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Reduced physical activity and weight gain are associated with an increase of depressive symptoms during the COVID-19 pandemic. A general practitioners' prospective observational study

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Key message: COVID-19 is a great challenge for ambulatory care. We provide evidence that depressive symptoms significantly deteriorate in GP patients during the pandemic and are associated with reduced physical activity, weight gain, and an increase of dyspnea. Hypertension is no driver for deterioration of these symptoms.

Abstract

Objectives: We aimed to assess associations between depressive symptoms, lifestyle, and somatic symptoms during the COVID-19 pandemic.

Design: A prospective, observational study using a self-designed questionnaire.

Setting: Three general practitioners' (GP) offices in rural Germany.

Participants: 271 adult patients without manifest cardiovascular or pulmonary disease with (n = 82) and without (n = 189) hypertension reporting to our GP offices.

Main outcome measures: The reported increase of depressive symptoms (loneliness, sleeplessness, joylessness, listlessness) prior to the first documented case in Germany on 27.01.2020 (t_0) as opposed to patients' health perception during the Corona pandemic (t_1) was the primary outcome measure. The secondary outcome measures were changes in physical activity (PA), dyspnea and angina in the two groups.

Results: Out of 271 patients (50.8 ± 16.8 years, 55.1% females), 1.5% were tested positive for COVID-19. Overall, listlessness (8.5%, $p = 0.001$), sleeplessness (5.2%, $p = 0.001$) and joylessness (4.2%, $p = 0.003$) were increased. Dyspnea significantly increased (9.2%, $p < 0.001$) and employment status worsened (6.5%, $p < 0.001$). There were significant associations between the increase of depressive symptoms, weight increase ($p = 0.017$), and reduction in physical activity ($p = 0.046$). However, after adjusting for age, hypertensive patients did not show more depressive symptoms ($p = 0.704$), dyspnea ($p = 0.063$) or angina ($p = 0.432$), nor was there any difference in PA ($p = 0.906$) compared to healthy individuals.

Conclusions: We demonstrate an association between the deterioration of depressive symptoms, weight gain, and reduced physical activity during COVID-19, both in hypertensives and healthy controls. Hypertension is no driver of symptom deterioration during the pandemic. The trial was registered in the German Clinical Trials Registry (DRKS00022157).

Keywords

General practice, COVID-19, depression, hypertension

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Introduction

Since the beginning in December 2019 the Corona pandemic has caused enormous economic and health care problems.[1] The associated restrictions have reduced direct patient-physician contacts and delayed early intervention in disease progression of chronically ill patients.[1] General practitioners (GPs) have established telephone and video councils in the UK to provide additional patient support.[2]

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Psychological and physical consequences of restrictive measures on patients[3] and medical personnel[4] have been published in other countries, but there is no data in the GP setting. It has been shown that symptoms of depression have increased during the Corona pandemic and have been associated with isolation and quarantine.[5] Cardiovascular mortality is increased in the presence of co-morbidities such as depression,[6] weight gain,[7] and a sedentary lifestyle with reduction of physical activity.[8] We hypothesise that the COVID-19 pandemic increased depressive as well as somatic symptoms, such as dyspnea and angina pectoris, in patients reporting to our GP offices prior to the first documented case in Germany on 27.01.2020 (t_0) compared to patients' health perception during the Corona pandemic (t_1).

Furthermore, we claim that the deterioration of these symptoms may be explained by a change in lifestyle with an increase of unhealthy diet and associated weight gain, a reduction of physical activity, and an associated increase of depressive symptoms. Such a finding would necessitate a more active surveillance strategy in GP offices to prevent major cardiovascular events.

COVID-19 has been shown to cause myocardial injury,[9] and co-morbidities such as hypertension are associated with disease severity and are associated with depression.[10] In a sub-analysis we aimed to analyse whether there are differences in the increase of depressive symptoms during the pandemic between healthy controls and patients suffering from hypertension.

Methods

Study design and setting

There are well-validated assessment scores for individual diseases, such as quality of life in chronic heart failure (Kansas City Cardiomyopathy Questionnaire)[11] or depression (DSM-5).[12] As GPs need to screen for a broad range of diseases from different specialties, we aimed to elaborate a not yet validated screening tool implementing questions on somatic and psychological symptoms as well as physical activity in one questionnaire. One major aim of this questionnaire is its applicability in routine clinical practice and the potential to complete it in a realistic amount of time in the GPs waiting room under 'real-world' conditions. This should serve as a pilot project to demonstrate its feasibility in the GP setting.

