vast majority, personal contact with physicians was still important. This was reflected in the tendency over the course of the study to obtain more information from physicians and increase face to face contact with them. This suggests that irrespective of the advantages of remote care, patients rely on the personal contact with physicians at regular intervals, especially as there are differences between physicians and patients regarding the perception and evaluation of clinical state. [16] On the other hand, in our study COPD patients with high symptom burden and exacerbation risk reported to avoid contact with physicians in favour of tele-consultation. This indicate that remote care should be tailored to the specific needs of a certain group of patients.

While several studies reported that the number of exacerbations leading to hospitalization decreased during the COVID pandemic [17, 18], two studies showed an increase or at least frequent exacerbations during the first phase of COVID-19 in UK and Spain. [4, 19] Our data showed an increase in symptoms indicative of mild exacerbations. This may result from different definitions. Also, stronger protection against infectious agents may have prevented moderate and severe exacerbations, whereas the reduction in medical care led to a slight deterioration over time. Despite reductions in medical care, patients did not report increased impediments to access respiratory medication and denied a decrease in the quality of respiratory care (see Figure S1). The numbers of appointments cancelled by either physicians or patients also decreased over time which indicates that both sides got accustomed to the new situation. Regardless, the self-reported physical capacity of the patients decreased, in accordance with objective measurements. [20]

The assumption that the protective measures against COVID-19 were effective, is in line with the observation that only five of 564 patients became infected with COVID-19. Considering that severe exacerbations are known to have a major impact on the course of the disease, [3, 21] it could be argued that in the future COPD patients might benefit from some of the protective measures established during the pandemic., such as a careful selection of contacts and the wearing of face-masks under specific conditions. While a previous analysis of COSYCONET data showed an association between better lung function and higher educational status, [13], the present study found lower levels of adherence to infection control measures among patients with higher education. This should be considered when advising patients on infection control measures.

Limitations

Due to the low number of patients with COVID-19, our data does not allow to draw conclusions on the impact of this disease in COPD. By contrast, the data reflects the impact of protective measures against COVID-19 on these patients, which is particularly relevant for the majority of our study population who did not suffer from COVID-19. Although the initial response rate to the questionnaires of 95% was rather high, the number of responses decreased with each iteration of the questionnaire, especially between COVID2 and COVID3 (see Table 1). Except for a higher prevalence of asthma, gastrointestinal disorders and the use of oral corticosteroids, the characteristics were very similar between the drop-outs and the patients having at least the first two assessments. Regarding the occurrence of increased symptoms and deteriorations compatible with mild exacerbations, we had to rely on patients' answers as we naturally could not include functional measurements or physical examinations that were avoided by a significant number of patients. Until now, the assessment of single CAT items has not been validated so far. Nevertheless, we analysed the single CAT items as a proxy of COPD specific symptoms, which was shown to be an effective approach in previous COSYCONET investigations.[22] This also allowed a direct comparison of the pre-COVID and COVID era.

Conclusion

When monitoring the potentially disease-relevant behaviour and clinical state of well characterized COPD patients from May 2020 to the beginning of 2021 through the responses to three repeated questionnaires, we observed slight deteriorations of clinical state and self-reported exercise capacity despite high and partially increasing adherence to the protective measures and at the same time decreasing limitations in the access to medical care. According to most patients, the personal treatment by

physicians could not be adequately substituted by remote care. However, women and COPD patients with high symptom burden and exacerbation risk reported an increased avoidance of personal contacts with physicians, while all patients did not favour tele-consultation. Therefore, the results suggest that in particular women and GOLD D patients should be actively contacted by the physician for the diagnosis of deteriorations.

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Data sharing statement

The basic data are part of the German COPD cohort COSYCONET (www.asconet.net/) and available upon request. There is a detailed procedure for this on the website of this network. Specifically, the data can be obtained by submission of a proposal which is evaluated by the steering committee. All results to which the manuscript refers to are documented by the appropriate in the text, figures or tables.

