

The Influence of the COVID-19 Lockdown on Regular Physical Exercise Habits in Multiple Chronic Diseases

Der Einfluss der COVID-19 bedingten Kontaktbeschränkungen auf sportliche Aktivitäten bei chronischen Erkrankungen

Summary

- **Problem:** Physical exercises (PE) have positive effects on health related quality of life (HQoL) and chronic non-communicable diseases (NCD). This survey assessed the extent of the Covid-19 induced lockdown on changes of PE and HQoL of study patients with at least two chronic NCD.
- **Methods:** An online survey, including the Veterans Rand 12 (subscales general health (GH), physical (PCS), mental (MCS) component scales) and questions on lockdown-induced PE habit changes was held. HQoL was assessed prior, during and after the lockdown. Also, the usage of digital training videos was assessed. Kruskal-Wallis-Tests and post-hoc analysis evaluated if HQoL differed between categories of PE changes during the lockdown (less, same, more).
- **Results:** 27 (18 females, mean age: 54.6 ± 11.4) completed the survey. 37% stated less or no PE, 22% more PE. Especially strength training was affected with 72% of the responders performing less strength training during lock down. MCS and PCS differed not significantly according to PE change, but better GH was associated with increased PE in comparison to less/no PE ($z=-2.5$, $p=0.04$, $r=0.6$).
- **Discussion:** Participants who increased PE during the lockdown showed better GH scores, highlighting the importance to maintain PE. Permission to continue sports in nature is recommended in similar situations. Digital media such as training videos designed to fulfill the needs of people with NCD have to be created, so that people can continue strength training.
- **Trial registration:** The study was registered in the German clinical trial register (DRKS00016702).

KEY WORDS:

Sport, Pandemic, Multimorbidity, Health Related Quality of Life, Non-Communicable Chronic Conditions, Germany

Zusammenfassung

- **Hintergrund:** Sport hat positive Auswirkungen auf die gesundheitsbezogene Lebensqualität (HQoL) und chronische Erkrankungen. Ziel dieser Arbeit war es darzustellen, inwieweit sich COVID-19 bedingte Kontaktbeschränkungen auf Sportgewohnheiten von Studienteilnehmenden mit mindestens zwei chronischen Erkrankungen auswirken und mit der HQoL zusammenhängen.
- **Methodik:** Es wurde eine online Befragung durchgeführt, die den Veterans Rand 12 (allgemeine Gesundheit (GH), physische (PCS) und psychische Summenskala (MCS)) und Fragen zu den, durch den Lockdown bedingten, Veränderungen der Sportgewohnheiten enthielt. Die HQoL wurde vor, während und nach dem Lockdown bewertet. Auch die Nutzung digitaler Trainingsvideos wurde erhoben. Kruskal-Wallis-Tests und Post-hoc-Analysen bewerteten, ob sich die HQoL zwischen den Kategorien der veränderten Sportgewohnheiten während des Lockdowns (weniger, gleich, mehr) unterschied.
- **Ergebnisse:** 27 (18 Frauen; Alter: 54,6 ± 11,4) nahmen an der Befragung teil. 37% waren weniger oder gar nicht sportlich aktiv, 22% waren aktiver. Vor allem das Krafttraining war betroffen: 72% führten während des Lockdowns weniger Krafttraining durch. MCS und PCS unterschieden sich nicht signifikant durch eine veränderte sportliche Aktivität, aber eine bessere GH war mit einer erhöhten Sportaktivität im Vergleich zu weniger/keiner Sportaktivität verbunden ($z=-2.5$, $p=0.04$, $r=0.6$).
- **Fazit:** Die Ergebnisse unterstreichen die Notwendigkeit, Sportaktivitäten beizubehalten. Die Genehmigung, Sport in der Natur fortzusetzen, wird in ähnlichen Situationen empfohlen. Zusätzlich müssen digitale Medien wie Trainingsvideos entwickelt werden, die auf die Bedürfnisse von Menschen mit chronischen Mehrfacherkrankungen zugeschnitten sind, damit sie ihr Krafttraining fortsetzen können.
- **Studienregistrierung:** Die Studie wurde in das deutsche Register für klinische Studien eingetragen (DRKS00016702).

