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Effect of Statewide Lockdown in Response to COVID-19 Pandemic on Physical Activity Levels of Hemodialysis Patients

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Hemodialysis · Physical activity · Social distancing · Sedentary

Abstract
Background/Objectives: On March 22, 2020, a statewide stay-at-home order for nonessential tasks was implemented in New York State. We aimed to determine the impact of the lockdown on physical activity levels (PAL) in hemodialysis patients. ***Methods:*** Starting in May 2018, we are conducting an observational study with a 1-year follow-up on PAL in patients from 4 hemodialysis clinics in New York City. Patients active in the study as of March 22, 2020, were included. PAL was defined by steps taken per day measured by a wrist-based monitoring device (Fitbit Charge 2). Average steps/day were calculated for January 1 to February 13, 2020, and then weekly from February 14 to June 30. ***Results:*** 42 patients were included. Their mean age was 55 years, 79% were males, and 69% were African Americans. Between January 1 and February 13, 2020, patients took on average 5,963 (95% CI 4,909–7,017) steps/day. In the week prior to the mandated lockdown, when a national emergency was declared, and in the week of the shutdown, the average number of daily steps had decreased by 868 steps/day (95% CI 213–1,722) and 1,222 steps/day (95% CI 668–2300), respectively. Six patients were diagnosed with COVID-19 during the study period. Five of them exhibited significantly higher PAL in the 2 weeks prior to showing COVID-19 symptoms compared to COVID-19 negative patients. ***Conclusion:*** Lockdown measures were associated with a significant decrease in PAL in hemodialysis patients. Patients who contracted COVID-19 had higher PAL during the incubation period. Methods to increase PAL while allowing for social distancing should be explored and implemented.
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Introduction

In the United States (US), there have been over 16.5 million confirmed cases of COVID-19 and almost 300,000 deaths from the disease as of December 9,2020 [1]. To ease the burden placed on healthcare systems and to stop

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the spread of the disease, many countries and states have implemented social distancing policies and lockdowns.

By March of 2020, it was generally known that COVID-19 had arrived in the US and a national emergency was declared on March 13, 2020 in response to the growing epidemic [2]. Not all regions of the US have experienced the same incidence of COVID-19 to date. New York State (NYS) was among the first and hardest hit by the pandemic, which led to the NYS governor to enforce a strict stay-at-home order for all works and tasks that were deemed as "nonessential." On March 20, 2020, Governor Cuomo signed the "New York State on PAUSE" executive order which stated that residents of NYS must cancel all social gatherings, practice social distancing, and refrain any other activities not deemed essential, for example, operation of hospitals, grocery stores, pharmacies, police departments, etc., as of March 22 at 8 p.m. [3].

During the implementation of the stay-at-home order, in-center hemodialysis patients in NYS still needed to attend their thrice-weekly dialysis sessions. However, it is unclear how the physical activity levels (PAL) in this already mostly sedentary population would change due to the lockdown. Maintaining adequate levels of physical activity in the end-stage kidney disease population is crucial for preventing negative outcomes; increased physical activity has been associated with decreased all-cause mortality, cardiovascular morbidity and mortality, as well as decreased fatigue, increased quality of life, and better sleep [4–7]. Previous studies reported that on average HD patients walk less than 5,000 steps per day, the threshold to classify sedentariness [8–10]. Given the risk of sedentary behavior in this population, it is important to understand the effect of the mandatory stay-at-home orders on PAL.

On the other hand, patients with end-stage kidney disease represent a vulnerable population for COVID-19 infection and experience higher mortality due to COVID-19 compared to the general population [11–14]. Greater mobility could be associated with higher rates of spread of COVID-19 [15]. While an association between PAL and the risk of COVID-19 infection is unclear, it could be reasonably posited that mobility and physical activity are directly correlated. Therefore, it could be expected that patients who become infected with COVID-19 would have greater mobility and thus higher PAL, compared to that of COVID-19 negative patients in the period prior to exhibiting COVID-19 symptoms.