Ethics approval and consent to participate

All assessments were approved by the central (Marburg (Ethikkommission FB Medizin Marburg) and local (Bad Reichenhall (Ethikkommission bayerische Landesärztekammer); Berlin (Ethikkommission Ärztekammer Berlin); Bochum (Ethikkommission Medizinische Fakultät der RUB); Borstel (Ethikkommission Universität Lübeck); Coswig (Ethikkommission TU Dresden); Donaustauf

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Information on the study

The study comprised patients recruited within the COSYCONET framework (ClinicalTrials.gov, Identifier: NCT01245933). For further information see: Karch A, Vogelmeier C, Welte T, Bals R, Kauczor HU, Biederer J, Heinrich J, Schulz H, Glaser S, Holle R et al: The German COPD cohort COSYCONET: Aims, methods and

descriptive analysis of the study population at baseline. Respir Med 2016, 114:27–37.

Consent for publication

Within the ethical approval the participants of the study gave their consent to publish the data collected during the study period.

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Table 1. Baseline characteristics

	Study population (n=375)		Excluded (n=189)		p-value
Male	218	(58.1)	109	(57.7)	0.9165
Age	71.1	± 8.4	70.4	± 8.7	0.3737
Education					
Basic	188	(50.1)	76	(40.2)	0.0829
Secondary	117	(31.2)	70	(37.0)	
Higher	70	(18.7)	43	(22.8)	
Smoking Status					
Current smoker	63	(18.3)	17	(11.4)	0.0053
Ex-Smoker	261	(75.9)	112	(75.2)	
Never Smoker	20	(5.8)	20	(13.4)	
Packyears	34.2	± 15.5	30.6	± 16.8	0.0134
Comorbidities					
Gastrointestinal	149	(41.7)	105	(56.2)	0.0014
Asthma	65	(18.2)	50	(26.7)	0.0206
Hyperuricemia	52	(14.6)	38	(20.3)	0.0862
Hyperlipidemia	150	(42.0)	88	(47.1)	0.2602
Osteoporosis	43	(12.0)	32	(17.1)	0.1035
Arterial hypertension	187	(52.4)	100	(53.5)	0.8080
Coronary artery disease	49	(13.7)	25	(13.4)	0.9083
Diabetes	40	(19.7)	26	(13.8)	0.2812
Medication					
OCS	22	(5.9)	31	(16.4)	<.0001
ICS	217	(57.9)	120	(63.5)	0.1985
FEV_1 (%predicted)	61	± 22.4	58.2	± 21.7	0.1550
FEV_1/FVC	0.55	± 0.14	0.57	± 0.14	0.1678
BMI (kg/m²)	26.9	± 4.8	27.3	± 5.5	0.3224
GOLD 1	40	(10.7)	13	(7.0)	0.1972
GOLD 2	141	(37.8)	63	(33.9)	
GOLD 3	116	(31.1)	62	(33.3)	
GOLD 4	20	(5.4)	14	(7.5)	
GOLD 0	56	(15.0)	34	(18.3)	
GOLD A	55	(14.8)	24	(12.9)	0.7680
GOLD B	210	(56.6)	105	(56.5)	
GOLD C	3	(0.8)	3	(1.6)	
GOLD D	103	(27.8)	54	(29.0)	
PHQ-9	5.6	± 4.3	6	± 4.3	0.3800

CAT score	17.1	± 6.9	17.9	± 7.3	0.1786
mMRC	1.5	± 0.9	1.5	± 0.9	0.5769

Table 1 shows baseline characteristics of the study population as well as the excluded patients. Comparison between groups were performed by chi-squared statistics for categorical variables and by ANOVA for continuous variables. The level of significance was set at $p<0.05$. OCS= oral corticosteroids, ICS =inhalative corticosteroids.