SCHLÜSSELWÖRTER:

Sport, Pandemie, Multimorbidität, gesundheitsbezogene Lebensqualität, nicht übertragbare chronische Krankheiten, Deutschland

Introduction

Physical exercise (PE) is a relevant and effective treatment for many chronic diseases (22). Beside others, benefits for the health-related quality of life (HQoL), including mental health, better physical functioning and general well-being have been described (7, 22). In contrast, longer periods of physical inactivity are associated with an increased risk of non-communicable diseases (NCD) (3, 13). In turn, HQoL, physical function more than mental health, decreases

as the number of diseases increases (18). A recent epidemiological study has outlined that the majority of German citizens does not meet the physical activity recommendations, and that the number of people being sufficiently active decreases with an increasing number of co-morbidities (31). Those who would profit the most are therefore least likely to take advantage of the health benefits of physical activity (5, 23). ➤

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Table 1

Physical (PCS), Mental (MCS) and General Health (GH) Scales baseline values and values through the lockdown according to differences in physical exercise (PE) participation during lockdown. For this scale 100 is best and 0 is the worst possible score. The value 50 represents the mean value of the American norm population of the year 1990. * One person was missing for the calculation of the baseline values. ** Data refer to the PE and realted dosage principles (frequency, intensity, duration according to the national PE recommendations) before the restrictions. GH: General health; MCS: mental component scale; PCS: Physical component Scale; PE: Physical exercise.

PARTICIPATIONS	PCS MEDIAN (IQR)	MCS MEDIAN (IQR)	GH MEDIAN (IQR)
BASELINE			
Overall (n=26)	49.0 (13.1)	51.2 (10.0)	60.0 (25.0)
Group 1 (n=13)*	52.5 (15.2)	53.3 (7.2)	60.0 (25.0)
Group 2 (n=13)	47.2 (11.1)	49.0 (12.2)	35.0 (42.5)
PE change category**			
Less (n=10)	49.3 (19.2)	52.3 (10.6)	47.5 (33.8)
Same (n=11)	47.2 (13.9)	49.7 (11.4)	60.0 (25.0)
More (n=5)	53.3 (8.0)	53.3 (14.8)	60.0 (25.0)
LOCKDOWN			
Overall (n=27)	51.5 (16.0)	43.2 (6.3)	60.0 (25.0)
Group 1 (n=14)	52.9 (17.5)	43.2 (3.2)	60.0 (25.0)
Group 2 (n=13)	50.7 (17.3)	45.5 (7.7)	60.0 (37.5)
PE CHANGE CATEGORY**			
Less (n=10)	47.9 (19.1)	45.6 (7.9)	60.0 (6.3)
Same (n=11)	49.7 (20.1)	43.2 (7.2)	60.0 (50.0)
More (n=6)	57.3 (6.3)	43.1 (3.6)	85.0 (25.0)
	H= 6.0, p= 0.05	H= 1.2, p= 0.54	H= 6.1, p= 0.047

The Coronavirus disease (COVID-19) has led to numerous restrictions in Europe and overseas. Social distancing and home stay were major restrictions that were introduced by the governments as a policy to stop the spread of the disease. In some countries, including Germany, one exception had been made: outdoor physical activities were allowed as long as an interpersonal distance could be maintained. However all exercise facilities had been closed from End of March until the beginning of June 2020.

It has been shown that COVID-19 related lockdowns have affected people's physical activity level and sedentary behaviour (30). This situation leads to a considerable conflict of interests, especially for people with one or more chronic diseases, who are considered to be at high risk for both a severe course of COVID-19 infection and negative health effects from sedentary behavior (16, 29, 32). We therefore aimed for a better understanding of lockdown-related changes in PE levels and their relatedness towards measures of HQoL in patients with multiple chronic diseases who were just involved in an intervention study targeting for the implementation of regular PE into their daily habits.