In our study, we aimed to determine if the NYS lockdown had any effect on the PAL of hemodialysis patients. Additionally, we also investigated if hemodialysis patients who contracted COVID-19 exhibited higher levels of physical activity compared to their COVID-19 negative counterparts during the incubation period, prior to showing COVID-19 symptoms.

Materials and Methods

Setting and Participants

This prospective, multicenter observational study is conducted in 4 Renal Research Institute hemodialysis clinics in Manhattan, New York City, NY, starting in May 2018. Participants are followed up for up to a year with enrollment concluded in November 2019. Patients were eligible to participate if they were 18 years or older, and on hemodialysis for ≥3 months, patients were required to be able to walk without assistance and own a smartphone, tablet, or PC. Only patients who were still active in the study as of March 2020 were included in this study.

Physical Activity Level

PAL was defined as number of steps taken per day and was monitored by a wrist-based wearable activity tracker, the Fitbit Charge 2 (Fitbit, San Francisco, CA, USA). Patients were asked to wear the device continuously, except when bathing/swimming and sync the data collected by the device to the Fitbit app regularly. Monitoring wear/sync adherence was done via Fitabase (Small Step Labs LLC, San Diego, CA, USA). A series of interventions were deployed should the subject be nonadherent in syncing their data from the Fitbit to the app. After 7 days of nonsync, patients were sent either a text message (SMS) or email, depending on their preference, with a message to remind them to sync their devices. Should the participant not resume sync after this, a research staff member would call to remind the subject to sync their device. After that if the subject does not sync their device, then a research staff member would schedule an in-person meeting with the subject at their hemodialysis session in the clinic. Due to social distancing practices put into place, starting from March 13, 2020, in-person meetings with the patient were replaced with up to 3 consecutive phone calls from the research staff to counsel the patient to resume sync.

Physical activity data collected from January 1, 2020, to June 30, 2020, was used in this analysis. The period of January 1, 2020 to February 13, 2020, was considered the "pre-COVID period," which can be interpreted as the baseline PAL prior to COVID-19 becoming a significant event in the northeastern US. After that period, weeks were classified relative to the NYS lockdown mandate, for example, week of the mandate was week 0, the week before that was week −1, the week after that was week 1, and so on.

Clinical and Laboratory Data

Baseline parameters were captured during the 2 months prior to the start of the study. Standard of care laboratory data (Spectra Laboratories, USA) was captured from the electronic health record (EHR). Laboratory parameters included hemoglobin, Cr, BUN, serum albumin, serum sodium, serum potassium, serum phosphorus, and neutrophil-lymphocyte ratio. Patient level data on clinical parameters including BMI, hemodialysis vintage, equilibrated Kt/V, and comorbidities (chronic heart failure, diabetes mellitus, and chronic obstructive pulmonary disease) were captured from EHR. Dialysis treatment parameters including treatment duration,