Table 2. Changes in CAT, PHQ-9 and mMRC

	COSYCONET	**COVID 1**	**COVID 2**	***Mean change***	***Mean change***	***p-value***	***p-value***
	(1)	**(2)**	**(3)**	***1 to 2***	***2 to 3***	***1 vs. 2***	***2 vs. 3***
						"before/ during "	***"during pandemic"***
	mean ± std	*mean ± std*	*mean ± std*				
CAT item	17.1 ± 6.9	18.0 ± 7.5	18.5 ± 7.6	+0.90	+0.05	*0.0003*	*0.0417*
(1) Cough	2.16 ± 1.10	2.25 ± 1.17	2.34 ± 1.17	+0.09	+0.09	*0.1272*	*0.0879*
(2) Sputum	2.17 ± 1.23	2.19 ± 1.33	2.23 ± 1.31	+0.02	+0.04	*0.7937*	*0.5208*
(3) Chest tightness	1.74 ± 1.24	1.68 ± 1.35	1.85 ± 1.39	-0.06	+0.17	*<.0001*	*0.0074*
(4) Dyspnea/ stairs	3.59 ± 1.27	3.77 ± 1.30	3.78 ± 1.36	+0.18	+0.01	*<.0001*	*0.6409*
(5) Limitations/ home activties	2.10 ± 1.47	2.35 ± 1.59	2.44 ± 1.59	+0.25	+0.09	*0.0555*	*0.1212*
(6) Confidence leaving home	0.80 ± 1.17	1.16 ± 1.52	1.14 ± 1.47	+0.36	-0.02	*<.0001*	*0.8585*
(7) Sleep	2.00 ± 1.43	2.03 ± 1.55	2.12 ± 1.51	+0.03	+0.09	*0.1321*	*0.2743*
(8) Enery	2.40 ± 1.17	2.59 ± 1.30	2.64 ± 1.29	+0.19	+0.05	*<.0001*	*0.4507*
mMRC	1.47 ± 0.91	1.62 ± 0.97	1.70 ± 1.01	+0.15	+0.08	*<.0001*	0.0673
PHQ-9	5.63 ± 4.27	5.98 ± 4.92	6.16 ± 4.65	+0.35	+0.18	*0.0863*	*0.2318*
	n (%)	*n (%)*	*n (%)*				
Healthy	170 (54.8)	173 (46.4)	161 (45.1)			*<.0001*	*<.0001*
Clinically unremarkable	142 (38.3)	132 (35.4)	122 (34.2)				
Mild depression	43 (11.6)	40 (10.7)	52 (14.6)				
Moderate depression	11 (3.0)	19 (5.1)	18 (5.0)				
Severe depression	5 (1.4)	9 (2.4)	4 (1.1)				

Table 2 shows the comparison of changes of the single CAT items, the PHQ-9 as well as the mMRC between the pre-COVID COSYCONET visit and COVID1, as well as the comparison between the two COVID surveys during the pandemic. The level of significance was set at $p<0.05$. The comparisons between groups were performed using pairwise t-test for the metric variables. Additionally, the PHQ-9 categories were compared using wilcoxon signed-rank tests for dependent samples.