For this purpose, a survey was amended to the original study protocol of which relevant details are open to the public in the German Clinical Trial Registry (DRKS00016702). The main explorative questions were related towards PE levels and dosages during the COVID-19 induced lockdown in comparison to the time before, including reasons for change. The description of the longitudinal course of the HQoL throughout the whole study period was another scope of the study. We further wanted to investigate the relatedness of the lockdown-induced PE change and HQoL during lockdown. We hypothesized that an increase in PE during lockdown would be related to a better HQoL and vice versa.

Materials and Methods

Study Design

The study was designed as a cross-sectional retrospective online survey which was conducted in the context of a longitudinal exercise intervention study in patients with multimorbidity (MultiPill-Exercise). In addition, several baseline measures and repeated self-reported measures of HQoL of the original study were integrated into the analysis of the survey.

Participants

All participants of the MultiPill-Exercise study were eligible for the survey (n= 39). All of them had two or more pre-stage or manifested chronic conditions including overweight or obesity, DMT2, hip or knee osteoarthritis or cardiovascular disease. None of them was physically active beyond 75% of the national recommendations at the beginning of the study. In- and exclusion criteria were identical to the original study protocol and not queried again. The complete list of criteria can be viewed in table 2 (see supplemental material online). Due to organizational reasons, participants of the intervention study were recruited in two successive groups. The first group finished the study before the onset of the lockdown. According to the aim of the intervention implementing PE into daily habits, participants were still expected to participate in regular PE even after ceasing the study. We therefore included this cohort into the survey as well as the second recruitment group who was directly affected by the lockdown during the time of intervention.

Setting

The original intervention study was conducted at the University Hospital and its fitness gym being located at the Department of Sports Medicine. The survey was provided online.

Intervention

The intervention study Multi-Pill-Exercise aimed to increase the participation in PE in multimorbid patients. The targeted PE was based on the national PA recommendations with 150 minutes of moderate or 75 minutes of vigorous PE and muscle strengthening exercises twice a week (23). The study intervention was divided into two phases, each lasting 12 weeks. The first intervention phase contained three training sessions each week, including supervised and home exercises. In the following 12 weeks, participants were asked to continue regular PE. Further details on the concept of the intervention design are described elsewhere (26). The lockdown came into force in the 9th week of the supervised first intervention phase of the second recruitment group.

Subsequently, participants of this group were contacted by email and telephone on a regular base and training diaries were sent. Both groups were provided with 60 minutes video tutorials for different kinds of home trainings (i.e. Pilates, Yoga, functional strength training, Aerobic, fascial training). The sports facility related lockdown phase lasted from March 17th to June 2d 2020 (20, 21). Subjects of both groups were invited to the survey on June 15th via email. The email included a link to the online software Questback Survey (Questback GmbH, Köln, Germany). Non-responders were reminded twice (June 18th and June 25th). Participants provided informed consent to the COVID-19 amendment before starting the self-reported survey. The survey was closed after July 2nd. The study amendment was approved by the local ethics committee. The original trial is registered at DRKS00016702.

Baseline Measures

Patient characteristics were obtained from the parent study MultiPill-Exercise.

Outcome Measures

HQoL was quantified by the Veterans Rand 12 (VR12) (14). The VR12 covers the global health status of patients, differentiated into eight health domains. Out of these measures, a physical component score (PCS) and a mental component score (MCS) can be computed, both being related to the US reference-population of 1990 (range 0-100 with a mean value of 50). The general health (GH) item, which is also used as a one-item scale (4, 12), PCS and MCS were included for further analysis. HQoL during lockdown was assessed with the survey. HQoL measures before (t0), after the first (t3) and after the second intervention period (t6) were taken from the longitudinal dataset. Questions related to PE can be divided into three categories:

1. PE (duration/week) within the lockdown phase.
2. Changes of this PE status in comparison to the time before the lockdown as well as to lockdown-related changes of exercise settings and dosages including reasons for change.
3. Usage of digital media in the context of exercise. Table 3 (see