The questionnaire consisted of six blocks: (1) patients' individual management of the pandemic, including personal quarantine, change of employment status, personal autonomy, and use of the media. (2) The medical history contained questions on cardiovascular risk factors and vaccinations against lung diseases. (3) General information on hospital admissions, substance consumption and GP visits were obtained. (4) Psychological symptoms, (5) changes of physical activity, and (6) somatic symptoms were also assessed. Patients were instructed to select a symptom only if it was present on almost all days of a week (t_0, t_1).

PHQ-9 is a well-validated score to detect depression in the primary care setting.[13] This test consists of nine items. For each item three points are given if the symptom is present on most days of the week. A minor depressive episode must be suspected if at least five points are reached. This means that only two symptoms persisting on most days of the week allow this diagnosis.[13] We chose three items from PHQ-9 (listlessness, sleeplessness, and joylessness) and added loneliness as a potential trigger for depression and a common phenomenon of social deprivation during the pandemic.[5] In accordance with the validated PHQ-9, we claimed that the occurrence (from t_0 to t_1) of two out of these four symptoms would qualify to suspect a depressive episode during the pandemic.

Data acquisition was performed prospectively by using the self-designed questionnaire (Supplement 1) in our three GP offices in rural North-Rhine Westphalia, Germany, from 01.08 to 01.10.2020 asking patients about their physical and psychological status prior to the first documented COVID-19 case in Germany on 27.01.2020 (t_0) as opposed to their health perception during the Corona pandemic between 27.01.2020 and the date of questionnaire completion (t_1). Patients were explicitly advised that t_0 reflected the period before 27.01.2020.

The consultation assistants asked all eligible patients who reported to our offices if they were willing to participate and fill out a self-designed questionnaire to assess socio-economic, physical and psychological changes before and during the Corona pandemic. Self-selected approval and written consent to participate were followed by an educational talk with a physician on the purpose of the study and patients were then given an unlimited amount of time to anonymously complete the questionnaire. All questions had to be answered in order to be valid for further analysis. The files were then sealed and stored in a study compartment and were handed to the first author for further analysis at the end of recruitment. 402 patients were screened and consented to participate, 271 fulfilled the inclusion criteria (baseline characteristics are shown in Table 1; Figure 1 illustrates the recruitment flowchart).

Participants

All patients registered in our GP offices who were 18 years or older were eligible to participate. Previously diagnosed depression, pulmonary disease, manifest cardiovascular disease, and cancer were exclusion criteria as well as cognitive (dementia, acute psychological or neurological disorders) or physical (acute medical or trauma conditions) inabilities to independently fill out questionnaires. Legal capacity and willingness to participate was a prerequisite

Table 1. Baseline characteristics of all patients (n = 271). GP: General practitioner.

Age	50.8 ± 16.8 years
Females	55.1%
BMI	27.4 ± 5.6 kg/m^2
Diabetes	8.5%
Atrial fibrillation	7.1%
Active smokers	24.5%
Highest education	
• Mandatory school	19.9%
• Professional school	59.7%
• A-levels	15.7%
• University graduation	4.7%
Hypertension	30.3%

for participation. Hypertensive patients were defined as having a diagnosis of arterial hypertension in our offices prior to the first documented COVID-19 case in Germany; the diagnosis had to be established following current guidelines.[14]

Outcome measures

The primary outcome of the study was an increase of depressive symptoms (loneliness, sleeplessness, joylessness, listlessness) during the Corona crisis (t_1) compared to the pre-COVID-era before 27.01.2020, the first documented case in Germany (t_0). A new depressive episode was diagnosed if at least two of the four symptoms were reported. The secondary outcomes were an increase of dyspnea (change of New York Heart Association, NYHA, class), angina pectoris (change of Canadian Cardiovascular Society, CCS, class), and a reduction of physical activity (PA, defined according to the ESC 2020 guidelines[8]). At first, changes from t_0 to t_1 were analysed across the entire study population (n = 271) and outcomes were calculated. In a second step, age-adjusted differences between the group of hypertensive patients (n = 82) and healthy controls (n = 189) were calculated.