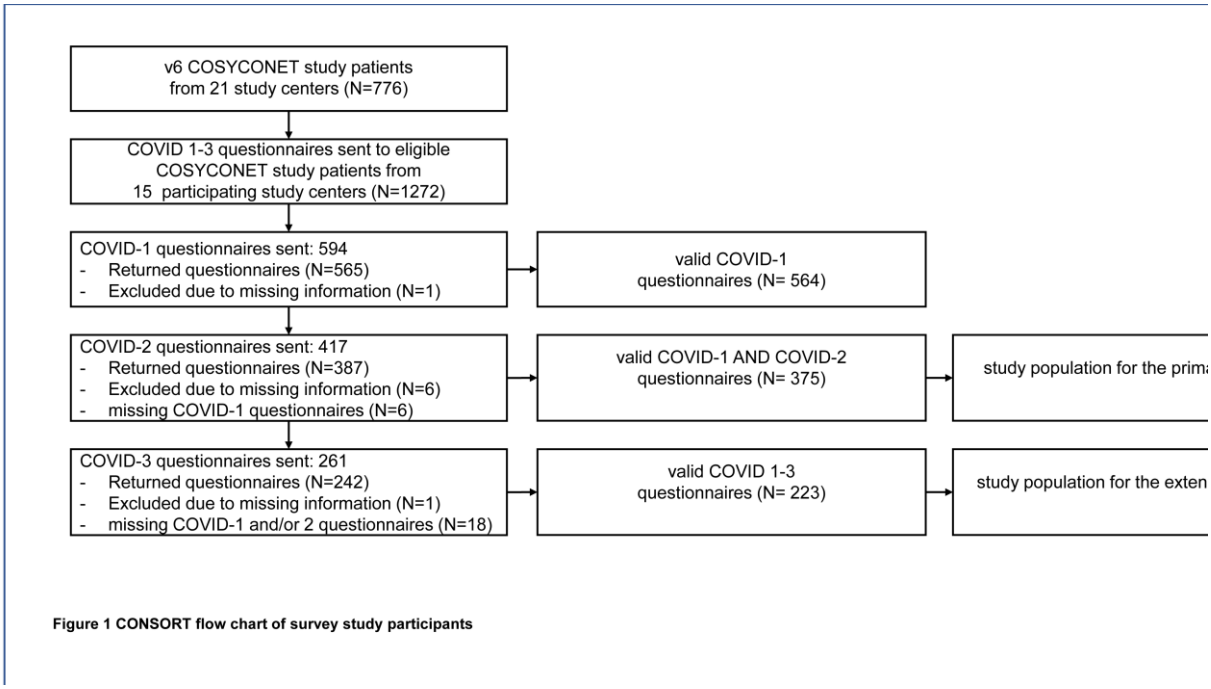

Figure 1. Consort diagram

Figure 1 shows the CONSORT flow chart of COVID survey study participants. The questionnaires were only sent out again by the study centers, if the first or second questionnaire was returned. Furthermore, due to the increasing capacity bottlenecks caused by the COVID pandemic, not all study centers were able to send out the questionnaires at the third timepoint. This led to differences in the number of questionnaires sent on each occasion."