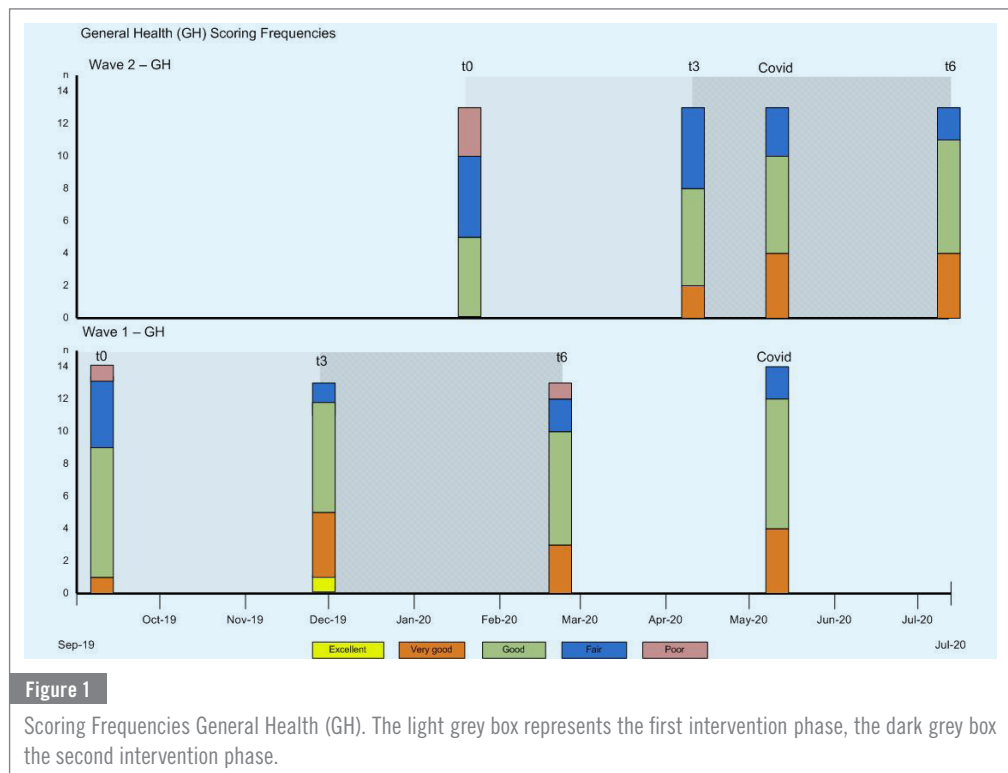


Figure 1

Scoring Frequencies General Health (GH). The light grey box represents the first intervention phase, the dark grey box the second intervention phase.

supplemental material online) outlines the categories and number of questions (items) included as well as exemplary items.