Table 1. Patient baseline characteristics

	All patients (*n* = 42)	COVID-19 positive (*n* = 6)	COVID-19 negative (*n* = 36)
Demographics			
Age, years	55±11	49±10	55±11
Gender			
Male	79%	100%	75%
Female	21%	0%	25%
Race			
White	12%	17%	11%
African American	69%	83%	67%
Asian	2%	0%	6%
Hispanic	17%	0%	19%
Clinical parameters			
Vintage, years	4.5±4.4	6.4±3.2	4.6±5.4
BMI, kg/m^2	28.9±8.7	30.0±6.1	28.7±9.1
Congestive heart failure	17%	17%	14%
Chronic obstructive pulmonary disease	12%	17%	11%
Diabetes	19%	17%	33%
Equilibrated Kt/V	1.49±0.52	1.33±0.19	1.5±0.55
Socioeconomic parameters			
Employment			
Employed	29%	67%	22%
Unemployed	50%	33%	53%
Other	21%	0%	25%
Education			
Some high school	5%	0%	6%
High school	45%	50%	44%
Some college	24%	0%	28%
College	17%	50%	11%
Masters	7%	0%	8%
Other professional degree	2%	0%	3%
Marital status			
Divorced	10%	0%	11%
Married	43%	50%	42%
Single	48%	50%	47%
Living situation			
Alone	33%	33%	33%
Other	2%	0%	3%
With family	64%	67%	64%
Treatment parameters			
Treatment time, min	224±33	224±37	226±33
Intradialytic weight gain, kg	2.4±1.4	3.2±1.3	2.3±1.3
Predialysis weight, kg	92.0±25.4	98.3±15.8	91.9±26.6
Postdialysis weight, kg	89.6±24.9	95.1±15.2	88.6±26.1
Predialysis SBP, mm Hg	145.0±22.6	154.5±18.5	143.4±22.9
Predialysis DBP, mm Hg	81.5±13.7	89.6±12.2	80.1±13.5
Postdialysis SBP, mm Hg	134.0±22.7	136.4±18.9	133.6±23.3
Postdialysis DBP, mm Hg	76.7±13.3	81.2±12.1	76.0±13.4
Ultrafiltration volume, L	1.4±0.6	1.7±0.5	1.4±0.5
Ultrafiltration rate, mL/kg/h	6.6±2.3	8.2±2.0	6.3±2.2
Laboratory parameters			
Hemoglobin, g/dL	11.2±1.4	12.3±1.3	11.0±1.3
Cr, mg/dL	10.4±3.1	12.9±3.6	10.0±3.0
BUN, mg/dL	57.1±14.8	58.9±16.4	56.9±14.7
Serum albumin, g/dL	4.0±0.3	4.0±0.3	4.0±0.3
Serum sodium, mmol/L	138.5±2.2	138±1.6	138.6±2.3
Serum potassium, mmol/L	4.7±0.6	4.5±0.6	4.7±0.6
Serum phosphorus, mmol/L	6.0±1.5	6.9±2.3	5.9±1.3
Neutrophil-to-lymphocyte ratio	2.9±1.5	1.5±0.7	3.0±1.5