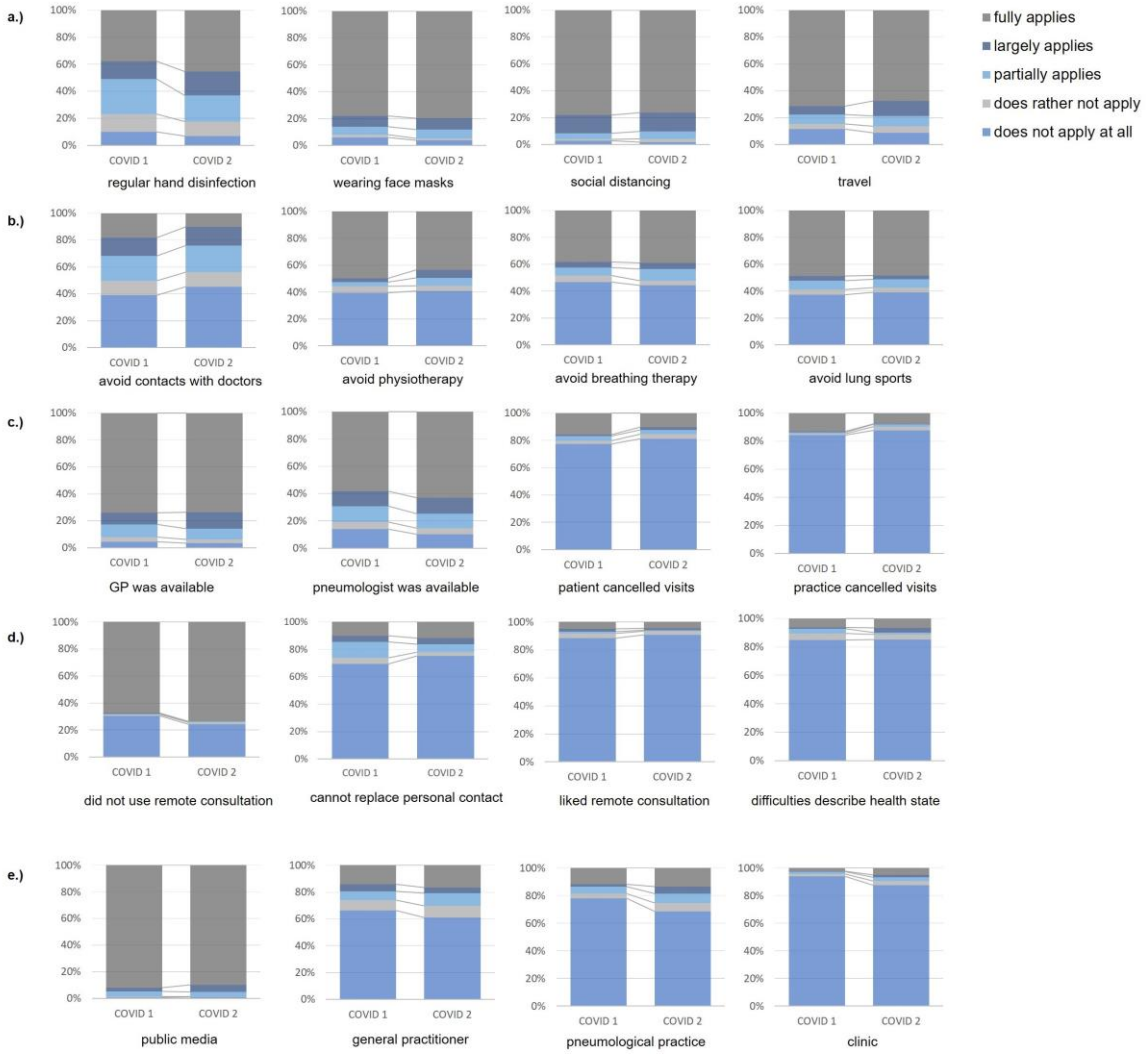

Figure 2 a-e. Results of the repeated surveys regarding patients' behaviour

Figure 2 shows results of COVID1 and COVID 2 regarding individual measures of hygiene (a.), disease-specific behaviour (b.), access to medical care (c.), video or telephone consultation (d.) and information on infection control measures (e.). Answers range from blue =" does not apply at all" to grey = "fully applies".