Statistical methods

We used SPSS (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.) to analyse the data. Frequency distributions of variables and patient characteristics were provided by means of descriptive statistics. Distribution was tested with Shapiro-Wilk-and Kolmogorov-Smirnov tests with Lilliefors significance correction. McNemar testing and crosstabulation were applied to assess change in symptoms before and during the pandemic. Bivariate associations between the primary outcome and nominally scaled influencing factors were evaluated by exact chi-squared testing and Cramer's V as correlation measures. As a level of significance α was set at 0.05.

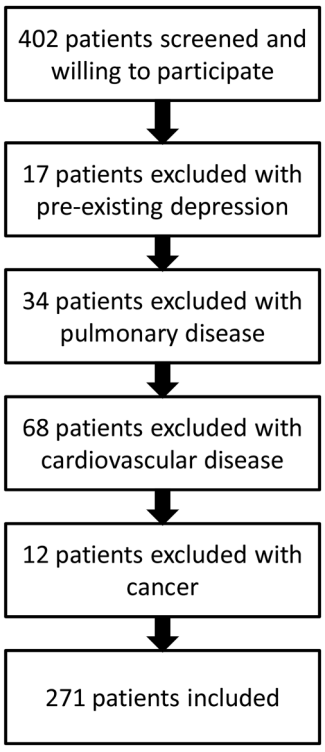

Figure 1. Flowchart of study inclusion.

Filtering of all factors assessed in the questionnaire and influencing the dependent variable was done by inspecting the overall correlation structure. Finally we evaluated the dependencies of some selected factors as independent variables in a multivariable stepwise (AIC oriented) logistic regression model.[15,16] Estimated odds ratios with 95% confidence intervals were derived from the regression coefficients. Finally, as an exploratory analysis, we calculated the potential of independent variables assessed in the questionnaire to predict deterioration of depressive symptoms during the crisis with regression analysis.

Results

Analysis of the entire population

9.7% were sent to quarantine, while only 1.5% (Confidence Interval, CI: 0.5–3.2%) were tested positive for COVID-19. 11.9% were worried about their professional future and we

observed a significant deterioration of employment status during the pandemic (for further descriptive statistics see Table 2). Dyspnea, but not angina, increased significantly between t_0 and t_1 (Table 3). Depressive symptoms deteriorated in 7.0% (4.7%–9.9%) and improved in 2.2% (1.0%–4.2%) of patients ($p = 0.003$). Overall, listlessness, sleeplessness and joylessness deteriorated significantly from t_0 to t_1 (Table 3).

2.5% of patients were prescribed new sedatives during the pandemic and in 4.2% pre-existing pain medication was increased. 4.7% of the 25.4% active smokers increased their consumption during the pandemic, while 4.2% of the 14.2% patients with regular alcohol consumption increased their intake. 16.2% reported that their health status had declined during the pandemic.

Bivariate analysis between increase of depressive symptoms during the pandemic (primary outcome) and potential influencing factors revealed significant associations between the primary outcome and weight increase, reduction of physical activity, and worries on the future (Table 4).

PA did not change significantly ($p = 0.231$) between t_0 (5.2 h/week ± 5.3) and t_1 (5.0 h/week ± 5.3), but 19.2% of patients decreased PA. The analysis of the correlation structure from Cramers's V coefficients revealed that the factors BMI, age, worries on the future, worsening of employment, and reduction of PA could qualify for further analysis in a multivariable stepwise regression analysis. Following AIC-forward/backward analysis, only worries on the future and reduction of PA remained as significantly independent factors in the model. However, the effect of PA reduction (OR: 2.1, CI: 1.1–3.9) and worries on the future (OR: 2.7, CI: 1.3–5.5) are not sufficient to discriminate worsening of depressive symptoms in a regression model ($R^2 = 0.05$, $C = 0.6$).

Subgroup-analysis: healthy controls and hypertensive patients

After adjustment for age, there was no significant difference in the increase of depressive symptoms from t_0 to t_1

Table 2. Descriptive statistics of all patients (n = 271). GP: General practitioner.