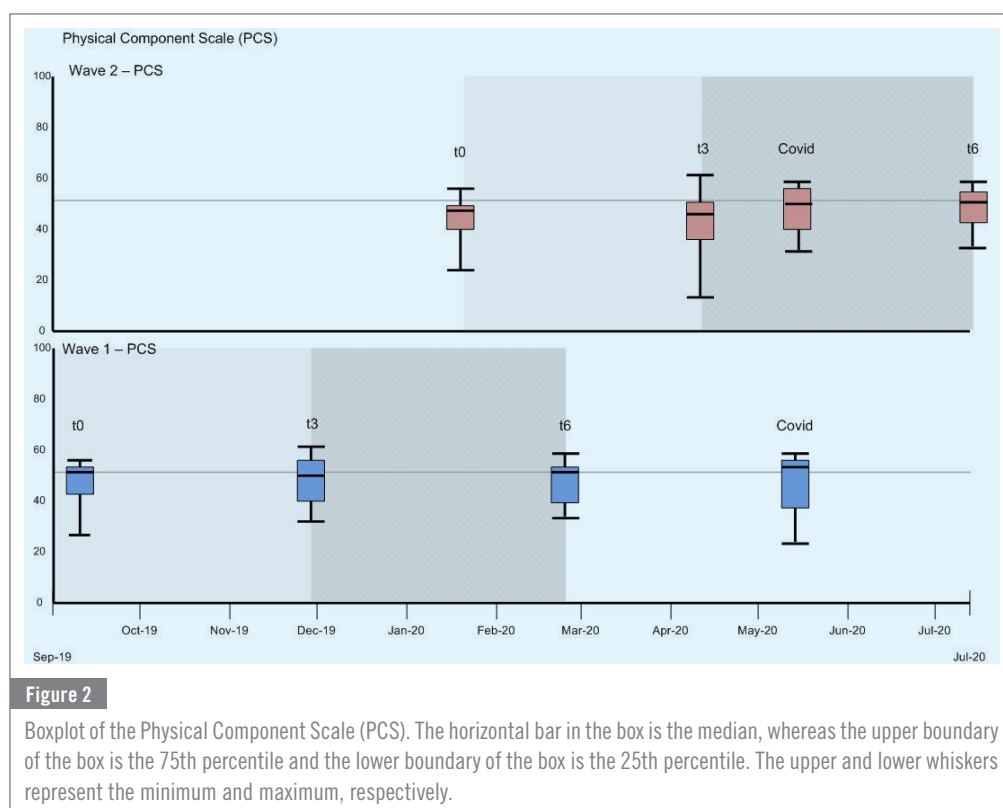
Statistical Analysis

Statistical analysis was performed using SPSS Statistics version 24 (IBM, USA). Descriptive statistics were conducted with all data. 5-level scales comparing PE during versus before the lockdown and exercise dosages were simplified by summarizing the two lower and upper levels, resulting in three answer categories (less/same/more). These categories were used as grouping variables for further analyses. Due to non-normally distributed data, Kruskal-Wallis-Tests were calculated to examine whether there was a difference between the categories PE change and each score of HQoL (PCS, MCS and GH) reported in the COVID survey. Dunn-Bonferroni-Tests, adjusting for multiple testing were computed as post hoc analyses to assess differences between the groups with more exercise, same amount of exercise and less exercise participation. The z-value was reported to illustrate the comparison of the average rank of each group to the average rank of all observations. Pearson's correlation coefficient (r) was calculated as an effect size and interpreted according to Cohen (6). R=0.1 indicates a weak effect, r=0.3 a medium effect and r=0.5 a strong effect. The longitudinal change of HQoL was displayed and described descriptively using the scores from t0, t3, t6 and during the lockdown.

Results

Sample Characteristic

27 subjects (female: 18; male: 9; BMI=31 ± 3.5 kg/m²; Age=54.6 ± 11.4 years) from initially 39 contacted participants responded to the survey with 14 (female: 9; male: 5) of the first recruitment group and 13 (female: 9; male: 4) of the second. Five patients reported two risk factors or diseases only, all other participants reported three or more. Further sample characteristics are shown in table 4 (see supplemental material online). >



Changes in Physical Exercises during Lockdown in Comparison to the Time before

A decrease in PE was stated by around 37%, an increase was reported by 22% of the participants. For endurance training, 65% of the participants kept or increased the dosage principles (frequency, intensity, duration). But a reduction in all three dosage principles was stated by around 80% of the participants for strength training. Details are given in table 5 (see supplemental material online).

Type, Setting, Facilitators and Barriers of Physical Exercise Participation during Lockdown and before

The most reported PE during the time of restrictions was walking or jogging, cycling and functional exercises. As reasons for an increase in PE participants reported that they experienced more leisure time due to short-time working, home-office or omission of relative care (n=4). Less organisational effort (n=3) and more multimedia training tutorials were available (n=3). A compensation to less PA in everyday life (n=2) and distraction from everyday life (n=1) were also stated. Reasons for a decrease of PE were the lack of open sport facilities and/or possibilities for training (n=8). A low general mood (n=3), lack of motivation (n=2), fear of infecting oneself and others with COVID-19 (n=3) and the resulting domestic quarantine were also mentioned as reasons for less exercise participation. Also, a perceived increased organisational effort (n=4), COVID-19-related working overtime (n=2) and no pre-scheduled training sessions (n=1) were reported.