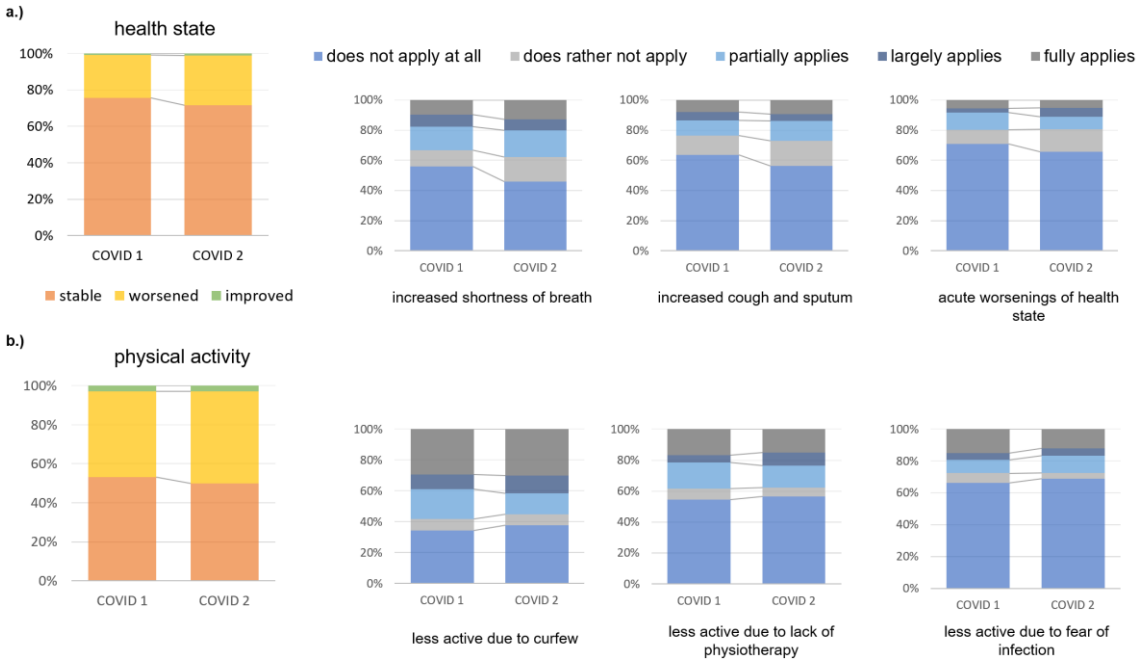

Figure 3a and b. Results of the repeated surveys regarding health status and physical activity

Figure 3 shows results of COVID1 and COVID 2 regarding the course of COPD, a) health status and b) physical activity. Answers range from blue =" does not apply at all" to grey = "fully applies".

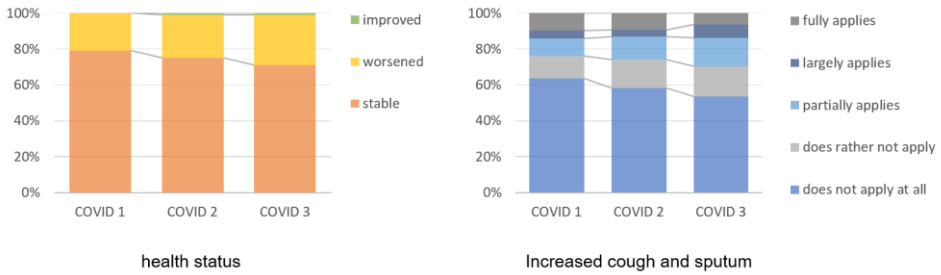

Figure 4. Additional changes in the COVID3 assessment

Answers for "increased cough and sputum production" range from blue =" does not apply at all" to grey = "fully applies".

SUPPLEMENT

Comparison of physical characteristics and specific COVID survey items

The comparison between men and women showed significantly lower medical consultations in females ($p=0.0048$, see Table S1), whereas there were no differences regarding dyspnoea and physical capacity ($p>0.05$, each). The comparison between patients with higher versus lower exacerbation risk (GOLD groups CD vs AB) revealed lower medical consultations ($p=0.0205$), higher dyspnoea levels and lower physical capacity in the high-risk group ($p<0.001$, each). Similarly, symptomatic patients (GOLD groups BD versus AC, equivalently mMRC≥2) reported significantly less medical consultations ($p=0.024$), more dyspnoea ($p<0.001$) and less physical capacity ($p<0.001$). High educational level was associated with less compliance to the wearing of face-masks and the reduction of travel. For further details see Table S1.

Since arterial hypertension, coronary artery disease, diabetes and obesity have been identified as risk factors for worse COVID-19 outcome, we additionally assessed their relationship to the answers in the COVID1 survey, since we assumed that patients might be informed in the public media on appropriate behaviour. There were, however, no strong, consistent relationships (Table S1).

Moreover, the answers to the COVID1 questionnaire, particularly those on clinical state, did not depend on the rate of annual decline of spirometric lung function or diffusing capacity as determined since inclusion into COSYCONET.