Documented contact to positively tested patients	4.2%
Quarantine during observational period	9.7%
Tested positive for COVID-19	1.5%
Sick leave during pandemic	19.9%
Weight gain during pandemic	22.1%
Increase of internet activities during pandemic	34.6%
Well-informed on COVID by GP and the media	88.1%
Elective medical procedure delayed	5.7%
Hospitalisation during observational period	11.7%
Phone council during pandemic	13.2%
Living alone	37.6%

Table 3. Comparison of work and symptoms before (prior to 27.01.2020, the first documented case of COVID-19 in Germany, t_0) and during (after 27.01.2020, t_1) the pandemic (n = 271). 95% confidence intervals (CI) are provided, significance ($\alpha < 0.05$) is marked with an asterisk. Employment: Worsening was defined as moving from either full/self- employment to part-time work or to unemployment. Improvement was defined as moving from unemployment to part-time work or full/self- employment. AP: Angina pectoris according to the Canadian Cardiovascular Society (CCS) classification. Class 0: No symptoms. Class I: Angina during strenuous activity. Class II: Angina during moderate exertion. Class III: Angina with mild exertion. Class IV: Angina at rest. Dyspnea is categorized according to the New York Heart Association classification (NYHA): Class I: No symptoms. Class II: Slight symptoms during ordinary activity. Class III: Symptoms during less than ordinary activity. Class IV: Symptoms at rest.

	t_0	t_1	p-value and CI
Employment			
Employed/ self-employed	67.7%	61.2%	Worsened from t_0 to t_1: 6.5% (4.3%–9.3%)
Unemployed	2.0%	4.0%	Improved from t_0 to t_1: 0%
Part-time work	0.5%	5.0%	p < .001*
Retired or student	29.8%	29.8%	
Listlessness	13.4%	19.2%	Worsened from t_0 to t_1: 8.5% (5.9%–11.6%)
			Improved from t_0 to t_1: 2.7% (1.4%–4.8%)
			p = .001*
Sleeplessness	21.9%	26.1%	
			Worsened from t_0 to t_1: 5.2% (3.3%–7.9%)
			Improved from t_0 to t_1: 1.0% (0.3%–2.5%)
			p = .001*
Joylessness	5.7%	9.2%	
			Worsened from t_0 to t_1: 4.2% (2.5%–6.7%)
			Improved from t_0 to t_1: 0.7% (0.1%–2.2%)
			p = .003*
Loneliness	2.7%	4.7%	
			Worsened from t_0 to t_1: 3.0% (1.6%–5.2%)
			Improved from t_0 to t_1: 1.0% (0.3%–2.5%)
			p = .077
AP			
CCS 0	92.0%	91.3%	Worsened from t_0 to t_1: 2.0% (0.9%–3.9%)
CCS I	6.0%	5.5%	Improved from t_0 to t_1: 0.7% (0.1%–2.2%)
CCS II	1.7%	2.5%	p = .363
CCS III-IV	0.2%	0.7%	
Dyspnea			
NYHA I	66.2%	60.9%	Worsened from t_0 to t_1: 9.2% (6.6%–12.5%)

(continued)

Table 3. Continued.

	t_0	t_1	p-value and CI
NYHA II	29.4%	32.3%	Improved from t_0 to t_1: 2.2% (1.0%–4.2%)
NYHA III-IV	4.0%	6.7%	p < .001*

Table 4. Bivariate analysis of increase of depressive symptoms during (after the first documented case in Germany on 27.01.2020) the pandemic (primary outcome) and nominally scaled influencing factors (n = 271). Significance ($\alpha < 0.05$) is denoted with an asterisk. Associations are expressed with Cramers V (0 expressing no, and 1 full, dependence between variables). Worsening of dyspnea was defined as deterioration in New York Heart Association class. PA [hours/week]: Physical activity. Worsening of employment was defined as moving from full/self employment to part-time work or unemployment or from part-time work to unemployment. BMI: Body mass index [kg/m^2].

Age	p = 0.093 Cramer's V = 0.126
Sex	p = 0.776 Cramer's V = 0.018
BMI	p = 0.0261 Cramer's V = 0.100
Worsening of dyspnea	p = 0.0459 Cramer's V = 0.041
Chronic pain	p = 0.713 Cramer's V = 0.026
Weight increase	p = 0.017* Cramer's V = 0.122
Reduced PA	p = 0.046* Cramer's V = 0.106
Quarantine	p = 0.145 Cramer's V = 0.081
Worries on future	p = 0.011* Cramer's V = 0.133
Worsening of employment	p = 0.079 Cramer's V = 0.094