Before the lockdown, on average 26% of PE was conducted in nature. This increased to 42% during the contact restrictions. The individual's home accounted for about 13% of the training location before the restrictions and increased to 20% during the lockdown. Before the contact restrictions, 26% of the PE was performed in fitness gyms and 9% in Sport clubs, these options were not quoted throughout the phase of the lockdown. Regular video training was used by 7 (26%) of the participants throughout the lockdown.

Longitudinal Course of Health-Related Quality of Life (HQoL)

The following figures (Figure 1-3) show the scoring frequencies of the one-item scale GH as well as the boxplots of MCS and PCS for the two groups over the whole study period (t0, t3, t6 + COVID survey). The rating of GH (Figure 1) increased over the study period including the time of the lockdown. The PCS (Figure 2) also showed a positive change over the study period. Only MCS (Figure 3) decreased in both groups by the time of the lockdown.

Changes in Physical Exercises and its Interaction with Health-related Quality of Life (HQoL) during Lockdown

The differences of the subscales for HQoL between the groups and the categories of

PE change throughout the lockdown in comparison to before are outlined in table 1. Results of the Kruskal-Wallis-Test revealed a significant difference between the categories of PE change for the sub-dimension GH ($H(2)=6.1, p=0.047$). Post hoc analyses displayed a significant difference between the group that decreased and the group that enhanced exercise participation ($z=-2.5, p=0.04, r=0.6$), with r indicating a large effect. More active people stated a better GH during lockdown. Similar results, yet statistically non-significant, were obtained for PCS ($H(2)=5.9, p=0.05$). MCS scores did not interact with PE change ($H(2)=1.2, p=0.5$).

Our hypothesis that an increase in PE during lockdown would be related to a better HQoL and vice versa could therefore be confirmed for self-reported GH and to a limited extent for physical functioning as well, but not for mental health.

Discussion

The need of PE as a non-pharmacological treatment option for multiple chronic NCD is well studied (17). Still, 31% of the world's population does not achieve the national PA recommendations (11), and many people fail to adopt a long term regular PA including exercises (28, 35). In this regard it is important to encourage PE newcomers to continue exercise participation. Fixed appointments and group settings are known as facilitators for adherence to exercise (35). However, these facilitators for PE were significantly limited or even impossible during the time of the lockdown and there was a risk of giving up regular exercise activities especially for people who just engaged in PE. The main objective of the current study was to examine if the restrictions due to the COVID-19 pandemic had an influence on the PE participation of people with multiple chronic conditions. The longitudinal description of HQoL throughout the whole study was added for a better understanding of changes over time. It was of further interest to evaluate the interaction of lockdown induced changes in PE and the HQoL during the lockdown.

The descriptive comparison of the exercise participation revealed that 41% of the participants have not changed their PE during the lockdown, while 37% were not able to keep up the same amount of PE. On the other hand, 22% managed to increase their PE habits. But the training intensity was reduced in 40%. Subjects managed to maintain endurance training better than strength training during the time of the lockdown. Endurance training can easily be conducted outdoors. Even before the contact restrictions, many participants had already completed activities in nature, therefore no conversion to alternative settings was necessary. Since outdoor exercises were still allowed in Germany, it seems reasonable that the performance of the endurance activities was less influenced by the contact restrictions. The situation is different for strength training. Reasons for reduced activities were often related to the lack of sports facilities and an increased organizational effort. Although the opportunity for video guided home training sessions was given, it was only used by one third of the participants. Important strategies for regular exercise participation such as fixed appointments or motives such as contact in and through sports (10, 25) are only possible to a limited extend with videos. Likewise, individual correction or exercise adaptation is hardly possible. Virtual group appointments could counteract these problems (35).