SBP, systolic blood pressure; DBP, diastolic blood pressure

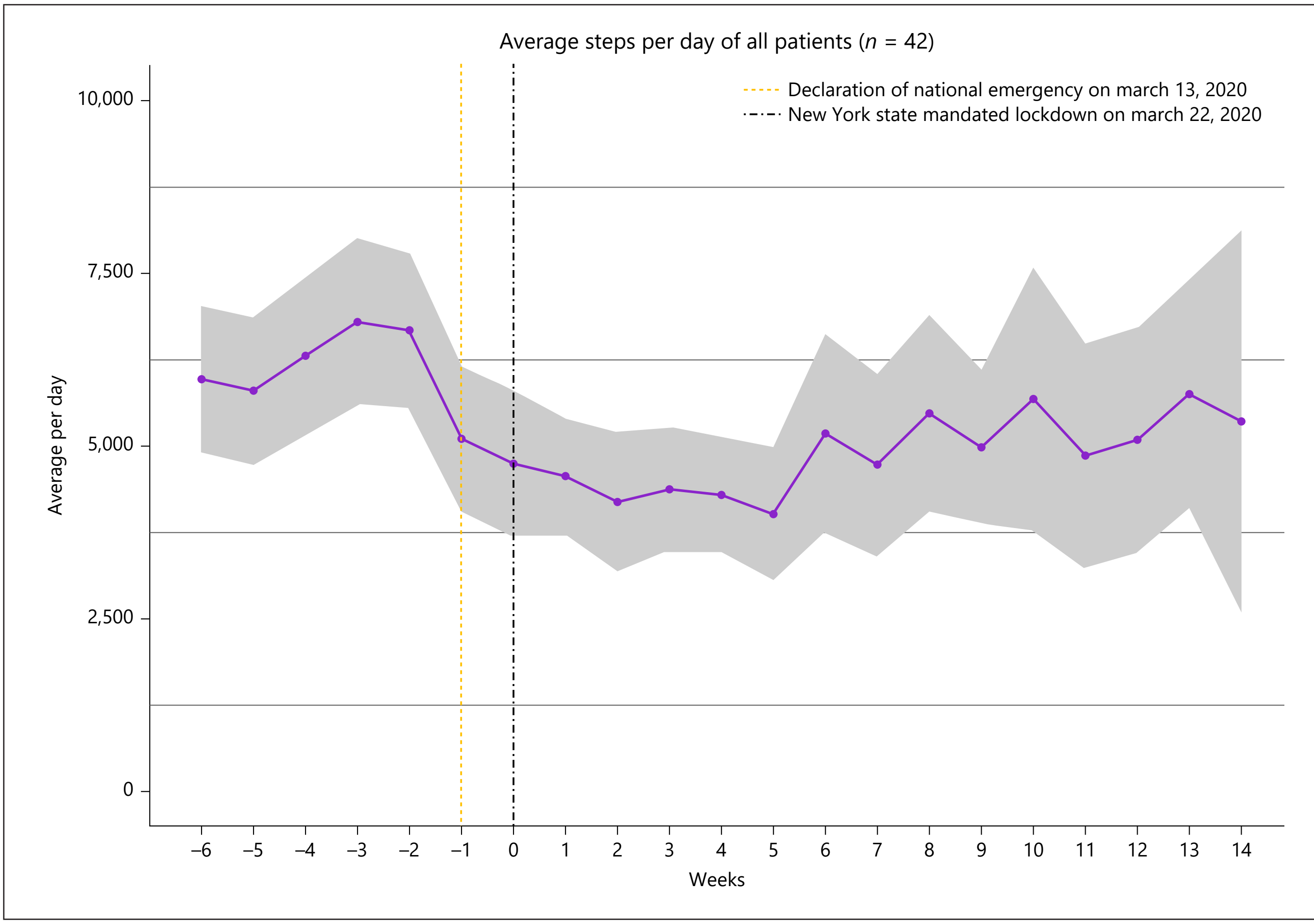

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Fig. 1. Average steps taken per day by HD patients and 95% confidence interval from January 1, 2020, to June 30, 2020. −6 Week = January 1, 2020–February 13, 2020.

pre-/postdialysis weight, interdialytic weight gain, pre-/postdialysis sitting systolic and diastolic blood pressure, ultrafiltration volume, and ultrafiltration rate were also captured from EHR.

Demographic and Socioeconomic Data

Upon enrollment in the study, participants were asked about details pertaining to their socioeconomic status. Participants reported their employment status (employed, unemployed, or other), highest education level (some high school, high school, some college, college, masters, or other professional degree), marital status (divorced, married, or single), and living situation (alone, with family or other). Demographic data including age, gender, and race were also captured at the beginning of the study period.

COVID-19 Status

COVID-19 diagnosis, date of start of COVID-19 symptoms, date of COVID-19 diagnosis, and date of recovery from COVID-19 were all recorded via weekly reports from dialysis clinic administration and EHR. Patients were categorized as "recovered" when they could return to their regular dialysis shift from the COVID-19 isolation dialysis shift.

Statistics and Analysis

Continuous variables are summarized as means and standard deviations and categorical variables are reported as proportions. Mean steps taken per day and 95% confidence intervals were estimated with a linear mixed effect model. Days with 0 steps recorded were removed from the analysis.

Results

Patient Characteristics

Forty-two patients were included in this analysis. On average the participants were 55 years old, 79% male, and 69% African American. They had an average dialysis vintage of 4.5 years, BMI of 28.9 kg/m^2, and equilibrated Kt/V of 1.49. Half of the participants were unemployed, half had highest education level of some college or more, almost half were single, and over half lived with their families. Average dialysis treatment time was 224 min, intradialytic weight gain was 2.4 kg, ultrafiltration volume was 1.4 L and ultrafiltration rate was 6.6 mL/kg/h. Description of the study population's demographics, clinical, socioeconomic, treatment, and laboratory parameters are included in Table 1.