between hypertensive patients and healthy controls (p = 0.704), nor was there any difference on worries about the future between the groups (p = 0.650).Furthermore, hypertensive patients did not differ from healthy individuals in terms of PA changes (p = 0.906), increase of dyspnea (p = 0.063) or angina (p = 0.432). 88.6% of hypertensive patients were treated with antihypertensive drugs: 64.2% were on ACE inhibitors or ARB's, 12,1% on beta-blockers, 33,2% on calcium channel blockers, 9,4% on thiazides, and 13,2% on mineralocorticoid receptor antagonists. There was no significant interaction between drug class and depressive symptoms (p = 0.321), PA (p = 0.453), dyspnea (p = 0.632) and angina (p = 0.646).

Discussion

Depressive symptoms, weight, and dyspnea increased and PA decreased in our population during the pandemic, but there was no difference between hypertensive patients and healthy controls. The antihypertensive drug class was not associated with the outcome measures.

We provide the first prospective data on the psychological and somatic consequences of patients reporting to the GP office. We also demonstrate the importance to consider not only depressive symptoms but especially their association with reduced physical activity, which increases the risk of chronic diseases, such as cardiovascular disease, commonly faced in the GP office. Hypertension as a risk factor for cardiovascular disease was not associated with a higher rate of symptom deterioration compared to healthy controls. The lack of evidence for an association between depressive symptoms and hypertension (as suggested by the literature[10]) in our study may be due to the fact that hypertension was defined as a diagnosis prior to the COVID-19 onset in Germany. Thus, we may have missed a new diagnosis of hypertension during the pandemic due to the fact that patients did not report to the office as frequently as before. None of our healthy controls was (knowingly) diagnosed with hypertension during the study period.

The association of depressive symptoms, reduced PA, and weight gain in the entire population deserves attention, as it may further accelerate the vicious circle of depression and also the further increase of the cardiovascular burden of disease. The pandemic has caused symptoms associated with severe psychiatric conditions such as posttraumatic stress disorder.[17] Our data support the impact of COVID-19 on our patients' psyche and physical health: As GPs we have to be aware of the associations between reduced physical activity, increase of depressive symptoms, and malnutrition associated with weight increase and anticipated negative long-term consequences on our patients' health during the COVID-19 pandemic. We must help counteract this development by instructing patients on home-based physical activity and nutrition.

Our study has several limitations. A complete assessment of all somatic and psychological symptoms was not practically feasible, because patients completed the questionnaire during their regular GP visit. Our questionnaire was a self-designed, multi-component screening tool, which requires validation. A selection bias has to be taken into account, since only motivated patients usually take part in a questionnaire survey. From the 402 screened patients 271 completed the questionnaire. We deemed it unethical to recruit patients at poor health, such as acute infection or severe symptom manifestation. This may even have led to an underestimation of symptom severity in our study. Furthermore, reporting and recall bias cannot be excluded when using questionnaires in our own patients. Additionally, patients had to recollect their symptoms before COVID-19 onset in Germany, which spans a time period between six to ten months and may have led to incorrect reporting.

We address a similar issue than a recently published work from Hong Kong which analysed anxiety, loneliness and depression in 583 older adults (mean age 70.9 years) in the GP setting in a large survey consisting of an in office visit (pre-COVID-19) and a telephone follow-up (during the COVID-19 pandemic).[5] Increased loneliness was

independently associated with female sex, multimorbidity, and living alone. Despite obvious similarities, our study differs in distinct ways: Our offices are "regular" GP offices without access to university resources, while the Hong Kong study analysed data from four large primary care clinics, which were affiliated with the university. We used in office questionnaires and recruited patients, who were significantly younger. Thus, we demonstrate that COVID-19 not only increases depressive symptoms in older patients, but also in our younger population. In contrast to Wong et al. we also investigated somatic symptoms and found dyspnea and weight increase to worsen significantly during the crisis.[5] Furthermore, we investigated PA in our rural area (as opposed to the crowded city of Hong Kong), which decreased significantly in patients with more depressive symptoms. Our study adds knowledge to the study by Wong et al.[5] by demonstrating not only the increase of depressive symptoms during COVID-19, but also a decrease in employment and increased worries on the future as well as a deterioration of physical symptoms. A major difference between our study and the survey by Wong et al. is the time frame of data acquisition (08 to 10.2020 vs. 03 and 04.2020), which may be associated with a completely different COVID-19 prevalence (the city of Hong Kong vs. rural Germany). Our study was conducted in a period of low COVID-19 prevalence; a more pronounced deterioration of depressive symptoms might be assumed in a time of higher infection rates, which could mean that our results even underestimate the true severity of symptoms. Furthermore, our population had a much higher number of participants who lived alone (37.6% vs. 15.0%). This may contribute to the increase of depressive symptoms and is probably also attributable to the different population densities in rural Germany and Hong Kong.