The VR12 with its subscales was used to assess the participants' health related quality of life. The median of all participants increased from baseline to the time of the lockdown. The two recruitment groups both increased their GH throughout the complete intervention and showed similar scoring frequencies in the phase of the lockdown. The MCS scores decreased from baseline to subsequent follow-up measures in both groups and also in those people that increased PE during the lockdown. This is somehow surprising as PA can positively influence mental health (17, 19). On the other hand, social distancing has been proven to lead to increased stress and depression (9, 13) and the decreased values for MCS in both groups after the onset of the lockdown indicate, that mental health was negatively related to the special situation induced by the pandemic. The PCS score showed some improvement from baseline to the phase of the lockdown for the 'same' and 'more' exercise group. All three groups were already above the 50th percentile of the US reference population at baseline (27).

When HqoL was related to the amount of change of PE during the lockdown, the GH scores during the lockdown were significantly better for participants that increased their exercise activity levels during the lockdown. Similar results were obtained for the PCS yet not in a statistically significant manner. MCS was not related to the amount of PE change. Data of this cross-sectional study do not allow a final statement if increasing PE levels during lock-down cause better GH or a better

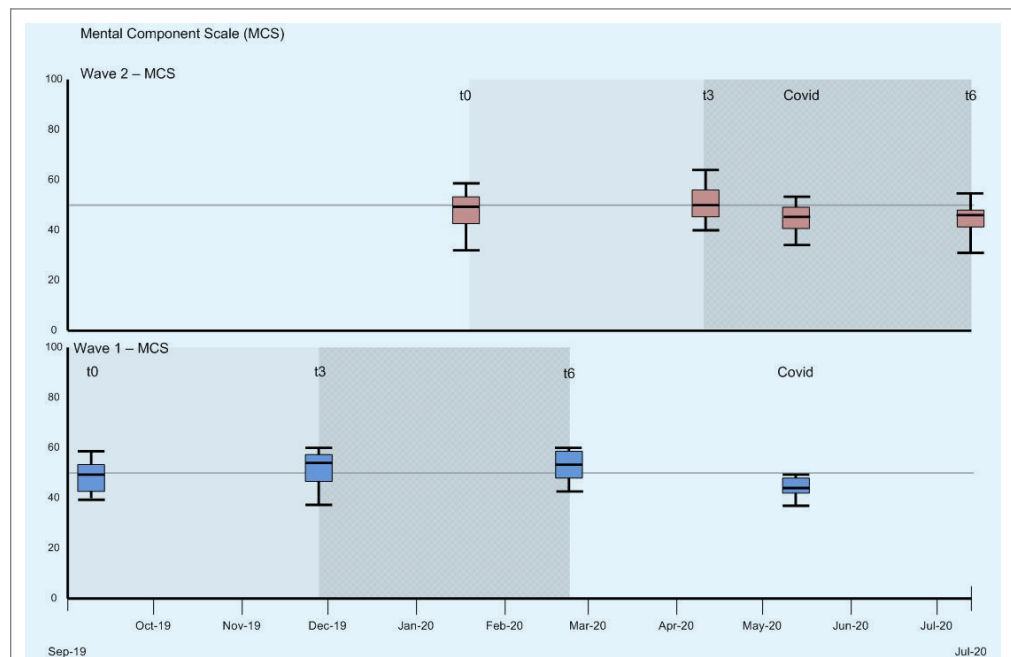


Figure 3

Boxplot of the Mental Component Scale (MCS). The horizontal bar in the box is the median, whereas the upper boundary of the box is the 75th percentile and the lower boundary of the box is the 25th percentile. The upper and lower whiskers represent the minimum and maximum, respectively.