Physical Activity Levels

In the pre-COVID period, patients had taken a mean of 5,963 (95% CI 4,909–7,017) steps per day. In the week prior to the NYS mandated lockdown (week −1), a substantial decrease in average steps per day took place compared to pre-COVID levels with participants taking a mean of 5,095 (95% CI 4,044–6,147) steps per day (difference of 868 steps per day [95% CI 213–1,722]). This change aligned with the National Emergency declared by the U.S. president in response to the COVID-19 pandemic. In the following week, the NYS mandated lockdown was put in place and PAL decreased further to a mean of 4,741 (95% CI 3,678–5,083) steps per day (difference of 1,222 steps per day [95% CI 668–2300]). Week −3 had the highest step count with 6,793 steps per day (95% CI 5,591–7,995), and week 5 had the lowest step count with 4,011 steps per day (95% CI 3,057–4,966) (Fig. 1).

COVID-19 and PAL

Six of the 42 participants included in this analysis were diagnosed with COVID-19 as of June 30, 2020. Five of the 6 patients recovered and 1 died. Patients' characteristics based on COVID-19 status are shown in Table 1. Of note, COVID-19 patients tended to be younger, more likely to be African American, more likely to be male, have a higher dialysis vintage, and more likely to be employed. Average steps per day during the baseline period (−6 weeks), 5 weeks prior, and 14 weeks after the NYS mandated lockdown of individuals diagnosed with COVID-19 are shown in Figure 2. Five of the 6 COVID-19 positive participants exhibited PAL greater than the upper 95% CI limit of the COVID-19 negative group in at least 1 of the 2 weeks prior to showing COVID-19 symptoms. In the 2 weeks prior to becoming symptomatic, the patient who succumbed to COVID-19 exhibited lower than average PAL compared to COVID-19 negative participants.

The gray band shown in Figure 2 demonstrates the mean and 95% CI of steps taken by the COVID-19 negative cohort. Like in the overall cohort, we observed a statistically significant decrease in steps taken in the week prior to and in the weeks 0–5 after the lockdown mandate compared to baseline in the COVID-19 negative cohort. At baseline, the COVID-19 negative group took a mean of 5,586 steps per day (95% CI 4,467–6,704) and PAL decreased anywhere from 1,308 steps per week (95% CI 617–1,998) in week 1–2,346 (95% CI 1,209–3,662) steps per week in week 5. Finally, as we observed in the overall cohort, subjects in the COVID-19 negative group took 849 steps per day (95% CI 83–1,615), which was less in the week prior to lockdown measures were put into place compared to baseline.

Discussion

The main finding of this study is that PAL of maintenance hemodialysis patients decreased by as much as 1,200 steps per day or 20% compared to baseline, as an effect of social distancing and lockdown measures put in place to combat the COVID-19 pandemic in New York City. It was also observed that patients who tested positive for COVID-19 exhibited higher than average PAL at some point in the 2 weeks prior COVID-19 symptoms compared to their COVID-19 negative counterparts.

Baseline PAL, from January 1, 2020, to February 13, 2020, were lower than that reported in another in-center hemodialysis cohort also located in New York City (5,963 steps per day vs. 8,454 steps per day) [9]. However, PAL in the baseline period did not differ greatly from previously reported data in hemodialysis patients which averages anywhere from 4,000–6,000 steps per day [8, 16, 17]. The drop in PAL in weeks −1 to 5 reflects previously reported measures of mobility in New York City, which showed that in the month of March, driving, transit, and walking mobility decreased by 80% compared to baseline [18]. Also of note, in January and February 2020, prior to the COVID-19 pandemic in US, according to smartphone data, the primary mode of mobility in New York City was walking, but as mobility level has risen due to restrictions being eased the primary mode of mobility became driving [18].

The pre-COVID-19 pandemic PAL which were already below the WHO recommended 10,000 steps per day and the further decrease associated with social distancing measures and government mandated lockdown may have adverse effects. It was previously reported that a sedentary lifestyle in hemodialysis patients is associated with greater risk of all-cause and cardiovascular mortality, as well as decreased health-related quality of life, depression, anxiety, and increased frailty [4, 6, 19–21]. In the healthy population, it has also been shown that there is a nonlinear dose-response pattern between physical activity and reduced risk of premature mortality [22]. It has also been shown in the general population that taking a