Additional topics for discussion

Associations of psychological disorders and specific COVID survey items

Protective measures such as social distancing and isolation, however, may also induce or enhance adverse social behaviour and psychological disorders, like depression, as known for various chronic diseases [1]. Depression is known to be linked to the clinical state and course of COPD, [2, 3]. However, a cautious approach should be taken in interpreting specific questionnaires, like the PHQ-9, and the influence of COPD symptoms on the results should be taken into account. [4]

Associations on Risk factors and answers to covid survey items

Several risk factors for a severe course of COVID-19 have been described, especially male sex, the presence of cardiovascular disease such as hypertension and coronary artery disease, as well as diabetes and obesity. [5-7] Interestingly, we did not observe significant relationships between these conditions and indicators of the patients' clinical state. There were, however, relationships to the degree of adherence to the protective measures. These were most obvious when comparing males and females, as females showed a better adherence in a number of aspects. [8] Regarding comorbidities, a lower level of behavioural compliance appears to be counterproductive in light of the risk factors that can be assumed to be known by patients.

Changes in established measures (CAT, mMRC, PHQ-9)

Minimally important differences (MID) are used to assess, whether an intra-individual change is clinically meaningful and potentially recognized by a patient. For the CAT, a MID of 2 points is established [9], while for mMRC and PHQ-9 no MIDs have been published, to our knowledge. One might assume that their maximum values of 5 and 27, respectively, could be scaled to the maximum CAT value of 40, as CAT very well correlates with PHQ-9 and mMRC in COPD. Thus, regarding mMRC and PHQ-9, one might assume 0.25 (=2*5/40) and 1.5 (≈2*27/40) points, respectively, as relevant

changes. When considering the period from COSYCONET visit 6 to COVID 2, the mean change was 1.4 in the CAT total score, i.e. less than 2 but in our view this still indicates at least a trend. In comparison, the changes in mMRC and PHQ-9 were smaller, being 0.23 and 0.53 points on average.

For the sake of clarity, we used pairwise comparisons for statistical analysis. When repeating this with a mixed model comprising all time points, essentially the same results were obtained; as expected, there were also significant differences between the results for time points 1 and 3, in accordance with the results given in table 2.

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Patients‘ charateristics	Differences in answers COVID1 survey
Female gender	- Increased hand washing - Increased hand desinfection - accumulate more food stocks - avoid travelling - keep more distance in everyday life - Avoid contact with doctors - Information is more obtained less in clinics - Move less due to public restrictions
BMI≥30kg/m²	- Wear less mouth-nose protection in public spaces
High education (versus basic secondary education)	- Wear less mouth-nose protection in public spaces - forgo less travel - Report that less physiotherapy treatment does not negatively affect activity levels
Higher exacerbation risk (GOLD CD)	- disinfect hands less - accumulate more food stocks - avoid travelling - Avoid contact with doctors - Renounce lung sports - Information is more obtained through public media - Information is more obtained through pneumologist - Scheduled checkup appointments were increasingly canceled by practices - health condition has deteriorated - report more dyspnoea - report more cough and sputum production - report more exacerbations - physical capacity deteriorated
Higher GOLD grades 3/4 (versus 0/1/2)	- Information is more obtained through public media - report a better accessibility of the general practitioner - health condition has deteriorated - report more dyspnoea - physical capacity deteriorated
mMRC≥2	- accumulate more food stocks - Avoid contact with doctors - Renounce lung sports - Report more that personal meetings can be replaced by tele-consultation - health condition has deteriorated - report more dyspnoea - report more cough and sputum production - report more exacerbations

	- Move less due to public restrictions - Report that less physiotherapy treatment does negatively affect activity levels - Walks less due to fear of infection - physical capacity deteriorated
Diagnosis of coronary artery disease	- keep less distance in everyday life - Renounce less lung sports - Information is more obtained through general practitioner - report more exacerbations
Diagnosis of arterial hypertension	- Increased hand washing
Diagnosis of Diabetes	- Information is more obtained through general practitioner

Table S1. Associations between patients' characteristics as determined in COSYCONET and answers in the COVID1 survey.

Only significant associations are given ($p<0.05$). For each patient characteristic all single survey items were tested by chi-squared statistics