PA is known to positively influence the renin angiotensin system,[18] which may prove beneficial to prevent a further spread of the disease. However, indulging in excessive outdoor sports, such as jogging, may increase transmission, because droplets may spread seven to eight meters.[19] We found that PA in our patients consisted mainly of domestic activities, such as walking or gardening and did not significantly change during the pandemic, but there was a significant association between reduced PA and worsening of depressive symptoms. Thus, a balance of adequate precautions and prevention of a sedentary lifestyle, especially in chronically ill and older patients, seems to be of paramount importance.[20] This may be best achieved by structured education (e.g. infographic. COFIT-19[21]) and home-based PA during the crisis.[22]

22.1% of our patients reported weight gain during the pandemic, probably due to unhealthy diets during the pandemic (and isolation) rather than an increase in symptoms of heart or respiratory disease (9.2% suffered from an increase of dyspnea). This considerable number of weight gain may be biased, because of a high percentage of obese patients in our population and a potential selection bias: More obese patients may tend not to adhere as stringently to a healthy diet and may show less effort to perform PA than normal weight participants. However, the pandemic itself may predispose people to reduced dietary adherence, which has already been reported in the literature.[23] In turn, social isolation and increase of depressive symptoms may even exacerbate malnutrition and physical inactivity, prolonging the vicious circle.[24–26] We demonstrate a significant deterioration of depressive symptoms during the pandemic in our population, which may partly explain the high percentage of weight gain in such a short period of time. On the other hand, the positive effects of PA on mental health have been shown in the COVID-19 era,[27] which necessitates adequate public intervention to interrupt the vicious cycle.

Similar to the United Kingdom, Germany has established a clinical code to improve the surveillance system for GP offices.[28] North-Rhine Westphalia has introduced a Corona warning app to further disrupt transmission in the public,[29] also because it has faced most of the SARS COV-2 infections in all German states. Consequently, the internet (34.6% increased their activities during the crisis) as a source of information should be more widely used.

An analysis of British GP consultations found out that phone councils doubled and face-to-face as well as home visits declined for more than 60% during the pandemic.[30] This was confirmed in our study in which 13.2% of patients made use of phone councils, which is around double the rate of the pre-COVID-19 era. We believe that this means of communication has to be further promoted in the GP setting. Future research should focus on the validation of our questionnaire in a larger cohort.

Conclusion

Our study demonstrates a significant increase of depressive symptoms and a deterioration of dyspnea during the pandemic. Furthermore, we illustrate a significant association between increase of depressive symptoms and weight increase, worries on the future, and reduced physical activity during the pandemic. However, we did not observe any differences between hypertensive patients and healthy controls.

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Contributorship

All authors read and approved the final manuscript. SW developed the questionnaire to assess patients' symptoms, wrote the ethics application, and the study registration information, he also wrote the manuscript. EW commented on all parts of the manuscript and the supplement. TR co-authored the manuscript and added important information on the structure of the manuscript with an emphasis on a better readability.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Approval of the local ethics committee was obtained (Ethics Committee University Münster, Germany, number: 2020-449-f-S), the trial was registered in the German Clinical Trials Registry (number DRKS00022157).

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Guarantor

The corresponding author is responsible for data validity.

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Supplemental material

Supplemental material for this article is available online.

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Abbreviations

ACE inhibitor	Angiotensin- converting enzyme inhibitor
ARB	Angiotensin II receptor blocker
BMI	Body mass index
CCS	Canadian Cardiovascular Society
CI	Confidence interval
COVID-19	Coronavirus disease of 2019
ESC	European Society of Cardiology
GP	General practitioner
NYHA	New York Heart Association class
PA	Physical activity
T_0	pre-COVID-19 era, prior to first documented case in Germany 2020 on 27.02.2020
T_1	time period during the pandemic in Germany