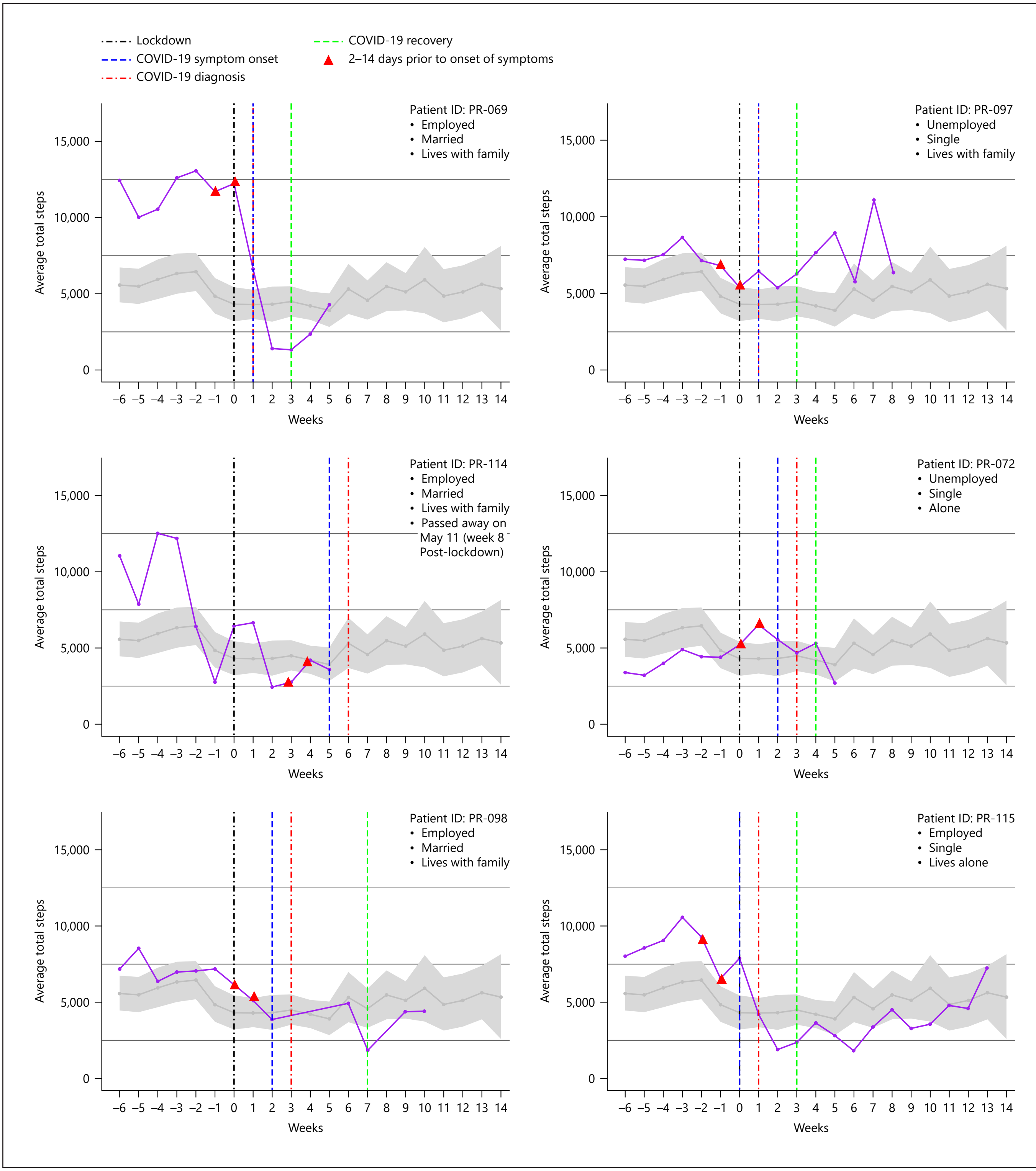

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Fig. 2. Average steps per day taken by COVID-19-positive HD patients from Jan 1, 2020, to July 2, 2020. Mean and 95% CI of COVID-19 negative HD patients is denoted in gray. Red triangles denote the 2 weeks prior to exhibiting COIVD-19 symptoms. –6 Week = January 1, 2020–February 13, 2020.