GH allows persons to increase their PE levels. However, other results of the literature hint towards the former argument: A previous study on workstation users being forced to home-office during lockdown has shown that improved physical and mental well-being was predicted by higher levels of PE (36). Therefore, results confirm our findings, that PE has the potential to protect against negative health outcomes although this was not valid for mental health in our study population. This study is not without limitations. First to be mentioned is the small sample size. This survey was conducted in the context of an interventional pilot study and its sample size was therefore restricted to the included patients of the parent study. In addition, some participants of the parent study did not respond to the survey. The small sample size remains a draw-back of this study limiting the external validity of the findings. However, the specific situation of the pandemic made it necessary to estimate their impact on study results of the parent studies and conclusions that can be drawn may especially be valuable to underline the importance of PE and its promotion for those who take the most advantage of the health benefits of PE - people with multiple chronic diseases. Another limitation was caused by the specific situation of the pandemic. The survey study was conducted in the context of an ongoing study in which some of the participants were already out of the study while others were in the middle of the intervention phase. As such, results of this study are confounded by a performance bias, as participants of the first group did not receive the same amount of support during lockdown in comparison to participants of group 2. This may have influenced different activity behaviors during the lockdown in the two treatment groups. It further has to be mentioned that the lockdown came into force in spring which was characterized by temperatures above and precipitation below average (33). The environmental conditions may have made it easier to the patients to maintain their endurance activities despite the closure of sports facilities and the finding can therefore not be generalized to times with lower temperatures and more precipitation as in autumn and winter times.

Conclusion

From our perspective four main conclusions can be drawn from this study.

1. Study results show that an increase in PE during lockdown coincided with a better self-reported GH and – although not in a significant manner – with a better self-reported physical health. Despite unknown causality of this interaction, this is an indicator for the relevance of PE for health-related quality of life in times with radical social contact restrictions and many other uncertainties. It is an important argument to motivate people to increase their PE level in case of another lockdown or comparable situations. This seems especially important for patients with multiple chronic conditions for which a clearance for PE is given.
2. Study results further indicate that self-reported GH as well as physical health can increase in an intervention study promoting PE despite the outbreak of the pandemic. These findings highlight the need to care about PE promotion for patients with NCD in extraordinary times like now.
3. Endurance exercises could be maintained even in newcomers as long as outdoor activities are still allowed. In case of another lockdown, it is therefore strongly recommended to keep the regulation that outdoor exercise activities are still permitted as long as physical interactions with other people are kept to a minimum. This German strategy had shown not to counteract the successful diminution of the nationwide infection numbers that decreased from about 6000 new registered infections per day at the end of March to less than 200 at the end of May (15).
4. The picture is different for strength training. The closure of gyms and sports centers was associated with a reduction of exercise frequency, intensity and duration. Therefore, possibilities should be discussed how individual strength training can be better supported. In this regard, digital applications become increasingly important as behavior change techniques to promote exercise participation such as action planning, self-monitoring, feedback, rewards etc. can easily be implemented in this type of media (2, 8, 10, 24). Many apps promoting PA do also provide social support including forums of communities or the implementation of virtual workouts (challenges) (2). Social support features seem especially valuable in these days of the COVID-19 pandemic in which psycho-social interaction is restricted. Digital media cannot replace a face-to-face encounter. However, the current situ-

ation highlights the need to further develop sophisticated digital solutions to support populations with special preconditions (1). Most available apps for PA and PE promotion are neither specifically designed for people with multiple chronic diseases nor for the elderly or for people with a low technical affinity and the most popular promote endurance workouts. Referring to the results of our study and the recommendations for PA (23, 34), apps should explicitly include strengthening programs as well.

In summary, this study underlines the relevance of PE for patients with multiple chronic conditions in general and in times of the pandemic COVID-19 in particular. It provides information on how to deal with restrictions in public life and about the potential of digital media to support an active lifestyle in this population. ■

Declarations

Ethics Approval and Consent to participate

Approval for the current study was obtained through the Ethic committee of Tuebingen, approval number: 298/2019BO2 and all participants provided consent to participate in this study.

Availability of Data and Materials

The datasets used and/or analysed during the current study are available from the corresponding author on request.

Funding

The parent study MultiPill-Exercise is a cooperation study with the health insurance company AOK Baden-Württemberg (AOK BW). The AOK BW financed the parent study but not the additional survey study.

Authors' Contributions

SiS participated in the design of the study, contributed to data collection and data reduction/analysis and interpretation; IK participated in the design of the study data reduction/analysis and interpretation of results. Both authors contributed to the manuscript writing. Both have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Conflict of Interest

The authors have no conflict of interest.

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