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greater number of steps per day (8,000 vs. 4,000) is associated with lower risk of all-cause mortality [23]. While large and growing body of literature has been dedicated to identify and address the lack of physical activity in hemodialysis patients, no work, to the authors' knowledge, has studied the effect of COVID-19 pandemic on PAL in this vulnerable population.

On the other hand, it was observed that participants who were diagnosed with COVID-19 walked on average more steps per day, compared to non-COVID-19 patients, in at least 1 of the 2 weeks prior to showing symptoms of COVID-19. Two weeks prior to the appearance of symptoms were of interest as the incubation period of COVID-19 has been identified to be between 3 to 14 days [24]. A possible explanation may be that patients who walked more had a greater probability of being exposed to the virus. While this line of thinking has some plausibility, our data are insufficient to corroborate or refute it. Of note, PAL do not always reflect mobility, which has been shown to be directly related to the spread of COVID-19. Additionally, there are also other factors, such as employment status and type, living situation, and income level which could also contribute to 1 being more susceptible to COVID-19 infection. Given the small number of events in our cohort, it was not possible to assess the role of physical activity and these other possible confounders on the likelihood of one contracting COVID-19 in a rigorous fashion. This novel finding should be further investigated in future studies.

The decrease in PAL associated with lockdown measures in this urban hemodialysis population may not be generalizable to other populations such as suburban or rural populations. It was found previously that patients residing in suburban settings had a significantly lower PAL compared to an urban population [10]. If these other populations are less active at baseline, then there may not be a drastic decrease in daily step counts as a result of stay-at-home orders.

This study has leveraged the use of a wearable device to measure PAL continuously. In the literature, it is apparent that the scientific community believes that widely used wearable devices such as smartwatches may hold immense value in combating the spread of a pandemic. Work done by Quer et al. [25] has shown that data from smartwatches along with other parameters such as symptom reporting is able to detect COVID-19 infection. Moreover, a paper recently published by Mishra et al. [26] demonstrated that by utilizing retrospective data from smartwatches in a large population alongside symptom and standard of care medical data, they were able to detect COVID-19 prior to the appearance of symptoms. As the use of wearables become more pervasive, the ability to use big data will aid in combating public health crises.

The lockdown measures put in place and the social distancing practices required to curb the spread of the COVID-19 pandemic have been associated with a significant decrease in physical activity in in-center hemodialysis patients living in an urban setting. Given the importance of physical activity and the already high prevalence of sedentariness in this population, this decrease in physical activity must be acknowledged by healthcare professionals who care for it. Interventions to increase PAL which are conducive to social distancing must be explored and implemented. With rising cases of COVID-19 still in the US and elsewhere globally and no vaccine publicly available, lockdown measures, quarantines, and social distancing are likely to stay with us in some form for the foreseeable future. It is up to us to encourage our patients to improve their physical activity, while staying safe.

Conclusion

Lockdown measures were associated with a significant decrease in PAL in hemodialysis patients. Patients who contracted COVID-19 had higher PAL during the incubation period. Methods to increase physical activity while allowing for social distancing should be explored and implemented.

Statement of Ethics

This study was conducted in accordance with the Declaration of Helsinki. Study protocol and informed consent form were approved by the Western IRB (IRB #: 20172501, Study # 1180366). All participants completed informed consent process prior to initiating study activities.

Conflict of Interest Statement

All authors are employees of Renal Research Institute, a wholly owned subsidiary of Fresenius Medical Care. P.K. holds performance shares in Fresenius Medical Care and receives author's honorarium from UpToDate. P.P. receives speaker's fees from Fresenius Medical Care.

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Author Contributions

Ma.H., P.P., O.T., X.T, L.M.T.S., L.R.F., and P.K. contributed to the study design. Ma.H, P.P., O.T., X.T., L.M.T.S, L.R.F., Mo.H., A.P., L.T., and P.K. contributed to the implementation of the study. Ma.H, H.Z., and P.W. contributed to data analysis and interpretation. All authors participated in the preparation of the manuscript. P.K. directed the project. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

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